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Research Activities at Partner Universities - Annotated Bibliography - Student Contributions - ATHENA Talks - Work Package Reports

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Introduction by the Editors

The second volume of the ATHENA Research Book (ARB) complements the first volume, published in November 2022, by putting more emphasis on the institutional aspects of research carried out by the members of the alliance and on their achievements through an annotated bibliography of their outstanding academic publications. This new volume also reflects the alliance's performance in the form of short reports on work packages and on the lectures given within the ATHENA Colloquial Talks. A chapter with student contributions is again included, as in the first volume.

> *The ATHENA European University is an alliance of nine Higher Education Institutions with the mission of fostering excellence in research and innovation by facilitating international cooperation. ATHENA stands for Advanced Technologies in Higher Education Alliance. The partner institutions are from France, Germany, Greece, Italy, Lithuania, Portugal, Slovenia, Spain and Poland: University of Orléans, University of Siegen, Hellenic Mediterranean University, Niccolò Cusano University, Vilnius Gediminas Technical University, Polytechnic Institute of Porto, and University of Maribor. In 2022, institutions from Poland and Spain joined the alliance, namely University of Vigo and Maria Curie-Skłodowska University.*

Thus, the ATHENA Research Book, Volume Two, consists of three main chapters (the research landscape of alliance members, their annotated bibliographies, the student contributions) and two supplementary chapters (ATHENA Talks abstracts and work-package reports). The book not only gives an overview of research potential in the alliance but also displays the strong relationship between research and the educational part of ATHENA. It also presents the advancement in different project areas that led to the sustainable configuration of the ATHENA European University as an outcome.

Chapter One provides a comprehensive insight into ATHENA partners' research activities, covering both the institutions' overall research landscape and their outstanding achievements in research and innovation. Its authors, the ATHENA Research Board members, are mainly vice-rectors of the alliance members,

responsible for research. The chapter showcases research activities and identifies partners' strengths; it contributes to easier facilitation of cooperation between the ATHENA partners. Authors were asked to cover the following sections: *Introduction* (the role of research at the institution – the ATHENA alliance member), *The Research Landscape* (an overview of research activities at the institution in general), *Outstanding Research* (flagships to be identified), *From Research to Innovation* (endeavours to transfer technology and other research results to society at large), *Involvement of Students* (participation of graduate/postgraduate students in the research and innovation process) and *The vision of ATHENA research-based cooperation* (strategic message/contribution to the idea of alliance). The rich information provided herein may be used by the institutional leadership of the alliance members to inform future cooperation as well as by principal investigators/researchers to identify mutual interests. The authors in Chapter One also recognised the importance of using ATHENA's Shared Resources Directory (SRD), an on-line registry and communication tool of capabilities and other research-related data of the alliance members/partners, developed and maintained by one of the alliance members (University of Maribor) in cooperation with the other ATHENA partners. SRD also contains the list of ATHENA research priorities and of shared research infrastructures.

Chapter Two – *The Annotated Bibliography* – presents a list of outstanding and most notable publications of each alliance member's researchers published over the past five years. Though the partner institutions' size varies, we expected up to 25 bibliographical records by alliance member in this chapter. The individual records are tagged in one of four research field groups: (1) Physical sciences and engineering, (2) Social sciences and humanities, (3) Life sciences or (4) Multidisciplinary. The contributors – again, the ATHENA Research Board members – were encouraged to restrain from using (just) the quantitative criteria of journal impact factor and to involve more qualitative selection criteria in line with the principles of the Leiden declaration and those displaying the variety of research excellence spanning through more fields of science. The final list of annotated bibliographies, sorted by alliance members and then by the field of research, clearly displays their soaring and influential presence in the worldwide research community.

The chapter entitled *Student Contributions* addresses research topics of students but also demonstrates students' involvement in research. It comprises both short communications summaries of student theses at the master or doctoral level and short communications on best practices and cooperation models, displaying the interrelation between teaching and research from the student perspective. Each contribution had to be first approved and reviewed by the students' academic

supervisors. Papers were then reviewed by the editors or members of the Editorial Board; when additional expertise was needed, external reviewers were invited. 80 per cent of papers were accepted. Each contribution was assigned a unique DOI (Digital Object Identifier). Supporting the open access to research publications and research data, the editors encouraged the registration of their preliminary results at arXiv or a similar free distribution and an open access archives/site.

The remainder of this volume brings two informative chapters, one with concise reports on ATHENA project's *work packages* and on the lectures given in the framework of the alliance's recurrent *ATHENA Talks*.

The ATHENA Talks series, initiated in 2020 and organized by the Hellenic Mediterranean University, is still ongoing, attracting an increasing number of viewers (more than 9000 views in YouTube). Talks are given remotely by renowned scientists cooperating with or working at one of the ATHENA alliance institutions. In this volume the abstracts for 90 talks are published, with links to the full lecture.

Both volumes of the ATHENA Research Book were initiated within the first phase of the EACEA-funded ATHENA project (2020-2023) and formally they have a deliverable status. However, ATHENA European University is more than a project; it is a long-term vision of alliance members to cooperate and implement the EU European Universities initiative. Both volumes offer an insight into the strengths and sustainability of the alliance. We, the editors, are already looking forward to the next volume, one that will showcase further achievements of our members as well as our joint research efforts, contributing to the globally competitive and attractive European Education Area and European Research Area beyond the project phase.

József Györkös
Rob Blonder
Anne Friederike Delouis
Jana Javornik
Konstantinos Petridis

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Chapter 1

Research Activities at Partner Universities

Research Activities at the Hellenic Mediterranean University

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1 Introduction

The H.M.U. [1] is a particularly active University in conducting research. The H.M.U.'s research policy emphases on basic, technological, or applied research promoting science and education, while respecting the academic ethics. Among others H.M.U. focuses at promoting cooperation with national and international bodies in higher educational and research. A wide network of research collaborations has been developed, which is intensively supported through national and international research and development projects, the close collaboration with prestigious research bodies, the cooperation with the private sector in general and of course the interaction with the society.

The H.M.U. has achieved top performance and recognition among its peers as recognised by the external evaluators and reflected in the University ranking catalogues and the National Documentation Centre. As a result, students have many opportunities to actively participate in research and development programs, this being also one of the primary policies of the University.

H.M.U.'s researchers are actively involved in extensive scientific activities in collaboration with national and international research teams, which have led to results of great significance and have contributed to the development of internationally recognized innovative products. It is the significant distinctions of the members of H.M.U.'s staff in the international stage, as well as those of its students, that constitute the most convincing evidence of the impact of the research conducted in the laboratories and research units of the University.

The fundamental, technological and applied research at H.M.U. focuses on cutting-edge research in the following fields: exact and engineering sciences; health sciences; agriculture

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and environmental sciences; materials science; economics sciences; humanities and social sciences. For further information about the H.M.U. please watch the video at https://www.youtube.com/watch?v=EnKRE5Qcu8c.

2 The Research Landscape

The H.M.U. focuses in fundamental, technological and applied research aiming at promoting science and technology for the benefit of society [2]. Each of the five schools/faculties in H.M.U. focuses on research topics of their specialty conducted in the research laboratories of the faculties or the departments. Below a brief picture of these research topics is given, which composes the research landscape of H.M.U..

School of Engineering:

- Energy Systems / Grid Systems and Management
- Renewable and Clean Energy Sources
- Lasers and Optoelectronics / Plasma Applications / Electronics
- Control Systems and Robotics
- Advanced Materials / Nanomaterials for Energy and Environmental Applications / Graphene
- Informatics / Multimedia
- Internet of Things
- Telecommunication Networks / Antennas
- Geophysics / Seismology / Geology / Geoinformatics

School of Agricultural Sciences:

- Biotechnology
- Plant Protection / Ecotoxicology
- Olive Production Systems
- Climate Change
- Management of Natural Resources / Environment / Waste and Wastewater Management

School of Health Sciences:

- Social Work
- Human Health
- Road Safety
- Advanced Clinical Practice
- Food Technology
- Nutrition / Dietology

School of Management and Economic Sciences:

- Economics / Accounting / Finance
- Management
- Data Analysis / Modelling
- Tourism / Entrepreneurship

School of Music and Optoacoustic Technologies:

- Music Technology and Informatics
- Room and Structural Acoustics
- Environmental Acoustics
- Ultrasounds and Applications

University Research & Innovation Centre:

To further strengthen research at the university, the senate decided in 2019 to establish the University Research & Innovation Centre (U.R.I.C.) of the Hellenic Mediterranean University, based on the new legislation for the Higher Education which operates as a distinct research centre of the H.M.U. [3]. The purpose of U.R.I.C. is to conduct fundamental and applied research, exploit research results for the benefit of the society, support new scientists acquiring specialization, provide services to public and private entities, educate and train, collaborate with other national and international research institutions, engage in large research infrastructures, provide developmental and consultative activities with national and international institutions.

U.R.I.C. consists of the following Institutes:

- Institute of Plasma Physics and Lasers (IPPL) - https://ippl.hmu.gr/en/home-en/
- Institute of Emerging Technologies (i-EMERGE) - https://i-emerge.hmu.gr/
- Institute of Physics the Earth's Interior & Geohazards (IFEGG) - https://earth-phys.hmu.gr/en/home/
- Institute of Energy, Environment & Climate Change (IEECC) - https://ieecc.hmu.gr/en/home/
- Institute of Financial Analysis, Business Administration and Tourism - https://hmu.gr/en/research/university-research-center/
- Institute of Agri-Food and Life Science - https://agro-health.hmu.gr/en/home/

3 Outstanding Research

A large number of competitive research programs are being realized in H.M.U. within the research laboratories and the institutes of U.R.I.C.. Technologies of the 4th industrial revolution such as Analytics and Intelligence, Internet of Things, Optoelectronics, Lasers, Nanotechnology and Nanomaterials, Robotics, 3D manufacturing technologies, Ultrasounds are the spearhead for the research topic area of technology and the exact sciences.

In addition to the above, outstanding research activities are conducted in the areas of Energy, Environment and Climate Change (RES, Smart Grids, Circular Economy, Water and Waste Management), Agri-Food Complex (Sustainable Agriculture, Organic Crops, Plant Protection, Precision Agriculture, Food and Nutrition, packing and logistics), Health and Social Sciences, Accounting-Finance, Management and as well as in Tourism.

Only in 2022, 200 researchers, 150 PhD students and 20 Postdoctoral researchers have been recruited for the implementation of the aforementioned research. The U.C.R.I. on the other hand, has 220 affiliated researchers among them 60% external researchers proving the extroversion of the research in H.M.U. in line with its strategic plan. Research Institutes of the UCRI are members of ESFRI and National Research Infrastructures (e.g., HELLAS-CH,

HELPOS, EMERGE). Funding comes from competitive International and National programmes as summarised in Figure 1.

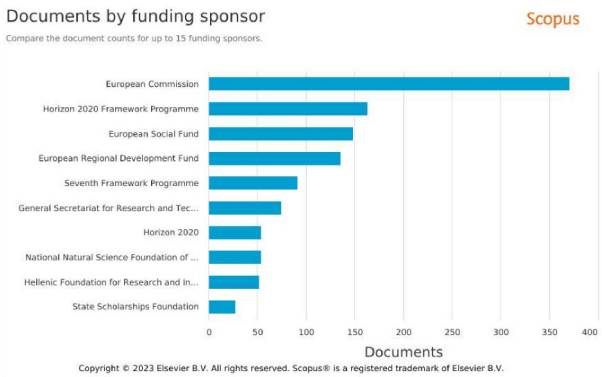

Figure 1. Funding of the Research at H.M.U.. Documents by funding sponsor, Source: Scopus

The research management is supported by the Special Research Fund Account unit and the decision making Research Committee. Furthermore, actions for the dissemination of H.M.U.'s research results to society and industry are taking place, among others the Researcher's Night funded by the European Commission, Horizon Europe Framework Programme (HORIZON), actions organised by the International Relations Office (IRO) [4] as well as actions organised by the research laboratories, the research institutes and the faculty departments of H.M.U.. They also significantly contribute to the creation of a connection between research and education, as well as lifelong learning and training.

4 From Research to Innovation

H.M..U's research policy focuses on creating a culture of quality and excellence leading to innovation, extroversion and societal benefits. Leading role for the realisation of this goal plays the development of an atmosphere of academic cooperation respecting the ethics and on recognition of values. The above policy is founded on four main pillars [5]:

- respecting and encouraging specialized knowledge while at the same time promoting the removal of any obstacles impeding cross-fertilization,
- supporting the production of new knowledge, both thematic and interdisciplinary within and between the scientific fields and disciplines,
- facilitating collective and collaborative work practices,
- encouraging strong national and international collaborations and establishing research infrastructure of high impact factor aiming to creating opportunities and prospects, all leading to a higher level of research.

In addition, H.M.U.'s quality policy emphases among others on the internal organization of the University's research units adapting good international practices, on the implementation of quality systems which guarantee the production of high-quality scientific research through procedures which are constantly improving, on the realisation of research in high added value for the society research areas. Furthermore, compensating high individual

performance with the unquestionable value of the teamwork and establishing an environment conducive to innovation, are all constituents of H.M.U's innovation policy.

Research at H.M.U. is conducted at research areas with high impact factor as published by the National Documentation Centre (NDC) and shown in Figure 2(a) while Figure 2(b) presents the distribution of the research outcome in the areas of research. An intense interdisciplinary result is shown following the strategic plan of the H.M.U..

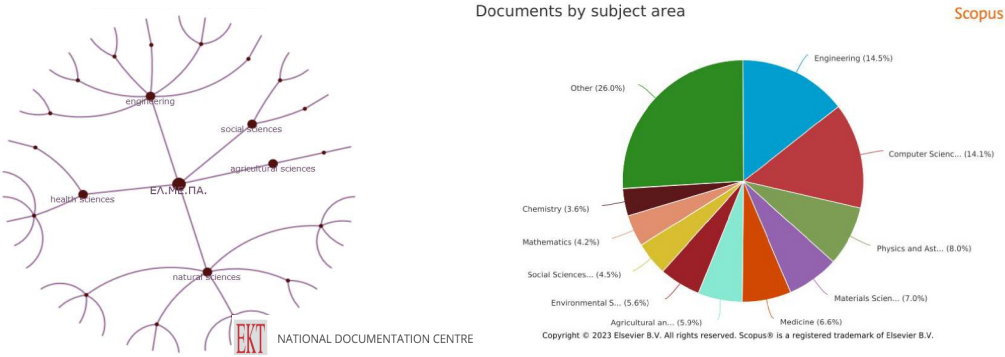

Figure 2. a) Research areas of H.M.U.'s research as recorder by the National Documentation Centre, b) Peer review publications per research area.

5 Involvement of Students

Universities in Greece enjoy full self-administration and academic freedom supervised by the Ministry of Education and Religious Affairs and Sports, in accordance with article 16 of the Constitution. In this frame, each university has the autonomy to determine the way in which its students participate in its research activities. H.M.U. has set the goal of the greatest possible participation of its students in research activities since its strategic position is that quality education and research are closely related concepts. Students at H.M.U. have indeed many opportunities to actively participate in research and development programs. This is achieved through four main pillars of actions.

- The first pillar is based on the personal interaction of the students with the coordinators of the research programs for the auxiliary execution of research within the research project.
- The second pillar is determined by the undergraduate study programme which assumes the compulsory diploma work for the students as part of it. During the diploma semester students are encouraged to participate in the research activities of their departments.
- The third pillar takes advantage of the student internship which is optional but important for the students who choose to use to use this feature. The action is organized and supervised by the Internship Office of H.M.U.. Internship positions are given upon request in the research laboratories
- The fourth pillar is based on the postgraduate programs of study and the doctoral study program where students are de facto part of the research process.

6 The vision of ATHENA research-based cooperation

The research mission of the ATHENA University is as important as the educational mission and consists in the systematic support and promotion of scientific research.

The research policy document of the ATHENA University is under development and defines the mission and priorities of the University and its alliances. The policy focuses on innovative, including interdisciplinary, research aiming at creating immediate, medium and long-term benefits to the students society as well as the European society, economy and humanity in general. The policy is focused on creating a culture of quality and excellence based on cooperation and a synergetic academic environment. In this spirit, it was launched by the author of this article at the 1st ATHENA research board meeting in Orleans on 28th February 2022, the idea of establishing common research infrastructures within the ATHENA University. The "Challenges of a step by step Research Integration" manifesto was presented and analysed by the author, and discussed within the board. The advantages are presented below:

- Will strengthen the ATHENA university entity in EU and national authorities,
- Such action is in line with the EU policy for the European higher education era including research integration,
- Is rather the most efficient path for ATHENA to be developed as an entity of excellence in research and education,
- Will reinforce the efforts to attract research funds within the present competitive environment,
- Is the appropriate way to elaborate the new knowledge into the education curricula of ATHENA university.

The benefits of the creation of common research infrastructures giving research access to ATHENA partners are summarized below:

- Reduce breaking up of the research and innovation ecosystem of ATHENA University and avoids duplication of expenses and efforts,
- Launch policies for the ATHENA, offering well-established inter-institutional or Research Infrastructures or to develop strong bonds with national RI's,
- Join forces to construct and run large, complex or expensive infrastructures, respond to global challenges and/or foster combining skills, data and efforts of the world's best scientists,
- Foster the innovation potential of Research Infrastructures by making industry more aware of opportunities offered to improve their products and by the co-development of advanced technologies,
- Need for personnel costs covered partially by the EC.

Such integrated research infrastructures will strengthen the creation of ATHENA Doctorate School and the establishment of joint doctoral programs. Furthermore, the action will support activities building a strong research osmosis between the partner Institutions.

The aforementioned actions, are being implemented and developed by the WP4 working group supported by the ATHENA research board.

References

[1] https://hmu.gr/

[3] https://hmu.gr/ereyna/ereyna-sto-elmepa/

[3] https://hmu.gr/en/research/university-research-center

[4] https://iro.hmu.gr/

[5] https://hmu.gr/en/research/research-in-hmu

Research Activities at the Maria Curie-Skłodowska University

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1 Introduction

Maria Curie-Skłodowska University in Lublin (UMCS) is the largest public university in Poland, located on the eastern side of the Vistula River. This is an institution deeply rooted in the region. Since 1944 UMCS has been acting as a cultural and opinion-forming factor in the region and has made a significant contribution to building its knowledge-based economy.

The scientific and research potential of the university is growing. UMCS encompasses 13 faculties, 22 research institutes and many supporting central units. Almost 3 000 employees make up the academic community of the University. More than 100 patents prove its commercialization potential. UMCS can boast of, among others, a modern Institute of Informatics, the Centre for Functional Nanomaterials at the Faculty of Chemistry and the Media and Art Incubator. Together with four research and scientific units, the Analytical and Program Centre for Advanced Environmentally Friendly Technologies ECOTECH-COMPLEX has been established, equipped with innovative laboratories and high-quality equipment, including high-field magnetic resonance scanner.

UMCS also maintains active relations with foreign research centres. A significant event in 2017 was the establishment of the Polish-Chinese Research Centre Green Pharmaceuticals (green pharmacy), which is the first Polish-Chinese research institution of this type.

A strong focus is put on Early Stage Researchers' development. The University offers PhD programmes at three Doctoral Schools: the Doctoral School of Humanities, Social Sciences, and Quantitative and Natural Sciences. In 2019 the Young Researchers Council was created to comprehensively support young researchers in their scientific career development.
In 2017, UMCS received the HR Excellence in Research Logo, awarded by the European Commission. It confirms that we create the best working conditions for scientists and provide transparent recruitment rules and an appropriate space for the development of science, in line with European standards.

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UMCS in a nutshell:

- 13 faculties
- nearly 80 fields of studies
- over 250 specializations
- over 16 000 students
- more than 250 000 graduates
- about 1 800 international students
- over 100 research groups, including both student and doctoral organisations
- 209 agreements on scientific and educational cooperation with international partners
- ca. 2 500 publications per year published by UMCS-based researchers
- 15 scientists from UMCS are listed in the TOP 2% Scientists, the prestigious ranking of the world's most influential people in science.

2 Research Landscape

Researchers at UMCS conduct their scientific activities in 23 research disciplines, including formal and natural sciences, social sciences, arts and humanities. The research is conducted both at individual institutes and multidisciplinary centres, such as:

- **Optical Fibre Technology Laboratory (LOFT)**, which is a well-recognized research facility experienced in the production of telecommunications, special and photonic fibres. The Laboratory has a full technological line for the production of optical fibre, including preform preparation and fibre extraction equipment.[1] The Laboratory's research team have been engaged in numerous R&D projects over years, such as:
  - ACPHAST 4R: support for researchers who have a conceptual breakthrough and would like to implement their prototype (or some components for their prototype) using mature photonics technologies. This project is supported by the EU (GA no. 825051).[2]
  - ACPHAST 4.0: support for European companies that want to boost the innovation of their projects with photonics. This project is supported by the EU (GA no. 779472).[3]
- **Analytical Laboratory**, which is a facility at the Institute of Chemical Sciences, conducting analyses for scientific, research and didactic projects, as well as issuing scientific or analytical expert opinions commissioned by external companies and individuals.
- **ECOTECH-COMPLEX Analytical and Programme Centre for Advanced Environmentally-Friendly Technologies**, which is open to cooperation with businesses, other research institutions as well as distinguished scientists wishing to conduct research with the use of its state-of-the-art scientific and research equipment.

[1] The research team on photonics has been one of the founders of the Lublin Upland of Photonic Technology dedicated to the promotion and further development of photonic and optical fibre technologies.

[2] https://www.actphast.eu/en/what-is-actphast

[3] https://www.actphast.eu/en/what-is-actphast

The Centre's mission is to create unique conditions facilitating the conduct of scientific research and the provision of high-quality industrial research services by highly qualified, interdisciplinary research teams working in the following key areas: health, ecology, food, and agriculture. The Centre houses the following laboratories:[4]

- Chromatographic Analysis Laboratory and NMR/LC-NMR-MS Laboratory
- Protein Bioengineering Laboratory
- Bio-crystallography Laboratory
- Laboratory of Geohazard Management and Spectral Spatial Analysis
- Laboratory of Genomics, Transcriptomics and Proteomics
- Ultra-High Field Magnetic Resonance Lab
- Optical Polymers Laboratory.

- **Video Game Research Centre**, which conducts research into video and computer games, as well as cyber culture and digital media,
- **UMCS Centre for Eastern Europe**, which analyses the problems of Eastern Europe in the geographical, political, historical and civilizational context,
- **UMCS Centre for Climate Change and Environment Research**, (CeReClimEn Centre) established in 2021 as a platform for interdisciplinary, interinstitutional and international cooperation, operating as a consortium that brings together leading scientific institutions from Poland and abroad interested in conducting joint scientific research and undertaking promotional and educational activities in the field of climate and environmental changes (including, inter alia, climate reconstruction, climate change modelling, analysis of social, economic and political effects of climate change),
- **Centre for Artificial Intelligence and Computer Modelling**, tasked with implementing research and developmental activities as well as commercialization of the results of scientific and research work in the area of AI use.

3 Outstanding Research

Below we list the main achievements of UMCS in research collaboration (projects). These projects involve all research disciplines represented at the University, which testifies to the quality of each individual research institute and the interdisciplinary potential of UMCS as a whole:

- **REINITIALISE** (GA no. 952357, twinning programme): aimed at strengthening and stimulating scientific excellence and the innovation capacity of UMCS in the design and use of digital technologies in the health sector in compliance with the ethical principles.[5]
- **GOLD** (GA no. 101006873): aimed at growing lignocellulosic crops on contaminated sites and producing sustainable biofuels with no risk of indirect land use change, while removing soil pollutants and ultimately reclaiming those lands for agriculture.[6]

[4] https://www.umcs.pl/en/ecotech-complex-en.htm

[5] Project website: https://www.reinitialise.eu/, Project coordinator: Prof. Ilona Biernacka-Ligięza: ilona.biernacka-ligieza@mail.umcs.pl

[6] Project website: https://www.gold-h2020.eu/, UMCS Team Coordinator of: Prof. Małgorzata Wójcik: malgorzata.wojcik@mail.umcs.pl

- **SWATNET** (GA no. 955620, MSCA ITN Programme): aimed at establishing a PhD training network in the field of forecasting solar activity and space weather with cutting-edge and interdisciplinary research techniques.[7]
- **DARIAH-LAB** (Digital Research Infrastructure for the Arts and Humanities): aimed at building an infrastructure with hardware and software tools using state-of-the-art technological solutions and integrated digital resources from various fields of the humanities and arts.[8]
- **ACPHAST**: a unique one-stop-shop solution for supporting photonics innovation, currently 2 ACTPHAST projects are in progress to support innovation with photonics.
- **Xanthophylls in the Retina of the Eye**: aimed at examining the role of retina xanthophylls to obtain crucial information that can be used in the development of therapies for age-related macular degeneration.
- **Molecular Spectroscopy for BioMedical Studies**: aimed at obtaining precise information on molecular mechanisms responsible for formation of supramolecular structures of AmB, which can be responsible for toxic side effects of the antibiotic.

4 From Research to Innovation

For many years, Maria Curie-Skłodowska University has been one of the leading drivers for socio-economic growth of Lublin and the region. This claim is supported by outstanding achievements in R&D projects implementation as well as commercialization of our research results. As an example, the number of orders accepted in the 2021/2022 academic year was 527, an almost 30% increase over the previous academic year's results.

Out of concern for the welfare of bees and the whole society, **WAXO**, a mobile laboratory detecting contamination of natural bee products has been created. The invention received a prestigious award at the International Exhibition of Inventions Prix Eiffel 2022 (the gold medal of the French Federation of Inventors (FFI), the French Association of Inventors – Europe France Inventeurs (EFI) and the Haller Pro Invention Foundation), and a special award of the Toronto-based International Society of Innovators and New Technologies (TISIAS).9

At the Institute of Education, NeuroEduLab, an innovative and interdisciplinary brain neuroimaging laboratory has been established under the project "The Use of Near-Infrared Spectroscopy (NIRS) in Neuropedagogy and Neuropsychology for Prevention and Treatment of Selected Lifestyle Diseases and Improvement of the Quality of the Education System", equipped with a functional near-infrared spectroscopy system (fNIRS).

Researchers from the Institute of Chemical Sciences have worked on smart polymer varnish based on acrylates (photoluminescent paint composition that absorbs visible

[7] Project website: https://swatnet.eu/, UMCS Team Coordinator: Prof. Krzysztof Murawski: krzysztof.murawski@mail.umcs.pl

[8] Project website: https://lab.dariah.pl/en/, UMCS Team Coordinator: Dr Kamil Filipek: kamil.filipek@mail.umcs.pl

[9] WAXO was invented by UMCS researchers: Prof. Mariusz Gagos, Dr Marek Pietrow and Dr Jan Wawryszczuk. For more information, see: https://www.umcs.pl/pl/o-waxo,20615.htm

radiation). The invention was awarded with the Gold Medal at the International Invention and Innovation Fair INTARG 2022.

5 Involvement of Students

Students and PhD students are involved in research activities since the beginning of their academic career. At UMCS there are around 100 scientific clubs (including also the Scientific Club of UMCS Doctoral Schools) for students (with over 4 500 students actively engaged).[10]

The UMCS Rector's Council allocates funds for the implementation of scientific, educational, cultural, artistic and sport projects. There are also specials funds dedicated for scientific clubs and student/doctoral organizations registered at UMCS. Each year numerous grant proposals are submitted by students (see Figure 1).

Students and doctoral students are provided with special research scholarships awarded for academic achievements in a given academic year (Rector's scholarships). They are awarded based on great academic performance, individual scientific achievements, including the initiation or implementation of a research project related to the field of study conducted at UMCS, number of publications in scientific journals or participation in scientific conferences at which students presented papers, participation in research projects carried out by UMCS (1st year of PhD studies) or implementation of research tasks financed by other entities.

Students also conduct research that is funded externally. Since 2016, students at UMCS have implemented 12 research projects (financed by the Polish Ministry of Education and Science) with a total budget of almost PLN 500,000.

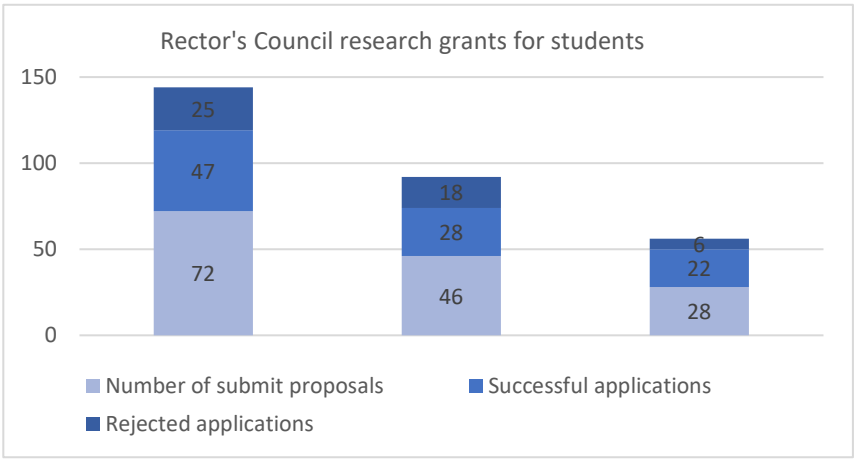

Figure 1. Number of Rector's Council grants for scientific clubs in the period 2019-2023: 2019/2020, 2022, 2023[11]

[10] Data provided by the Centre for Education and Study Services.

[11] Data provided by the Centre for Education and Study Services.

6 The vision of research cooperation within ATHENA

Active in a wide range of disciplines, involving the arts and humanities, social sciences, as well as formal and natural sciences, Maria Curie-Skłodowska University is a unique institution within the ATHENA network. This gives the network an opportunity to apply for inter- and multidisciplinary projects focusing on societal aspects.

The ATHENA research priorities such as Artificial Intelligence, Information & Communication Technologies, Digital Society & Digital Arts, Health & Food Technologies are strongly connected to the expertise of researchers at UMCS and the priority research areas of the University and the Lublin Region.[12] Cooperation with research centres and institutes in terms of joint research projects implementation, infrastructure sharing and R&D activities will be supported by our International Cooperation Centre.

The cooperation in cosmetic science could be another strategic cooperation priority with researchers at UMCS. At the Institute of Chemical Sciences there is a research group very actively cooperating internationally within cosmetology.[13] The cooperation can involve both education (joint summer schools, BIPs) and research (projects, sharing facilities). Another priority is photonics, particularly in view of the well-developed high-tech infrastructure at UMCS. LOFT UMCS is internationally recognized for its applied research in the field of optical fibres technology and is also uniquely involved in industry innovation projects in Poland and Europe. LOFT UMCS has more than 40 years of experience in implementing technology innovation projects.

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[3] Ecotech-Complex website: https://www.umcs.pl/en/ecotech-complex-en.htm

[12] The Lublin 2030 Strategy envisages the city as:

- "creative, academic and entrepreneurial",
- "green and sustainable in terms of urban planning",
- "open, multigenerational and socially engaged",
- "creative, open and hospitable"
- and "metropolitan".

For more information, see: https://lublin.eu/en/lublin-4-all/news/the-lublin-2030-strategy,164,1413,1.html

[13] Headed by Prof. Konrad Terpiłowski: konrad.terpilowski@mail.umcs.pl

Research Activities at the Niccolò Cusano University

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1 Introduction

Niccolò Cusano University (UniCusano) is a relatively novel reality in the Italian academic landscape. Born as a telematic institution, i.e. the courses are primarily delivered through online asynchronous activities, its main mission was devoted to education. Because of a fast growth in the demand for such an academic profile, the institution maintained its telematic structure, thus collecting students from all over the national territory, but at the same time it established as a university strongly rooted to the roman territory, with the acquisition of a wide campus and an increasing attractivity for both students and professors or researchers. While the teaching activities gradually moved to a blended mode, in which both synchronous and asynchronous activities are carried out [1], research grew up as well, with the availability of a large research staff and a wide basin of students eligible to be introduced to research activities.

The introduction of the Engineering Faculty in 2015 gave the final boost to research in UniCusano, with the establishment of a number of novel laboratories capable of gathering the researchers' competences and creating new ones. The last five years have been used to both establish and consolidate the role of UniCusano as a young but fervent reality in the Italian research landscape, confirmed by its positioning at the apical places among the Italian universities for the research quality in Industrial Engineering, according to the last evaluation (2015-2019) of the Italian Research and University Ministry [2].

There is no doubt that the Engineering faculty can be identified as the main driver of the overall research at UniCusano, which decisively moved from a didactic-based institution to a more balanced institution, in which research play its pivotal role, together with the public engagement activities. In this framework, we can mention the establishment of the Research and Technological Transfer Office, the empowerment of the National and International Projects Office, the recent institution of the Industrial Doctorate and the formation of a large network of competences.

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We can imagine research in Unicusano as an open construction site, yet possessing a defined vision on its role, with a strong vocation to grow within the national and international landscapes. In this framework, the participation in ATHENA represents a major chance to consolidate the trend of the last years.

2 The Research Landscape

Unicusano encompasses the cultural areas of Law, Psychology, Political Science, Economics, Education Science, Engineering, and it recently introduced Literature, Philosophy, Social Science, and Sport Science [3]. In many cases, the research activities are characterized by a strong interdisciplinarity, with a mixed humanistic-scientific approach where possible. Coming from appreciable results of the previous five-years period, research received a strong pulse during the last five years, where more than 1000 research products appeared on Scopus, which represented a 600% increase concerning the previous period [4].

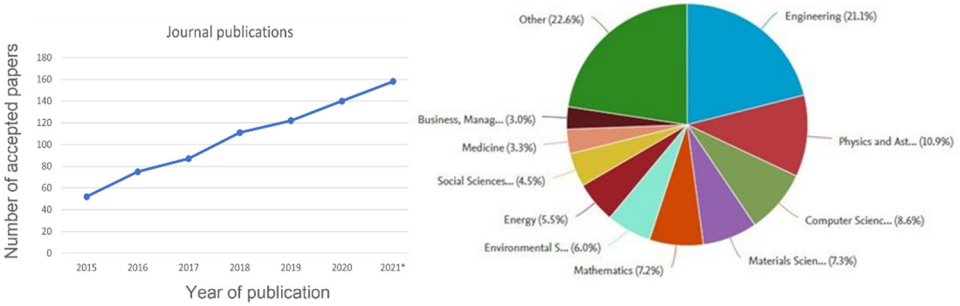

Figure 1. Number of publications in the 2015-2021 period and corresponding subject areas partition at UniCusano.

The subject areas of such a wide production are indicated in Figure 1, where the prominent role of Engineering, Physics and Astronomy, Computer Science, Material Science, Mathematics, Environmental Science and Energy areas is clearly visible. These areas enlighten the strong scientific and technological vocation of the institution.

The Economy Faculty covers both the management area and the economic analysis, thus being in close connection with the mathematic area. Since 2019, UniCusano is the editor of the Open Access journal *Symphonia. Emerging Issues in Management*, the only Italian economic journal indexed by the Academic Journal Guide. Recently, CESDE (Study Center for Dynamic and Economic Analysis) has been created, a research center focused on behavioural economics and mathematics applied to economy, which activates collaboration with both other academic centers and consulting companies.

Sports Science is the most recent faculty in UniCusano, encompassing research in evidence-based exercise intensity in physical and sports activities, performance indicators, and psychophysical well-being. It includes three laboratories, namely the Physical Activity, the Sport Activity, and the Medical Sport Orthopaedic labs. The first evaluates suitable parameters for the optimization of physical exercise in different ages and the effectiveness of training activities in special populations. The second is oriented to the investigation of

biological parameters during training activities of athletes and to the validation of novel training activities. The latter covers the area of technology-driven diagnosis, rehab, and treatment of sport-correlated illnesses.

The Engineering Faculty is the most structured at UniCusano and in the last five years has been equipped with several labs, some of them still growing. Research in Engineering follows the different branches of the different courses available for the students:

The Civil Engineering branch deals with the modelling of different phenomena, from fluid structure interaction to behavioural response in urban environment and transport. Mechanical Engineering ranges, among others, from fuel cell modelling, production, and optimization to material processing and characterization, passing through biomechanics and rehab robotics. Industrial Engineering found a main path to sustainability. Electronic covers metamaterial modelling and characterization, nanostructured semiconductors, and front-end for radiation detection.

Although UniCusano has not a Mathematic Faculty, there are a bunch of transversal research subjects in the mathematic area, including algebra and group theory, fractal groups, harmonic analysis and probability, statistical modelling and econometrics, community detection algorithms, data mining, and artificial intelligence. Each of them finds an application in at least one of the areas described above, setting a multidisciplinary approach to the research subjects.

3 Outstanding Research

Here we do not want to report one or more specific research topics which are considered at the top level, but rather to describe what resulted to be a best practice at Unicusano for the establishment of a research setting within the Engineering Faculty. Since its foundation in 2012, the Engineering Faculty at UniCusano distinguished itself for its strong vocation toward research, which was not straightforward in an on-line university like Unicusano. A close inspection of the stakeholders' demand brought heavy investments in human capital and infrastructure, allowing the formation of the critical mass needed to develop a virtuous circle among formation, research, and industry. One of the outstanding results of such politics was the positioning of the Engineering Faculty at the top of Italian academic institutions, according to the assessment of the research quality by the Italian University and Research Ministry.

At the moment, the Engineering Faculty dedicates 550 m^2 to research laboratories, encompassing 9 laboratories dedicated to specific activities, plus two more areas which are accessible to all groups [5]. All the labs are born to be inter- and multi-disciplinary, covering all the engineering areas, from civil to industrial and information.
The list of all the laboratories is shown in Table 1.

Table 1. List of the Laboratory in the Engineering Faculty

Laboratory	Reference Area
Civil Engineering lab	Civil Engineering
Fluid dynamics lab	Industrial Engineering
Mechanics of Machines	Industrial Engineering
Manufacturing Technologies and Systems	Industrial Engineering
Machines and Energy and Environmental Systems lab	Industrial Engineering
Material Science and Technology	Industrial Engineering
Mechanical Measurements and Mechatronics	Industrial Engineering
Optoelectronic and Microelectronic lab	Information Engineering
Applied Electromagnetism lab	Information Engineering
Mechanical Characterization lab	Shared
Mechanical Workshop	Shared

The fast growth of the personnel, including Professors, Researchers, Post-Docs and PhD students and their dense and constant scientific production allowed the possibility to form an Engineering Department (to be settled within 2023), which means more financial independence, more dedicated HR management, and more weight within the academic Senate, in other words more possibilities to further grow and established as a reference point for research and technological transfer. Correspondingly, research founding raised as well, with more than 30 approved research projects founded by regional, national and European agencies.

4 From Research to Innovation

The technological transfer initiatives at UniCusano during the last years intensified together with the research activities, confirming the role of an academic institution strongly oriented toward the production sector. In this framework it is worth mentioning a couple of activities involving the Economy and Engineering Faculties.

The first is the Niccolò Cusano Smart Factory, which can be considered a knowledge farm to promote the formation and the development of new start-up on the regional and national landscape. It operates in close connections with the different poles of UniCusano and with other centers for innovation promotion along the national territory, with the vision of reinforcing the production sector by diversifying the industrial innovation offer.

The second is the creation of a cluster of both Universities/research centers and companies [6], most of which operating in the regional landscape, started in 2015 and intended as a close network for promoting applied research and applying common regional and national research projects. The pulse to technological transfer involves an internal structure able to collect the various competences and make them available for the productive sector. The Committee for Research and Technological Transfer and the National and International Projects Office [4] continuously monitored the industrial requests to promote innovation in the productive processes and formation of new professional figures. A result of this activity was the creation

of a multidisciplinary technological cluster formed by companies and public research entities, encompassing Ferrari, the Italian National Research Council, and some companies working in aerospace, material processing and sustainability at the national and international level, able to propose several regional and national research projects.

5 Involvement of Students

As said, contrarily to initial vocation strongly oriented to education activities UniCusano recently moved toward introducing students to research. At the end of their master's studies, students are allowed to access the laboratories and all the faculties encourage them to participate in internships within the university or in external companies/research institutions. During the last five years, UniCusano promoted the natural prosecution of the student career in research, increasing the offer of Doctorate schools and courses to form young researchers. Nowadays, five Doctorates are accessible [3]:

- Law and Cognitive Neuroscience
- Epistemology and Neuroscience Applied in Education
- Management for Digital Transformation: Business, Communication, and Ethics
- Territory, Innovation, and Sustainability
- Civil and Industrial Engineering

Remarkably, in the last two years, UniCusano promoted collaborations with local and national companies and obtained funds for about ten doctorate fellowships for the Industrial Doctorate program, to directly connect young researchers with the productive fabric.

6 The vision of ATHENA research-based cooperation

Research at UniCusano is an established reality that is still growing fast, due to the synergistic effect of the formation of researchers, the collaboration with the production realities, and the effort to match between the two parts. In the framework of continuing to play a major role in the Italian research landscape and over, ATHENA represents a natural and perfect opportunity to create other links towards other European subjects.

What ATHENA can bring to UniCusano is a solid network of advanced research partners with whom to interact, a research infrastructure which can sustain its activities, and a way to enlarge its competences.

What Unicusano can bring to ATHENA is its model of an institution working in close connection with companies and industries, its established experience in advanced technology-driven education which can favour the formation and the mobility of researchers at all levels promoting the development of remote and/or shared research models, and the enthusiasm of a young institution which is growing due to its ability to fully recognize the need of its reference market.

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Research Activities at the Polytechnic University of Porto

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1 Introduction

In this research paper, we explore the role of research and development (R&D) at the ATHENA - European University, focusing on the Polytechnic University of Porto (P. PORTO) as one of its member institutions. P. PORTO has made R&D and knowledge transfer a top priority in its strategic plan, aiming to enhance its position in internationally recognized research rankings through the production of high-quality research. The institution also emphasizes the promotion of scientific, technological, and artistic activities, including the integration of research-based teaching and student engagement in R&D. The emphasis on high-quality research, transfer of results to the civil community, promoting synergies between research and education, and engaging students in R&D initiatives is well aligned with ATHENA strategic priorities.

P. PORTO currently has 23 research units and groups across eight schools, actively participating in more than seventy R&D projects that have received recognition for their scientific contributions and impact on the surrounding community. Eight of the autonomous R&D units of P.PORTO are positively evaluated and financially supported by the Foundation for Science and Technology (FCT) – the Portuguese governmental body in charge of R&D financing. P.PORTO also incorporates eight reference research groups within Associated Laboratories and external research units.

Research at P.PORTO spans a wide range of disciplines, including Engineering, Business Sciences, Education, Arts, Technology and Management, Health, Hospitality and Tourism, and Media Arts and Design, reflecting the increasingly multidisciplinary nature of modern research.

The institution is actively involved in various research-related concepts and activities, such as intellectual and industrial property, technology and knowledge transfer, social and technology-based innovation, creative industries, entrepreneurship, incubation, spin-offs, and start-ups. P. PORTO aims to contribute to the development of innovative policies and strengthen competitiveness within the knowledge economy.

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To facilitate research, technology transfer, innovation, and entrepreneurship, P. PORTO has established the PORTIC - Porto Research, Technology & Innovation Center. This center serves as a physical space where research units and groups converge, fostering interdisciplinary collaboration, partnership formation, and innovation. Additionally, P. PORTO offers dedicated structures like Porto Design Factory, Porto Business Innovation, and Startup Porto to further support innovation and entrepreneurship efforts.

The recognition of PORTIC as a Science and Technology Park within the mapping of Portuguese Technological Infrastructures signifies the external acknowledgment of P. PORTO's commitment to research and innovation. The mapping process was coordinated by the National Innovation Agency (ANI) under the guidance of the Working Group for Technological Infrastructure Capacity Building (GTCIT), led by the Office of the Portuguese Secretary of State for Economic Affairs.

2 The Research Landscape

Research plays a crucial role in enhancing the quality, prestige, credibility, differentiation, and attractiveness of an institution. The quality of education provided by an institution significantly relies on the quality of research produced by its faculty and researchers. Therefore, research is a central and strategic axis for any higher education institution, necessitating the establishment of a research policy.

The research policy at the institution is defined through five key lines of action:

1. Consolidation of Research Units and Groups;
2. Strategic Measures for Science Management and Support Structures;
3. Integration of Research and Teaching: Promotion and Enhancement of Research Activities in Teaching and Learning.

In general, these measures aim to strengthen the research landscape at the institution, foster collaboration and synergy among researchers, and promote the integration of research activities into teaching and learning, thereby enhancing the institution's research capabilities and impact.

2.1 Outstanding Research

To enhance the research environment and activities, the institution has developed several strategies:

1. Integration and Commitment of Researchers;
2. Identification and Dissemination of Research Activities;
3. Enhancement and Promotion of Research.

These strategies aim to consolidate the institution's research capabilities, promote research visibility, recognize outstanding researchers, and create an open and supportive research environment that fosters innovation and collaboration.

3 From Research to Innovation

The P. PORTO has identified research and knowledge transfer as a key priority in its Strategic Plan, aiming to strengthen its position in internationally recognized rankings of scientific research quality. One of the institution's goals is to promote pedagogical innovation by encouraging research-based teaching and involving students in research activities.

To facilitate research, technology transfer, innovation, and entrepreneurship, P. PORTO has established the PORTIC - Porto Research, Technology & Innovation Center, which brings together multiple research units and groups from P. PORTO's organic units in a single physical space. The PORTIC's vision is to foster sustainable projects that promote interdisciplinary and multidisciplinary knowledge exchange, discussion, and partnership-building, stimulating innovation, transfer, and entrepreneurship within a distinctive and inclusive community. P. PORTO also hosts innovation and entrepreneurship-focused structures such as Porto Design Factory, Porto Business Innovation, and Startup Porto.

Externally, the PORTIC has been included in the mapping of Portuguese Technological Infrastructures as a Science and Technology Park under the coordination of the National Innovation Agency (ANI), Working Group for the Strengthening of Technological Infrastructures (GTCIT).

By fostering a collaborative and innovative research environment, P. PORTO aims to contribute to knowledge advancement, technological progress, and socio-economic development, positioning itself as a key player in research-to-innovation endeavors.

4 Involvement of Students

Student involvement in research and innovation activities at P.PORTO is seen as an integral part of its education and training. Research is conducted in research units funded by FCT or external units that collaborate with P.PORTO. Each study program is associated with one or more research units in cooperation with the course director.

The involvement of students in research-related activities includes organized visits to research units, dissemination of ongoing projects and participation opportunities, a collaboration of researchers in the curricula with specific topics integrated into the course contents, and the completion of research projects within research units. Students also have the opportunity to establish connections with companies and industries, gaining valuable experiences related to their future professional careers.

Furthermore, P.PORTO organizes seminars, workshops, webinars, and conferences inviting experts from various fields to contribute to the student's education. These events facilitate networking and provide students with contacts that can be beneficial for their future professional activities.

P.PORTO offers research initiation courses to students starting from the first year of their undergraduate studies. These courses aim to stimulate scientific activities, critical thinking, creativity, and autonomy among students by engaging them in research practices, teaching them research methods, and involving them in the life of research units and groups.

The involvement of students in research projects has been growing, often leading to project funding applications and attracting students to research and educational activities in scientific

institutions. P.PORTO provides a wide range of scholarships for students who contribute to the development of research projects. These scholarships include research initiation scholarships or research scholarships at the undergraduate or master's level, enabling students to acquire new knowledge and develop additional skills beyond their regular study programs. Scholarships are funded through various national (FCT, co-promotion, companies, industries, etc.) and international (Erasmus+, Interreg, H2020, Horizon, etc.) programs, forming a significant portion of the contracted funding.

P.PORTO has also participated in other funding programs, such as the FCT's "Summer with Science," which awards research initiation scholarships to selected students. This program, initiated in 2020, supports scientific, artistic, and technological research activities in research units, aiming to promote science in its various dimensions and its relationship with higher education and society. Its objective is to stimulate the initiation of scientific activity among higher education students.

As an integral part of research activities, students are funded to participate in scientific conferences and congresses to discuss their work through oral or poster presentations. In cases where the work leads to publications, students are listed as co-authors, most of the time as first authors. P.PORTO has launched the "Support Program for Publication in High-Quality Scientific Journals" (PAPRE). This program supports publications in Web of Science-indexed scientific journals with impact factors. To recognize scientific excellence, authors who affiliate their publications with P.PORTO and publish in journals appearing in the top 10% of their respective citation indexes receive "Certificates of Merit for Scientific Publication." Students have also been beneficiaries of these certificates, which are a source of pride for both the students and P.PORTO.

In the field of artistic, technical, and research training, P.PORTO has established the "Applied Artistic Research Award" since 2021. This award aims to recognize up to a maximum of four innovative academic projects, individual or collaborative, that promote transdisciplinarity between Photography and at least one of the main areas of study at ESMAD – the School of Media Arts and Design, including cinema, multimedia, sound, design, and informatics. In the field of music, the "Helena Sá e Costa Award," established in 2003, promotes the participation of students and young professionals in the early stages of their careers in an interpretative competition. This award provides opportunities for participants to perform with an orchestra or attend courses, seminars, or masterclasses in Portugal or abroad. Over the years, numerous students have been recognized and awarded through this program.

Overall, the student involvement in research and innovation activities at P.PORTO reflects the institute's commitment to fostering a research culture, promoting interdisciplinary collaboration, and nurturing the next generation of researchers and innovators. Through these initiatives, P.PORTO aims to create a vibrant and dynamic research ecosystem that bridges the gap between academia and society, fostering knowledge transfer, and driving positive societal and economic impact.

5 The vision of ATHENA research-based cooperation

ATHENA seeks to create a dynamic alliance that transcends boundaries, leveraging the collective expertise and resources of its members to address global challenges and drive impactful research outcomes. This proposal outlines the strategic message and contribution of ATHENA to the idea of an alliance [1].

1. Vision Statement: The vision of ATHENA is to establish a global alliance of research-intensive universities committed to advancing knowledge, driving innovation, and addressing societal challenges through collaborative research endeavors. By promoting cross-institutional collaboration, ATHENA aims to create a vibrant ecosystem where ideas, talent, and resources converge to generate transformative solutions that positively impact our world [2].
2. Strategic Message: ATHENA's strategic message revolves around four key pillars that underpin the alliance's mission and goals:
    a. Excellence in Research
    b. Global Engagement
    c. Knowledge Transfer and Innovation
    d. Talent Development and Education
4. Contribution to the Idea of Alliance: ATHENA's proposed research-based cooperation brings significant contributions to the broader idea of alliances by:
    a. Amplifying Research Impact [3].
    b. Fostering Collaborative Innovation
    c. Facilitating Global Networks
    d. Empowering Future Leaders [4].

In summary, the vision of ATHENA as a research-based cooperation is to establish a global alliance that promotes excellence in research, global engagement, knowledge transfer and innovation, and talent development and education. By focusing on these pillars, ATHENA aims to amplify research impact, foster collaborative innovation, facilitate global networks, and empower future leaders [5].

Through strategic partnerships, joint research projects, knowledge exchange programs, and collaborative initiatives, ATHENA will create a vibrant ecosystem where ideas flourish, research thrives, and impactful solutions are generated. By leveraging the collective strengths and resources of its member institutions, ATHENA will contribute to the advancement of knowledge, the development of innovative solutions, and the transformation of society.

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Research Activities at the University of Maribor

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1 Introduction

The University of Maribor (UM), established in 1975, is a distinguished public institution, the second largest university in Slovenia and the leading academic institution in Eastern Slovenia region. The university is committed to research excellence [1] and fosters a stimulating environment for remarkable research achievements [2]. The University of Maribor actively pursues new knowledge, collaborates with national [3] and international research organizations [4], engages students in research work and projects, and contributes to society's development and economic progress, both regionally and globally.

From the regulatory perspective, UM research structure and governance strictly adheres to Scientific Research and Innovation Activities Act [5], while also aligning with the Resolution on the Slovenian Scientific Research and Innovation Strategy 2030 [6]. Both national key legislative documents include directives for implementation of open science principles into legal framework of national research institutions and forward research assessment reforms.

The UM ingrains open science principles into its organizational structure by, for example, adopting the Open Access to Research Infrastructure policy [7]. This policy mandates that all researchers, both within and outside the institution, can access the university's high-quality research infrastructure. This open-access approach not only accelerates scientific innovation but also ensures equitable access to vital research tools. By leveraging technology and to support the university's open access to research infrastructure policy, the UM has developed and implemented an application (BriUM) designed as a digital gateway to UM's diverse research facilities and resources. It not only simplifies the process of seaching, reserving and utilizing the university's research infrastructure, but also encourages international collaboration and knowledge exchange.

Intertwined with research performed at UM are the efforts of the university to rethink and propose research assessment reforms with the goal to move towards responsible use of metrics like publication count and citation impact together with more comprehensive and

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qualitative evaluations. These evaluations consider factors such as societal impact, interdisciplinary collaborations, and researcher contributions to the national and global scientific community, ultimately nurturing a more inclusive and innovative research environment in Slovenia.

UM together with eight other european universities: Hellenic Mediterranean University (HMU), Maria Curie-Skłodowska University (MCSU), Niccolò Cusano University (NCU), Polytechnic Institute of Porto (IPP), University of Orléans (UO), University of Siegen (US), University of Vigo (UV), Vilnius Gediminas Technical University (VGTU) formed ATHENA university alliance [8] to develop and build a new european university from the unique and complementing educational and research potentials of the alliance members. In this contribution to the ATHENA Research Book Volume 2 we first look at UM's research landscape and analyze the fit of UM with other members of ATHENA from research perspective. We then follow with some observations of ATHENA research potential and discuss the potential of research cooperation of the alliance.

2 The Research Landscape

Over its nearly fifty-year existence, the research efforts at the UM have undergone substantial changes. Initially, the university primarily focused on engineering disciplines. However, over time, research activity at UM expanded into wider and more comprehensive exploration and now includes all major scientific fields. This transition emphasizes the university's dedication to fostering interdisciplinary collaboration and promoting diverse research activities.

In order to analyze current research landscape at UM and to illustrate some of its key points, we used bibliographic data for UM obtained from Clarivate's Web of Science (WOS) Core Collection database [9].

We gathered data on current highly cited publications from UM (hcUM), the publications that cited these UM's top research papers and the overall research production in last 15 years (15Y). In Table 1 we show the overlap of most frequent science categories of UM's own publication record between hcUM and the 15Y publication data (Table 1, column Publications). The column Citations in Table 1 shows the most frequent science categories of the overlap between publications that cited hcUM and 15Y UM's research work. These two columns reflect UM's research output and impact, respectively.

Table 1. Intersection between science categories of highly cited papers and all UM's publications in last 15 years in top 30 categories (data: WOS [9]) for UM's research output and impact.

	Publications	Citations
0	Materials Science Multidisciplinary	Materials Science Multidisciplinary
1	Mathematics Applied	Physics Particles Fields
2	Chemistry Multidisciplinary	Environmental Sciences
3	Physics Particles Fields	Engineering Electrical Electronic
4	Environmental Sciences	Multidisciplinary Sciences
5	Physics Multidisciplinary	Chemistry Multidisciplinary
6	Astronomy Astrophysics	Physics Multidisciplinary
7	Multidisciplinary Sciences	Green Sustainable Science Technology
8	Medicine General Internal	Astronomy Astrophysics
9	Energy Fuels	Mathematics Applied

Table 1 shows that engineering and natural sciences are both strong research areas at UM in research output as well as with its impact.

To assess the change in the research landscape and to discover rising research areas at UM, we searched for the science categories in highly cited publication data that do not appear in the list of most frequent science categories for UM in the last 15 years. In table 2 we show the detected rising fields using this approach separately for research output (column Publications) and impact (column Citations).

Table 2. Rising fields in publications and impact: science categories of highly cited works that were not in 30 top categories in overall UM research production in the last 15 years (data: WOS [9]).

	Publications	Citations
0	Physics Mathematical	Gastroenterology Hepatology
1	Engineering Environmental	Immunology
2	Neurosciences	Telecommunications
3	Biology	Medicine General Internal
4	Biophysics	Computer Science Theory Methods
5	Cardiac Cardiovascular Systems	Cell Biology
6	Computer Science Theory Methods	Neurosciences
7	Gastroenterology Hepatology	Nutrition Dietetics
8	Green Sustainable Science Technology	Pharmacology Pharmacy
9	Nutrition Dietetics	Genetics Heredity

Such comparison shows that UM is trending towards Life Sciences, Computer Science, Enviromental Engineering in recent years. This is in accordance with the research strategy that UM adopted which lists these non-exclusive research orientations [10]: (1) Advanced Materials and Technologies, (2) Health and Safe Food, (3) Smart Energy and Circular Systems, (4) Artificial Intelligence and ICT.

It is interesting to constrast these with the Research Priorities set by ATHENA university alliance [11]: (1) Sustainable Materials and Energy, (2) Emerging Manufacturing Technologies, (3) Artificial Intelligence, (4) Information & Communication Technologies, (5) Digital society & digital arts, (6) Health & Food Technologies, (7) Assistive technologies.

Although not completely overlapping, UM does seem to fit well with the ATHENA research landscape. An attempt at mapping UM reseach orientations to ATHENA reseach priorities could go like this: (UM) => (ATHENA), (1) => (1,2), (2) => (6), (3) => (1), (4) => (3,5).

Besides the well fit of UM research ladnscape with ATHENA reseach priorities there are also opportunities for UM research growth with ATHENA. To find complementary research fields of UM and ATHENA members, we looked for research fields in top 20 fields of each ATHENA member that do not occur in top 20 fields of UM. Table 3 shows top two fields for each pair. For example, from the data for the last five years we find these top two complementary fields for UM - UV pair: 'Food Science Technology', 'Biochemistry Molecular Biology'.

Table 3. ATHENA research opportunities for UM. The list of top 20 ATHENA reseach fields in not found in the list of top 20 UM reseach fields (data for the last five years: WOS [9]).

	research field 1	research field 2
HMU	Telecommunications	Plant Sciences
UO	Astronomy Astrophysics	Geosciences Multidisciplinary
NCU	Telecommunications	Neurosciences
US	Computer Science Theory Methods	Computer Science Interdisciplinary Applications
MSCU	Biochemistry Molecular Biology	Physics Condensed Matter
UV	Food Science Technology	Biochemistry Molecular Biology
IPP	Computer Science Artificial Intelligence	Computer Science Interdisciplinary Applications
VGTU	Engineering Civil	Economics

3 The vision of ATHENA research-based cooperation

The analysis presented in the previous section and its extension to all pairs of ATHENA universities alliance could inform the alliance on potential opportunities in fostering further mutual research cooperation. Here, to get a first look at the structure of ATHENA research space we constructed two graphs showing links between pairs of ATHENA members: a co-publication graph where two universities are linked if they share joint publications, and a cooperation graph where two universities are linked if they share institutions in their research collaboration. Such an analysis of research data helps us to start to understand the strengths and opportunities of ATHENA research space.

Figure 1 shows the co-publication graph of ATHENA. The links connect pairs of universities that share publications. The structure of the network might tell us something about the current state of ATHENA research collaboration.

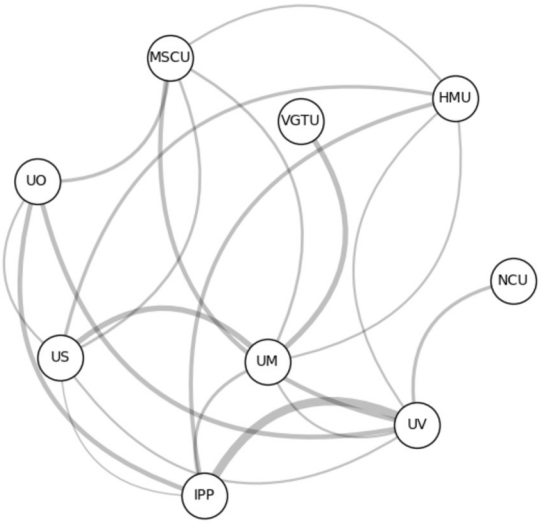

Figure 1. ATHENA university alliance co-publication graph (data from WOS [9]). The thickness of edges between the noudes (universities) indicates the strength of research cooperation as detected from number of joint publications.

Looking at the number of links per node or the degree of the node we notice that NCU and VGTU are connected only to one partner, while other ATHENA members share more links. We also computed the betweenness centrality of each node and explore the triads in the network or 3-node motifs. UV and UM emerge as central figures, with high betweenness centrality values (0.28, 0.29), suggesting they frequently serve as bridges in the shortest path between other universities. This is reinforced by their frequent appearance in various triadic 3-node motifs (12 and 10 out of 21), indicating their participation in numerous triadic collaborations. US, while having a moderate betweenness centrality, is also a common element in many 3-node motifs, suggesting its significant role in multi-institution collaborations. The presence of HMU (9) and UO (5) in a good number of triadic collaborations also shows their integral role in the network despite their lower betweenness centrality. NCU and VGTU, with their betweenness centrality of 0, do not appear in any of the 3-node motifs. This highlights their peripheral role in the network and suggests potential opportunities for them to increase their involvement in multi-university collaborations.

To construct a cooperation graph we mapped ATHENA Research Priorities into following WOS science categories: Green & Sustainable Science & Technology; Engineering, Manufacturing; Computer Science, Artificial Intelligence; Food Science & Technology; Computer Science, Information Systems; Health Care Sciences & Services; Art. We then gathered lists of research partners that collaborated on publications for each ATHENA university in all these science categories. From intersections of the lists of research partners (top most frequent 30 institutions) we finally obtained the cooperation graph shown in Figure 2. In this graph two nodes are linked in they share common research partners. So research partners of alliance members serve as coupling elements between them and indicate towards potential new collaborative research opportunities.

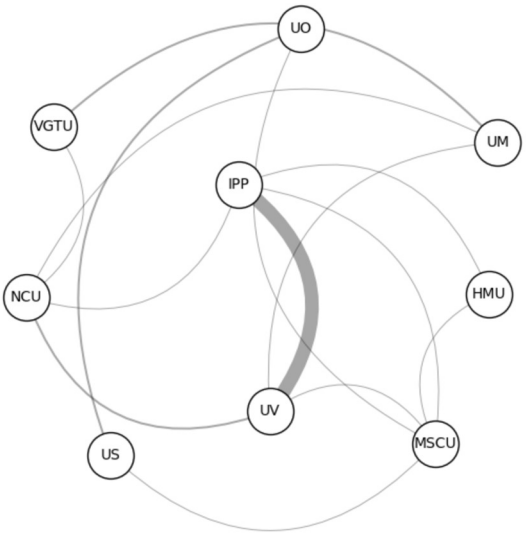

Figure 2. Graph of ATHENA alliance from overlap of top 30 partnering institutions for each pair of members (for example, this corresponds top 3 % of all reseach partners of UM)

Here, in contrast with publication collaboration graph, MSCU and UV serve as important bridges in the network with highest betweeness centrality. Both institutions are also most frequent in 3-node graph motifs (3 out of 6).

With this couple of examples of research landscape analysis we tried to quickly illustrate how the strengths, opportunities and challenges for research collaboration with ATHENA and wider can be explored using bibliographic data. The development of the methodology to follow and analyze research output of ATHENA alliance and in particular detect missing links that can strengthen the alliance can in our view be one of the important future tasks of the ATHENA Research Board.

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Research Activities at the University of Orléans

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1 Introduction

Research at the University of Orléans is carried out by our 24 laboratories, grouped into multidisciplinary thematic clusters which we will describe in the next section. This represents around 850 permanent staff and 500 PhD students.

Most of our laboratories are co-accredited with academic partners: CNRS (French National Centre for Scientific Research) and more than 100 researchers are based in Orléans, INSA Centre Val de Loire (engineering school located in Bourges and Blois), University of Tours and BRGM (the French Geological Survey whose headquarters are in Orléans). A major new development is the creation, in 2022, of a new faculty of medicine, while the Orléans Hospital is being transformed into a university hospital. This will trigger new research collaborations in health, with the support of INSERM (National Institute of Health and Medical Research). All these collaborations with several national research institutes, allow us to acquire common high quality laboratory equipment and set up large scale research projects.

The University of Orléans encompasses now all major research fields, from exact and experimental sciences to human and social sciences, including medicine.

2 The Research Landscape

Fundamental and applied research performed in the 24 laboratories of the University of Orléans is grouped into 4 thematic clusters (Figure 1) [1].

The **Energy, Materials, Earth-Space systems** cluster groups eight laboratories in material chemistry, physics, power engineering, geosciences, environment, and space science. They largely work on environmental issues: propulsion systems (including hydrogen or

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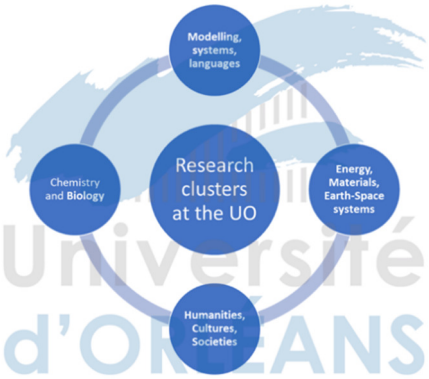

Figure 1. Four thematic clusters of the fundamental and applied research at the University of Orléans

ammonia-based engines, or even plasma propulsion for satellites), observation of pollution of the (sub)soil and the atmosphere (sensors, depollution), materials for energy storage. This cluster also has high quality teams in astrophysics (the Nançay Radio Astronomy Observatory is one of the most powerful radio telescopes in Europe), in space studies (equipment built in Orléans is on board of Rosetta, Parker Solar Probe, and more recently Juice), in the study of magmas and the deep earth.

These laboratories benefit from state-of-the-art platforms for microscopy, propulsion (engine benches, wind tunnels), the study of soils and the atmosphere, the study of materials in extreme pressure and/or temperature conditions.

The **Chemistry and Biology** cluster groups five labs of human and vegetal biology, biochemistry, sports, health, well-being. They work together on drug design, biomedicals, imaging technologies, chemical analysis, cosmetics, tumour detection, physical activities adapted to people with illness or disability, often in partnership with hospitals, pharmaceutical and cosmetics companies. The bio and chemo-informatics specialists also provide databases with selected molecules and their behaviour in clinical trials.

Research scientists share high quality platforms for molecular characterization of small molecules and biomolecules (mass spectrometry, RMN) and for imaging from cells to small animals (flow cytometry and cellular imaging, MRI / SRM, small animal imaging).

The scope of the **Humanities, Cultures, Societies** cluster ranges from archaeological heritage studies to management, from the geography of ponds to the analysis of legal, political or cultural models. The seven research labs address major societal challenges (globalization, political and cultural transformations, collective and individual responsibility, environment and heritage, citizenship) in a critical way. Research is carried out in close connection with society: museums, schools, local authorities.
Therefore, in addition to the classic scientific production (articles, books), the teams also propose exhibitions, advice to local authorities, support to teachers, etc.

The **Modelling, systems, languages** cluster comprises five teams in mathematics, computer science, automatic and signal processing, linguistics and economics. Economists and linguists have strong expertise in modelling and digital processing of economic data or written and spoken language. Gathering these teams together allows strong synergies, exchanges of skills and development of original projects.

Let us point out that most of the university's laboratories make intensive use of mathematical modelling and digital data processing via statistical and artificial intelligence tools.

In addition to this thematic structuring of the laboratories into four clusters, several large-scale projects, with durations of four to ten years, enable us to make great strides in areas of study such as cosmetic sciences (CosmetoSciences), materials in extreme conditions (MatEx), and the design of digital twins for the environment (Junon).

3 Outstanding Research

In addition to the outstanding publications listed in the dedicated chapter, let us mention a few other markers of the high level of research at the University of Orléans.

During the last two years, our researchers have obtained three ERC (European Research Council) grants in exobiology (BIOMAMA – Biogenicity of Martian Materials [2]), geology (TRACE-it: Controlling particle flow […] in geological porous media [3]) and atmosphere sciences (APATE - A primitive solar atmosphere around the young Earth [4]).

Research on hydrogen and ammonia-based engines is strongly supported by national funds France 2030 [5] (project PL-H2 - Heavy Duty Vehicle Combustion Engine Demonstrators) and international funds (projects EKI - Engine Knock Intensity Modelling for Future Fuels and ADONIS - Ammonia-Hydrogen Combustion in Micro Gas).

In life sciences, the research carried out in Orléans on messenger RNA has a high international impact. It is the subject of major funding from Horizon Europe (EIC pathfinder Challenge project Yscript - Yeast cell factory for mRNA bioproduction [6]) and our National Research Agency (project BiopRNA - Bioproduction of therapeutic mRNA and vaccines).

Excellence concerns all our research fields, for example several colleagues are members of the prestigious Institut Universitaire de France (IUF) in economy, automation, mathematics, biology and space sciences.

4 From Research to Innovation

Complementarity between fundamental and applied research is a matter of concern for all the teams at the University. Many projects are in collaboration with companies and public or private institutions, promoting joint laboratories with companies in engineering and life sciences.

Since 2019, the University of Orléans has been a founding member of the regional technology transfer structure called C-Valo [7], which facilitates the rise in technology readiness level, the patenting and creation of start-ups. Life sciences and engineering are particularly active in patenting. In 2022, the university has, for the first time, taken shares in the Viewaves start-up company emerging from in-house research activities. Its goal is to “see beyond visible to better treat cancer”, by conceiving molecules to illuminate tumours and metastases.

5 Involvement of Students

While our doctoral students are a great support to research, the involvement of master and engineering students in our laboratories still needs to be improved in several disciplines. This is the purpose of an important project led by the university, with funding over 10 years, called MINERVA. Its objective is to develop the immersion of students in our research teams (learning by doing), to generalise project-based training to strengthen the master's degree-doctorate links and the internationalisation of training paths. MINERVA is the Latin version of ATHENA… and this is no mere coincidence, the former was built as complementary to the latter.

6 The vision of ATHENA research-based cooperation

For the first phase of ATHENA, we focused on identifying partnerships, through visiting programs for researchers, joint conferences and meetings, and collaborative projects in informatics, automation and signal processing, materials sciences, linguistics. We have been greatly helped financially for these actions by the support of the French research agency (ANR) dedicated to European universities.

Research projects already structured on the scale of Orléans and our Region, such as MatEx, CosmétoSciences and Junon have invested in the organization of conferences specially dedicated to the creation of an ATHENA network in the respective fields. We relied heavily for all this animation on Le Studium, (regional) Institute for Advanced Studies.

For the second phase of our European alliance, we intend to build on these contacts to refine the strategy of exchanges and joint events, to share the use of large equipments, to propose more extensive collaborative projects, with a leverage effect to acquire European and national funds.

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Research Activities at the University of Siegen

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1 Introduction

The University of Siegen is a research-oriented university with the goal of promoting excellent, internationally recognized research. As the driving force and mirror of developments in society as a whole, universities have a duty to contribute to the solution of current and future societal challenges and to transfer scientific insights to society. The guiding principle of the University of Siegen "Shaping a humane future" characterizes the mission and actions in research, teaching and transfer. Two of the major challenges, namely the comprehensive digitalization of all areas of life and the transformation towards a sustainable economy and society, intersect all research areas.

Thereby the University of Siegen is committed to the principles of Good Scientific Practice, to the respect of different cultures across disciplines and research directions, the trusting and open handling of scientific discourse and the recognition and appreciation of the achievements of researchers. Its goal is to maintain the existing variety of research topics and to further develop a balanced relationship between individual research projects and collaborative research projects.

2 The Research Landscape

The University of Siegen focuses on the promotion and expansion of the already existing internationally visible profile areas and research foci in order to further sharpen the universities research profile. Those **profile areas** are characterized by long-time strengths in fundamental research. While already established through proven past merits at the University of Siegen, they are to be strengthened and expanded for future research. The profile areas of the University of Siegen represent thematically focused, partly interdisciplinary oriented research foci that address the major scientific and societal challenges. The four profile areas

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are (1) Media & Culture, (2) Education & Social Society, (3) Sensorics & Visual Computing and (4) Matter & Quantum Systems

The University of Siegen supports research activities that pick up on pioneering trends and take part in developing and shaping new research areas. On the one hand, these **areas of competence** are research-active areas that are either in the process of being established or redefined. These are being further expanded and supported by the university in order to lay the foundation for innovative research clusters and coordinated, large-scale research alliances. On the other hand, these areas also include research groups that conduct applied and practice-oriented research with a focus on transfer. The three areas of competence are: (1) Smart Work & Smart Everyday, (2) Nanotechnology & New Materials and (3) Health Care & Gerontology.

3 Outstanding Research

The traditionally strong profile area **Media & Culture** investigates practices in media and culture of contemporary societies and the respective social and societal effects. Currently, the research concentrates on the ubiquity of media practices and the transformation of society through new methods to measure attention and develops new methodological approaches and theories. New sensor-supported or autonomously acting media as well as the associated data practices determined by algorithms or smart devices are shaping the current transformation of our society from a digital network society to a data society. Algorithms and automation are also the driving force regarding the determination of popularity values (likes, usage, sales, etc.) in rankings of all kinds, with serious consequences for the social distribution of attention and its legitimation in art and literature, science and politics, religion and education. The associated fundamental social and cultural change not only affects our perceptions and communication structures, but also significantly influences our social life and our cultural and political identity. The transdisciplinary research of this area analyses these developments and combines cultural studies, literature and media studies, linguistics and social sciences, history, educational sciences, psychology, economics and computer science. With currently two Collaborative Research Centres, the University of Siegen is one of the internationally outstanding locations in the field of praxeologically oriented media and cultural studies.

The profile area **Education & Social Society** focuses on social integration as a challenge for an increasingly diverse and dynamically changing society. Education, social participation, migration, and social systems are topics that deal with the challenges of an inclusive society, which is characterized by diversity and mobility. Intensive cooperation in inter- and transdisciplinary collaborative research projects among the disciplines of social work, special education, and social science, are dedicated to researching the welfare state and its governance structures as well as the facilitation of social participation from a wide variety of perspectives: Specifically, both intended and unintended consequences of social assistance are looked at from the perspective of the persons addressed. Another research network is working on how migration changes institutions and when do institutions mobilize or immobilize; this network joins migration research, sociological and political research on institutions by taking sociological, ethnological, and political science perspectives into account.

The profile area **Sensorics & Visual Computing** is centred around trendsetting sensor developments and nanotechnological research. The close interdisciplinary cooperation of groups working on fundamental research in physics and physical chemistry, microelectronic sensor development and data processing in information technology is very unique at the University of Siegen. One main focus is the development of intelligent sensor systems. Using new methods of machine learning allows us a simultaneous integration of hardware and information processing. This highly interdisciplinary approach and the close cooperation between the disciplines opens up a wide range of advantages in terms of data efficiency, privacy protection and the ubiquitous integrability of future sensor systems. With its focus on "Smart Sensing", the Center for Sensor Systems (ZESS) forms the condensation point of this research. Another research focus includes biomolecular assisted sensing, personalized digital medicine or sensor-based systems and materials for diagnostics, which are developed in the Research Center of Micro and Nanochemistry and (Bio)Technology (Cμ), using methods of micro- and nanochemistry and microelectronic sensor development. This research area is also characterized by a high degree of interdisciplinarity, bringing together researchers working on topics like nanotechnological integration, ubiquitous sensing, intelligent autonomous recognition and classification methods. The development of integrated electrotechnical and chemical sensors, which is relevant for both focal areas, is supported by establishing the Interdisciplinary Research Center for Nanoanalytics, Nanochemistry and Cyber-physical Sensor Technologies (INCYTE).

The profile area **Matter & Quantum Systems** comprises fundamental research in the fields of elementary particle physics and quantum optics. This internationally visible area of the University of Siegen carries out its research in theoretical and experimental physics to study matter and quantum information technology in coordinated collaborative research projects. Theoretical research in elementary particle physics deals with conceptual aspects of quantum field theory, with the development of mathematical methods for performing precise calculations within the framework of the Standard Model of particle physics and its possible extensions. The focus lies on heavy quark flavours, quantum chromodynamics, Higgs physics, and new models beyond the Standard Model. The development of novel detectors and the analysis of data from two large experiments, the ATLAS experiment at the Large Hadron Collider (LHC) and the Pierre Auger Observatory, are the centre of experimental research activities in particle physics. The research is embedded in internationally relevant collaborations, such as CERN or DESY. The fields of quantum optics and quantum information theory form another research area. Research on an innovative quantum core module as the basic building block of a future quantum computer is being pursued in collaboration with other universities and industry collaborations.

4 From Research to Innovation

In **Smart Work & Smart Everyday**, the focus is on the design of successful smart production, process optimization for SMEs based on artificial intelligence, and smart applications for everyday life. Particular attention is paid to the consequences and opportunities of digitality for consumers and regional economy, especially for small and medium-sized enterprises. The transfer between science and regional SMEs takes place in

joint projects and competence centres, in which the realization of smart production or the research of innovative tool concepts and components are tested. A key question of this competence area is the research and configuration of human-machine interaction in both working and everyday environment. This includes smart applications in sustainability and resource optimization, but also in health care and assistance robotics for the aging society. The central question is how technology can be designed to be accepted, used and experienced as meaningful by humans.

The development of highly efficient materials and manufacturing processes that minimize resource consumption, maximize performance parameters and being ecologically sustainable is the focus of the **Nanotechnology & New Materials** competence area. Areas of work also include materials that can endure infinite duty cycles, nanostructured composites, smart multifunctional materials, micro- and nanostructured (bio)materials, monitoring systems for structural integrity, and composite materials for lightweight automotive manufacturing. These research activities are primarily located at the Research Center of Micro and Nanochemistry and (Bio)Technology (Cμ), and at the Multidiscipilary Center for Innovative Materials at the University of Siegen. The three central research topics, materials science, sensor development and cross-scale characterization are to be brought together by establishing the new the Interdisciplinary Research Center for Nanoanalytics, Nanochemistry and Cyber-physical Sensor Technologies (INCYTE). This will form the infrastructural base for future-oriented, interdisciplinary research and development of new materials and sensors at the University of Siegen.

The focus of the competence area **Health Care & Gerontology** is an application-oriented approach to individualized, evidence-based, and integrated health care. Innovative care models for rural regions with limited access to the healthcare system (especially in the context of the model project "Medicine Rethink®" and the Digital Model Region Health Dreiländereck DMGD) are developed. The central research topics are biomedical sensor technology, mobile health information technology or digital assistance systems. A special focus is laid on aging research and IT applications for the aging society. In the Gerontology Network Siegen (GeNeSi) together with partners from health, business, politics and care, the requirements for good and self-determined aging are analysed and new concepts are developed in interdisciplinary research projects.

5 Involvement of Students

In Germany doctoral studies are in general not considered as a third cycle of an academic education, but rather as a first employment. Thus, this part of the training of young scientists is usually seen as research work, however, with still some supervision. As a consequence, doctoral students are naturally involved in the current research work, providing an excellent "training on the job".

The University of Siegen considers the creation of excellent career conditions for the qualification and profiling of young academics an important matter. The University of Siegen offers an optimal environment for the development of individual academic career paths at all career levels, starting with master's students, doctoral students, and postdoctoral researchers

to junior professorships. The graduate center "House of Young Talents" was set up to provide intensive and interdisciplinary advice to young researchers.

In addition to support and counselling offers in the qualification levels of master's students and doctoral students, postdoctoral researchers in particular are to be shown and paved the way to scientific independence as early as possible. Young scientists with a doctorate and with visible potential are increasingly funded with the aim of supporting them in their development into research personalities and to optimally accompany them on their further career path. The independent implementation of research projects and the acquisition of third-party funds is an important component here. The Research Funding department supports and coaches young scientists in a targeted and individual manner with the initial application and, together with the graduate center "House of Young Talents", offers workshops and information events on third-party funding.

6 The vision of ATHENA research-based cooperation

Our society is experiencing sudden changes in the way people and institutions produce and manage value. These changes are in part due to the growing ease with which people can collaborate nowadays. Many successful cases of peer-to-peer models of organization arise and assume leading positions in world economy. People are evolving and interacting inside heterogeneous teams composed by members from many different cultural groups and with distinct skills and backgrounds.

Modern economy and society being highly dependent on technology requires complex problem solving and communication skills in technical subjects. In such a demanding and culturally diverse environment as the professional world is today, it is essential to promote the development of team-work and communication skills at an international and intercultural level.

Presently, there is an increasing need for the establishment of international and multidisciplinary teams. These teams, either spontaneously or explicitly generated, are capable of conceiving and developing successful products to be distributed worldwide. Therefore, we consider being of extreme importance to start promoting this type of work as early as possible – even in students' academic activities. Leading future engineers at an early stage of their higher education to be involved in an academic multinational project where they will need to interact and communicate at distance with their team and work together to fulfil a common target, will certainly be challenging and enriching both for students and teachers as well as researchers involved. Furthermore, it will provide all with the communication and cooperation skills essential to survive in the international world market.

An alliance of different Universities as the European University ATHENA provides an ideal platform for students, teachers and researchers to cooperate in education as well as in research projects, that generate relevant outputs to the community.

The starting point for establishing the core group of ATHENA has been the *Multinational Undergraduate Team Work* project (MUTW), in which students from different countries have been collaborating in small research projects. This activity has now been successfully continued since more than 10 years.

The cooperation of these Universities has been continued by several Erasmus plus research projects establishing an innovative infrastructure to promote the communication between deaf and non-deaf as well as among international deaf students.

The expansion of the core group with three additional universities created the ATHENA Alliance. The mission of ATHENA is to become a global hub for excellence and inclusion, intensifying high-end knowledge production, radically improving access and sharing results in more innovative ways.

Research Activities at the University of Vigo

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1 Introduction

Established in 1990, the University of Vigo (UVigo) has managed to consolidate itself in time as a reference of modernity and innovation in Galicia (Spain). Its three campuses at Ourense, Pontevedra and Vigo offer degree programs in the fields of science, humanities, technology and legal-social sciences. These are distributed over nearly thirty centres where research groups also carry out their R&D activities. A network of own centres completes the research infrastructure map of the University of Vigo.
The University of Vigo's general internationalisation objectives are to promote exchange of researchers, students and administrative staff and prepare them for the global labour market; gain recognition in the international education area by establishing strategic partnerships and internationalising teaching and research; promote innovative international projects within a multilateral, cross-border cooperation framework to attract and retain the best talent, for example, by participating in all education and research European calls.

In 2017, the University of Vigo was awarded the European Commission's HR Excellence in Research Award accreditation and the HRS4R seal of excellence [1]. This seal represents our commitment to continuous improvement, through alignment of our human resources strategies and policies with the principles of the European Charter for Research Staff and the Code of Conduct for Recruitment of Research Staff (C&C).

Within this excellence framework, the University of Vigo has developed various training, recruitment, retention, and stabilisation plans with the aim of attracting talented teaching and research staff to contribute to maintaining and improving research, transfer, innovation and creative capacity. The final objective is to retain persons with the greatest merit and capacity, by always abiding with the principle of equal opportunities. One of UVigo's strengths is that it has pioneered many gender equality actions, which have recently enabled us to lead the gender equality work package in the ATHENA proposal.

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2 The Research Landscape

The research structure (Fig. 1) is comprised of research groups, research institutes, research centres, and support centres. There are 172 research groups which span many disciplines such as science, technology, health sciences, humanities, and social sciences, that have 2630 researchers including staff and PhD students. All groups are comprised of at least three members. Some relevant groups funded by the Galician Government are: potential growth groups (PGG, minimum 3 members) and reference competitive groups (RCG, with a minimum of 5 members).

There are three university research institutes, namely; IFCAE (Physics & Aerospace Sciences Institute [2]), Agroecology & Food, and IXEX (Law & Gender Institute). The first two are located on the Ourense Campus while the third is distributed over the three campuses.

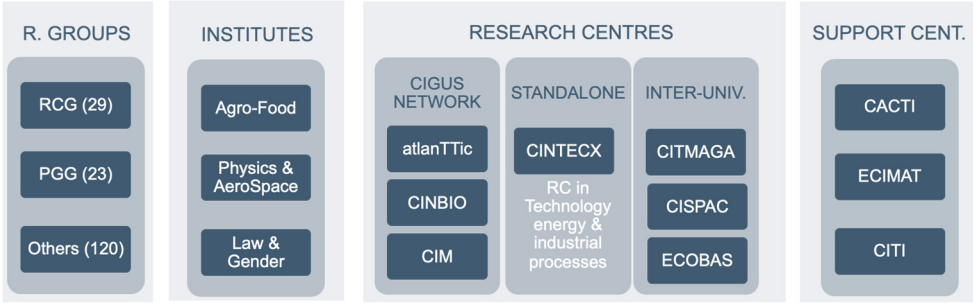

Figure 1. Main research structures at the University of Vigo.

The Research Centres (RC) are either standalone or inter-university centres. Three of them are recognized for excellence within the Galician University System's CIGUS network of Research Centres: atlanTTic [3] dedicated to Information and Communication Technologies; CINBIO [4], dedicated to nanomaterials and biomedicine, and CIM [5], dedicated to Marine Science. The fourth, CINTECX [6], is dedicated to Technology and Industrial Processes. There are three inter-university RCs that collaborate with the University of Santiago de Compostela (USC), and the University of Coruña (UDC). These are CITMAGA [7], dedicated to Research and Transference in Mathematics in Galicia; CISPAC [8], dedicated to Atlantic Cultural Landscapes; and ECOBAS [9], dedicated to Economy and Business Administration.

The support infrastructure is comprised of CACTI [10] (Scientific-Technical support Centre for Research), ECIMAT (Marine Science Station) and CITI (Technological and Industrial Centre). These research support centres provide instrumental, scientific, and technological assistance in all knowledge, research, development, and innovation areas, not only to UVigo but also to the other public bodies or companies. They facilitate use of equipment and facilities, which due to their specificity, technological level or cost, are best exploited in a centralised manner. The online platform RESUV [11] provides information on all technical facilities and services available at the university.

The research portal collates the scientific production generated by UVigo research staff, with a view to dissemination, thereby providing greater visibility and transfer of research results and know-how to society.

3 Outstanding Research

The University of Vigo occupies a relatively good position in national and international rankings as shown in Table 1. Considering the Times Higher Education (THE) Ranking, where 30% is based on research and 30% on citations, UVigo's overall ranking is 800-1000, but 601-800 in Engineering & Technology. In terms of the 2022 Shanghai ranking of World Universities, UVigo was placed among the 501-600 best universities in the world, and obtained best position in the following areas: Food Science & Technology: 51-75; Telecommunications & Civil Engineering: 201-300; Electric & Electronic Engineering together with Ecology: 301-400; Chemical Engineering & Biotechnology: 401-500, among others.

Table 1. Position of the University of Vigo in THE Ranking (World Universities), ARWU Ranking, 2022 Greenmetrics: overall, by fields, subjects, region, country, and rural campus.

Position	**THE 2022**	**Position**	**ARWU 2022**	**Position**	**Green metrics 2022**
Overall	801-1000	Overall	501-600	Overall	300
Engineering	601-800	Food Science & Technology	51-75	In Europe	94
Physical Sciences	601-800	Oceanography	151-200	In Spain	17
Computer Sciences	601-800	Telecommunications Engineering	201-300	Rural Campus	22
Social Sciences	601-800	Hospitality &Tourism Management	201-300	Setting & infrastructure	271
Business & Economics	601-800	Electrical & Electronic Engineering	301-400	Energy & Climate change	358
Education	601+	Political Sciences	301-400	Waste	222
Life Sciences	501-600	Oceanography	201-300	Water	210
Arts & Humanities	501-600	Political Sciences	301-400	Transportation	591
THE Citation Score	39.9	Earth Sciences	401-500	Teaching & Research	419
		Biotechnology	401-500		

The aforementioned positions by subject are clearly related to the structure of the university's institutes and centres as shown in Fig. 1. The Agro-Food Institute, which promotes personalized food oriented to biomedicine and attempts to reach zero hunger, is aligned with the second Sustainable Development Goal (SDG). The Marine RC (CIM), with climate change and underwater life as one of its main objectives, is aligned with SDGs 13 and 14. Telecommunications is the main focus of atlanTTic, which is a world reference in 5G and 6G technologies and is at the forefront of quantum communications. Its other lines of research

range from security and privacy, biomedical signal analysis, multimedia technologies, space communications, radar and remote sensing, to electronic services or radio and optical communications. These lines complement those of the Institute of Physics and Aerospace Sciences: fluid dynamics and thermodynamics, optical systems, unmanned aircraft, space sciences, modelling & simulation, and aim to maximise the potential for generating research excellence in the areas of applied physics, aeronautical, and aerospace sciences, to intensify results transfer to society.

Insofar as the Engineering fields are concerned, CINTECX covers aspects of electronics and automation, manufacturing and materials, energy, transport, biomedical engineering and sustainability. It is fully integrated into the Galician industrial ecosystem in key economy sectors such as automotive, naval and metal industries. This is also mirrored in the Greenmetrics ranking as shown in Table 1.

CINBIO is focussed on biotechnology, with its cutting-edge research applied to health through collaboration projects with hospitals, where personalized medicine is one of its main goals.

ECOBAS, the inter-university RC, is relevant in the Humanities and Social Sciences, and focuses its lines of research and transfer in the field of economic, environmental, and social sustainability, to respond to the great challenges of society.

The IXEX institute, is aligned with the 5th SDG. It applies a gender perspective and covers lines of research such as gender-based violence, equality in the labour market, women and social identity, family, mediation, therapeutic and restorative justice, among others.

4 From Research to Innovation

A university that generates basic and applied knowledge, also must work with companies, and define cooperation policies. Figure 2 compares some research and innovation indicators between UVigo (black line) and the average of the Spanish universities (blue area).

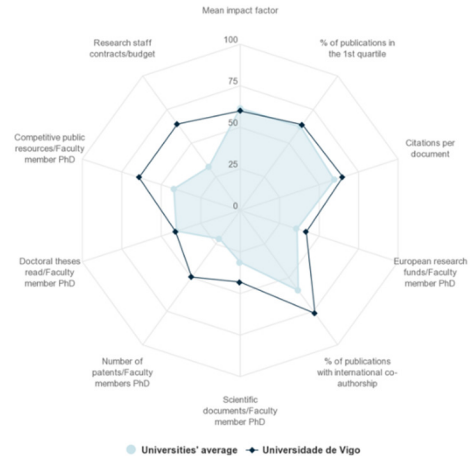

Figure 2. Research and innovation indicators in comparison with the Spanish Universities' average. Minimum value = 0 and maximum value= 100. Taken from [12]

UVigo shows higher than average values for research staff contracts/budget and number of patents; two good indicators for innovation. On average, UVigo has about 500-600 contracts/year that represent about € 6M/year. The number of UVigo spin-offs is another good indicator. Forty-two knowledge-based spin-offs have emerged from the University of Vigo since 2004, which transfer UVigo's high benefit and economic potential knowledge, technology and research results to society. Some examples in the technological field are: Alén Space [13], Ancora Mobile [14], Codelab 17 [15], CoderIam, S.L. [16], EM3works [17], Environmental Physics Technologies [18], etc.

UVigo is also part of the Digital Innovation Hubs: DIHGIGAL, DATAlife and INFABHUB, and Business Incubators (BF): BFAuto, BFFood, BFAero as an integrative part in the Galician Innovation Ecosystem.

5 Student participation

UVigo students actively participate in research via three student associations: UVigo Space Lab, UVigo MotorSport and UVigo Aerotech, which is the most outstanding in terms of technological focus.

UVigo Space Lab is comprised of a multidisciplinary team of university students from different engineering fields (industrial, telecommunications, aerospace, computer science) dedicated to the design, manufacture and operation of small educational satellites and space missions. The next mission of this association is the BIXO project, which will be key to understanding the effect of prolonged exposure of living organisms in space.

UVigo Motorsport has been designing and manufacturing single-seater racing cars for several years and currently involves 70 students from mechanical engineering, computer science, aerospace, and artificial intelligence. It also has students from other degrees such as Social Education, Organizational Engineering or Business Administration and Management. The objective is to pass all technical & mechanical inspections and safety tests of the single-seater, and thus qualify for competing in the Formula Student race. The plan is to achieve a functional and truly autonomous prototype to participate in an autonomous car competition.

UVigo Aerotech is an aeromodelling team of 18 Aerospace Engineering students from the Ourense campus. This team was created to broaden knowledge beyond the academic field and thus facilitate entry into the aeronautical sector. They started in December 2019 and currently are in the final stretch of designing a prototype.

6 The ATHENA research-based cooperation vision

UVigo's entry into the ATHENA alliance will facilitate synergies for new research and transfer projects, thereby promoting quality and impact research. This will contribute to creating a network of research infrastructures and teams, to increase competitiveness of project proposals and fundraising, thus boosting socio-economic development and reciprocally facilitating infrastructures and resources from UVigo, Galicia and the Galicia-North Portugal Euroregion to ATHENA partners.

Teaching and research staff, as well as technical and administrative staff, will avail of training opportunities within a European cooperation environment. From the point of view of educational offer, ATHENA will also promote internationalisation of UVigo's bachelor and master's degrees, and doctoral programmes. At the industrial and social level, the ATHENA membership will provide benefits in relation to the transfer of results, training of professionals for excellence, better European level job prospects and for fostering exchange between universities, industry and society.

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Research Activities at the Vilnius Gediminas Technical University

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1 Introduction

Vilnius Gediminas technical university (VILNIUS TECH) is an innovative Lithuanian university that cultivates creative and highly qualified specialists. The university is a leader in the field of technological sciences with modern and labour market-oriented approach to education.

VILNIUS TECH inspires and develops talents: socially responsible, creative, forward-thinking individuals who together bring change to the environment and large university community, working toward social, economic, cultural welfare and technological progress.

VILNIUS TECH's vision for 2030 is to be an international and prestigious European technical university that stands out for the quality of its education and research, as well as its significant impact on individuals, communities, and society.

The value system of VILNIUS TECH's mission and vision is ingrained in the university's DNA and is demonstrated through its promoted activities.

The following values are fostered by the VILNUS TECH community and then shared with our partners:

- Sustainability. For us, this entails adopting a sustainable approach to nature and the environment, laying a foundation for long-lasting economic well-being, establishing and building a forward-thinking, harmonious society. It's about prioritising environmental and social needs over our own and adopting a future-orientated mindset.
- Connectivity. We define this as the synergy among various technologies, subjects, social groups, and problem-solving methods; as well as a continuous drive to collaborate, seek common ground, and contribute to the development of a multi-layered and multicultural society.
- Creativity. We have the courage to experiment, apply non-standard thinking, look for new unique opportunities in any situation, create solutions to overcome the challenges of the present and the future. VILNIUS TECH promotes the culture of technical makers who create for tomorrow.

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- Openness. We are the university without borders, where cooperation and networking with partners around the world, transparency of activities, acceptance of each person's individuality and uniqueness, opportunity to express one's ideas and be heard by others are important. We are open to the world and new experiences.
- Innovation. We persistently search for the best technological solutions that contribute to global progress in this rapidly evolving world.

2 The Research Landscape and Outstanding Research

Scientific research and experimental development projects are conducted across 13 institutes, 3 scientific centers, and 22 research laboratories. Some major facts and numbers:

- 1563 employees work at the university;
- 930 lecturers, scientists and researchers;
- 75% of the academic personnel hold a degree in science;
- Commercial research output of €4,3 million;
- 532 articles published in Clarivate Analytics Web of Science database journals;
- 543 articles for Scopus database publications;
- Doctoral studies are offered in 12 scientific fields.

In line with VILNIUS TECH's 2021–2030 Strategy and its established four moonshots, the university conducts research and innovation activities that support all moonshots, with a focus on empowering two of them: "International center of attraction for talent, business, society" and "Each partner receives a knowledge-based smart solution". The primary direction of the University Research Strategy is to carry out research and experimental development (R&D) activities in priority cross-cutting focus areas and fields:

1. **Sustainable building:**
   - smart building structures,
   - low emissions building materials and technologies,
   - architecture and build environment,
   - BIM and sustainable lifecycle of structures,
   - geodetic technologies;
2. **Environmental and energy technologies:**
   - efficient use of resources and energy,
   - environmental protection technologies,
   - building energetics,
   - renewable energy,
   - change of anthropogenic environment;
3. **Sustainable transport:**
   - autonomous land and air transport,
   - environment-friendly transport,
   - green logistics, international transport corridors,
   - traffic safety technologies,
   - urban mobility;

4. Mechatronics:
- smart embedded systems,
- mechatronics for Industry 4.0 systems,
- metamaterials and nano-structures,
- bionics and biomedicine engineering systems,
- innovative electronic systems;

5. Information and communication technologies:
- information and IT security,
- smart signal processing and telecommunication technologies,
- artificial intelligence and decision-making systems,
- geoinformation technologies,
- virtual and augmented reality;

6. Fundamental research on materials and processes:
- mathematical models of physical, technological and economic processes,
- investigations of cells and their biologically active components,
- economics engineering, management and communication,
- management of the development of contemporary organizations,
- high value-added economy,
- dynamic management,
- communication management in an inclusive and creative society,
- creative industries for digital society development.

The priority cross-cutting focus areas align with the most recent national (Smart Specialization, Lithuania 2030, New Generation Lithuania), European research and innovation strategies (Science Europe; Europe 2030;) and the United Nations Sustainable Development Agenda.

3 From Research to Innovation

The University's vision for 2030 is for VILNIUS TECH to become a prestigious and international European technical University, distinguished by the quality of studies and research, as well as its significant impact on individuals, communities, and society. Main objectives are directly related to scientific excellence in R&D, the European Universities initiative, integration into the European Research Area, empowerment and nurturing of talents for R&D activities and dissemination of knowledge for the application of solutions addressing society's needs.

The main means to achieve R&D goals are:
- Establishing research centers and enabling shared infrastructures that unite research groups from aviation, mechanics, transport, civil and environment engineering, electronics, informatics, management, economics, communication, humanities and other newly emerging priority fields to initiate and implement long-term international research and research-based innovation (Horizon 2020; Horizon Europe).
- Promoting Open Science, multidisciplinary R&D teams, and attracting frontier researchers and academic staff focused on tackling societal challenges.

- Developing and attracting talents to state-of-the-art international doctorate programmes that will provide next generation of researchers capable of conducting research across the European Research Area.
- Harmonizing university-level processes and refining personnel competencies that deal with all aspects supporting R&D project activities – from project idea generation and planning to its initiation, implementation and results dissemination.
- Developing new approaches to better recognise and promote a broader array of research outputs, as well as various career pathways and activities.
- Shaping of the remuneration and evaluation system to encourage influential scientific publications, cross-border R&D collaboration, and participation in the international research and research-based innovation projects.

To achieve the intended strategic goals, VILNIUS TECH community regularly analyses the results of R&D activities, consolidates human resources, and promotes interdisciplinary research activities. All processes for making strategic decisions and prepare strategic documents are defined in the VILNIUS TECH Quality Management System.

In order to reach this heights, VILNIUS TECH faculties, research centres, applied science institutes, and accredited laboratories already provide R&D services, offering innovative solutions, testing mock-ups in laboratories, and debugging prototypes in real-life conditions, in cooperation with fast-growing innovative businesses and young technological companies. It is encouraging to see the activity of all the units, the wide range of applications of their solutions, the orientation towards advanced technologies, and companies that implement them. VILNIUS TECH's strong relationship with Vilnius city as the main testing ground for our experiments and the latest smart solutions works well. We believe it is accurate to say that VILNIUS TECH already connects ambitious scientists, fosters technical creativity and the arts, and addresses societal challenges through the application of advanced technologies.

VILNIUS TECH researchers have developed a software tool to determine the emotional impact of visual content on viewer. The software is unique because it utilises affective computing technology. The viewer is shown visual content (e. g., an advertisement, a film) and a camera captures their facial expressions, while an artificial intelligence-based algorithm recognises the emotions the viewer is experiencing (e. g., sadness, boredom, interest, etc.). Content creators can check whether the viewers' reactions align with their intended outcome and make decisions on editing and improving the content. The software could be used by advertising, film, television and other visual content creators.

VILNIUS TECH scientists have created a unique demonstration structure – a pedestrian bridge using bio-concrete. Only a few experimental programmes worldwide have used bio-concrete for real structures. What makes bio-concrete special is that the bacteria inside it can spontaneously fill cracks in the structure without the need for routine repairs. This can significantly extend the structures life and reduce maintenance costs. Both the materials used in the construction of the bridge and the architecture emphasise the connection with nature.

This summer, graduates of the Antanas Gustaitis Aviation Institute and the founders of the space technology company Astrolight, together with the European Space Agency, carried out successful optical satellite communication tests at the Teide Observatory in Tenerife, Spain. During this test, the laser signal from the satellite was successfully redirected to the detector of the mobile station developed by VILNIUS TECH and Astrolight. Free-space

optical communication systems offer higher security and data throughput than radio communications. A laser satellite communication system is being developed for use in low Earth orbit and, in the future, throughout the Solar System to provide communications for missions to other planets.

VILNIUS TECH researchers have developed a product that allows people with visual impairments to move independently on public transport. The technology, called the Blind and Visually Impaired Information System, enables a blind or visually impaired person to identify the route number of a public transport vehicle that has stopped at a bus stop. The core of the system is the interactivity of a smart device owned by a blind or partially sighted person with the equipment installed in the public transport vehicle. The communication is two-way – the driver is also informed of the presence of a blind or partially sighted person near the vehicle. The prototype product was successfully tested in near real-life conditions with the participation of representatives from public transport entities and the Lithuanian Association of the Blind and Partially Sighted.

The Klaipėda Vaidila Square project, created by the researchers from the Faculty of Architecture at VILNIUS TECH, has been recognised by the international jury as the best landscape architecture project in Lithuania in the "Green Space 2022" competition. The authors of the project aimed to create a contemporary image of the city by preserving the original design of Vaidila Square and to breathe life into the square so that it would be a bustling place for people. While retaining the square's original rectangular structure, the designers added new spaces and activities, such as lounge areas, benches, moving urban furniture, significantly more greenery and trees, a stage, children's playgrounds, a dancing fountain, and a new bicycle path.

In a significant move this year, VILNIUS TECH is launching a joint laboratory facility that brings together the Faculties of Mechanics, Electronics, and Transport Engineering. This initiative aims to centralize and concentrate our capacity for research and experimental development. By consolidating our human resources and infrastructure within this innovative laboratory facility, we seek to foster a more dynamic interaction between academia, research, and innovation.

VILNIUS TECH is not only open to, but also particularly encourages, our ATHENA partners to engage in joint research projects, PhD student internships, and various other collaborative initiatives within these state-of-the-art facilities.

Figure 1. Joint Laboratory Facility for the Faculties of Mechanics, Electronics, and Transport Engineering

4 Involvement of Students

VILNIUS TECH aims to prepare and support the next generations of scientists, as it is a crucial factor in the development of advanced and modern technology and innovations. Nowadays, this goal of VILNIUS TECH is essential, considering the intense global competition for talent and the rapid and inevitable pace of scientific changes.

The university is working towards creating the conditions and meeting the needs for the next generation of researchers to flourish: it fosters early-stage researcher talents with attractive career structures, provides research positions with access to research facilities in laboratories and research centres, promotes careers in the research and academic sectors, and finances international mobility. Furthermore, VILNIUS TECH is creating the conditions at the university level to attract the brightest people to the doctoral programs.

Involving students in the research activities of departments and institutes significantly enhances their practical and theoretical skills and encourages them to pursue a scientific career in the future. VILNIUS TECH departments and institutes ensure their accessibility to students at all levels (bachelor's, master's, and doctoral students). Students have the opportunity to participate in research projects and are involved in research activities as laboratory staff.

Students have been able to take advantage of additional funding for research (Lithuanian Academy of Sciences, Competition of University Students' Research) and internships during the summer or their studies (Research Council of Lithuania, Internships during Summer and Semester).

A new VILNIUS TECH initiative, the "Student Involvement in Research Incentive Competition" (according to the internal competition of VILNIUS TECH Students' Involvement in R&D), was launched in the 2020/2021 academic year to encourage undergraduate students to get involved in research and pursue a career as a scientist. More than 90 research project topics have been offered to students.

VILNIUS TECH participates in both pre- and post-doctoral training programs that provide collaboration not only with experienced supervisors and scientists at VILNIUS TECH to support a student's pathway to becoming an independent researcher but also with an outstanding international scientific community to make science an integral part of a changing culture and policy worldwide.

5 The vision of ATHENA research-based cooperation

Trends in Europe and around the world, such as rapid technological development, digital transformation, the Green Deal, and the Industrial Revolution, are prompting universities to change. Global challenges – including climate change, economic instability, pandemics – pose threats, yet they also provide unique opportunity to pursue cutting-edge technological solutions, motivating swift and effective responses as well as long-term thinking.

VILNIUS TECH is prepared to face these challenges and changes. By building on the values of our community – sustainability, connectedness, creativity, openness, and innovation – we leverage our strengths.

Research Activities at the Carinthia University of Applied Sciences

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1 Introduction

CUAS is a university of applied sciences with regional roots and an international orientation. It is active in the priority fields of health and social affairs, business and various technology topics of engineering and constructions. Its core tasks are in the areas of study and teaching, applied research, knowledge transfer and training courses. More than 165 researchers with around 250 cooperation partners and a research volume of 8 mio € in 2022 bring new insights and impulses from science for business, industry, politics and society. Four research centers and 19 research groups conduct research with the aim of addressing socially and industrially relevant topics. The establishment of a doctoral program fosters junior scientists and provides overall carrier paths. The deliberate interweaving of teaching and research gives students the opportunity to become scientifically involved in projects up to the doctorate level at an early stage. Research and teaching are seen as necessary complements to each other. Outstanding quality in one area is only conceivable through outstanding quality in the other.

In addition to the classic task of research, namely to increase the prosperity of society, society and most funding institutions expect, above all, effective solutions to the global challenges we face due to various causes and effects. CUAS with its pillars of teaching, continuing education and research, contributes to the development of the necessary, multi-layered resilience in each of these core areas. In this context, research is reserved for bringing forward new concepts, ideas, approaches to solutions, pilot activities and implementations, for trying them out and for carrying them forward into teaching and further education. Applied research is oriented towards the issues of the future and is closely interwoven with regional, national and international partners. It represents a core competence of CUAS. In order to remain fit for the future, CUAS is growing thematically and structurally with the global issues in research and development. Concrete projects are continuously adapted to the dynamically changing environment through a rolling strategy process.

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With its research, CUAS aims to contribute to increasing the resilience of society, business and industry. The R&D as well as education ambitions are based on the principles of sustainability and inclusion, with a focus on reasonable digital solutions.

2 The Research Landscape

Research topics at CUAS are thematically clustered within 4 research centers and 19 research groups, which guarantee competence and know how, high quality research connected to transfer of knowledge, as well as any capacity needed. The topics are allocated within the meta themes human beings – technology – environment - economy and are application oriented by default. Innovation and technology management charactarize all research approaches of CUAS. Particular emphasis shall be given to research designs including accompanying topics, guaraneeting an holistic view on research issues, as well as new methods, new technologies and participative approaches. Citizen science research is interwoven with thematic research by involving citizens, stakeholders, students and pupils in R&D projects. CUAS´ research is locally effective and collaborates on pan-European issues, networks and European projects.

CUAS´ research unit FH Kärnten Research bundles all expertise for project submission, administration, monitoring, financial reporting, management and science communication. Each R&D project is guided by a R&D support of FH Kärnten Research, who takes care of financial monitoring and reporting, evidence of the audit trails and compliance with eligibility rules. Separate cost centers and an R&D project database guarantee clear cost assignment, spot-on financial monitoring, transparency and overview.

Own financial contributions of co-funded R&D projects are covered by an annually coordinated R&D budget. CUAS is based on public funding by federal, province and municipal grants. CUAS is experienced in project coordination of international R&D projects with up to 12 partners, and 2 mio € project volume. In 2022 a research volume of 8 mio € of co-financed projects was managed, comprising 120 R&D projects. Between 2013 and 2022 a total of 80 EU co-financed projects were successfully implemented.

CUAS strives to establish horizontal as well as vertical interconnections of its research landscape. Horizonal interconnections are represented by reflections on a research topic from different point of views (scientific disciplines), e.g. ageing in research center IARA, constructions and nature in research group CONNA, environmental health and geoinformation in research group EnHeGi. Permeability of cross cutting issues like digitalization, sustainability and resilience of society, nature and economy represents vertical interconnections.

3 Outstanding Research

Outstanding research is particularly bundled within CUAS´ research centers. Each research center is led by a renowned researcher in the respect scientific field, constitutes of international team members and performs cutting edge research in the topics of:

3.1 Additive Manufacturing- Center ADMIRE

ADMIRE is specializing in additive manufacturing, intelligent robotics, sensors, and engineering. The research focuses on the topics of Material, Design, Process, and Application, with a strong emphasis on sustainability. ADMIRE aims to push additive manufacturing as a fabrication technology towards the Green Deal and which enables easy access to everybody in need. Current application fields include: sensor integration into smart wearable systems, smart medical phantoms, development of smart prosthesis and orthosis systems with future prospects toward exo-skeletons, robotic path planning for 3D printing, sensor and system simulation for environmental perception and interaction based on tactile and proximity sensing, sensor signal processing and AI, robotic gripper design of multi-material and soft robotic systems.

3.2 Integrated Electronic Systems- Center CIME:

CIME is a competence center for research and development of integrated electronic systems. Integrated Circuits (ICs) became a key technology for modern electronic systems embedded in almost any application of daily life ranging from data processing, telecommunications, medical electronics, automotive and power electronics to any kind of miniaturized sensing networks. The monolithic integration of billions of transistors on a single silicon chip with an area of a few cm2 enables nowadays reliable and cost-efficient electronic platforms with enormous computing and signal processing power for future electronics. CIME is a competent research partner, with strong alignment to industry needs and the clear focus on research excellence with international visibility. The main topics are:

- Modelling and Design of Integrated Systems and Circuits
- Radio Frequency Front-Ends
- Sensor Integrations in Mechatronics Systems
- System-on-Chip Design Automation

3.3 Smart Materials – Center CISMAT:

CiSMAT is a Green Transition Competence Center, dedicated to the research and development of innovative solutions based on Smart Materials, for the industry and society of the future. CiSMAT works closely with a network of local and international companies, which it also supports in their transformation efforts towards a more efficient, more secure and greener industry. CiSMAT offers advanced trainings for R&D professionals and conducts research in the fields of:
Integrated piezoelectric sensors
Smart and meta-materials for improved acoustics and vibration mitigation
Phase-changing materials

3.4 Applied Research on Ageing – Center IARA:

At IARA research on the topic of ageing is networked across disciplines in order to take account of the challenges and potential of an ageing society. The main interests are laid on the changing living environments of older people, the technical support possibilities and on the economic framework conditions. Current findings and trends about ageing processes are collected, analysed and processed so that this knowledge can be made available to politics, business and civil society. IARA promotes in particular application-oriented and transdisciplinary approaches through its own projects. Research focuses on the topics of:

- Demographic change and regional development
- Social inclusion and participation until old age
- Socio-technological innovation

Outstandig research in CUAS´ research centers is characterized by research volumes exceeding 2 Mio € p.a., research topics that are crossing the boundaries of different scientific disciplines and involvement of a variety of researcher of different backgrounds and carrier stages.

Apart from research centers CUAS´ R&D activities are bundled within 19 research groups, each dedicated to a particular research focus. The research groups cover the topics of:

- Active & Assisted Living - Research group AAL
- Advanced Battery Management System – Research Group ABML
- Additive Manufacturing in Agile Virtual Systems for Design - Research Group AMAVIS
- Construction Needs Nature – Research Group CONNA
- Digital Transformation Modelling – Research Group DTMO
- Environmental Health and Geoinformation – Research Group EnHeGi
- Future Concrete Solutions – Research Group FuCoSu
- Innovation Research and Transformation – Research Group IRaT
- Spatial Informatics for Environmental Applications – Research Group SIENA
- Online & Pocket Labs – Research Group OuPL
- Modelling and Design of Integrated Systems and Circuits – Research Group OuPL
- 5G Use Case Integrations – Research Group ROADMAP 5G
- Smart Materials for a Greener Industry – Research Group SMGi
- Sensor Integrations in Mechatronics Systems – Research Group SIMS
- TRANSformative Societal and Political Cultural Engagement – Research Group TRANS SPACE
- Entrepreneurship & Entrepreneurship Education – Research Group TRIPLE E
- Management of Conservation Areas – Research Group MCA
- Interprofessional treatment approach for patients with osteoarthritis – Research Group PEREZOSO
- Sustainable Innovation Research and Development – Research Group SIRAD

4 From Research to Innovation

R&I at CUAS is applied by default and closely interwoven with regional, national and international partners from public and private sectors. Bringing research and innovation back to the market is our main intention. We pursue this intention by a) cooperating with partner from industry and private sector, b) fostering the start-up and spin-off scene by providing entrepreneurial starter support. A dedicated fundiging cooperation between CUAS and the Carinthian Economy Funding Agency supports young founder by financial, infrastructural and know-how matters. The elaborated educational program "Scientrepreneur – Basic knowledge for founder" was intiated and implemented by experienced innovation manager of CUAS´research group TRIPLE-E (see section 3 – Outstanding research). It covers topics from entrepreneurship thinking & strategy, innovation & business modelling, founding & financing and marketing & exploitation and brings together interested persons with external experts from each topic.

5 Involvement of Students

CUAS routinely involves students in research activities by providing topics for Bachelor or Masters Theses as well as research collaborations in R&D projects. PhD positions and a docotoral program provide continuous academic career paths and foster young talents.

6 The vision of ATHENA research-based cooperation

As an institution, Carinthia University of Applied Sciences (CUAS) is always eager to further its research and teaching excellence, as well as to increase its visibility and involvement on the European level.

CUAS sees itself as an integral part of the network in the area of R&D, and thus strives to increase its participation in the European Research Area through the Alliance. CUAS is willing to share its expertise, research laboratories and equipment with the ATHENA universities and is ready to learn from them in return. CUAS vision of research is that cooperation between people from different backgrounds, be it in disciplines, focuses or cultures, allows for richer and more fruitful results. Hence, the research-based cooperation between ATHENA and CUAS will enrich our institutions' fields of research, while also offering our researchers opportunities to gain experiences within ATHENA.

Chapter 2

Annotated Bibliography

Hellenic Mediterranean University

1 Physical Sciences and Engineering

Cybersecurity for Industrial Internet of Things: Architecture, Models and Lessons Learned

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Abstract Modern industrial systems now, more than ever, require secure and efficient ways of communication. The trend of making connected, smart architectures is beginning to show in various fields of the industry such as manufacturing and logistics. The number of IoT (Internet of Things) devices used in such systems is naturally increasing and industry leaders want to define business processes which are reliable, reproducible, and can be effortlessly monitored. With the rise in number of connected industrial systems, the number of used IoT devices also grows and with that some challenges arise. Cybersecurity in these types of systems is crucial for their wide adoption. Without safety in communication and threat detection and prevention techniques, it can be very difficult to use smart, connected

systems in the industry setting. In this paper we describe two real-world examples of such systems while focusing on our architectural choices and lessons learned. We demonstrate our vision for implementing a connected industrial system with secure data flow and threat detection and mitigation strategies on real-world data and IoT devices. While our system is not an off-the-shelf product, our architecture design and results show advantages of using technologies such as Deep Learning for threat detection and Blockchain enhanced communication in industrial IoT systems and how these technologies can be implemented. We demonstrate empirical results of various components of our system and also the performance of our system as-a-whole.

Keywords Blockchains, Focusing, Market research, Safety, Deep learning, Reliability, Computer security, Internet of Things, Anomaly detection

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Development of Mobile IoT Solutions: Approaches, Architectures, and Methodologies

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Abstract Modern Living, as we know it, has been impacted meaningfully by the Internet of Things (IoT). IoT consists of a network of things that collect data from machines (e.g., mobile devices) and people. Mobile application development is a flourishing tendency, given the increasing popularity of smartphones. Nowadays, users are accessing their desired services on the smartphone by means of dedicated applications as the latter offers a more customized and prompt service. In addition, companies are also looking to persuade users by offering interactive and effective mobile applications. Mobile application developers are using IoT to develop better applications. However, there is no generalized consensus on the selection of best architecture or even the most suitable communications protocols to be used on an IoT application development. Therefore, this article aims at presenting approaches, architectures, and methodologies relevant to the development of mobile IoT solutions.

Keywords Architecture, Internet of Things (IoT), methodology, mobile development

Publication IEEE Internet of Things Journal, Volume 8, Issue 22, Pages 16452 - 1647215

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Improving recommender systems via a Dual Training Error based Correction approach

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Abstract We propose a method to improve the prediction performance of recommender systems via a Dual (user and item) Training Error based Correction approach (DTEC). The proposed method is applied to the Synthetic Coordinate Recommendation system (SCoR) (Papadakis et al., 2017) and to other three state-of-the-art systems. Initially, a recommender system is used to provide recommendations for users and items. Subsequently, we introduce a second stage, after initial execution of the recommender system, that improves its predictions taking into account the error in the training set between users and items and their similarity. These corrections can be performed from both user and item viewpoints, and finally a dual system is proposed that efficiently combines both corrections. DTEC computes a model that makes zero the recommendation error in the training set, and then applies it on the test set to improve the rating predictions. The proposed DTEC approach is applicable to any model-based recommender system with positive training error, potentially increasing the accuracy of the recommendations. The experimental results demonstrate the efficiency and high performance of DTEC on four well-known, real-world datasets.

Keywords Recommender system, Collaborative filtering, Matrix factorization, User/item similarity, Synthetic coordinates

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UAV Trajectory Optimisation in Smart Cities using Modified A* Algorithm Combined with Haversine and Vincenty Formulas

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Abstract It is anticipated that the backbone of Smart Cities concerning automation and networking will be formed by Unmanned Aerial Vehicles in the imminent future. Therefore, our research focuses on developing advanced microcontrollers embedded with Artificial Intelligence techniques for self-governing Unmanned Aerial Vehicles. The main objective of this research was to enable full automation for the execution of flight paths with non-trivial sequences that will be performed with centimetre-level accuracy. Also, by utilising dynamic flight plans and trajectories, we aim to secure autonomous aviation based on norms, with control loops and fundamental constraints. More specifically, we evolved a novel algorithmic technique for trajectory optimisation, which deploys a modification to the A* search algorithm, implemented by the Haversine formula and enhances accuracy using Vincenty's formula. Furthermore, realistic values for trajectory optimisation and obstacle avoidance were found through the implementation of a simulative investigation. The outcomes of our methodology indicate that the safety constraints associated with the integration of Unmanned Aerial Vehicles in the urban environment can be significantly mitigated. Consequently, their effectiveness will be increased in realising their diverse operations and capabilities.

Keywords Unmanned aerial vehicles, air traffic control, air transportation, Smart vehicles, aircraft navigation, Internet of Things, Autonomous

Publication IEEE Transactions on Vehicular Technology, early access

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COVID-19 and holiday intentions: The case of Crete, Greece

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Abstract COVID-19 pandemic has impacted the global tourism sector in an unprecedented manner (Gössling et al., Citation2020; Hall et al., Citation2020). At the current phase of the outbreak, where several tourist destinations have started to relax travel restrictions, important questions that need to be addressed are how far tourists have been affected by the pandemic, and what their current travel intentions are. This paper aims to examine the degree to which tourists' intentions have been affected as a result of the pandemic. The current research endeavour focuses on the island of Crete as the case study. Crete is the largest island of Greece. It is a famous destination for international and domestic tourists, with more than 40 percent of regional GDP coming from tourism. At the time of the research, there were 15 confirmed COVID – 19 cases throughout the island. This study significantly contributes to the respective literature since it is one of the first surveys offering empirical evidence for travelling behaviour during the pandemic.

Keywords Covid-19, tourism, travelling behaviour, Crete

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Integration of two-dimensional materials-based perovskite solar panels into a stand-alone solar farm

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Abstract As a vital step towards the industrialization of perovskite solar cells, outdoor field tests of large-scale perovskite modules and panels represent a mandatory step to be accomplished. Here we demonstrate the manufacturing of large-area (0.5 m2) perovskite solar panels, each containing 40 modules whose interfaces are engineered with two-dimensional materials (GRAphene-PErovskite (GRAPE) panels). We further integrate nine GRAPE panels for a total panel area of 4.5 m2 in a stand-alone solar farm infrastructure with peak power exceeding 250 W, proving the scalability of this technology. We provide insights on the system operation by analysing the panel characteristics as a function of temperature and light intensity. The analysis, carried out over a months-long timescale, highlights the key role of the lamination process of the panels on the entire system degradation. A life-cycle assessment based on primary data indicates the high commercial potential of the GRAPE panel technology in terms of energy and environmental performances.

Keywords Environmental management; Environmental technology; Life cycle; Perovskite solar cells; Solar concentrators; Solar panels

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A Survey on the Internet of Things (IoT) Forensics: Challenges, Approaches, and Open Issues

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Abstract Today is the era of the Internet of Things (IoT). The recent advances in hardware and information technology have accelerated the deployment of billions of interconnected, smart and adaptive devices in critical infrastructures like health, transportation, environmental control, and home automation. Transferring data over a network without requiring any kind of human-to-computer or human-to-human interaction, brings reliability and convenience to consumers, but also opens a new world of opportunity for intruders, and introduces a whole set of unique and complicated questions to the field of Digital Forensics. Although IoT data could be a rich source of evidence, forensics professionals cope with diverse problems, starting from the huge variety of IoT devices and non-standard formats, to the multi-tenant cloud infrastructure and the resulting multi-jurisdictional litigations. A further challenge is the end-to-end encryption which represents a trade-off between users' right to privacy and the success of the forensics investigation. Due to its volatile nature, digital evidence has to be acquired and analyzed using validated tools and techniques that ensure the maintenance of the Chain of Custody. Therefore, the purpose of this paper is to identify and discuss the main issues involved in the complex process of IoT-based investigations, particularly all legal, privacy and cloud security challenges. Furthermore, this work provides an overview of the past and current theoretical models in the digital forensics science. Special attention is paid to frameworks that aim to extract data in a privacy-preserving manner or secure the evidence integrity using decentralized blockchain-based solutions. In addition, the present paper addresses the ongoing Forensics-as-a-Service (FaaS) paradigm, as well as some promising cross-cutting data reduction and forensics intelligence techniques. Finally, several other research trends and open issues are presented, with emphasis on the need for proactive Forensics Readiness strategies and generally agreed-upon standards.

Keywords Security, Digital forensics, Internet of Things, Tools, Standards, Cloud computing

Publication IEEE Communications Surveys and Tutorials, Open Access, Volume 22, Issue 2, Pages 1191 – 1221

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A soft-bodied aerial robot for collision resilience and contact-reactive perching

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Abstract Current aerial robots demonstrate limited interaction capabilities in unstructured environments when compared with their biological counterparts. Some examples include their inability to tolerate collisions and to successfully land or perch on objects of unknown shapes, sizes, and texture. Efforts to include compliance have introduced designs that incorporate external mechanical impact protection at the cost of reduced agility and flight time due to the added weight. In this work, we propose and develop a lightweight, inflatable, soft-bodied aerial robot (SoBAR) that can pneumatically vary its body stiffness to achieve intrinsic collision resilience. Unlike the conventional rigid aerial robots, SoBAR successfully demonstrates its ability to repeatedly endure and recover from collisions in various directions, not only limited to in-plane ones. Furthermore, we exploit its capabilities to demonstrate perching where the three-dimensional collision resilience helps in improving the perching success rates. We also augment SoBAR with a novel hybrid fabric-based bistable (HFB) grasper that can utilize impact energies to perform contact-reactive grasping through rapid shape conforming abilities. We exhaustively study and offer insights into the collision resilience, impact absorption, and manipulation capabilities of SoBAR with the HFB grasper. Finally, we compare the performance of conventional aerial robots with the SoBAR through collision characterizations, grasping identifications, and experimental validations of collision resilience and perching in various scenarios and on differently shaped objects.

Keywords soft aerial robots, passive dynamics, soft fabric-based robots, collision resilient aerial robots, perching

Publication Soft Robotics, [Ahead of Print]

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Multi-functional medical grade Polyamide12/Carbon black nanocomposites in material extrusion 3D printing

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Abstract Carbon black (CB) modified polyamide 12 (PA12) nanocomposites (PA12/CB) were fabricated through melt mixing extrusion for a range of different filler weight-to-weight ratios (0.1%, 0.5%, 1.0%, 2.5%, 5.0%, and 10.0%). Filaments fabricated via thermomechanical extrusion, were employed to manufacture electrothermally conductive nanocomposites, through 3D Printing Fused Filament Fabrication (FFF). Mechanical performance was assessed, whilst, the electrical percolation threshold was identified, with the nanocomposites exhibiting electrical conductivity for a filler ratio of 2.5 wt% and above. Scanning Electron Microscopy (SEM) was conducted to reveal nanocomposite's fracture mechanisms. Dynamic Mechanical Analysis (DMA) tests revealed a stiffening mechanism, while the antibacterial response of the nanocomposites for two bacteria was also investigated through a screening process, i.e., Escherichia coli (E. Coli) and Staphylococcus aureus (S. aureus). The highest reinforcement was observed at the PA12/CB 5.0 wt% nanocomposite material. The increase of the nanofiller concentration increased the electrical conductivity and the antibacterial performance of the nanocomposites. A better biocidal response was found against the S. aureus bacterium than the E. Coli bacterium. The studied nanocomposites, exhibited multifunctional behavior, suitable for various applications requiring enhanced mechanical performance, such as free-of-shape and stretchable conductors, circuitry resistors, Joule-heating elements, piezoresistive sensors, etc., as well as medical supplies.

Keywords Three-dimensional (3D) Printing; Nanocomposites; Flexible Conductors; 3D Printed Electronics; Conductive Polymer Composites (CPCs); Electrothermal Effect

Publication Composite Structures, Volume 311, 116788

Date 1 May 2023

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High-intensity laser-driven secondary radiation sources using the ZEUS 45 TW laser system at the Institute of Plasma Physics and Lasers of the Hellenic Mediterranean University Research Centre

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Abstract The rapid development of high-intensity laser-generated particle and photon secondary sources has attracted widespread interest during the last 20 years not only due to fundamental science research but also because of the important applications of this developing technology. For instance, the generation of relativistic particle beams, betatron-type coherent X-ray radiation and high harmonic generation have attracted interest from various fields of science and technology owing to their diverse applications in biomedical, material science, energy, space, and security applications. In the field of biomedical applications in particular, laser-driven particle beams as well as laser-driven X-ray sources are a promising field of study. This article looks at the research being performed at the Institute of Plasma Physics and Lasers (IPPL) of the Hellenic Mediterranean University Research Centre. The recent installation of the ZEUS 45 TW laser system developed at IPPL offers unique opportunities for research in laser-driven particle and X-ray sources. This article provides information about the facility and describes initial experiments performed for establishing the baseline platforms for secondary plasma sources.

Keywords High power laser, laser plasma, secondary sources

Publication High Power Laser Science and Engineering, Volume 9, 2021, e53

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Wearable textile antenna with a graphene sheet or conductive fabric patch for the 2.45 GHz band

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Abstract Textile patch antennas of simple rectangular, triangular, and circular shape, for operation in the 2.4–2.5 GHz free industrial, scientific, and medical (ISM) band, are designed in this paper. Thirty-six patch antenna prototypes have been fabricated by engaging different patch geometries, patch materials, and substrate materials. Each patch antenna is designed after optimization by a genetic algorithm, which evolves the initial dimensions and feeding position of the prototype's microstrip counterpart to the final optimal geometrical characteristics of the wearable prototype (with the originally selected shape and materials). The impact of the design and fabrication details on antenna performance were thoroughly investigated. Graphene sheet patches were tested against conductive fabric and copper sheet ones, while denim and felt textile substrates were competing. The comparative study between a large number of different graphene, all, and copper textile prototypes, which revealed the excellent suitability of graphene for wearable applications, is the main contribution of this paper. Additional novelty elements are the compact, flexible, and easy-to-fabricate structure of the proposed antennas, as well as the use of state-of-the-art conductive materials and commercially available fabrics and the extensive investigation of many prototypes in various bending conditions. Simulations and measurements of the proposed antennas are in very good agreement. All fabricated prototypes are characterized by flexibility, light weight, mechanical stability, resistance to shock, bending and vibrations, unhindered integration to clothes, low-cost implementation, simple, time-saving, and industry-compatible fabrication process, and low specific absorption rate (SAR) values (computed using rectangular and voxel models); the graphene prototypes are additionally resistant to corrosion, and the circular ones have very good performance under bending conditions. Many antenna prototypes demonstrate interesting characteristics, such as relatively wide bandwidth, adequate gain, firm radiation patterns, coverage of the ISM band even under bending, and very low SAR values. For example, the circular graphene patch (with 55.3 mm diameter attached upon a 165.9 × 165.9 mm) felt substrate CGsF1 prototype accomplishes 109 MHz measured bandwidth, 5.45 dBi gain, 56% efficiency, full coverage of the ISM band under bending, and SAR less than 0.003 W/Kg.

Keywords patch antenna; curved antenna; textile antenna; wearable antenna; graphene sheet patch; conductive fabric patch

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Resource-aware adaptive indexing for in situ visual exploration and analytics

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Abstract In in situ data management scenarios, large data files, which do not fit in main memory, must be efficiently handled using commodity hardware, without the overhead of a preprocessing phase or the loading of data into a database. In this work, we study the challenges posed by the visual analysis tasks in in situ scenarios in the presence of memory constraints. We present an indexing scheme and adaptive query evaluation techniques, which enable efficient categorical-based group-by and filter operations, combined with 2D visual interactions, such as exploration of data points on maps or scatter plots. The indexing scheme combines a tile-based structure, which offers efficient visual exploration over the 2D plane, with a tree-based structure, which organizes a tile's objects based on its categorical values. The index is constructed on-the-fly, resides in main memory, and is built progressively as the user explores parts of the raw file, whereas its structure and level of granularity are adjusted to the user's exploration areas and type of analysis. To handle the cases where limited resources are available, we introduce a resource-aware index initialization mechanism, we formulate it as an NP-hard optimization problem and we propose two efficient approximation algorithms to solve it. We conduct extensive experiments using real and synthetic datasets and demonstrate that our approach reports interactive query response times (less than 0.04sec) and in most cases is more than 100× faster and performs up to two orders of magnitude less I/O operations compared to existing solutions. The proposed methods are implemented as part of an open-source system for in situ visual exploration and analytics.

Keywords Data visualization, Visual analytics, Adaptive indexing, In-situ processing, Interactive exploration

Publication S. Maroulis, N. Bikakis, G. Papastefanatos, P. Vassiliadis, and Y. Vassiliou, "Resource-aware adaptive indexing for in situ visual exploration and analytics", The VLDB Journal, vol. 32, pp. 199–227

Date 2023

DOI https://doi.org/10.1007/s00778-022-00739-z

2 Social Sciences and Humanities

Exploring the Behavioral Intentions of Food Tourists Who Visit Crete

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Abstract Food tourism has been growing globally in recent years. Food tourism is considered as special interest tourism, attracting tourists who have a great interest in food. Tourists spend a significant percentage of their budget on the purchase of local food products and related food activities, contributing to the sustainable development of the touristic destination in the process. This survey took place in Crete, Greece, throughout the touristic period of 2021, and 4268 valid questionnaires were completed by international tourists. For the data analysis, the Structural Equation Model and an extended Theory of Planned Behavior Model, based on subjective norms, attitudes, perceived behavioral control, and satisfaction, were used to better understand the consumers' intentions to revisit and recommend the region of Crete. The outcomes of the research pinpointed that the perceived quality and perceived value of local foods positively influenced satisfaction, which, in turn, evoked favorable intentions to revisit and recommend Crete as a touristic destination. Moreover, while satisfaction, attitude, and subjective norms seem to be the most significant drivers affecting positive behavioral intentions, perceived behavior control seems to have had no significant impact. The implications and limitations of the survey, as well as future recommendations, are also discussed.

Keywords food tourism; Theory of Planned Behavior; attitude; subjective norms; perceived behavioral control; satisfaction; motivational factors; behavioral intentions

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Gamified or traditional situational judgement test? A moderated mediation model of recommendation intentions via organizational attractiveness

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Abstract Recently, gamification and gamified assessment methods have attracted increasing attention among both scholars and practitioners in recruitment and selection. However, little is known about the role of gamified assessment methods in determining applicant outcomes and, even more, their effect compared to more traditional methods. Using signalling theory as an overarching theoretical framework, the present study attempts to contribute to this gap by comparing the effect of a gamified situational judgement test which includes game elements, such as avatars, narrative and fantasy on applicants' recommendation intentions through their organizational attractiveness compared to a traditional situational judgement test. Moreover, we suggest that these effects are moderated by applicants' videogaming experience. Using experimental design, we found that the positive effect of the gamified assessment method compared to the traditional method on organizational attractiveness and, in turn, recommendation intentions was significant only for those with a high level of video gaming experience. Implications for theory and practice are discussed.

Keywords Gamified assessment method; situational judgement test; organizational attractiveness; recommendation intentions; video gaming experience

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The fraud triangle–an alternative approach

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Abstract In recent years, Public Accountability and Integrity have been matters of growing attention, both in the public and private sector, as citizens demand value for money entrusted to the governments through their taxes. In addition, in many countries, after the recent recession, government budgets and corporate returns have been reduced. Many corporate scandals have occasionally become known and have had a great impact on confidence in the market. Even worse, after the pandemic of COVID-19, «bare and exacerbated massive preexisting problems in the world's economic, social and security order, threatens to push up to 100 million people into extreme poverty in 2020, struck at a time of dwindling trust in representative governance» (UNDP, 2020). The funds of organizations in the private and public sector have been shrinking, whereas the situational pressures of fraud are increased. In this context, Dorris, President and CEO of the ACFE warns for explosion of fraud in the coming years and reminds that during the 2008 economic, companies cut-off, non-revenue generating activities, such as the internal audit and the compliance departments leaving them exposed to fraud. Therefore, organizations have to do more with less. The purpose of this paper is to present the development of the fraud theory on the management's perspective aiming to contribute to the efficient development of anti-fraud mechanisms. Having identified the fraud theory developed so far, we provide a framework for the fraud risk management. This paper incorporates cost/benefits considerations, practical considerations and empirical evidence on fraud. This paper provides valuable information to enable the management, who has the primary responsibility to prevent and detect fraud, to disclaim responsibility by broadening their understanding of fraud theory.

Keywords Fraud, Corruption, Fraud triangle, Fraud diamond, Hierarchy of needs

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Independent policy, dependent outcomes: A game of cross-country dominoes across European yield curves

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Abstract This study investigates the dynamic transmission mechanism between 2Y, 5Y and 10Y interest rate swaps (IRS) for six European currencies (CHF, DKK, EUR, GBP, NOK and SEK) from August 6, 1999 to March 4, 2021 applying the time-varying parameter vector autoregressive connectedness approach in the spirit of Antonakakis et al. (2020). Furthermore, we propose a novel conditional connectedness approach that extends the original framework (Diebold and Yilmaz, 2012, 2014) by analysing dynamic connectedness measures in more depth and improving the interpretability of information concerning the cross-maturity/cross-currency propagation mechanism. We document that EUR and DKK have been the most prominent transmitters of shocks in the network. We also find that the 10Y IRS has increasingly assumed a net-transmitting role at the expense of the 2Y IRS—in line with a shift towards unconventional monetary policy and quantitative easing. From a policy-making perspective, this implies means that the role of the domestic short-term interest rate has become significantly less relevant for the monetary transmission mechanism at the expense of the foreign long-term interest rate.

Keywords Aggregated connectedness; Conditional connectedness; Dynamic connectedness; Interest rate swaps; TVP-VAR; Yield curves

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Inspiring winery experiences to benefit destination branding? Insights from wine tourists at Yantai, China

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Abstract The purpose of this study is to explore the impact of service quality on the formation of destination brand equity through customer satisfaction at a winery, from the perspective of Chinese wine tourists. This study utilized a survey research design. A convenience sample of 311 visitors to a major winery located in Yantai, China, was surveyed, and 265 useable questionnaires were analyzed. To analyze the data, the study used partial least squares structural equation modeling (PLS-SEM). The results of the study reveal that service quality at a winery is a significant determinant of winery satisfaction among Chinese wine tourists, which in turn affects the brand equity of a wine tourism destination. This study contributes to the growing body of literature focusing on identity-based branding in the context of wine tourism. As such, this study brings together knowledge of a place branding dimension (i.e. destination brand equity), satisfaction and tourism experience at a winery. The results suggest that the road to favorable assessments of a wine destination brand (macro level) go through a satisfying experience at a winery (micro level). Therefore, the need to co-create the wine experience through various stakeholders' involvement is crucial for the success of wine tourism.

Keywords Winery service quality, Satisfaction, Destination brand equity, Chinese wine tourists

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Financial stress, economic policy uncertainty, and oil price uncertainty

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Abstract The role of non-financial sector market fluctuations such as the role of oil price uncertainty either on financial stability or on policy-related economic uncertainty has not been investigated extensively. This study examines the connectedness of financial stress and economic policy uncertainty with a non-financial market of Brent oil and its prices, by employing a Diebold and Yilmaz (2012, 2014) generalized framework and a TVP-VAR model specification. We use monthly series of 7 advanced countries, namely the US, UK, Canada, Japan, Germany, France, and Italy and 2 different indices for measuring financial stress (FSI) and economic policy uncertainty (EPU), over the period 2007–2020. Furthermore, the literature on oil price uncertainty and its effect on financial stress and on economic policy uncertainty is scarce. We additionally, examine the impact of oil price volatility on FSI and on EPU, by employing a structural VAR-GARCH-M model specification and IRFs analysis. Our results from the dynamic connectedness analysis indicate that during the COVID-19 pandemic, spillovers have increased substantially but not exceeded the Global Financial Crises 2007 levels. Finally, our estimation results from the IRFs analysis reveal that oil price uncertainty is associated with higher financial stress for some of the G7 countries while it is not related to economic policy uncertainty.

Keywords FSI, financial stress; Financial stability; Economic policy uncertainty EPU; Oil price shock; Spillovers; GARCH-M; Impulse responses; Pandemic

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Greek government-debt crisis events and European financial markets: News surprises on Greek bond yields and inter-relations of European financial markets.

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Abstract We study the impact of Greek government-debt crisis events on inter-relations of European financial markets during the European sovereign debt crisis. To this end, we examine the effects of three categories of Greek government-debt crisis events in the realized correlations and correlation jumps of government bonds, CDS, and stock indices of seven European countries (i.e., France, Germany, Greece, Ireland, Italy, Portugal, and Spain) via the respective dummy variables and news surprises on 2-year, 5-year, and 10-year government bonds and CDS in a non-parametric framework by employing Tobit regression models. According to the results, the direction of most impacts on correlations and correlation jumps is negative, suggesting that the Greek government-debt crisis events reduced the homogeneity among member states in the Eurozone. We also investigate the types of Greek government-debt crisis events that have the highest impacts on correlations and correlation jumps and find that the highest impacts mainly result from news originating from Greek and European sources.

Keywords Contagion; Correlation jumps; Greek debt crisis; Realized correlation

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Exploring the Psychosocial Needs of People Living in Extreme Poverty and Introducing Brief Interventions: The Case of Crete Region in Greece

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Abstract The financial crisis of the last decade has increased the number of people living in extreme poverty in Greece. Despite this fact, little evidence exists on their profile and psychosocial needs. The current study explored the socioeconomic circumstances and psychosocial profile of 798 people confronted with severe poverty. This article further reports on brief interventions introduced at individual-, group-, and community level to address the psychosocial burden of these people.

According to the results, a huge health and mental health burden was found among the participants. People also experienced long periods of unemployment, bad housing and living conditions, and absence of a supportive social/family network. Brief interventions increased people's self-awareness, self-expression, and self-esteem and improved their problem-solving and coping skills.

Integrated and family-focused care seems necessary. Mapping the biopsychosocial needs of these people is important for health care and social welfare planning.

Keywords poverty, field of practice, mental health, counseling, outcome study, intervention, welfare recipients, population

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Social capital, social support and perceived stress in college students: The role of resilience and life satisfaction

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Abstract The study examined whether online and offline social capital and offline social support are associated with less perceived stress in 403 undergraduate Greek college students through the mediating role of resilience and life satisfaction. Gender differences were also explored. A path analysis explored the relationships among the study variables and multi-group analysis explored gender differences. Perceived stress was predicted indirectly by offline social support and offline bonding social capital through resilience and life satisfaction and directly by online bonding. However, offline bonding was associated with reduced resilience and life satisfaction, whereas social support was associated with increased levels of both. Interestingly, whereas offline bonding was associated with reduced perceived stress through resilience for women, for men it occurred through life satisfaction, and it was primarily resilience for women and life satisfaction for men that predicted reduced perceived stress. It was concluded that different personal ties/relationships are associated with perceived stress through diversified pathways and the pathways are different for men and women. Offline social support between closely tied persons is positively associated and offline bonding is negatively associated with the inner resources for a person to cope with stress, whereas online bonding is beneficial in directly decreasing stress.

Keywords A path model; close relationships; gender differences; mental health; perceived stress; social relationships; stress reduction.

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Trauma Recovery Rubric: A Mixed-Method Analysis of Trauma Recovery Pathways in Four Countries

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Abstract Research is beginning to examine gender-based violence (GBV) survivors' recovery, but little is known about diverse recovery trajectories or their relationships with other distress and recovery variables. This interdisciplinary, international multisite mixed-method study developed and used the TRR to identify and classify survivors' trauma pathways. This study describes the phases of the initial development of the preliminary TRR (Phase 1), refines and calibrates the TRR (Phase 2), and then integrates the TRR into quantitative data from four countries (Phase 3). Seven recovery pathways with six domains emerged: normalizing, minimizing, consumed/trapped; shutdown or frozen, surviving, seeking and fighting for integration; finding integration/equanimity. Depression scores were related to most recovery domains, and TRR scores had large effect sizes. At the same time, PTSD was not statistically related to TRR scores, but TRR had a medium effect size. Our study found that the TRR can be implemented in diverse cultural settings and promises a reliable cross-cultural tool. The TRR is a survivor-centered, trauma-informed way to understand different survivorship pathways and how different pathways impact health outcomes. Overall, this rubric provides a foundation for future study on differences in survivor healing and the drivers of these differences. This tool can potentially improve survivor care delivery and our understanding of how to meet best the needs of the survivor populations we intend to serve.

Keywords trauma; recovery; rubric; mixed method

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3 Life sciences

Phytochemical Analysis of the Aerial Parts of Campanula pelviformis Lam. (Campanulaceae): Documenting the Dietary Value of a Local Endemic Plant of Crete (Greece) Traditionally Used as Wild Edible Green

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Abstract Abstract: Native wild edible greens usually include plants with widespread geographical ranges and represent a long tradition associated with well-documented health effects, especially in the frame of the Mediterranean diet. Although consuming local endemic and range-restricted plants as wild edible greens is rare, in some areas of Crete this is a long ethnobotanical tradition. The present study is focused on the phytochemical and nutritional element analyses of the edible parts of the wild-growing green Campanula pelviformis. To date, nine secondary metabolites have been isolated: lobetyolin (1), calaliukiuenoside (2), demethylsyrrigin (3), wahlenoside A (4), chlorogenic acid methyl (5) and butyl ester (6), nicotiflorin (7), rutin (8) and corchoionoside A (9). This first-time research on the phytochemical composition of this local endemic plant of Crete is a basic step in attempts to document its nutritional value, also allowing an exploration of its beneficial properties. The nutritional value of the Mediterranean diet owes much to the inclusion of native edible wild plants, which are abundant in mineral elements and bioactive compounds known to promote human health. Among these plants, the local Cretan endemic species C. pelviformis stands out as a rare and valuable source of wild edibles with traditional dietary significance in eastern Crete. This plant's rich content of mineral elements and bioactive compounds makes it an intriguing subject for further research into the potential health benefits of wild plant consumption. .

Keywords Cretan diet; phytonutrients; minerals; megastigmane; calaliukiuenoside

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Adherence to the Mediterranean Diet Is Associated with a More Favorable Left Ventricular Geometry in Patients with End-Stage Kidney Disease

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Abstract Introduction. The aim of the study was to examine the impact of adherence to a Mediterranean-style diet (MD) on left ventricular hypertrophy (LVH) and cardiac geometry in chronic kidney disease patients on dialysis (CKD-5D), given the high prevalence of cardiovascular morbidity in this population. Methods. n = 127 (77 men and 50 women) CKD-5D patients (69 on hemodialysis and 58 on peritoneal dialysis) with a mean age of 62 ± 15 years were studied. An MD adherence score (MDS) (range 0–55, 55 representing maximal adherence) was estimated with a validated method. Echocardiographic LVH was defined by LV mass index (LVMI) > 95 g/m2 in women and >115 g/m2 in men. Based on LVMI and relative wall thickness (RWT), four LV geometric patterns were defined: normal (normal LVMI and RWT), concentric remodelling (normal LVMI and increased RWT > 0.42), eccentric LVH (increased LVMI and normal RWT), and concentric LVH (increased LVMI and RWT). Results. Patients with LVH (n = 81) as compared to patients with no LVH (n = 46) were older in age (66 ± 13 vs. 55 ± 16 years; $p < 0.001$) had lower MDS (24 ± 2.7 vs. 25 ± 4.3; $p< 0.05$) and higher malnutrition-inflammation score (5.0 ± 2.7 vs. 3.9 ± 1.9; $p < 0.05$), body mass index (27.5 ± 4.9 vs. 24.1 ± 3.5 kg/m2; $p < 0.001$), prevalence of diabetes (79% vs. 20%; $p < 0.05$), coronary artery disease (78% vs. 20%; $p < 0.05$) and peripheral vascular disease (78% vs. 20%; $p < 0.01$). In a multivariate logistic regression analysis adjusted for all factors mentioned above, each 1-point greater MDS was associated with 18% lower odds of having LVH (OR = 0.82, 95% CI: 0.69–0.98; $p <0.05$). MDS was inversely related to LVMI ($r = -0.273$; $p = 0.02$), and in a multiple linear regression model (where LVMI was analyzed as a continuous variable), MDS emerged as a significant ($B = -2.217$; $p < 0.01$) independent predictor of LVH. Considering LV geometry, there was a progressive decrease in MDS from the normal group (25.0 ± 3.7) to concentric remodelling (25.8 ± 3.0), eccentric (24.0 ± 2.8), and then concentric (23.6 ± 2.7) group ($p < 0.05$ for the trend). Conclusions. The greater adherence to an MD is associated

with lesser LVH, an important cardiovascular disease risk factor; MD preserves normal cardiac geometry and may confer protection against future cardiac dysfunction in dialysis patients.

Keywords Mediterranean diet; end-stage kidney disease; cardiac geometry; left ventricular hypertrophy

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Dairy Processing: The Soft Spreadable Cheese Xygalo Siteias

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Abstract The aim of cheese manufacturers is to produce high quality and safe products. Along the food chain of "milk to cheese and food products", milk is collected, transferred, and managed in a standardized manner; processing results in safe, ready-to-eat products, of high nutritional quality. Soft, acid cheeses are prepared in various regions of Greece, mainly from ewe milk, goat milk, or their mixtures. They are produced from the rennet and/or acid coagulation of thermally-treated, full-fat milk undergoing acidification/curdling and ripening. Xygalo Siteias is a Greek soft cheese, produced in the area of Siteia, Crete, where it was recognized as PDO in 2011. It is close—more in texture and less in taste—with other cream cheeses PDO of Greece, such as Pichtogalo of Chania, and Katiki Domokou, still it differs in the preparation technique as well as in its physicochemical, biochemical, microbiological, and organoleptic characteristics. In this review, we focus on the processing and characteristics of Xygalo Siteias, mentioning perspectives for the further microbiological characterization of the product, the determination of its shelf-life in combination with new packaging-materials, as well as the attention it deserves as a food important for breeders, the local economy, and consumers, since it is associated with the Cretan-Mediterranean diet type.

Keywords Food chain; dairy processing; soft cheese; PDO; Xygalo Siteias

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Impact of Graphene Derivatives as Artificial Extracellular Matrices on Mesenchymal Stem Cells

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Abstract Thanks to stem cells' capability to differentiate into multiple cell types, damaged human tissues and organs can be rapidly well-repaired. Therefore, their applicability in the emerging field of regenerative medicine can be further expanded, serving as a promising multifunctional tool for tissue engineering, treatments for various diseases, and other biomedical applications as well. However, the differentiation and survival of the stem cells into specific lineages is crucial to be exclusively controlled. In this frame, growth factors and chemical agents are utilized to stimulate and adjust proliferation and differentiation of the stem cells, although challenges related with degradation, side effects, and high cost should be overcome. Owing to their unique physicochemical and biological properties, graphene-based nanomaterials have been widely used as scaffolds to manipulate stem cell growth and differentiation potential. Herein, we provide the most recent research progress in mesenchymal stem cells (MSCs) growth, differentiation and function utilizing graphene derivatives as extracellular scaffolds. The interaction of graphene derivatives in human and rat MSCs has been also evaluated. Graphene-based nanomaterials are biocompatible, exhibiting a great potential applicability in stem-cell-mediated regenerative medicine as they may promote the behaviour control of the stem cells. Finally, the challenges, prospects and future trends in the field are discussed.

Keywords nanotechnology; graphene oxide; mesenchymal stem cells; tissue engineering

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A Literature Review of High-Tech Physiotherapy Interventions in the Elderly with Neurological Disorders

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Abstract Neurological physiotherapy adopts a problem-based approach for each patient as determined by a thorough evaluation of the patient's physical and mental well-being. This work aims to provide a literature review of physical therapy interventions in the elderly with neurological diseases (NDs) and discuss physiotherapy procedures and methods that utilize cutting-edge technologies for which clinical studies are available. Hence, the review focuses on acute NDs (stroke), deteriorating NDs (Parkinson's disease), and age-related cognitive impairment. The most used physiotherapy procedures on which clinical data are available are balance and gait training (robot-assisted or not), occupational therapy, classical physiotherapy, walking and treadmill training, and upper limb robotassisted therapy. Respectively, the most often-used equipment are types of treadmills, robotic-assisted equipment (Lokomat® and Gait Trainer GT1), and portable walkway systems (GAITRite®), along with state-of-the-art technologies of virtual reality, virtual assistants, and smartphones. The findings of this work summarize the core standard tools and procedures, but more importantly, provide a glimpse of the new era in physiotherapy with the utilization of innovative equipment tools for advanced patient monitoring and empowerment.

Keywords physiotherapy; neurological disorders; cognitive aging; stroke; Parkinson's disease; e-health; patient empowerment

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Drug Interactions for Patients with Respiratory Diseases Receiving COVID-19 Emerged Treatments

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Abstract Pandemic of coronavirus disease (COVID-19) is still pressing the healthcare systems worldwide. Thus far, the lack of available COVID-19-targeted treatments has led scientists to look through drug repositioning practices and exploitation of available scientific evidence for potential efficient drugs that may block biological pathways of SARS-CoV-2. Till today, several molecules have emerged as promising pharmacological agents, and more than a few medication protocols are applied during hospitalization. On the other hand, given the criticality of the disease, it is important for healthcare providers, especially those in COVID-19 clinics (i.e., nursing personnel and treating physicians), to recognize potential drug interactions that may lead to adverse drug reactions that may negatively impact the therapeutic outcome. In this review, focusing on patients with respiratory diseases (i.e., asthma or chronic obstructive pulmonary disease) that are treated also for COVID-19, we discuss possible drug interactions, their underlying pharmacological mechanisms, and possible clinical signs that healthcare providers in COVID-19 clinics may need to acknowledge as adverse drug reactions due to drug-drug interactions.

Keywords drug-drug interactions; COVID-19; ADRs; healthcare personnel; nursing personnel; respiratory diseases; COPD

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Acoustic detection of unknown bird species and individuals

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Abstract Computational bioacoustics is a relatively young research area, yet it has increasingly received attention over the last decade because it can be used in a wide range of applications in a cost-effective manner. This work focuses on the problem of detecting the novel bird calls and songs associated with various species and individual birds. To this end, variational autoencoders, consisting of deep encoding–decoding networks, are employed. The encoder encompasses a series of convolutional layers leading to a smooth high-level abstraction of log-Mel spectrograms that characterise bird vocalisations. The decoder operates on this latent representation to generate each respective original observation. Novel species/individual detection is carried out by monitoring and thresholding the expected reconstruction probability. We thoroughly evaluate the proposed method on two different data sets, including the vocalisations of 11 North American bird species and 16 Athene noctua individuals.

Keywords Computational bioacoustics, variational autoencoders, audio signal processing, bird calls detection

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Integrated pest management of *Tuta absoluta*: practical implementations across different world regions

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Abstract The South American tomato pinworm, Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae), has invaded most Afro-Eurasian countries and is threatening worldwide tomato production. Various strategies have been developed and implemented to manage this pest. Here, we present a timely review on the up-to-date development and practical implementation of integrated pest management (IPM) programs for tomato crops across different world regions infested by T. absoluta. While insecticide resistance is a growing concern, biological control via releasing or conserving arthropod natural enemies and sex pheromone-based biotechnical control are the most successful management practices. Agronomic control-related research is an emerging area where the soil fertilization and/or irrigation, as well as breeding of resistant cultivars, has the potential to enhance IPM effectiveness. Grower survey responses in the native areas (i.e., South America), early-invaded areas (i.e., first report between 2006 and 2012) and newly invaded areas (i.e., first report after 2012) showed that the control programs evolved along with the areas and time since invasion. Growers in the early-invaded areas shifted more rapidly from chemical control to biological control compared to those from the native area. In all concerned regions, the pest control failure risk following chemical insecticide applications and the high cost associated with either biological or biotechnical control methods have been the greatest concerns for growers. The information gathered from the native and/or early-invaded areas may help achieve a more effective management in newly invaded areas. Lastly, researchers are expected to break the bottlenecks of some key issues that would enable lowering application cost of novel biorational alternative management options.

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4 Multidisciplinary

Agriculture 5.0: A new strategic management mode for a cut cost and an energy efficient agriculture sector

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Abstract The farmers' welfare and its interlinkages to energy efficiency and farm sustainability has attracted global scientific interest within the last few decades. This study examines the contribution of Agriculture 5.0 to the prosperity of the farmers in the post-pandemic era and the gradual transition to an energy-smart farm. To obtain an insight into the attributes of Agriculture 5.0 and the emerging technologies in the field, Bibliometrix analysis with the use of an R package was conducted based on 2000 data consisting of peer-reviewed articles. The data were retrieved from the Scopus database. A bibliometric approach was employed to analyze the data for a comprehensive overview of the trend, thematic focus, and scientific production in the field of Agriculture 5.0 and energy-smart farming. Emerging technologies that are part of Agriculture 5.0 in combination with alternative energy sources can provide cost-effective access to finance, weather updates, remotely monitoring, and future energy solutions for the establishment of smart farms. Keywords such as "renewable energy," "Internet of Things," and "emission control" remain the trending keywords. Moreover, thematic analysis shows that "economic and social effects", "energy efficiency", "remote sensing", and "Artificial Intelligence" with their associated components such as "anaerobic digestion", "wireless sensor network," "agricultural robots", and "smart agriculture" are the niche themes of Agriculture 5.0 in combination with green energy sources, which can lead to the cut cost, energy-efficient, and sustainable energy-smart farms.

Keywords Agriculture 5.0; anaerobic digestion; artificial intelligence; bibliometric; cost-efficient; energy efficiency; renewable energy; strategy

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Deep learning for diabetic retinopathy detection and classification based on fundus images: A review

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Abstract Diabetic Retinopathy is a retina disease caused by diabetes mellitus and it is the leading cause of blindness globally. Early detection and treatment are necessary in order to delay or avoid vision deterioration and vision loss. To that end, many artificial-intelligence-powered methods have been proposed by the research community for the detection and classification of diabetic retinopathy on fundus retina images. This review article provides a thorough analysis of the use of deep learning methods at the various steps of the diabetic retinopathy detection pipeline based on fundus images. We discuss several aspects of that pipeline, ranging from the datasets that are widely used by the research community, the preprocessing techniques employed and how these accelerate and improve the models' performance, to the development of such deep learning models for the diagnosis and grading of the disease as well as the localization of the disease's lesions. We also discuss certain models that have been applied in real clinical settings. Finally, we conclude with some important insights and provide future research directions

Keywords Deep learning; Deterioration; Diagnosis; Error detection; Eye protection; Grading; Image classification; Image segmentation; Pipelines; Reviews

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Feasibility for the introduction of decentralised combined heat and power plants in agricultural processes. A case study for the heating of algae cultivation ponds

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Abstract The article analyzes the technical and economic feasibility of a biogas-fired Combined heat and power (CHP) plant used in the agricultural sector for the heating of algae cultivation ponds. Specific thresholds are set for typical Key Performance Indicators (KPIs): the cogeneration efficiency, the power-to-heat ratio and the Primary Energy Saving Ratio, which should be satisfied while maximizing the CHP unit's annual electricity production. A new operation algorithm and a plant's layout are formulated, with a water heat storage tank and a back-up heat production unit, examined alternatively with and without a biogas production facility, being the article's main novelties. Alternative sizing scenarios are investigated, optimized versus economic indices. Payback periods close to 5 years are achieved for all investigating scenarios without the biogas production facility, while satisfying all KPIs' thresholds. The high set-up cost of the biogas production facility affects negatively the investment's efficiency. The electricity selling price from the CHP unit (higher than 0.12 €/kWh) and the biogas procurement price (lower than 0.046 €/kWhch) constitute critical parameters for the project's economic viability. The proposed plant exhibits high technical and economic feasibility for similar agricultural applications, fostering the rational use of energy in this sector.

Keywords Agriculture energy saving; Biogas; CHP dynamic simulation; Combined heat and power cogeneration plant.

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Few-shot learning for modeling cyber physical systems in non-stationary environments

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Abstract This paper proposes a modeling scheme for cyber physical systems operating in non-stationary, small data environments. Unlike the traditional modeling logic, we introduce the few-shot learning paradigm, the operation of which is based on quantifying both similarities and dissimilarities. As such, we designed a suitable change detection mechanism able to reveal previously unknown operational states, which are incorporated in the dictionary online. We elaborate on spectrograms extracted from high-resolution ultrasound depth sensor timeseries, while the backbone of the proposed method is a Siamese Neural Network. The experimental scenario considers data representing liquid containers for fuel/water when the following five operational states are present: normal, accident, breakdown, sabotage, and cyber-attack. Thorough experiments were carried out assessing every aspect of the present framework and demonstrating its efficacy even when very few samples per class are available. In addition, we propose a probabilistic data selection scheme facilitating one-shot learning. Last but not least, responding to the wide requirement for interpretable AI, we explain the obtained predictions by examining the layer-wise activation maps.

Keywords Cyber physical systems, small data, few-shot learning, Siamese Neural Networks, liquid containers

Publication Neural Computing and Applications

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A Detailed FEM Study on the Vibro-acoustic Behaviour of Crash and Splash Musical Cymbals

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Abstract Advanced numerical simulations, that include modal and frequency response function finite element analysis, frequency domain and time domain finite element method – boundary element method analysis, are performed to study the vibro-acoustic behaviour of crash and splash musical cymbals. The results of the modal analysis agree well with experimental measurements found in literature. The frequency domain and time domain coupled finite – boundary element method simulations, despite their high computational resources and time demands, are used for the crucial comparison of the velocity spectrograms on the cymbal to the radiated sound pressure spectrograms in the air. The computational analysis results show that the splash cymbal is characterized by a faster decay and a higher frequency content compared to the crash cymbal. The advanced multiphysics vibro-acoustic simulations that correlate the displacements and velocities of the vibrated structure with the radiated sound pressure results demonstrate the future capability to synthesize the sounds of cymbal music instruments.

Keywords Numerical simulation, finite element analysis, vibro acoustics, drums cymbals, finite-boundary element method

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The challenge of unprecedented floods and droughts in risk management

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Abstract Risk management has reduced vulnerability to floods and droughts globally, yet their impacts are still increasing. An improved understanding of the causes of changing impacts is therefore needed, but has been hampered by a lack of empirical data. On the basis of a global dataset of 45 pairs of events that occurred within the same area, we show that risk management generally reduces the impacts of floods and droughts but faces difficulties in reducing the impacts of unprecedented events of a magnitude not previously experienced. If the second event was much more hazardous than the first, its impact was almost always higher. This is because management was not designed to deal with such extreme events: for example, they exceeded the design levels of levees and reservoirs. In two success stories, the impact of the second, more hazardous, event was lower, as a result of improved risk management governance and high

investment in integrated management. The observed difficulty of managing unprecedented events is alarming, given that more extreme hydrological events are projected owing to climate change.

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1 Physical sciences and engineering

Recycling of Energy Dissipated as Heat Accounts for High Activity of Photosystem II

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Abstract Photosystem II (PSII) converts light into chemical energy powering almost all life on Earth. The primary photovoltaic reaction in the PSII reaction center requires energy corresponding to 680 nm, which is significantly higher than in the case of the low-energy states in the antenna complexes involved in the harvesting of excitations driving PSII. Here we show that despite seemingly insufficient energy, the low-energy excited states can power PSII because of the activity of the thermally driven up-conversion. We demonstrate the operation of this mechanism both in intact leaves and in isolated pigment−protein complex LHCII. A mechanism is proposed, according to which the effective utilization of thermal energy in the photosynthetic apparatus is possible owing to the formation of LHCII supramolecular structures, leading to the coupled energy levels corresponding to approximately 680 and 700 nm, capable of exchanging excitation energy through the spontaneous relaxation and the thermal up-conversion.

Keywords photosynthesis, energy transfer, up-conversion, LHCII, fluorescence

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Planar Silicene: A New Silicon Allotrope Epitaxially Grown by Segregation

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Abstract 2D sheets of graphene-like silicon, namely planar silicene, are synthesized. This new silicon allotrope is prepared on Au(111) thin films grown on a Si(111) substrate in the process of surface segregation. Owing to its almost perfectly flat geometry it shares the atomic structure with graphene rather than with low-buckled silicene. Scanning tunneling microscopy measurements clearly display an atomically resolved planar silicene honeycomb lattice. Ab initio density functional theory calculations fully support the experimental findings and predict a pure sp2 atomic configuration of Si atoms. The present work is the first experimental evidence of epitaxial planar silicene.

Keywords 2D materials, Dirac fermions, silicene, STM, DFT

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2 Social sciences and humanities

Towards an integration of two aspects of semiosis – A cognitive semiotic perspective

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Abstract Meaning-making processes, understood hierarchically, in line with the Semiotic Hierarchy framework, change on various timescales. To account for and predict these changes, one can take a cognitive view on semiosis. I adopt an interdisciplinary approach combining semiotic studies and cognitive studies in an attempt to account for meaning-making activity and to predict the course of semiosis. In this context, I consider meaning-making activity as shaped by both "external" (to a semiotic system) as well as "internal" factors. I also show how both the "external" and "internal" sources of the dynamicity of meaning-making should be framed in terms of studies on cognition. I start with a non-standard, 4e approach to meaning-making. According to this framework, meaning-making processes are constituted by (and not just dependent on) environmental and bodily factors. The dynamicity of semiosis can be accounted for in terms of an experiencing, embodied subject (agent) enacting her/his/its own domain of meaningful phenomena. As I argue, this perspective on meaning-making is the cognitive foundation of the first two levels of the Semiotic Hierarchy. In the following sections I present the Peircean view on signs and semiosis, according to which semiosis is a result of the very nature of a sign and a sign system. In this view, the dynamicity of semiosis has primarily "internal" sources: it stems from the unavoidable fallibility of interpretation and synechism of signs. As I show, this aspect of semiosis can be addressed by means of standard (cognitivist) cognitive science and by means of cognitive modelling. Ultimately, I sketch a proposal of an attempt to develop a uniform cognitive framework allowing for integration of the above-mentioned aspects of semiosis – a framework based on Rowlands' idea of the Amalgamated Mind.

Keywords Cognitive Semiotics, meaning-making, embodiment, artificial agents, the Amalgamated Mind

Publication Towards an integration of two aspects of semiosis – A cognitive semiotic perspective. Sign System Studies. University of Tartu Press

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From making visible to hiding. Visual representations of financial markets as tools of manipulation and active and living agents

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Abstract This article shows that visual representations of financial markets not only make them visible, i.e. present and reveal certain important financial information such as the size and distribution of demand and supply, the quantity, type and intentions of sellers and buyers, trends and patterns in price movements, or the depth, liquidity and sentiment of the market, but also hide what they are supposed to reveal and make visible. What is important, they do this not only because of the ways of their production; not only because of pitfalls and errors inherent in them; not only because of framing processes they are subjected to, but also because of their interactive nature that allows financial agents to manipulate them. This fact, and above all its possibility, carries with itself important consequences for the role that the visual representations play in the functioning of capital markets. Namely, it causes that these representations, regardless of other factors, themselves become a source of uncertainty in these markets. As such, they are therefore not so much neutral and passive representations of financial exchange as rather tools for manipulation on the one hand and active and living agents on the other.

Keywords Visual representations, financial markets, financial agents

Publication From making visible to hiding. Visual representations of financial markets as tools of manipulation and active and living agents. Visual Studies. Taylor & Francis

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General Reference Clauses in the Judicial Process. Context of Legislative Intentions and Interpretative Discretion

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Abstract The monograph contains an analysis of the functioning of axiological extra-legal criteria expressed in general clauses in the legal order. The presence of these references in contemporary legal systems, appearing as an instrument of legislative policy, changes the linguistic properties of legal texts and enlarges the judicial discretion, opening the law to social norms and values but also optionally strengthening political impact on judiciary.

Outcomes of the research allow to build the general model of the judicial discretion in the context of the process of the interpretation of law divided into the validation, reconstruction, construction and decisional phases. Then, this model is confronted with differentiating factors: the type of legal culture, type of political system, place of the clauses in the structure of the legal system and the type of decision-making process. The work ends with the presentation of generalized functions of the references in the legal order and optimization model of their functioning.

Keywords general reference clauses, extra-legal criteria, legislative intentions, interpretation of law, judicial discretion, statutory legal culture

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Criterion "The Good of the Child" in the Legal Order: Between the Normative Structure and Judicial Case Law

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Abstract The good of the child in the course of the operative interpretation constitutes not only a theoretical and legal issue, but also a practical one. The "good of the child" is the basis for the formulation of numerous legal provisions, which seemingly do not refer to this criterion. However, important normative acts that indicate the presence of this category are: the Declaration of the Rights of the Child, adopted by the General Assembly of the League of Nations in 1924, the so-called Geneva Declaration and the Constitution of the Republic of Poland of 1997. The criterion of "the good of the child" as an element of the normative structure appears, for example, in the UN Declaration on the Rights of the Child of 1959 and the Convention on the Rights of the Child of 1989. In referring to the content of normative acts whose subject-matter is the "good of the child", it can be pointed out that the indicated criterion should be associated with the child's right to a happy childhood and the concept of humanity. Therefore it seems that the term in question must be interpreted in precisely this tone.

Keywords good of the child, general clause, morality, human rights, interpretation of law, international and national law

Publication Lex Localis, Maribor

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At the Origins of German Liberalism: the State in the Thought of Robert von Mohl

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Abstract The main task of the monograph is to deliver an in-depth analysis of the idea of the state in the views of Robert von Mohl (1799-1875). This German liberal scholar and politician developed comprehensive theory of the state, which combined absolutist as well as liberal approaches and tendencies. In the book, Von Mohl's political philosophy is depicted against the backdrop of the socio-political situation of German states in the nineteenth century and views of other contemporary thinkers as well. The main focus of the book is one of von Mohl's most important intellectual achievements, namely - the concept of Rechtsstaat. This idea is discussed in the context of its material and formal dimensions. In conclusion, the author draws similarities and differences between von Mohl's various ideas constituting the background of the chosen contemporary legal institutions in Germany and Poland.

Keywords Robert von Mohl, Rechtsstaat, rule of law, the concept of state, Germany, 19th century liberalism

Publication Peter Land GmbH, Berlin

Date 2020

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State-Owned Enterprises in the Global Economy

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Abstract State-owned enterprises (SOEs) combine economic activities resulting from their position on the market with non-economic functions determined by the state owner. In many of the world's major economies, SOEs play an important role, and in some, such as China, India, Russia and Brazil, they are outright dominant. At the same time, the existence of SOEs is largely ignored by economic theory and the current figures on SOEs on a global scale available in the literature are questionable in terms of their methodological validity and thus they do not allow for a proper cross-country analysis. This book fills this research gap. It focuses on the scope and importance of SOEs in a broad group of the largest economies, primarily on a variety of quantitative estimates. It contains the results of an extensive and unique empirical study of 37 of the world's largest economies over the period from 2009 to 2018. The findings showed that the average share of SOEs – measured by operating revenues and total assets – in the group of the largest 100 enterprises (Top 100) of a given country is nearly 30%, while in the Top 20 group it is even slightly higher. The authors present an econometric analysis showing the relationship between the scope of SOEs and the various economic and non-economic characteristics of the studied set of countries. The book also contains an in-depth discussion of selected key issues, such as the functions of SOEs in various types of economies, the role of SOEs in capital markets and the phenomenon of SOEs with foreign capital. This work is addressed to both academic economists, dealing with macroeconomics and economic policy, as well as researchers and analysts from various international organizations and think-tanks.

Keywords state-owned enterprises, state ownership, role of the state in the economy, government intervention, global economy

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State Corporate Control in Transition: Poland in a Comparative Perspective

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Abstract Since the global financial crisis of 2008-2009, there has been a growing interest among policy makers towards the more active role of the state in the enterprise sector. This book provides insight into the changing role of state-owned enterprises in economic policy, a topic at the cross section of several interrelated, but usually independent research streams first of all transition research, varieties of capitalism literature, public choice approach and institutionalism studies. With the existing literature on state ownership concentrating on the developed economies and on selected emerging economies, this book fills an important gap in focusing on the post-communist transition countries. The Polish experience is looked at in a comparative perspective of selected transition countries, which deserve special attention as they had to cope with a radical change of their economic policies towards the enterprise sector. This book will be valuable reading for academics in economic policy, transition economics, and institutional economics, and policy makers and practitioners in EU bodies and emerging economies.

Keywords Economic policy, state-owned enterprises, post-communist economies, post-communist transition, corporate governance, Polish economy, varieties of capitalism.

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Date 2021

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Darknet imaginaries in Internet memes: the discursive malleability of the cultural status of digital technologies

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Abstract Dominant discourses on the darknet present it either as a dangerous space with flourishing crime or a place for civic action and political activism. However, these depictions have been challenged in online popular culture, particularly in memes. By utilizing the concepts of double articulation of media and cultural imaginaries, this article reveals how memes shape popular definitions of darknet. Our qualitative, social semiotic content analysis of 505 memes reveals an ambiguous and complex vision of the darknet that both supports and demystifies the mainstream imagery. We introduce the concept of *discursive malleability of niche technologies* to describe how cultural practices reshape technologies, especially those with small userbases. Additionally, we present a "representational map of the darknet" and indicate how this contributes to social understanding of digital technologies more generally, and, not least why the analyzed memes may be read as lens exposing contradictory notions and policies regarding digital technologies nowadays.

Keywords darknet, memes, social semiotics, cultural imaginaries, discursive malleability

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Neither anguish nor salvation: The necessity of media technology use by early adults living in Poland at the beginning of the COVID-19 pandemic

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Abstract The aim of the study was to determine the significance of media technologies for early adults living in large urban Polish agglomerations and actively studying, working or operating in both areas at the beginning of the COVID-19 pandemic. The exploratory and qualitative research was conducted during the first weeks of the first lockdown. Internet surveys with mainly open questions were conducted with people aged 18–40, living in the biggest Polish agglomerations. The study shows that media technologies played a key role in the lives of early adults at the beginning of the COVID-19 pandemic, but were valued very ambivalently. The support functions and burdensome influence of media technologies were determined. Support functions were mainly related to home duties and interpersonal communication. Remote working and education, as well as searches for and the sharing of information were ambivalent. In the area of self-care, media technologies were burdening users. The results indicate that the adaptation of users to the new situation led to consequences of a different nature (ranging from physical, mental, to social). It was observed that there was a sudden digital intoxication and maximization of opportunities and profits from task-oriented use of technologies, which were gained at a loss to individual well-being.

Keywords media technology, pandemic, lockdown, COVID-19, digital media users, media technology functions, media technology influence

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Mediatization: Conceptual developments and Research Domains

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Abstract Mediatization is nowadays considered an influential theory explaining societal, political, and cultural alterations driven by media technologies. Mediatization research, initiated almost 20 years ago (with its precursory ideas placed in the first half of the 20th century), witnesses at present dynamic theoretical, methodological, and empirical developments, obtaining a status as one of the most essential and ambitious research fields within the social sciences. Mediatization theory deals with (meta)process in which media communication is becoming increasingly complex, takes place more often, covers a growing number of topics, and lasts longer. The goal of this study is to contribute to our understanding of mediatization as well as to make the theory more familiar to non-media scholars by presenting the state of the art and the most promising research lines of scientific inquiry. Starting from conceptualization and operationalization, we also aim to sketch the dimensions, fields, and forms of mediatization as well as to present examples of different domains where mediatization is most advanced, that is, mediatization of culture, society, and politics, or most promising, that is, mediatization of journalism.

Keywords mediatization

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The human core of the public realm: women prisoners' performed 'radio' at the Majdanek concentration camp

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Abstract The article elaborates Hannah Arendt's thought on the public realm to analyse the performed 'radio' that women prisoners 'produced' with their voice at the Majdanek concentration camp, Poland, in Spring 1943. The authors reconstruct the rationale that clarifies why an image of a radio was meaningful at a death camp. The documented memories reveal that the 'radio' created a resistant, harm-preventing and despair-relieving space. Mobilizing the meanings Arendt gives to the public realm as the shared reference and shared belonging, the authors show that the memories point towards the prisoners' efforts to break their exclusion by decisively continuing their belonging to the public world through their own performance. In Arendt's concepts, 'broadcasting' and listening to 'programmes' actualized prisoners' being and subjectivity, both of which were under constant assaults. Conceptualized through Arendt's thought, the performed 'radio' reveals amid the extreme exclusion, isolation and cruelty of the death camp how profoundly meaningful the public realm is to humans

Keywords action, concentration camp, exclusion, Hannah Arendt, public realm, radio, resistance, social participation

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Population genomics of the Viking world

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Abstract The maritime expansion of Scandinavian populations during the Viking Age (about ad 750–1050) was a far-flung transformation in world history. Here we sequenced the genomes of 442 humans from archaeological sites across Europe and Greenland (to a median depth of about 1×) to understand the global influence of this expansion.

We find the Viking period involved gene flow into Scandinavia from the south and east. We observe genetic structure within Scandinavia, with diversity hotspots in the south and restricted gene flow within Scandinavia. We find evidence for a major influx of Danish ancestry into England; a Swedish influx into the Baltic; and Norwegian influx into Ireland, Iceland and Greenland. Additionally, we see substantial ancestry from elsewhere in Europe entering Scandinavia during the Viking Age. Our ancient DNA analysis also revealed that a Viking expedition included close family members. By comparing with modern populations, we find that pigmentation-associated loci have undergone strong population differentiation during the past millennium, and trace positively selected loci—including the lactase-persistence allele of LCT and alleles of ANKA that are associated with the immune response—in detail. We conclude that the Viking diaspora was characterized by substantial transregional engagement: distinct populations influenced the genomic makeup of different regions of Europe, and Scandinavia experienced increased contact with the rest of the continent.

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Isotopic evidence of millet consumption in the Middle Bronze Age of East-Central Europe

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Abstract Broomcorn millet is one of the most important plants species in prehistory. It was first domesticated in China and subsequently spread across Eurasia becoming a significant staple crop. For a long time, the arrival of millet into Europe was assumed to have taken place in the Neolithic. However, this has recently been challenged, with new direct radiocarbon measurements on reportedly Neolithic charred millet grains in fact dating to the Middle Bronze Age.To aid in understanding the timing of millet's spread across East-Central Europe in the Bronze Age we present the results of over 120 new paired radiocarbon dates and stable isotope (δ13C and δ15N) measurements on human bone collagen from individuals across 33 archaeological sites in Poland and western Ukraine. In doing so we directly assess millet's role in the Bronze Age diets.Our results show a clear increase in bone collagen δ13C values from the middle 15th century BC onwards. This increase is rapid across the whole study area, occurring almost simultaneously with respect to the precision of our radiocarbon dates. Pilot stable isotope data for contemporary animals suggests that they were not foddered with millet and hence it was probably eaten directly by humans. Interestingly, individuals consuming millet appear to be exclusive to geographically upland regions compared to lowland ones. However, not all individuals from upland zone have δ13C values consistent with millet consumption. Based on the stable isotope evidence for upland millet consumption and the well documented evidence for connections between these people and those in the northern Carpathian Basin at this time, we posit that it is through this route, across the Carpathians, that millet was introduced into the region. An increase of its economic importance in Lesser Poland was plausibly caused by a significant growth in human populations.

Keywords Poland, Ukraine, Bronze Age, Millet, AMS dating, Stable isotopes, Diet reconstruction

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The Statehood of Kosovo: Genesis, Conditioning, Present Day

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Abstract The monograph presents and discusses the Kosovo's statehood – its theoretical foundations (epistemological dimension), genesis and conditioning (historical dimension), construction (ontological dimension) and functioning (functional dimension).

Chapter I represents the epistemological basis for research on the modern statehood. It presents selected scientific concepts, problems and theoretical issues within the field of political and administrative sciences, international relations, international law and sociology, which demonstrate the complex, multidimensional and processual nature of statehood.

Chapter II discusses the genesis and a broad conditioning of Kosovo's statehood. It presents: the history of national integration of Albanians and their aspirations for independence at the turn of the 19th and 20th centuries; the administrative status of Kosovo during the Socialist Federal Republic of Yugoslavia; the dispute over Kosovo's status and its role in the breakdown of SFRY; autonomous and secessionist Albanian movements in Kosovo between the years 1945 and 1999; the 'parallel state' of Kosovo Albanians in the 1990s; Kosovo Albanian war for independence (1998-1999); the military intervention of the North Atlantic Treaty Organization against the Federal Republic of Yugoslavia (1999); the process of building of legal and administrative autonomy of Kosovo under the UN territorial administration (1999-2008); and finally, the negotiations between the Kosovo autonomous institutions and the authorities of Serbia on the final status of Kosovo (2006-2007).

The analysis of the ontological dimension of Kosovo's statehood remains under consideration in Chapter III. The following issues are presented: geographical environment; geopolitical and geo-economic position of Kosovo; demographic structure; settlement pattern and migration processes at the territory of Kosovo; the system of government of the Republic of Kosovo; the continuation of the international civilian and military presence in Kosovo; the institutions of the Republic of Serbia operating at the territory of Kosovo; the scope of Kosovo's legal capacity and its capacity to perform legal acts in international relations; the characteristics of Kosovo's sovereignty; the international recognition of Kosovo's statehood; and the advisory opinion of the International Court of Justice on the accordance with international law of the Kosovo's declaration of independence.

Chapter IV analyzes the functional dimension of Kosovo's statehood. It presents patterns of behavior, social interactions, adaptive mechanisms, actions, phenomena and processes which determine the specificity of the functioning of Kosovo's statehood and results in limitations of its strength and scope. This chapter discusses inter alia: the evolution of the geopolitical position of Kosovo; the functioning of Kosovo's borders; the social legitimation of Kosovo's statehood; the functioning of the social dimension of Kosovo's statehood; the mechanisms and ordering principles of the system of government in Kosovo; the formal and real limitations of Kosovo's international legal personality; the factual limitations on jurisdiction of the Pristina authorities which limit Kosovo's sovereignty; the activities of the international civil and military institutions in Kosovo after declaration of independence; the impact of limited international recognition of Kosovo's statehood on its functioning; and an evolution of bilateral relations between the authorities of Serbia and Kosovo.

This publication presents and discusses the state-building process which led to the creation of the Republic of Kosovo as well as the whole specificity of the Kosovo's 'unfinished' statehood. It claims that Kosovo's statehood remains one of the most complex and controversial international questions, which generates real challenges for international security in the sub-regional (Western Balkans), regional (South-Eastern Europe), and continental (Europe) dimensions. It concludes that the case of Kosovo is an extremely interesting subject of research as it brings together many important and current research problems concerning the formation, existence and functioning of states in contemporary international relations and international law.

Keywords Kosovo, Serbia, Kosovo's Statehood, State in International Law, Statehood Criteria in International Law, NATO, KFOR, EULEX

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Date 2018

Rozwój samopodtrzymujący w polityce Unii Europejskiej wobec państw Maghrebu (Self-sustaining development in the European Union's policy towards the Maghreb)

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Abstract The monograph Sustainable development in the European Union's policy towards the Maghreb countries, Lublin 2019, p. 718 was created in the Lublin political science research center, as part of the theoretical and methodological identity of the science of international relations. Firstly, an important distinguishing feature of the monograph is the value of the research topic undertaken. The subject of sustainable development concerns both the conceptualization and practice of actions in the face of existential civilization challenges related to the preservation of the natural environment and its necessary quality for future generations.

Therefore, it has both a normative and a practical meaning. It is analyzed on the example of a specific, multilateral entity which is the European Union and taking into account the specificity of the Maghreb as a region. What is new in the research on the issues raised in the publication is also the inclusion of sustainable development in thinking about the place of the EU in the international environment, in perceiving it as a normative power and an entity of soft power mainly through liberal values and human rights.

Pointing to the importance, originality and innovativeness of the research topic taken up in the monograph, it should be emphasized that the subject of sustainable development and EU activities in this area synthesizes the analysis, is a kind of synergy of many important problems and challenges, mainly civilization-related, such as development strategies, climate change, forms of life organization at the local, state, regional and global levels, migrations, patterns of human behavior, economic processes, especially non-military dimensions of security, the effectiveness of international institutions, etc. Thus, the monograph is an important, original, but deeply rooted in scientific research voice on the identification of the main contemporary problems and challenges and the conceptualization of actions to address them.

Secondly, an important distinguishing feature of the monograph is the high level of its author's research culture, which is reflected in the conceptual and methodological layer of the conducted research, manifested by a reliable research query, knowledge of a huge number of documents, multilingual literature, often critically overvalued

Keywords sustainable development; ecological, economic and social problems and challenges; Maghreb countries; multi-level governance in the Mediterranean Basin.

Publication Wydawnictwo Uniwersytetu Marii Curie-Skłodowskiej, Lublin 2019, ss. 717
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Date 2019

The Mentality of Partisans of the Polish Anti-Communist Underground 1944–1956

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Abstract This book is the first study of the mentality of anti-Communist underground fighters and presents, detail, their thinking, ideals, stereotypes and customs.

The models and psychological processes that the volume analyzes are relevant not only to the Polish partisans, but also to members of other underground organizations, in East-Central Europe, South America and Asia. It explores how the underground organizations were created, who joined them and why, what thoughts and emotions were involved, and what were the consequences of the decisions to join them. Experiences and situations are illustrated with excerpts of diaries and memoirs which reveal the thinking of people in extreme situations, when their lives are in danger, when they are caught in desperate conflicts, or are fighting against overwhelming government forces.

The Mentality of Partisans is useful for upper-level undergraduates, postgraduates, and scholars interested in the history of Europe, resistance movements, anticommunism, military and political conflicts, World War Two and non-classical historiography.

Keywords History of Poland (1944–1956), anti-Communist underground, mentality of Partisans

Publication Routledge

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Great Change. History in the face of challenges... Memoirs of the 20th General Congress of Polish Historians in Lublin

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Abstract In the first part, the authors focus on the search for an answer to the question: what kind of history do Poles need today? In the second part, the subject of reflection becomes the road that Polish historiography has traveled between the Tenth and the Twentieth General Congress of Polish Historians, and it is steered by the question: Which way to know the past? The phenomenon of Polish history museums is the subject of Part 3. Part 4 - Memory in History Education - presents the achievements of the history didactics community. The Twentieth and Twenty-First Centuries is the last of three volumes of the Memoirs of the Twentieth General Congress of Polish Historians, presenting the intellectual output of the twentieth Congress. It contains papers and voices in discussion concerning the history of the Second Polish Republic, People's Poland, the recent history of Poland 30 years after the transformation, and Polish history from the perspective of women. The whole concludes with considerations on the new perspective of source studies in the auxiliary sciences of history.]

Keywords History of Poland, polish historiography, congress of polish historians

Publication II. From Antiquity to the 19th Century," "III. The 20th and 21st centuries

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3 Life sciences

Investigating brain cortical activity in patients with post-COVID-19 brain fog

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Abstract Brain fog is a kind of mental problem, similar to chronic fatigue syndrome, and appears about 3 months after the infection with COVID-19 and lasts up to 9 months. The maximum magnitude of the third wave of COVID-19 in Poland was in April 2021. The research referred here aimed at carrying out the investigation comprising the electrophysiological analysis of the patients who suffered from COVID-19 and had symptoms of brain fog (sub-cohort A), suffered from COVID-19 and did not have symptoms of brain fog (sub-cohort B), and the control group that had no COVID-19 and no symptoms (sub-cohort C). The aim of this article was to examine whether there are differences in the brain cortical activity of these three sub-cohorts and, if possible differentiate and classify them using the machine-learning tools. he dense array electroencephalographic amplifier with 256 electrodes was used for recordings. The event-related potentials were chosen as we expected to find the differences in the patients' responses to three different mental tasks arranged in the experiments commonly known in experimental psychology: face recognition, digit span, and task switching. These potentials were plotted for all three patients' sub-cohorts and all three experiments. The cross-correlation method was used to find differences, and, in fact, such differences manifested themselves in the shape of event-related potentials on the cognitive electrodes. The discussion of such differences will be presented; however, an explanation of such differences would require the recruitment of a much larger cohort. In the classification problem, the avalanche analysis for feature extractions from the resting state signal and linear discriminant analysis for classification were used. The differences between sub-cohorts in such signals were expected to be found. Machine-learning tools were used, as finding the differences with eyes seemed impossible. Indeed, the A&B vs. C, B&C vs. A, A vs. B, A vs. C, and B vs. C classification tasks were performed, and the efficiency of around 60–70% was achieved. In future, probably there will be pandemics again due to the imbalance in the natural environment, resulting in the decreasing number of species, temperature increase, and climate change-generated migrations. The research can help to predict brain fog after the COVID-19 recovery and

prepare the patients for better convalescence. Shortening the time of brain fog recovery will be beneficial not only for the patients but also for social conditions.

Keywords brain fog, EEG, ERP, COVID-19, cortical activity, LDA

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Satisfiability in MultiValued Circuits

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Abstract The satisfiability of Boolean circuits is NP-complete in general but becomes polynomial time when restricted either to monotone gates or linear gates. We go outside the Boolean realm and consider circuits built of any fixed set of gates on an arbitrarily large finite domain. From the complexity point of view this is connected with solving equations over finite algebras. We want to characterize finite algebras A with a polynomial time algorithm deciding if an equation over A has a solution. We are also looking for a polynomial time algorithm deciding if two circuits over a finite algebra compute the same function. Although we have not managed to solve these problems in the most general setting we have obtained such a characterization (in terms of nice structural algebraic properties) for a very broad class of algebras from congruence modular varieties, including groups, rings, and lattices and their extensions.

Keywords circuit satisfiability, circuit equivalence, solving equations

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Activated biochars derived from wood biomass liquefaction residues for effective removal of hazardous hexavalent chromium from aquatic environments

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Abstract Residues obtained after wood biomass liquefaction were used as precursors for the synthesis of two activated biochars. The source of biomass liquefaction constituted of industrial wood processing by-products, including bark and wood sawdust. The liquefied residues were analyzed in terms of chemical components and structure. Carbonization under nitrogen atmosphere followed by physical CO2 activation allowed to obtain microporous activated carbons with specific surface areas of 741 and 522 m2 g−1, and micropore volumes of 0.38 and 0.27 cm3 g−1, respectively. The obtained activated carbons were used to remove toxic hexavalent chromium from the aquatic environment. The observed sorption capacities were 80.6 mg g−1 versus 36.7 mg g−1 for wood bark-derived and wood sawdust-derived carbon, respectively, indicating a key role of the wood residue source in the effectiveness of Cr(VI) removal by resulting carbons. Despite the dominant microporous structure, the adsorption kinetics was surprisingly fast, especially for the bark-derived carbon, since the adsorption equilibrium was reached within 2 h. The sorption mechanism of chromium was based on the carbon surface-mediated reduction of toxic hexavalent form to its non-toxic trivalent form, as confirmed by the X-ray photoelectron analysis. Therefore, the residues from wood liquefaction can be easily converted into porous activated biocarbons capable of adsorbing significant amounts of hazardous Cr(VI) while reducing them to non-toxic Cr(III).

Keywords adsorption, bark, biochar, chromium removal, lignocellulosic biomass, liquefaction by- products, liquefied wood, wood sawdust

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Enhanced uranium removal from acidic wastewater by phosphonate-functionalized ordered mesoporous silica: Surface chemistry matters the most

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Abstract The removal of uranium species from aqueous phases using non-hazardous chemicals is still an open challenge, and remediation by adsorption is a prosperous strategy. Among the most crucial concerns regarding the design of an efficient material as adsorbent are, except the cost and the green character, the feasibility to be stable and effective under acidic pH, and to selectively adsorb the desired metal ion (e.g. uranium). Herein, we present a phosphonate functionalized ordered mesoporous silica (OMS-P), prepared by a one-step co-condensation synthesis. The physicochemical features of the material were determined by HR-TEM, XPS, EDX, N2 sorption, and solid NMR, while the surface zeta potential was also measured. The removal efficiency was evaluated at two different temperatures (20 and 50 °C) in acidic environment to avoid interferences like solid phase formation or carbonate complexation and the adsorption isotherms, including data fitting with Langmuir and Freundlich models and thermodynamic parameters are presented and discussed. The high and homogeneous dispersion of the phosphonate groups within the entire silica's structure led to the greatest reported up-todays capacity (345 mg/g) at pH = 4, which was achieved in less than 10 min. Additionally, OMS-P showed that the co-presence of other polyvalent cation like Eu(III) did not affect the efficiency of adsorption, which occurs via inner-sphere complex formation. The comparison to the non-functionalized silica (OMS) revealed that the key feature towards an efficient, stable, and selective removal of the U(VI) species is the specific surface chemistry rather than the textural and structural features. Based on all the results and spectroscopic validations of surface adsorbed U(VI), the main interactions responsible for the elevated uranium removal were proposed.

Keywords Uranium adsorption, Ordered mesoporous silica, Chemical functionalization, Water pollutants remediation, Wastewater treatment.

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Concentrations and loads of DOC, phenols and aldehydes in a proglacial arctic river in relation to hydro-meteorological conditions. A case study from the southern margin of the Bellsund Fjord – SW Spitsbergen

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Abstract Climate warming accelerates the melting and thawing of cryosphere components. Therefore, it favours the release of contaminants stored in High-Arctic glaciers for many years. The rate of land-based glacier retreat is of particular importance for the hydrological regime of glacial rivers, but also for the chemical composition of their waters. In this study, we examined 84 surface water samples collected during a period of 42 days (melt season 2012) from the Scott River of glacial-hydrological regime (NW Wedel-Jarlsberg Land). The studies of Scott River hydro-meteorological conditions provided indication on the relation between mean air temperatures (T) and mean daily discharge (Q) ($r = 0.67$). Moreover, they confirmed the role of short-term meteorological events (increasing of air temperature and heavy precipitation) on the acceleration of glacier melt. In this context, the study also demonstrated incidents of the release of a more concentrated pulse of chemical compounds delivered by the Scottbreen valley glacier. The analysis covered fluctuations of physicochemical parameters, and presence of selected organic pollutants (∑phenols, formaldehyde (HCHO)). Based on the correlation matrix analysis, it was found that fluctuations of physicochemical indices (pH, specific electrolytic conductivity (SEC) and dissolved organic carbon (DOC)) were related to changes in T and Q. Principal components analysis (PCA)permitted us to distinguish two principal components (hydro-meteorological and biogeochemical conditions) responsible for 71.1% of the total hydrochemical variation. In terms of the first principal component, it was found that there was a relationship with the intensified ablation of glacier ice and with the second one, the influence of geological and biological conditions of the environment on the chemistry of the river. The combination of these factors directly shaped the hydrochemistry of the proglacial river during the melt season of 2012. The results of organic compound loads, which are presented in this paper provide unique information about the transport of contaminants such as: (DOC) (9.41–579 mgC s^{-1}), ∑phenols (19.7–534 mg s^{-1}), HCHO (34.0–82.3 mg s^{-1})) in

the Scott River. It is worth noting that the differentiation of concentration and mean daily loads of DOC, between the gorge (96.0 mgC s^{-1}) and mouth (99.6 mgC s^{-1}) sections of the river, were related with the activity of a herring gull (Larus argentatus) colony at the river mouth.

Keywords Organic carbon, Phenols, Formaldehyde, Proglacial river, Glacier retreat, High-Arctic

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Sunken lanes – Development and functions in landscapes

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Abstract Sunken lanes are roads or tracks, 2 m or more wide, that are incised at least 0.5 m, but often by several meters, below the general level of the surrounding land surface. They are formed by the passage of people, animals, vehicles and erosion by water and gravity. Although these anthropogenic landforms are quite common worldwide they received limited interest by the international scientific community. This comprehensive review analyzed all available information on their characteristics, development and functions in landscapes. Most research on sunken lanes has been conducted in Europe, whereas sunken lanes have been occasionally reported in other continents as well. Major topics addressed are spatial distribution, origin and development, morphology, erosion rates, hydrology, ecology, management, geotourism and research needs.

Mean dimensions of sunken lanes reported for various regions vary widely: i.e. 30–2300 m for their length; 0.6–12.5 m for their depth and 2–36 m for their top width. Typical sunken lane densities in European regions (10 to 100 km^2 large) characterized by such landforms range between 0.2 and 0.5 km km^{-2} but for smaller areas (<10 km^2) densities may reach 1–2 km km^{-2}. In Europe and the Middle East sunken lanes already started to form during prehistoric times. During later periods, with increasing population, settlement density, cropland area and traffic, sunken lanes further deepened and widened and new ones were formed. Some of these evolved

towards large permanent gullies whereas others became footpaths or were completely abandoned and can still be observed today as dormant sunken lanes in old forests.

Sunken lane formation results from interactions between natural factors (i.e. lithology and soils, topography, climate, vegetation) and anthropogenic factors (i.e. traffic, land use and management). Rock type, weathering status and soil types control the erodibility of hillslope materials and hence the development and preservation of sunken lanes. Sunken lanes have been reported in several lithologies but most have been studied in loess regions. Sunken lanes, can be initiated at topographic landscape positions with a much lower slope gradient and corresponding contributing area than those needed to initiate classical gullies, due to the combined action of natural (i.e. concentrated flow erosion and mass movements) and anthropogenic processes (i.e. erosion by animal and human trampling, wheel traffic and digging). Once formed, medium to long-term average incision rates of unpaved bare sunken lanes are 1 to 5 cm $year^{-1}$ often exceeding erosion rates on nearby cropland by at least one order of magnitude.

Sunken lanes perform many functions in landscapes i.e. microclimatological, hydrological, geomorphological, ecological, transport, aesthetic, geotouristic, educational, scientific, strategic, and historical functions. Sunken lanes represent long-standing heritage of past agricultural landscapes and, taking into account their natural and cultural assets, justifies their protection. Unfortunately in several regions, sunken lanes are threatened by urban sprawl, agricultural intensification or land consolidation programs. It remains a challenge for environmental planners to conserve this characteristic geomorphosite for the Anthropocene and to reconcile its competing functions.

Keywords Sunken road, Hollow road, Hollow way, Anthropocene, Anthropogeomorphology, Geoheritage, Ecosystem services

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4 Multidisciplinary

The EU's New Borderland. Cross-border relations and regional development

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Abstract The strengthening of relations between Poland and Ukraine over the last 25 years is one of the most positive examples of transformations in bilateral relations in Central and Eastern Europe. In spite of the complex and difficult historical heritage dominated by the events of the World War II and the first few years that followed, after the fall of Communism in Poland and Ukraine, bilateral institutional cooperation was successfully undertaken, and mutual social contacts were recreated.

The issue of Polish-Ukrainian relations at the international and trans-border level gained particular importance at the moment of expansion of the European Union to the east, and announcement of the assumptions of the European Neighbourhood Policy in 2004. Since then, relations have continued to thrive and provide a blueprint for cross-border relations in other parts of the EU. In this book the authors examine the issue of cooperation and cross-border relations on the new external border of the EU. The book's primary objective is to present the way in which the Polish and Ukrainian parties develop the bilateral cooperation, adapting to the changing geopolitical conditions, and responding to the related challenges. The chapters offer a comprehensive diagnosis of the conditions determining the current and future state of Polish-Ukrainian cross-border cooperation and describe the area as a social, economic, and political space.

The EU's New Borderland will be of interest to university students of international relations, geography, economy, or history as well as those willing to expand their knowledge in the scope of regional geography, European integration, cross-border cooperation, and international relations.

Keywords regional geography, European integration, cross-border cooperation, and international relations.

Publication Routledge

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Niccolò Cusano University

1 Physical sciences and engineering

Improving the Performance of HPHT-diamond Detectors for Pulsed X-ray Dosimetry using the Synchronous Detection Technique

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Abstract A single-crystal diamond sample grown by highpressure high temperature (HPHT) technique was used for the fabrication of a metal-semiconductor-metal photoconductor. The sample quality was evaluated by means of spectral photocurrent measurements highlighting the presence of a significant density of defect states within the diamond bandgap, responsible for trapmediated conduction mechanisms. The photoconductor was fully characterized under 6 MeV pulsed X-rays, sourced by a medical linear accelerator, in the 0.05 – 20 Gy and 0.017–0.100 Gy/s dose and dose-rate ranges, respectively. Photocurrent measurements performed with a conventional precision electrometer showed that the detector performance is strongly affected by charge-trapping phenomena, resulting in a sub-linear dependence with the doserate (power-law dependence with an exponent of 0.86). Measurements were repeated in the same experimental conditions by coupling the detector to a specifically developed gatedintegrator, allowing for a synchronous integration of photocurrent pulses (limited to 40 µs) centered on each impinging X-ray pulse. In this case, the detector photoresponse showed an excellent linearity with both the dose and the dose-rate (power-law dependence with 1.0009 ± 0.0004 and 1.009 ± 0.005 exponents, respectively). Significantly, the proposed synchronous integration technique is then able to mitigate the detrimental effect that defects have on detector performance. The proposed method paves therefore the way to the exploitation of HPHT-diamond as a lowcost alternative to single-crystal CVD-diamond for the fabrication of accurate and linear X-ray dosimeters.

Keywords HPHT-diamond, gated-integrator, LINAC, X-ray detectors, Radiation Therapy

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A biogas-solar based hybrid off-grid power plant with multiple storages for United States commercial buildings

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Abstract In this paper, a hybrid renewable power plant with a storage system is designed. The benefits of sizing and energy management are assessed for a commercial building under eight different climatic conditions in the United States. In the considered system, photovoltaic panels are coupled to a unitized regenerative solid oxide fuel cell. The use of biogas to feed unitized regenerative solid oxide fuel cell is investigated, employing a detailed electrochemical model of electrolyzer and fuel cell modes. A battery pack is included in the plant as a secondary storage system, together with a diesel engine operating in backup mode.

Four scenarios where biogas amount is varied together with the initial state of charge of the battery were evaluated. Results demonstrate that the power plant can operate with 100 % renewable procurement if the digester produces from 6000 to 9500 stdm3/y and the battery is completely charged at the beginning of the year. By reducing the biogas availability or starting with a low state of charge, the use of the diesel generator is inevitable.

The study confirms that the proposed hybrid renewable power plant is technically feasible and can be considered a reliable and clean energy source in other areas and buildings.

Keywords Hybrid renewable energy, Microgrid, Polygeneration plant, Solar energy, Unitized regenerative fuel cell
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Direct Band Gap AlGaAs Wurtzite Nanowires

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Abstract Wurtzite AlGaAs is a technologically promising yet unexplored material. Here we study it both experimentally and numerically. We develop a complete numerical model based on an 8-band k · p method, including electromechanical fields, and calculate the optoelectronic properties of wurtzite AlGaAs nanowires with different Al content. We then compare them with our experimental data. Our results strongly suggest that wurtzite AlGaAs is a direct band gap material. Moreover, we have also numerically obtained the band gap of wurtzite AlAs and the valence band offset between AlAs and GaAs in the wurtzite symmetry.

Keywords Nanowires, Modeling, GaAs/AlGaAs, wurtize, $\mathbf{k} \cdot \mathbf{p}$

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Pricing of Connected and Autonomous Vehicles in Mixed-Traffic Networks

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Abstract For networks with human-driven vehicles (HDVs) only, pricing with arc-specific tolls has been proposed to achieve minimization of travel times in a decentralized way. However, the policy is hardly feasible from a technical viewpoint without connectivity. Therefore, for networks with mixed traffic of HDVs and connected and autonomous vehicles (CAVs), this paper considers pricing in a scenario where only CAVs are charged. In contrast to HDVs, CAVs can be managed as individual vehicles or as a fleet. In the latter case, CAVs can be routed to minimize the travel time of the fleet of CAVs or that of the entire fleet of HDVs and CAVs. We have a selfish user behavior in the first case, a private monopolist behavior in the second, a social planner behavior in the third. Pricing achieves in a decentralized way the social planner optimum. Tolls are not unique and can take both positive and negative values. Marginal cost pricing is one solution. The valid toll set is provided, and tolls are then computed according to two schemes: one with positive tolls only and minimum toll expenditure, and one with both tolls and subsidies and zero net expenditure. Convergent algorithms are used for the mixed-behavior equilibrium (simplicial decomposition algorithm) and toll determination (cutting plane algorithm). The computational experience with three networks: a two-arc network representative of the classic town bypass case, the Nguyen-Dupuis network, and the Anaheim network, provides useful policy insight.

Keywords autonomous vehicles; fleets; marginal cost toll; minimum expenditure toll; mixed-behaviour equilibrium; road pricing

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Dam-break flow dynamics over a stepped channel with vegetation

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Abstract In spite of the insistence of a variety of studies on floods triggered by a dam failure, the effects of channel unevenness and vegetation have not been fully explored. Some hydrological aspects, such as the sudden change in the topography of a river section, the density of vegetation, and its influence on flood development, need to be further addressed. Therefore, the present work investigates the complex effects of vegetation and channel's step on wave propagation during a dam break across a dry downstream channel. The Flow-3d Computational Fluid Dynamics package was used to simulate the flow phenomena during a dam break, adopting different geometric conditions and a densely vegetated area of the downstream channel in the far-field. Three-dimensional flow characteristics were reproduced by solutions of Navier-Stokes equations coupled with the standard volume of fluid to track the evolution of the free surface. The turbulent flow characteristics were represented by different approaches frequently used in the scientific literature. The computational model was optimized and validated using experimental data published in the literature. The results showed that the model had high accuracy in predicting the evolution of the free surface, moving hydraulic jump, flow velocity, and flow regime. In addition, the model was able to predict the formation and development of transitional, rotational, and transverse flows, jet flow, nappe flow, wave breaking, the bore evolution in different directions, and the change of the flow regime under the influence of the channel step and vegetation. Accordingly, the flow fluctuations during dam break, wave attenuation, flow separation, and turbulence structure evolution in the vegetated area were predicted.

Keywords Dam-break; Vegetation; Channel step; Free surface flows; Flooding

Publication Khoshkonesh A, Daliri M, Riaz K, Dehrashid F A, Bahmanpouri F, Di Francesco S (2022). Dam-break flow dynamics over a stepped channel with vegetation. JOURNAL OF HYDROLOGY, vol. 613, Part A, 128395, ISSN: 0022-1694

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Typological fragility curves for RC buildings: influence of damage index and building sample selection

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Abstract The recent earthquakes occurred in the last years in Italy registered a great number of casualties and large economic losses. In this perspective, the effective seismic risk assessment has become crucial for the Government mitigation policies that have to allocate the limited economic sources for the risk reduction. In this paper, data collected after the 2012 Emilia and the 2009 L'Aquila, Italy, earthquakes were used to derive novel fragility curves for RC frame buildings classes. Compared to previous studies, different aspects affecting the fragility curves parameters were investigated. First of all, data are completed accounting for the presence of undamaged buildings that are generally uninspected after the seismic events, considering alternative criteria to complete the database. Then, the influence of the building damage index definition was considered by selecting four damage indices available in the literature that allow converting the damage data collected with the post-earthquake form into one of the five damage states, according to the European macroseismic scale. Separate sets of fragility curves, as a function of peak ground acceleration, were developed for the building stock of the two regions. The results reveal that the database correction with the uninspected buildings is relevant to avoid the overestimation of the exceedance probability, especially at lower peak ground acceleration values, resulting in less steep curves. Then, the building damage indices accounting for the damage of both structural and non-structural elements led to a higher exceedance probability with respect to damage indices based on damage of only structural elements, especially for the lower damage states.

Keywords Census data; Completeness ratio; Damage index; Emilia earthquake; L'Aquila earthquake; Observational data; Vulnerability assessment

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Characterizing flax fiber reinforced bio-composites under monotonic and cyclic tensile loading

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Abstract Traditional composites such as glass and carbon fiber reinforced polymers (G- and CFRP) can be effectively approximated to linear-elastic materials with brittle failure in most of the cases. On the contrary, natural fiber-reinforced composites (NFRCs) are characterized by non-linear elasticity, viscous effects, and plastic strains far before failure. The present study presents the results of an extensive experimental campaign aimed to the mechanical characterization of unidirectional flax fiber composites (FFRCs) produced through Light Resin Transfer Molding. The nonlinear phenomena characterizing the stiffness evolution and its relations with damage propagation and accumulated inelastic strain is investigated and analyzed through pure monotonic loading tension, cyclic tension, and repeated progressive loading tests. The analysis of the experimental results concentrates on the evaluation of the evolution of the mechanic response as the inelastic strain is accumulated in the sample. Results highlight the need for a complex material model in order to predict the mechanical behavior of flax-based composites.

Keywords Accumulated strain, Bio-composites, Damage, Flax, Natural fiber-based composites, Stiffness evolution

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Promoting electric vehicle demand in Europe: Design of innovative electricity consumption simulator and subsidy strategies based on well-to-wheel analysis

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Abstract Decarbonization in the transport sector, especially in private mobility, is one of the main objectives of the European Union (EU) for next few years. Battery electric vehicles (BEVs) represent a promising solution for reducing pollution and GHG emissions; however, their purchase price contributes to curbing their diffusion. In this scenario, the aims of this study are to develop a flexible, simulation-based analysis for EU car fleets in terms of energy consumption and GHG emissions and, based on the simulation results, to propose an innovative system of financial subsidies. This can support governments in encouraging EU customers to prefer sustainable and green options for mobility. Different car segments have been considered; the electrical energy consumptions have been obtained through the development of an ad-hoc simulation model in Simulink®-MathWorks environment, while the Well-To-Wheel analysis has been performed to estimate GHG emissions. Based on these assumptions, four different subsidy strategies have been proposed and designed for countries of the EU-27. According to different logics, economic subsidies have been linked to GHG emissions avoided thanks to the use of BEVs. The results obtained show how BEVs' consumption of electricity is low, even for larger vehicles, and this allows BEVs to be considered less impactful than internal combustion engine vehicles (ICEV) with respect to GHG emissions. Furthermore, results are highly variable, depending on the electricity mix of each considered country, and they show how, for the countries that use the most renewable sources, the proposed subsidies even can generate gains from consumers' perspectives.

Keywords Battery electric vehicle; Economic subsidy; Electric powertrain; Electricity consumption simulation; Total cost of ownership; WTW analysis

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Micromechanical modeling of the constitutive response of FRCM composites

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Abstract In this paper, the tensile and shear constitutive behavior of Fiber Reinforced Cementitious Matrix (FRCM) composites is addressed. A nonlinear finite-element computational approach is developed, by accounting for the micromechanical mechanisms via the introduction of interface elements inside and between the FRCM constituents, i.e. fibers and mortar. The damage, the friction and the unilateral contact are considered for reproducing the mortar cracking and the slippage between the fibers and the mortar. The numerical approach is illustrated and it is validated with an available experimental result, highlighting the effectiveness of such proposed modeling approach for reproducing the constitutive tensile behavior of FRCM materials. Finally, the shear behavior is investigated, also considering cyclic loading patterns under different compressive load levels.

Keywords FRCM, Micromechanics, Nonlinear interface

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Waveform-selective Mantle Cloaks for Intelligent Antennas

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Abstract We present the design of an innovative wire antenna able to automatically hide or reveal its presence depending on the waveform of the received/transmitted signal. This unconventional behavior is achieved through the use of a novel waveform-selective cloaking metasurface exploiting a meander-like unit cell loaded with a lumped-element circuit capable to engineer the scattering of the antenna depending on the waveform of the impinging signal. Due to the time-domain response of the lumped-element circuit, the antenna is able switching its scattering behavior when interacts with either a pulsed wave (PW) or a continuous wave (CW) signal. The proposed configuration paves the way to a new generation of cloaking devices for intelligent antenna systems, extending the concept of antenna as a device capable to sense the external environment and change its electromagnetic behavior accordingly.

Keywords Dipole antennas, electromagnetic cloaking, mantle cloaking, metasurfaces, receiving antennas, reconfigurable metasurfaces, scattering, waveform selective metasurfaces

Publication IEEE Transactions on Antennas and Propagation

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Experimental characterisation of a novel thermal energy storage based on open-cell copper foams immersed in organic phase change material

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Abstract In this paper, a novel tubes-in-tank thermal energy storage (TIT-TES) based on open-cell copper foams immersed in organic paraffin is presented and experimentally studied. The system consists of a rectangular external case which encloses 16 U-tubes and phase change material (PCM) embedded in copper foams matrix, which guarantee an average power during both heat charge and discharge phases close to 1 kW and high storing/releasing energy efficiency. With the aim of measuring internal temperature, six thermocouples have been installed at two different sections, S1 and S2, located at 1/3 and at 2/3 of the total height, respectively. In order to thermally characterize the system during the heat charge and discharge phases, a series of tests have carried out under different inlet temperatures and flow rate of the heat transfer fluid (HTF). Temperature evolutions have obtained during the tests, and directional temperature derivative profiles, time-durations, average powers and energy efficiencies have derived so to evaluate and characterize the TIT-TES performance. The results have shown how both HTF volumetric flow rate and inlet temperature play a relevant role in heat charge and discharge phases. A larger temperature difference between the HTF and the PCM and a higher HTF input flow rate improve heat transfer and consequently increase the average exchanged power and energy efficiency as well. In particular,during the thermal charge phase, when the HTF temperature increases from 80 °C to 90 °C, the energy efficiencies increase from 73.6% to 91.4% and from 78.7% to 93.8% for the minimum and maximum HTF flow conditions respectively. The analysis of directional temperature derivative profiles have allowed to define some important characteristics of the apparatus, highlighting the preferential directions of the liquefaction/solidification front paths, and also confirming the importance of the HTF inlet temperature and flow rate.

Keywords Latent thermal energy storage, Phase change material, Copper foam Experimental procedure, Thermal characterisation

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Effect of pH control during rice fermentation in preventing a gliadin P31-43 entrance in epithelial cells

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Abstract Coeliac disease is an increasingly recognised pathology, induced by the ingestion of gluten in genetically predisposed patients. Undigested gliadin peptide can induce adaptive and innate immune response that unleash the typical intestinal mucosal alterations. A growing attention is paid to alternative therapeutic approaches to the gluten-free diet: one of these approaches is the use of probiotics and/or postbiotics. We performed lactic fermentation of rice flour with and without pH control, using Lactobacillus paracasei CBA L74 as fermenting strain. We evaluated bacterial growth, lactic acid production during fermentation and gliadin peptide P31-43 entrance in CaCo-2 cells with and without pH control. When pH control was applied no differences were observed in terms of bacterial growth; on the contrary, lactic acid production was greater, as expected. Both samples could inhibit the P31-43 entrance in CaCo-2 cells but the effect was significantly greater for samples obtained when the pH control was applied.

Keywords P31-43; coeliac disease; fermented food; functional foods; pH control.

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Environmental life cycle assessment of polyhydroxyalkanoates production from cheese whey

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Abstract Cheese whey (CW) is the main by-product of the dairy industry and is often considered one of the main agro- industrial biowaste streams to handle, especially within the European Union, where the diary activities play an essential role in the agrarian economy. In the paper, Life Cycle Assessment (LCA) is used to analyse the feasibility of producing polyhydroxyalkanoates (PHA) as the main output of an innovative CW valorisation route which is benchmarked against a conventional anaerobic digestion (AD) process. To this aim, the LCA inventory data are derived from lab-scale PHA accumulation tests performed on real CW, while data from the literature of concern are used for modelling both the PHA extraction from the accumulating biomass and for the alternative CW valorisation through AD. The comparison shows that AD would have better environmental performances than the baseline PHA production scenario. For example, the climate change indicator values result 44.8 and − 35.7 kg CO2 eq./t CW for the baseline PHA recovery and AD, respectively. LCA proved to be a useful tool to highlight the weak points of innovative processes and suggest proper improvements. Once improved and again analysed through the LCA, the PHA production process from CW shows that environmental performance com- parable to AD may be achieved. With reference, again, to the climate change indicator the value can be reduced to − 50.3 kg CO2 eq./t CW for the improved PHA production process.

Keywords Dairy residues; PHA; iopolymers; Bioenergy; LCA; Environmental footprint

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Preliminary design of a fuel cell/battery hybrid powertrain for a heavy-duty yard truck for port logistics

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Abstract The maritime transport and the port-logistic industry are key drivers of economic growth, although, they represent major contributors to climate change. In particular, maritime port facilities are typically located near cities or residential areas, thus having a significant direct environmental impact, in terms of air and water quality, as well as noise. The majority of the pollutant emissions in ports comes from cargo ships, and from all the related ports activities carried out by road vehicles. Therefore, a progressive reduction of the use of fossil fuels as a primary energy source for these vehicles and the promotion of cleaner powertrain alternatives is in order.

The present study deals with the design of a new propulsion system for a heavy-duty vehicle for port applications. Specifically, this work aims at laying the foundations for the development of a benchmark industrial cargo–handling hydrogen-fueled vehicle to be used in real port operations. To this purpose, an on-field measurement campaign has been conducted to analyze the duty cycle of a commercial Diesel-engine yard truck currently used for terminal ports operations. The vehicle dynamics has been numerically modeled and validated against the acquired data, and the energy and power requirements for a plug-in fuel cell/battery hybrid powertrain replacing the Diesel powertrain on the same vehicle have been evaluated. Finally, a preliminary design of the new powertrain and a rule-based energy management strategy have been proposed, and the electric energy and hydrogen consumptions required to achieve the target driving range for roll-on and roll-off operations have been estimated.

The results are promising, showing that the hybrid electric vehicle is capable of achieving excellent energy performances, by means of an efficient use of the fuel cell. An overall amount of roughly 12 kg of hydrogen is estimated to be required to accomplish the most demanding port operation, and meet the target of 6 h of continuous operation. Also, the vehicle powertrain ensures an adequate all-electric range, which is between approximately 1 and 2 h depending on the specific port operation. Potentially, the hydrogen-fueled yard truck is expected to lead to several benefits, such as local zero emissions, powertrain noise elimination,

reduction of the vehicle maintenance costs, improving of the energy management, and increasing of operational efficiency.

Keywords Energy conversion, Sustainable mobility, Fuel cells, Hydrogen technologies, Hybrid powertrains

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Tribological properties of Laser Powder Bed Fused AlSi10Mg: Experimental study and statistical analysis

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Abstract This study deals with the experimental analysis of the tribological properties of AlSi10Mg alloy components manufactured by Laser Powder Bed Fusion (LPBF). The influence of the LPBF parameters and building orientation was investigated for density, roughness, hardness, and wearing properties, as weight loss, wear volume, and friction coefficient. The tribological characterization was carried out by means of Ball on Plate Tests, using both 100Cr6 steel and alumina balls as counterpart. Then, the Analysis of Variance (ANOVA) allowed to verify the significance of process parameters, counterpart material and test area. The experimental results highlight the anisotropic effect of the process parameters on the performance of the manufactured samples for all the response variables. Tribological tests performed with steel ball showed an adhesive wear phenomenon, while the alumina ball an adhesive one. No remarkable differences were detected for varying the test area along the building direction. Finally, the analysis of the wear tests at increasing distance showed a progressive increase in the friction coefficient and a corresponding reduction in the wear rate for both counterpart materials.

Keywords Additive manufacturing; AlSi alloys; Anova; Friction coefficient; Sliding wear; Wear rate

Publication Journal of Manufacturing Processes

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Chitosan/clay nanocomposite films as supports for enzyme immobilization: An innovative green approach for winemaking applications

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Abstract Protein haze formation in white wines during storage is considered the most important instability phenomenon of non-microbial origin. The use of proteolytic enzymes, covalently immobilized on solid supports, has recently proved to be a promising approach for reducing the haze potential of white wines. In this study, supports based on chitosan and nanoclays were produced by solvent casting technique, and investigated for use as a covalently linked bromelain carrier in wine-like medium. Various kinds of nanoclays were tested, including montmorillonite, sepiolite and bentonite, in different amounts (1–5% w/w with respect to chitosan). More specifically, unmodified and organically modified clays and an activated bentonite authorized for contact with food (i.e. OPTIGEL CK) were considered, and their effect on the final microstructural, thermal and mechanical properties of the obtained composite systems was investigated, on the basis of their different chemical composition, morphology, hydrophilicity/hydrophobicity and surface charge, resulting in different interactions with the polymeric matrix and a different enzyme loading. The nanocomposite films were used as innovative supports for the covalent immobilization of pineapple stem bromelain, selected as reference enzyme, and the kinetic parameters of the immobilized bromelain were analyzed.

Keywords Chitosan films, Nanoclays, Microstructure, Pineapple stem bromelain, Enzyme immobilization

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Validation of a 3D Markerless System for Gait Analysis Based on OpenPose and Two RGB Webcams

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Abstract Markerless human motion capture could be a potential tool for studying body biomechanics. Despite the extensive previous studies, the design of an accurate markerless system able to perform a quantitative clinical gait analysis is still an open challenge. Our purpose was to characterize the performance of a low-cost markerless system, consisting of the open-source library OpenPose, two webcams and a linear triangulation algorithm. The system was validated in terms of 3D kinematic gait analysis, by comparison with inertial sensors. Two synchronized videos of six healthy subjects were recorded in three webcam configurations, in walking and running sessions on a treadmill. Sagittal joint angles were compared between the two systems, to evaluate the kinematic performance of the markerless system. Results showed that the angular paths, provided by OpenPose, were close to the ones computed by inertial sensors in all camera positions, but OpenPose inaccuracy affected the computation of joint angles parameters producing absolute errors up to 14.0°± 1.8°. The observed differences depended on OpenPose ability in the recognition of joints centers and on camera configurations. In the optimal condition (joint visible from both cameras during the whole trial) our system accuracy resulted equal to 1.6 °± 0.3 °. This system could be useful in those applications where a real-time body tracking is required, i.e. video games or virtual rehabilitative trials. When a quantitative analysis is needed, the low level of accuracy may be overcome, by both increasing the cameras' number and implementing an optimization triangulation algorithm.

Keywords cameras, gait analysis, image capture, image motion analysis, image sensors, optimisation, patient rehabilitation, public domain software

Publication IEEE Sensors

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The Role of Small Reservoirs in a Water Scarcity Scenario: a Computational Approach

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Abstract This paper presents the evaluation and management of water resources at the basin scale, focusing on small reservoirs. Due to a lack of knowledge on these untapped resources, a semiautomatic procedure for their surface area estimation is presented. Multispectral images from the Pleiades satellite were used to extract water bodies from a combination of different bands. In particular, the normalized difference water index (NDWI) was used to evaluate the presence or absence of water. This methodology was applied in a test area located in the upper Tiber River Basin. The performance for identifying and analysing small reservoirs was determined by comparing the satellite information with a reference database. The potential volume available from the investigated small reservoirs was compared with the water deficit derived from a decision support simulation model at the basin/subbasin scale, which studies water allocation for multipurpose uses. Five irrigation districts were analysed. For three of these districts, more than 60% of the annual deficit can be balanced with the volume stored in small reservoirs.

To date, water scarcity conditions have been increasingly frequent, so resilience in water resource management is a key requirement. Therefore, it is essential to evaluate the recovery and reuse of small reservoirs to strongly support water use, particularly irrigation and environmental uses.

Keywords Water allocation model, SimBaT, Pleiades, NDWI

Publication Di Francesco, S., Casadei, S., Di Mella, I. et al. The Role of Small Reservoirs in a Water Scarcity Scenario: a Computational Approach. Water Resour Manage 36, 875–889 (2022)

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Experimental behavior and analytical modeling of corroded steel rebars under compression

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Abstract The durability of reinforced concrete structures can be sharply reduced by the corrosion of the steel rebars. This phenomenon is of great concern, since it is one of main cause of degradation in RC structures, almost in non-exceptional conditions. Furthermore, the corrosion effects can influence the seismic behavior, leading to dangerous strain localizations and variations of strength distribution and rotation capacity. This problem is amplified if, due to the corrosion of the reinforcement, longitudinal and/or transversal, the buckling of the steel bars takes place. Main aim of the paper is the evaluation of the influence of the corrosion on the compressive and buckling behavior of corroded steel reinforcement bars. At the scope, a comprehensive experimental survey has been planned and performed, for different values of steel bar length-to-diameter ratios and different amount of corrosion. Furthermore, based on the obtained outcomes, a simplified analytical model is developed for the definition of the constitutive relationships of corroded bars under compression.

Keywords Analytical model; Buckling behavior; Experimental tests; Rebar corrosion

Publication Imperatore, S., Rinaldi, Z., Experimental behavior and analytical modeling of corroded steel rebars under compression. CONSTRUCTION AND BUILDING MATERIALS Volume 226, ISSN 09500618.

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ZnO Nanowires for Feedback-Assisted Tuning of Electromechanical Resonators

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Abstract The fabrication of devices with accurately controlled properties almost invariably takes advantage of feedback so that, based on real-time measurements, process parameters can be automatically adjusted in order to obtain the desired characteristics. Nevertheless, despite the outstanding advantages of wet-chemistry methods (e.g., simplicity, low-cost, low-temperature, and compatibility with almost any process and type of substrate), the use of feedback in the solution growth of nanostructures is almost unexplored. In fact, conventional techniques for the real-time in-liquid characterization of nanostructures are extremely complex and can introduce intricate artefacts. Here, by taking advantage of an electro-mechanical resonator as a substrate, we on-line monitor, at the system level, the nanostructure growth, thus enabling the feedback-assisted tuning of low-cost electro-mechanical resonators by ZnO nanowires. This approach allows for post-fabrication tuning of the resonant frequency with high accuracy and high tuning range (e.g., about 1% in our experiments) in a simple, fast, low power, and low-cost manner, without requiring expensive facilities such as clean rooms or high-vacuum deposition systems. Moreover, remarkably, we find that for a given desired resonant frequency, the quality factor of the resonance can be separately adjusted by modifying the nutrient solution, which can be a key advantage for filters. The straightforward interfacing and packaging of the final resonator stems from the large difference, about 5 orders of magnitude, between the key structure dimensions, namely, the diameter of the ZnO nanowires and the much larger (e.g., few millimeters) diameter of the quartz. Our results can lead to the widespread application of nanowire-tuned electro-mechanical oscillators and filters in electronics, sensors, and material science.

Keywords ZnO nanowires, ZnO nanodampers, ZnO nanowires on quartz microbalances, nanowire-tuning, feedback solution-growth, electromechanical resonators, oscillators, feedback-assisted, tuning of electromechanical resonators

Publication ACS Applied Nano Materials.

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2 Social sciences and humanities

Ascribed identities in the global era: a complex approach

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Abstract This study focuses on the process of identity-building, wherein I aim to provide theoretical tools, other than social-psychology (especially symbolic interactionism), to help analyze the said process. Within the epistemic framework of complexity theories, I demonstrate that historical sociology provides sufficient background for understanding contemporary identity phenomena from a macrosociological perspective. This enables the assessment of how, in the current scenario, identity dynamics can affect global phenomena and how the global social structure can affect identity-building processes worldwide. The notion of ascribed identities is, thus, crucial. In this study, I describe modernisation as a process where the ascribed characteristics (gender, religion, ethnicity) progressively lose their function of rigidly defining a person's identity, on behalf of personal achievements. Within this framework, I describe the current re-strengthening of ascribed identities and assess, through this description, which phase of the modernisation process is nowadays taking place.

Keywords Identity, Modernity, Post-modernity, Nation States.

Publication Contemporary Social Science. Journal of the Academy of Social Sciences

Date 3 Jun 2021

DOI 10.1080/21582041.2021.1933157

Operating modes and cost burdens for the European Deposit-Refund Systems: a systematic approach for their analysis and design

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Abstract Deposit-Refund Systems (DRS) are one of the most effective methods to collect one-way beverage packaging. Yet, the analysis of their operating modes and related cost burdens for each actor are still evolving. This study analyses the operating modes and the cost burdens of ten European DRS' using a number of building blocks shared among the different systems. This approach facilitates their comparison and the development of new models.

The building blocks are identified through content analysing some relevant reports. The results show that the required building blocks are the four actors in the process e namely the DRS operator, producers, retailers, and customers e, the money-material flows among the actors (operating mode), and the costs and revenues for each actor (cost burden). Using this approach, the ten models in Europe are reduced to four DRS archetypes. Each archetype has a different money-material flow and a different cost burden for each actor. There are in total 18 costs and 9 revenues.

This study contributes to the systematic analysis of DRS0 in terms of their operating modes and related cost burdens for each actor. Using building blocks to describe the DRS0 facilitates the comparison of different models and the analysis of their efficiency and effectiveness. Moreover, it provides a tool to develop new, country-specific DRS0 in those areas where DRS' do not exist.

Keywords Deposit-refund systems, Circular economy, Sustainability, Europe

Publication Journal of Cleaner Production

Date 2021

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Beyond nationalism and liberal democracy. Revolution and the new European order of Ordre Nouveau (1932-1938)

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Abstract Ordre Nouveau is at once a political movement and a revolutionary project among the most original within the groups of the so-called Non-conformistes des années Trente, which enlivened the thriving intellectual debate of the 1930s in France. Despite the diversity of their intellectual, political and confessional backgrounds, the members of Ordre Nouveau shared the rejection of any ideological or party commitment and a strong revolutionary impetus, going hand-in-hand with a firm pragmatism, though not lacking some utopian features. The purpose of this paper is to analyse the political doctrine of Ordre Nouveau, placing it in its peculiar historical context and stressing its philosophical principles. Starting from some major themes such as the distrust of rationalism, the rejection of capitalism, the criticism of parliamentary democracy and the condemnation of nationalism and of totalitarian regimes, Ordre Nouveau calls for a spiritual revolution, which should provide the foundations for a new personalist and federalist European order.

Keywords Ordre Nouveau, Nation-State, Integral Federalism, Personalism, European Federalism.

Publication Metábasis – Philosophy and Communication

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DOI 10.7413/18281567232

Terrorism

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Abstract In modern constitutional States, the terrorist threat has increasing made apparent the tension between the need for security and the guarantee of individual liberties. The threat has given rise to a 'war without end' to what have been termed 'times of crisis' and to the emergence of 'times of stress', during which the political community retains its identity and unity, but is decisively destabilized. Juridically, preventive or even repressive measures will have to be adopted, severely restricting the rights of the individual, in order that the community as a whole can enjoy the benefit of security. This issue is of some interest, since, if a state where to place security at the centre of its functions and objectives, in a scenario of 'war without end' it would be forced to adopt measures that would increasingly impinge upon basic freedoms, for the sake of security. The need for democratic States to defend themselves against terrorist attacks, therefore, implies the adoption of repressive and primarily preventive measures, both temporary and permanent, authorized by the system that produces the sources of law and which, to a significant extent, impinge upon the fundamental rights of the individual. The result is that, in facing the difficult task of balancing security and freedom, governments and parliaments, within their various legal systems, will be responsible for choosing and deciding on the most useful tools for dealing with the terrorist threat, while the courts will have the responsibility of making sure that their actions comply with the basic principles written into their Constitution.

Keywords State of emergency, National security, State of necessity, Terrorism,

Publication Max Planck Encyclopedia of Comparative Constitutional Law, Oxford University Press

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3 Multidisciplinary

A Taxonomy of Energy Resilience

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Abstract Resilience is receiving increasing scientific attention, albeit its notion is still in progress and not univocal, especially when it comes to specific sectors such as energy. Energy and resilience policy is detected as a dominant strategy to achieve international development objectives throughout long-term sustainability and wellbeing goals. Energy resilience also crosses major energy policy issues – namely energy vulnerability, security, poverty, and justice. Making use of the Web Of Science 2018 release, this work aims at contributing to a clarification of the concept of energy resilience, proposing a taxonomy. The bibliometric outputs show a sharp increase in scientific publications on the issue. The bibliometric analysis suggests a taxonomy of energy resilience based on 7 approaches or strategies. The results suggest an evolution of the conceptual contributions, that enlarge resilience early use, merely applied to technical and hard sciences. Resilience is today used in different disciplines, including social sciences and sustainability studies, as part of a holistic approach centered on sustainable development.

Keywords Energy resilience, taxonomy, bibliometrics, energy policy, sustainable development

Publication Gatto, A., & Drago, C. (2020). A taxonomy of energy resilience. Energy Policy, 136, 111007.

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DOI https://doi.org/10.1016/j.enpol.2019.111007

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1 Physical sciences and engineering

Inclusive MOOC Supported by Assistive Technology

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Abstract The deaf and blind communities often struggle to communicate. In scenarios such as academia, these communication challenges prevent these communities from progressing within the wider intellectual communities, as most digital content and tools used for disseminating information remain inaccessible to them. Our work aims to revamp the learning experience of deaf and blind students by granting them access to education in their first language and through proper effective channels. Massive and Open Online Courses (MOOCs) provide a new opportunity for education. MOOCs are easily accessible; however, their availability tends to be non-inclusive. The aim is for them to be viewed broadly, even though minority groups, with needs for specific channels and languages, such as deaf and blinds, are usually not considered. To maximize the potential of these courses, an inclusive MOOC was developed, a broad pedagogical model with technologies that enable deaf and blind people to access digital educational content.

Keywords Educational content, inclusive MOOC, pedagogical model, assistive technology, automatic translator

Publication IntechOpen: Massive Open Online Courses - Current Practice and Future Trends

Date 2023

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Inclusive MOOC - educational content for deaf people, a Portuguese proof of concept

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Abstract The communication gap between deaf and non-deaf communities arises due to the use of distinct mother languages. A deaf student, who used to communicate in sign language, cannot read fluently materials written in spoken language. This fact causes serious difficulties to deaf students since most didactic materials in higher education are available exclusively in spoken languages. In this paper, we propose a pedagogical model to deliver educational materials in sign language aiming to provide deaf students the same conditions to succeed as the others, i.e., didactical materials available in one's mother language. Our approach involves the integration of automatic translation technology between spoken and sign language pairs into MOOCs. As a proof of concept, we used this methodology to design a course addressing digital literacy for schoolteachers. The evaluation of the inclusive MOOC and its underlying model reveals its potential, even though further improvements are required, especially regarding evaluation and usability features. Keywords: educational content; inclusive MOOC, pedagogical model; assistive technology; automatic translator.

Keywords Educational content; inclusive MOOC, pedagogical model; assistive technology; automatic translator

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DOI 10.18844/cjes.v17i4.7151

An Inclusive Educational Tool

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Abstract Communicating in languages other than one's mother language is a demanding task. Even when mastering basic skills in a foreign language, communication is challenging unless you are a frequent user. The vocabulary and grammar rules tend naturally to be forgotten over time. This is even more critical when distinct channels are used by one's mother language and a given foreign language; this is the current setting when communication among deaf and non-deaf users is undergoing, even in the same country. We expect that the use of technology may assist users in such cases, notably through the Figure Out application. Figure Out is a mobile application designed to translate text, automatically captured by the mobile camera, to a given language. This application will allow translation from and to any language, including sign languages. The aim is to enable everyday users like, students, and all individuals to access information in their first language or the one they choose. By simplifying access to information, the application will improve accessibility, inclusion, and communication, namely between the deaf and non-deaf communities. With Figure Out it is possible to enhance the access of, students, tourists, and the deaf population to education, culture, and international mobility while reducing communication barriers.

Keywords Educational Communication, Inclusive Technology, Automatic Translation, Accessibility, Inclusion

Publication Multi Conference on Computer Science and Information Systems (MCCSIS 2022)

Date 2022

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Inclusive Technical Terms for the Deaf

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Abstract Understanding the meaning of technical terms is essential when using technical and scientific documentation, whether directed to education, research, or labour. In education settings, there is a need to provide clear definitions of terms, to use a glossary explaining the meaning of each technical term when introducing a new topic, and to align terminology and communication channels to the abilities of the target audience. It is exactly at this last point that equity and inclusion issues originate. If we provide definitions or explanations of new concepts using spoken languages in writing, as we commonly do, we leave apart all those who cannot fluently read them. Deaf people cannot read fluently. Sign languages and spoken languages are distinct languages, each one on its own. Sign and spoken languages in the same country use distinct channels, different phonology and morphology, different grammar and arise from different cultures. When we force deaf students to study via written/spoken languages, we are placing them at a clear disadvantage and seriously compromising equity. Inclusive education is about assuring that all students have the conditions and the resources they need to succeed; this does not happen when we force students to study using a language they do not master. There is a need for a tool that can introduce and explain to deaf students technical and scientific concepts from specific areas of knowledge in sign language. TechWhiz is a glossary of scientific and technic concepts, described in sign language, aiming to assist deaf students in gaining access to education in their first language and enhance their learning achievements.

Keywords Sign language, scientific glossary

Publication HCI International 2022

Date 2022

DOI 10.1007/978-3-031-17902-0_24

Eco Tetris: A Serious game on Sustainability

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Abstract Recycling has grown to be extremely relevant for the maintenance of our planet, but also for our well-being. Sustainability is a key issue in modern societies, relying on intergenerational care and education to promote recycling habits and social responsibility. Raising awareness towards recycling and healthy environmental habits, and motivating people to become more responsible about sustainability and the environment might be achieved through a game, designed to be simple and intuitive and to enhance the learning process. Eco Tetris is a game, designed to teach about the importance of recycling. Based on the well-known Tetris game, Eco Tetris builds upon this by adding card collecting mechanics and integrating the game with the real world via geo-referencing, beacons, and augmented reality experiences. The main goal of this game is to raise awareness and make the players more conscious of their environmental decisions and habits, while also being entertained. Our primary focus is the older generation, for whom the game is kept simple, in terms of both usability and design. Eco Tetris is a game whose main concern is to transmit knowledge on how to recycle and its importance for our planet. In this game, players are challenged to place the garbage in the right recycling bin. The mechanic is virtually the same as when recycling. Our goal is to imbue the player with recycling habits. The core gameplay loop will have the player doing the sorting exercise – separating garbage in-game, mentally associating it to its right colors. The bridge between the in-game and real-world is achieved via geo-reference modules and beacons. When visiting an eco-point, the player will have access to additional content, like an augmented reality experience, that provides positive reinforcement and knowledge about players' actions and the environment in general. We expect this game to promote ecological responsibility and a major view of one's role in the recycling process. The game is developed towards the enhancement of decision-making, memory skills, awareness, responsibility, and learning of its players.

Keywords Serious game, sustainability, learning process, usability testing, beacons

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Date 2022

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A Chemistry Inclusive and Educational Serious Game

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Abstract Promoting equal opportunities and social inclusion of disabled people is a concern of modern society and a key issue in European Education. The evolution of science and the emerging new technologies promote social inclusion and might gear traditional learning environments with the required features to assure disabled people face the same learning opportunities as all. Our current work brings in R&D world-class results in the field of Educational Serious Games, to help students to learn and to assimilate subjects related to the Chemistry study field. Chemistry subjects pose significant challenges to junior and high-school students. Chemistry is a hard learning subject that students are usually reluctant to learn through the traditional teaching/learning methods. Reading Chemistry class books for long hours is not very effective; this drawback is even more serious when it comes to students that do not master oral languages or face other disabilities. In this paper we describe a developed serious game meant to be educational and inclusive, to help high school Chemistry students to learn and explore the Table of Periodic Elements and the composition of molecules. The inclusive components of the game address several disabilities, such as color blindness, hearing, and mobility impairments. Adequate color themes, to enable color blind students, sign language, to enable hearing-impaired students, sensorial devices to enable mobility impaired students, will be provided to play the game without any stigma. High-Level Requirements will be established. The game has been required to be supported by a Serious Games architecture and Inclusive Games Standards. To meet these needs, several requirements must be met as part of the development such as Biometric Sensor; Beacons; Augmented Reality; Georeferencing; Multiplatform; Multiplayer; Closed source; DLC; and DDA.

Keywords Educational Serious Games, inclusive game, table of periodic elements, Serious Games architecture, inclusive games standards

Publication 2022 31st Annual Conference of the European Association for Education in Electrical and Information Engineering (EAEEIE)

Date 2022

DOI 10.1109/EAEEIE54893.2022.9820516

Higher education students' achievement emotions and their antecedents in e-learning amid COVID-19 pandemic: A multi-country survey

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Abstract The outbreak of the COVID-19 pandemic has had a wide range of negative consequences for higher education students. We explored the generalizability of the control-value theory of achievement emotions for e-learning, focusing on their antecedents. We involved 17019 higher education students from 13 countries, who completed an online survey during the first wave of the pandemic. A structural equation model revealed that proximal antecedents (e-learning self-efficacy, computer self-efficacy) mediated the relation between environmental antecedents (cognitive and motivational quality of the task) and positive and negative achievement emotions, with some exceptions. The model was invariant across country, area of study, and gender. The rates of achievement emotions varied according to these same factors. Beyond their theoretical relevance, these findings could be the basis for policy recommendations to support stakeholders in coping with the challenges of e-learning and the current and future sequelae of the pandemic.

Keywords COVID-19, achievement emotions, higher education students, e-learning, self-efficacy

Publication Learning and Instruction

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Training Course in B-Learning Mode: A Case Study

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Abstract This case study aims to examine how should we design training courses, while helping students acquiring skills in information and communication technologies. The course framework focuses on blended learning, thus creating a learning environment which is learner-centered, knowledge-centered, assessment-centered, and community-centered. The analysis of the data this study showed us that the design of the course appeared to have a positive impact on student learning, as far as complex problem solving and collaboration with peers and in their integration in companies. Results demonstrate that the learning structure can help to improve education for students in vocational education and training, while helping students, with academic qualifications, in a distinct area from information and communication technologies, to acquire tech skills, empowering them in accessing a demanding labour market.

Keywords Training, b-learning, constructivism theory, PBL

Publication International Conference on Information Technology & Systems (ICITS 2022)

Date 2022

DOI 10.1007/978-3-030-96293-7_33

Master Data Management

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Abstract This paper describes the creation of a product information management module for retail businesses. The project arose due to the significant growth of the retail area and its purpose is the creation of a backend application in C# ASP.N et that allows the management of all information products. The project was carried out following an Agile methodology, with two-week sprints, starting with an analysis and specification of the requirements. Then, the implementation was followed by several rules, nomenclatures and standards such as Mappers, Controllers, Data Transfer Objects and Repository, also following principles of Onion Architecture with Domain-Driven Design. In the end, it was possible to verify that the most critical requirements, such as period management, product hierarchies, price lists, VAT (Value Added Tax), groups, configuration files and the import and export of products, for the correct functioning of the system were successfully completed, although there were some limitations.

Keywords Agile, ASP.Net, A WS, C#, Information Management, MongoDB, RabbitMQ, Retail

Publication 2022 International Conference on Electrical, Computer, Communications and Mechatronics Engineering (ICECCME)

Date 2022

DOI 10.1109/ICECCME55909.2022.9988269

Schematic Map Development

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Abstract This document, developed within the scope of the course unit Project/Internship of the Degree in Informatics Engineering, aims to describe the internship project developed in the company Armis Group, more specifically, in the ITS (Intelligent Transport Systems) team, dedicated to the development of solutions in the area of transport, namely, management, planning and monitoring of road traffic. One of the products developed by the ITS team - DRIVE - is one of the most widespread in the national road network. The main goal of the project is the technological update of one of the Drive product modules - the Schematic Map -, since it doesn't respond technologically to the needs demanded by the current market, as well as the extension of its functional requirements. The solution obtained met all the functional requirements, from the technological update of the module to the implementation of all the extra functionalities that were not present in its old version. Furthermore, it also allows a future extension of the development of the Schematic Map module, without compromising the current project.

Keywords Armis Group, Intelligent Transport Systems, Web, Drive, Schematic Map, Angular, ASP.NET MVC, Microsoft SQL Server, Three.js, C#, InkScape

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Date 2022

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Machine learning techniques applied to mechanical fault diagnosis and fault prognosis in the context of real industrial manufacturing use-cases: a systematic literature review

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Abstract When put into practice in the real world, predictive maintenance presents a set of challenges for fault detection and prognosis that are often overlooked in studies validated with data from controlled experiments, or numeric simulations. For this reason, this study aims to review the recent advancements in mechanical fault diagnosis and fault prognosis in the manufacturing industry using machine learning methods. For this systematic review, we searched Web of Science, ACM Digital Library, Science Direct, Wiley Online Library, and IEEE Xplore between January 2015 and October 2021. Full-length studies that employed machine learning algorithms to perform mechanical fault detection or fault prognosis in manufacturing equipment and presented empirical results obtained from industrial case-studies were included, except for studies not written in English or published in sources other than peer-reviewed journals with JCR Impact Factor, conference proceedings and book chapters/sections. Of 4549 records, 44 primary studies were selected. In 37 of those studies, fault diagnosis and prognosis were performed using artificial neural networks (n = 12), decision tree methods (n = 11), hybrid models (n = 8), or latent variable models (n = 6), with one of the studies employing two different types of techniques independently. The remaining studies employed a variety of machine learning techniques, ranging from rule-based models to partition-based algorithms, and only two studies approached the problem using online learning methods. The main advantages of these algorithms include high performance, the ability to uncover complex nonlinear relationships and computational efficiency, while the most important limitation is the reduction in model performance in the presence of concept drift. This review shows that, although the number of studies performed in the manufacturing industry has been increasing in recent years, additional research is necessary to address the challenges presented by real-world scenarios.

Keywords Machine learning, Fault diagnosos, Fault prognosis, Manufacturing

Publication Applied Intelligence

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Learning sign language basics supported by assistive technology

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Abstract Individuals with hearing disabilities face numerous obstacles with regards to the practice of tourism activities and the use of infrastructure and services. Cultural settings are far from being inclusive for deaf tourists. The lack of knowledge of sign language among the non-deaf population is an obstacle. The ICHT – Inclusive Cultural Heritage Tourism project is expected to bring R&D world-class results in the field of automatic sign language translation to raise awareness to sign language and to motivate touristic operators to learn the basis of sign language communication to welcome and assist deaf tourists. Reducing barriers to the communication between deaf tourists and local touristic operators is expected to develop inclusive and innovative tools to promote accessibility and inclusion.

Keywords International Sign, Inclusive System, Automatic Bidirectional Translation, Sign Language Staff Training

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Date 2022

DOI 10.1109/EDUCON52537.2022.9766537

Towards a Virtual Environment to Teach Natural Resource Management based on a Virtual City Serious Game

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Abstract NATURE (Serious Games for Natural Resource Management) is an Erasmus+ project focused on building awareness, knowledge and skills on responsible natural resource management through digital experimentation in Higher Education. It is aimed to design and implement an experiential, game-based methodological learning framework to enrich existing pedagogical practices on environmental education. The NATURE solution will allow students to engage with several scenario environments through critical and entrepreneurial thinking interventions towards natural resources management. The platform functionality will include: formatting the scenario environment for the management of natural resources, actions for introducing services that promote environmental sustainability based on specific scenario objectives, visual feedback for allowing students to understand their progress and the results of their actions in the game and Services for educators for overlooking student progress.

Keywords Natural resource management, e-learning, computer games

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Residential load shifting in demand response events for bill reduction using a genetic algorithm

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Abstract Flexible demand management for residential load scheduling, which considers constraints, such as load operating time window and order between them, is a key aspect in demand response. This paper aims to address constraints imposed on the operation schedule of appliances while also participating in demand response events. An innovative crossover method of genetic algorithms is proposed, implemented, and validated. The proposed solution considers distributed generation, dynamic pricing, and load shifting to minimize energy costs, reducing the electricity bill. A case study using real household workload data is presented, where four appliances are scheduled for five days, and three different scenarios are explored. The implemented genetic algorithm achieved up to 15% in bill reduction, in different scenarios, when compared to business as usual.

Keywords Demand response, Distributed generation, Flexibility, Genetic algorithm, Load shifting

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Migration of a microservice from Payara Micro to Quarkus and performance analysis

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Abstract In recent years the technological evolution of vehicles has happened at an exponential pace and consequently every company must have the ability to innovate in order to keep up and overcome the competition. It was in the innovation process that the ICES application and more specifically AmbientMusic emerged. The goal of this project is to improve a microservice's performance by migrating the technology used to deploy the microservice to a newer one, namely from PayaraMicro to Quarkus. For this it is necessary to register the current state of the microservice, namely its memory and CPU limit when running, the maximum number of requests per second that the microservice can handle and the startup time of the service. Then perform the migration making all the necessary changes and as a final objective to register the data again and analyze the performance of the microservice after the migration. The backend microservice it's called AmbientMusic and its function is to provide background music for some vehicle features such as the Intelligent Personal Assistant by responding to words like "Hey BMW, I'm feeling sleepy".

Keywords Payara Micro, Quarkus, request, thread, performance

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Machine Learning Predictive Models for preventing Employee Turnover costs

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Abstract The problem arises in the turnover of employees in the company, something that represents high costs for the corporation, in the investment in the training of employees, as well as expenses in time and consequences in the dynamics of work in teams, due to the constant change of employees within teams, something that causes instability among employees. By analyzing data quality, doing a thorough profiling of the data, and also applying predictive models of Machine Learning algorithms, namely AdaBoost, Decision Tree and Support Vector Machine, the solution (developed in python) allows a better understanding of the reasons behind employee turnover and predicts which employees might leave the company soon, so that the human resources departments can prevent that from happening. The results were accurate for AdaBoost - which revealed an accuracy of 98% - and Decision Tree - which revealed an accuracy of 99% - were appropriate for predicting employee turnover, showing a high precision in the predictions, unlike Support Vector Machine which even though revealed an accuracy of 96%, revealed an Area Under the Curve of 0.50, which means this algorithm was not suitable for this data. This project was a contribution for the HR Predictive Analytics area, which allows companies to prevent employee turnover with contractual or moral incentives.)

Keywords Machine Learning, Data Quality, Profiling, HR Predictive Analytics, Python, AdaBoost, Decision Tree, Support Vector Machine

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Optimal model for local energy community scheduling considering peer to peer electricity transactions

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Abstract The current energy strategy of the European Union puts the end-user as a key participant in electricity markets. The creation of energy communities has been encouraged by the European Union to increase the penetration of renewable energy and reduce the overall cost of the energy chain. Energy communities are mostly composed of prosumers, which may be households with small-size energy production equipment such as rooftop photovoltaic panels. The local electricity market is an emerging concept that enables the active participation of end-user in the electricity markets and is especially interesting when energy communities are in place. This paper proposes an optimization model to schedule peer-to-peer transactions via local electricity market, grid transactions in retail market, and battery management considering the photovoltaic production of households. Prosumers have the possibility of transacting energy with the retailer or with other consumers in their community. The problem is modeled using mixed-integer linear programming, containing binary and continuous variables. Four scenarios are studied, and the impact of battery storage systems and peer-to-peer transactions is analyzed. The proposed model execution time according to the number of prosumers involved (3, 5, 10, 15, or 20) in the optimization is analyzed. The results suggest that using a battery storage system in the energy community can lead to energy savings of 11-13%. Besides, combining the use of peer-to-peer transactions and energy storage systems can potentially provide energy savings of up to 25% in the overall costs of the community members.

Keyword Local electricity market, local energy community, optimization, peer-to-peer transactions, prosumers

Publication IEEE Access

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DOI 10.1109/ACCESS.2021.3051004

ATHENA: a Novel Higher Education Approach to Advance a Green Digital Europe

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Abstract Sustainable education has many facets involving not only the conservation of our natural ecosystem, biodiversity and the development of a sustainable society but also promoting equity and ensuring life-long learning opportunities for all regardless of any handicaps or adverse circumstances. UNESCO, through its Sustainable Development Goals, and the European Commission through several programmes, push the society and the universities to promote Quality Education as a core asset in the digital era. ATHENA is a European University aimed at nurturing the development of all-inclusive green digitalization of societies. The educational model of ATHENA is based on several initiatives and novel pedagogies to advance green education and inclusion at the European Higher Education Area. At this paper we describe the general architecture of ATHENA focusing on concrete activities directly linked to sustainable education such as competence clusters, an embedded mobility culture and assistive technology. ATHENA will set all these in place in order to become by 2023 a renowned brand in higher education, a unified, yet distributed, campus underpinning a global value-chain for education and research services.

Keywords Competence clusters, blended mobility, sustainable education, European universities

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The ATHENA European University model for Sustainable Education: Mainstreaming good practices for all-inclusive life-long sustainable learning in the digital era

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Abstract Sustainable education has many facets involving not only the conservation of our natural ecosystem and the development of a sustainable society but also promoting equity and ensuring lifelong learning opportunities for all regardless of any handicaps or circumstances. UNESCO, through its Sustainable Development Goals, and the European Commission through several programmes, push the society and the universities to promote Quality Education as a core asset of modern societies in the digital era. ATHENA is a European University, a federation of seven higher education institutions, aimed to nurture the development of all-inclusive digitalization of societies. The educational model of ATHENA is based on several initiatives and novel pedagogies to advance green education and inclusion at the European Higher Education Area. At this paper we describe the general architecture of ATHENA focusing on concrete activities directly linked to sustainable education such as blended mobility, competence clusters, remote labs and assistive technology. ATHENA will set all these in place during the coming three years starting in October 2020. By 2023 ATHENA will be a renowned brand in higher education, a unified, yet distributed, campus offering sustainable equitable education and research to its stakeholders.

Keywords Blended mobility, remote labs, assistive technology, sign language interface

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Artificial intelligence, cyber-threats and Industry 4.0: Challenges and opportunities

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Abstract This survey paper discusses opportunities and threats of using artificial intelligence (AI) technology in the manufacturing sector with consideration for offensive and defensive uses of such technology. It starts with an introduction of Industry 4.0 concept and an understanding of AI use in this context. Then provides elements of security principles and detection techniques applied to operational technology (OT) which forms the main attack surface of manufacturing systems. As some intrusion detection systems (IDS) already involve some AI-based techniques, we focus on existing machine-learning and data-mining based techniques in use for intrusion detection. This article presents the major strengths and weaknesses of the main techniques in use. We also discuss an assessment of their relevance for application to OT, from the manufacturer point of view. Another part of the paper introduces the essential drivers and principles of Industry 4.0, providing insights on the advent of AI in manufacturing systems as well as an understanding of the new set of challenges it implies. AI-based techniques for production monitoring, optimisation and control are proposed with insights on several application cases. The related technical, operational and security challenges are discussed and an understanding of the impact of such transition on current security practices is then provided in more details. The final part of the report further develops a vision of security challenges for Industry 4.0. It addresses aspects of orchestration of distributed detection techniques, introduces an approach to adversarial/robust AI development and concludes with human–machine behaviour monitoring requirements.

Keywords Intrusion detection systems, Security, Industry 4.0, Artificial intelligence

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Removing education barriers for deaf students at the era of Covid-19

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Abstract Nowadays where Covid-19 threatens human lives, it is essential to adapt to this situation and try to continue our lives even though some activities are almost inevitable. Education system is one of the most affected daily activities. New technological means had to be adopted to overcome the distance and to continue education process. Although these new adopted means brought new perspectives, also many problems were raised. Deaf or hard hearing students faced more difficulties than in ordinary situations. Deaf students in order to communicate are either using lip reading and must see their interlocutor's whole body. In the not likely scenario that the schools are open, teachers and students must wear a face mask, while in distance learning only a small window of the participants is visible and most probably only their faces. Thus, communication at the era of Covid-19 for deaf and hard hearing students is almost inevitable. This paper makes a presentation of the special education system of deaf people in Greece, addresses the difficulties these students face and presents a novel educational tool that with the proper use should help them overcome this difficult situation.

Keywords Deaf students, distance learning, sign language, educational tool

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Ensemble learning for electricity consumption forecasting in office buildings

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Abstract This paper presents three ensemble learning models for short term load forecasting. Machine learning has evolved quickly in recent years, leading to novel and advanced models that are improving the forecasting results in multiple fields. However, in highly dynamic fields such as power and energy systems, dealing with the fast acquisition of large amounts of data from multiple data sources and taking advantage from the correlation between the multiple available variables is a challenging task, for which current models are not prepared. Ensemble learning is bringing promising results in this sense, as, by combining the results and use of multiple learners, is able to find new ways for current learning models to be used and optimized. In this paper three ensemble learning models are developed and the respective results compared: gradient boosted regression trees, random forests and an adaptation of Adaboost. Results for electricity consumption forecasting in hour-ahead are presented using a case-study based on real data from an office building. Results show that the adapted Adaboost model outperforms the reference models for hour-ahead load forecasting.

Keywords Ensemble learning, Machine learning, Random forests,

Publication Neurocomputing

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A collaborative city-based game to support soft skills development in engineering and economics

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Abstract HERA is an Erasmus+ project aimed at the development of soft skills in higher education engineering and economics students through collaborative serious games. It proposes a digital learning game platform whose goal is to expose students to complex challenges, the solution to which requires integration of knowledge from diverse fields in a manner that simulates how engineering and economics professionals work and collaborate in the real world. The platform shows the typical landscape of a virtual city game, like SimCity, where it is possible to perform different actions to develop a city in an appropriate and suitable way. Available scenarios involve problems related to sustainable mobility, smart parking solutions, circular economy related to recycling, flood management, e-commerce development, Olympic Games management and even COVID. Gamifying the problem-solving process will promote active student engagement in learning through a sense of mission, a sense of affiliation, healthy competition, rewards, and social recognition by peers among other mechanisms.

Keywords Soft skills, game-based learning, simulations

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Group decision support systems for current times: Overcoming the challenges of dispersed group decision-making

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Abstract We are living a change of paradigm regarding decision-making. On the one hand, there is a growing need to make decisions in group at both professional and personal levels, on the other hand, it is increasingly difficult for decision-makers to meet at the same place and at the same time. The Web-based Group Decision Support Systems intend to overcome this limitation, allowing decision-makers to contribute to the decision process anytime and anywhere. However, they have been defined inadequately which has been compromising its success. This work discusses the current Group Decision Support Systems limitations in terms of challenges and possible impediments for their acceptance by the organizations and propose a conceptual definition of a Web-based Group Decision Support System that intends to overcome the existing limitations and help them to affirm as a reliable and useful tool. In addition, some crucial topics are addressed, such as communication and perception, that are essential and sometimes forgotten in the support of dispersed decision-makers. We concluded that there are still some limitations, mostly in terms of models and applications, that prevent the design of higher quality systems.

Keywords Web-based Group Decision Support Systems, Dispersed Group Decision-Making, Microservices, Affective Computing, Cognitive Science

Publication Neurocomputing

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Games: The Motivation in Engineering Education

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Abstract The increased use of educational games as educational tools in classes is mainly explained by the motivational power that is attributed to games. In general, and by the need to change methodologies for emergency education. This article investigates the role of different motivational forms in educational games and the influence of the game context in teaching in motivating students to engage in the game. Based on self-determination theory and a mixed-method case study approach, seven educational games were studied in a graduate-level engineering course in two consecutive years. The authors reveal through the research that different motivational forms can coexist when students play games and that the interaction between the attractiveness of the game, learning and its operability can explain the emergence of motivational forms leading to the academic success of the subject in question.

Keywords Educational game, motivational effect, self-determination theory, mixed approach method

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Developing emotional intelligence with a game: The league of emotions learners' approach

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Abstract Being able to understand, express, and communicate emotions is widely recognized as a fundamental competence. For the younger generation entering the professional market, this is particularly relevant as, in this context, emotions are managed and communicated in ways (and channels) that are different from what they are used to and that can easily lead to misunderstandings. Therefore, it is important to analyze how young people deal with, understand, and interpret emotions, particularly in the context of a professional career where the ability to dialogue with different people and how to get around problems in a healthy and resilient way is essential. This analysis will allow one to design and create tools that allow the younger generation to improve their emotional intelligence and competence. This article introduces the League of Emotions Learners (LoEL) project, an innovative initiative that, through a game app, develops the emotional competence and intelligence of young people. The article then presents the results obtained in the initial validation that led to the positive understanding of its impact.

Keywords Emotions, emotional intelligence, serious games, apps

Publication Computers 2021

Date 2021

DOI 10.3390/computers10080097

Difficulties and Disparities to Distance Learning During Covid-19 Period for Deaf Students – A Proposed Method to Eradicate Inequalities

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Abstract During this critical period the humankind faces, one of the most affected daily activities is the education. Teachers and students of all education levels had to adopt new technological means to overcome the distance and to continue their education. Above and beyond the new prospects that this situation arises, also many problems were raised. For example, the special care education e.g., deaf or hard hearing students, face more difficulties than in ordinary situations. These students either read the lips or have to see their interlocutor's whole body, in order to understand what he/she is saying but this nowadays is almost inevitable. In the unlikely scenario that their school is open, all classroom participants including teacher must wear a face mask, while in distance learning they can see only a small window of their teacher and most likely only his/her face. This paper presents the ways of communication of deaf and hard hearing people and proposes a novel educational tool that with the proper use should help them overcome this difficult situation.

Keywords Deaf students, distance learning, sign language, educational tool

Publication International Conference on Intelligent Tutoring Systems (ITS 2021)

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Teaching Soft Skills in Engineering Education: A European Perspective

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Abstract Higher Education engineering students need to be prepared to address sustainable solutions to the complex problems faced in this century. They should become proficient problem solvers, able to work in multidisciplinary teams, ready to adapt to new technologies, and able to acquire new knowledge and skills when needed. Usually known as soft skills, these competences play a key role in Engineering and have been taught in the last two decades, to a greater or lesser extent, using different methodologies and tools. This study reviews the promotion and teaching of soft skills in Higher Education across 5 European countries: Greece, Estonia, Denmark, Portugal and Spain. It provides an overview of best practices on these countries, focusing also on technological solutions to actually enable the development of soft skills. The purpose of this research is to shed some light about how soft skills are being taught presently and the difficulties involved in that process.

Keywords Higher engineering education, soft skills, best practices, employability

Publication IEEE Access

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A Model for Knowledge Management in the e-Learning and Innovation Unit of the Polytechnic of Porto

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Abstract This research article aims to present the results of the case study on knowledge management at the e-Learning and Innovation Unit of the Polytechnic of Porto (EIPP). Knowledge management is a complex and multidisciplinary concept supported by technologies and processes, whose objective is to promote the creation, sharing and application of organizational knowledge. To be able to have an efficient management, knowledge management models are created adapted to organizations that apply practical measures that, when put into practice, enhance knowledge. It appears that the evolution in the improvement of organizational knowledge management processes is not necessarily a complex and time-consuming process, sometimes it is possible to achieve high levels of effectiveness with the implementation of small procedures supported by communication technologies and network collaboration.

Keywords Knowledge management, Case Study, EIPP

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Proposal of a learning design model developed for the creation of training courses Cobol programming course case study

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Abstract In this paper we present a model for designing professional courses in a blended learning context as a tool to help the interaction between students, teachers and learning resources. This model aims to promote new concepts, new approaches and new strategies that have been changing the paradigm of teaching and learning. To develop a course based on these objectives, a systematic process, driven by a series of well-defined phases and activities, is required to help us to effectively develop high-quality applications. The research presented here focuses on an improved design model in a blended learning context and consists of four main phases: requirements definition, planning, design of learning activities, implementation, and evaluation. The whole process begins with an analysis of the students and the characteristics of the environment. Content analysis is conducted to explore the structure of the course. The identification of learning events, learning units, and instructional methods are included in the design of learning activities. As evaluation is a critical factor, this model incorporates a questionnaire, whose purpose is to ensure a well-designed blended learning course. This questionnaire tries to answer the key points that determine the structure of the course and to check the satisfaction of the learners with the context taught. One of the main contributions of this research is allowing the requalification of professionals who meet the needs of professional staff in Information and communications technology (ICT).

Keywords Blended Learning, Collaborative Tools, Distance Education, Online Learning

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Blended Academic International Mobility: tearing down barriers to mobility in a sustainable way

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Abstract Modern economy requires engineers to excel in collaborative and communication skills at an international setting. However, these competences are not usually addressed in engineering curricula. In the Blended Academic International Mobility course, Blended-AIM, students develop their capstone project as members of an international and multidisciplinary team while working at their home institutions. Team members are geographically spread to assure heterogeneous teams and to promote international cooperation. This paradigm, although very suited for engineering degrees, can be adapted and applied in any project/internship course unit. The results from the first 10 editions of the course that ran between 2009/10 and 2018/19 support our initial hypothesis that Blended-AIM significantly promotes students' soft skills without requiring costly and time consuming changes to prior degree curricula. It has the additional benefit of tearing down most of the barriers to international mobility in a sustainable way. In 2019/20 we are running the 11th, edition of the course and planning to transfer this innovative educational paradigm to new partners outside EU borders.

Keywords Blended mobility, green education, soft skills, equity, employability, internationalization of education

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Teachers' skills required to design and deliver MOOCs in Engineering Education

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Abstract Universities are pressed to update their educational processes in face of the changing students' needs, the companies and industries requirements and the surrounding society evolving context. Never has this challenge been so dramatic and so immediate as it is now, in this COVID-19 pandemic! Much of the burden to adapt the teaching processes and the learning methodologies has fallen onto teachers that were required to improve their pedagogical and technical competences to be able to handle the present societal needs. Teachers must now be able to blend online activities with face-to-face teaching and to reuse existing open contents into their teaching practices to adapt efficiently to this new reality. This paper analyses and discusses the needs of teachers in such contexts, namely when Massive Open Online Courses (MOOCs) are blended with other forms of learning. This study was conceived and designed before the current pandemic, but it has been rendered even more relevant by this situation.

Keywords MOOCs, Open Education, Higher Education, Curriculum Design, Engineering

Publication 2020 IEEE Learning with MOOCS (LWMOOCS)

Date 2020

DOI 10.1109/LWMOOCS50143.2020.9234377

Self-assessing Teachers' Competences for Curricula Modernization Through MOOCs

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Abstract Massive Open Online Courses (MOOCs) paved the way for new instructional methods by and for academic early adopters, who shifted their traditional teaching in ways believed to improve the students experience and to provide more interactive learning opportunities. To analyze this impact in the education system, at different levels, we investigated the desired competencies of the academics who create, develop or integrate MOOCs in traditional higher education. For this purpose, a self-assessment tool for educators was created and this paper presents its pedagogical and technical design, its development and the main results from the first pilot evaluation with teachers from universities in different European countries.

Keywords MOOC, eLearning, Curricula modernization, Teacher competences, Self-assessment

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Addressing the Gender Gap in Computer Programming Through the Design and Development of Serious Games

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Abstract The gap between male and female participation in computer science education and careers is a worldwide issue that must be addressed by introducing early methodological learning interventions that make computer science attractive to all, that is by answering the following issues: a) misperception among educators, learners, parents, and youngsters on the suitability of computer science careers to girls and b) a wrong assumption of an insufficient preparedness to do it successfully. This article presents a European initiative - CODING4GIRLS - that proposes to teach coding through a game design and development process based on a design thinking methodological approach that is linked to creativity and human-centered solutions. In this methodology, students address increasingly complex real-life challenges by designing and developing awareness raising serious games for which they need to learn specific coding concepts.

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Student's social vulnerability in distance learning in COVID-19 times

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Abstract This work aims to analyze the social vulnerability of students in the disciplines taught in distance education in the context of the COVID-19 pandemic. This is a theoretical study, reflective analysis on the various issues of social vulnerability, focusing on how students experience distance learning within the social isolation obligation context. The following points are based on literature review with discussion: Distance learning as a realistic response on the fight against social isolation and social vulnerability, on higher education students, while aiming to avoid losing any semester topics. As a result, it is important to highlight the student's requirements in terms of preparation with information and communication technologies and, especially, those in a situation of social vulnerability who do not have all the necessary resources to access contents taught in this teaching modality, at a distance. There must be a perception of diversity, accessibility, and the principles of inclusion so that the demands of students in situations of social vulnerability can be met in an equitable way.

Keywords Distance Education, Educational Technology, Social Equity, Educational Equity, Distance Learning, Coronavirus, COVID-19, Pandemic

Publication International Conference e-Learning 2020

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Creating competitive opponents for serious games through dynamic Difficulty adjustment

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Abstract Competition is a basic element of our society. It drives us to rise above previously perceived limitations, increases our engagement and makes the world more interesting. Competition rewards our existing skills and prompts us to identify and improve our weaker skills. In games, player engagement is achieved, at least in part, by providing him/her with competition at the right amount of difficulty. Achieving and maintaining this exact level of challenge is one of the most difficult tasks for a game designer. The use of Dynamic Difficulty Adjustment techniques allows the game to dynamically adjust the challenge according to player performance, therefore keeping him/her always on edge, immersed and fully active. New information can then be more easily acquired, which is especially important in Serious Games. This paper describes how DDA techniques were used to create two strategic, goal-oriented computer-controlled (CC) players in order to deliver a higher level of competitiveness for the user in Transform@, a Serious Game aimed at developing entrepreneurship skills. As a result, the strength of the computer controlled player increased by more than 100%. By developing a good strategy for the AI and using DDA the game includes now a powerful opponent which has increased the engagement level of the player.

Keywords Serious games, artificial intelligence, dynamic difficulty adjustment, flow zone, entrepreneurship

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Towards transactive energy systems: An analysis on current trends

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Abstract This paper presents a comprehensive analysis on the latest advances in transactive energy systems. The main contribution of this work is centered on the definition of transactive energy concepts and how such systems can be implemented in the smart grid paradigm. The analyzed works have been categorized into three lines of research: (i) transactive network management; (ii) transactive control; and (iii) peer-to-peer markets. It has been found that most of the current approaches for transactive energy are available as a model, lacking the real implementation to have a complete validation. For that purpose, both scientific and practical aspects of transactive energy should be studied in parallel, implementing adequate simulation platforms and tools to scrutiny the results.

Keywords Transactive energy, P2P energy trading, Transactive control, Microgrids, Aggregators

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1 Physical sciences and engineering

Domination in digraphs and their direct and Cartesian products

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Abstract A dominating (respectively, total dominating) set S of a digraph is a set of vertices in D such that the union of the closed (respectively, open) out-neighborhoods of vertices in S equals the vertex set of D. The minimum size of a dominating (respectively, total dominating) set of D is the domination (respectively, total domination) number of D, denoted $\gamma(D)$(respectively, $\gamma_t(D)$). The maximum number of pairwise disjoint closed (respectively, open) in-neighborhoods of D is denoted by $\rho(D)$ (respectively, $\rho^o(D)$). We prove that in digraphs whose underlying graphs have girth at least 7, the closed (respectively, open) in-neighborhoods enjoy the Helly property, and use these two results to prove that in any ditree T (i.e., a digraph whose underlying graph is a tree), $\gamma_t(T) = \rho^o(T)$ and $\gamma(T) = \rho(T)$. By using the former equality we then prove that $\gamma_t(G \times T) = \gamma_t(G)\,\gamma_t(T)$, where G is any digraph and T is any ditree, each without a source vertex, and $G \times T$ is their direct product. From the equality $\gamma(T) = \rho(T)$ we derive the bound $\gamma(G\square T) \geq \gamma(G)\,\gamma(T)$, where G is an arbitrary digraph, T an arbitrary ditree and $G\square T$ is their Cartesian product. In general digraphs this Vizing-type bound fails, yet we prove that for any digraphs G and H, where $\gamma(G) \geq \gamma(H)$, we have $\gamma(G\square H) \geq \frac{1}{2}\gamma(G)\,(\gamma(H)+1)$. This inequality is sharp as demonstrated by an infinite family of examples. Ditrees T and digraphs H enjoying $\gamma(T\square H) = \gamma(T)\,\gamma(H)$ are also investigated.

Keywords Cartesian product, digraph, direct product, domination, packing

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A critical review on multifunctional smart materials 'nanographene' emerging avenue: nano-imaging and biosensor applications

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Abstract Smart electronic materials 'nanographene' stated, its significant authentication has undergone massive improvements and has emerged as a 'material of the century' in materialize fields of *'Chemical Biology'* and *'Materials Chemistry'*. 'Graphene' as a wonder material has been proposed to possess a high surface area ($\sim$2600 $m^2 g^{-1}$), high portability of charge carriers and excellent mechanical qualities. Moreover, the long-extend π-conjugation of graphene is an essential photocatalytic property enabling wide ranging biosensor activities. Herein, critical review article reflects well known yet a brand-new novel material 'nanographene' and its versatile integrations, utilized for substantial enrichment of desired properties. Target cost-effectiveness, plasticity, and environment-friendliness of melt mixing/compounding fabrication strategy employed to utilize *in-vivo, in-vitro*, and *in- situ*, pharmaceutical, nano-imaging protocols. Owing to nanographene's wide range expansion, summarized latest breakthroughs in Materials Science as well as Biomedical utilizations including cancer nanotechnology, drug delivery, tissue manufacturing, scaffold, photo-thermal therapy, antimicrobial activities, made up of exploring the significant opportunities and key challenges in this novel emerging field.

Keywords graphene, nanotechnology, nano-imaging, *in vivo*, biosensors

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Bioethanol production by enzymatic hydrolysis from different lignocellulosic sources

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Abstract As the need for non-renewable sources such as fossil fuels has increased during the last few decades, the search for sustainable and renewable alternative sources has gained growing interest. Enzymatic hydrolysis in bioethanol production presents an important step, where sugars that are fermented are obtained in the final fermentation process. In the process of enzymatic hydrolysis, more and more new effective enzymes are being researched to ensure a more cost-effective process. There are many different enzyme strategies implemented in hydrolysis protocols, where different lignocellulosic biomass, such as wood feedstocks, different agricultural wastes, and marine algae are being used as substrates for an efficient bioethanol production. This review investigates the very recent enzymatic hydrolysis pathways in bioethanol production from lignocellulosic biomass.

Keywords enzymatic hydrolysis, bioethanol production, biofuels, lignocellulosic biomass, agricultural waste, wood feedstock, marine algae

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Exploring the protection mechanism of a combined fluoropolymer coating on sulphide patinated bronze

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Abstract When bronze or artificially patinated bronze is exposed to an outdoor environment that contains aggressive ions such as sulphates, nitrates, and carbonates, the surface of the bronze changes its appearance due to the formation of corrosion products on the surface. Research is being conducted on versatile protective measures that can be used to protect the surface from these changes. A recently synthesised fluoropolymer-based coating with mercaptopropyl groups, i.e. a 3-component fluoropolymer coating FA-MS-SH (silane-modified poly methylmethacrylate (MS) with added mercaptopropyltrimethoxy silane (SH) and a fluoroacrylate (FA)) was explored in detail in this work where its protective mechanism on sulphide patinated bronze was investigated. Electrochemical tests were conducted on the sulphide patinated bronze with and without the 3-component coating FA-MS-SH. Furthermore, FA, MS and SH alone and various combinations and concentrations of FA-MS were studied in order to determine the protective effect and properties of each component. Colour change and contact angle measurements were also defined. FIB-SEM measurements and GCIB-XPS depth profiles were carried out to study surface bonding with the sulphide patina in detail.

A mechanism for the protection of sulphide patinated bronze was presented through the use of a multi-analytical tool approach. It was shown that FA physisorbed on the patinated surface, while MS and blends of the components chemisorbed on the layer of sulphide patinated bronze, also resulting in the surface being efficiently protected from corrosion processes.

Keywords bronze, sulphide patina, corrosion, protection, electrochemistry, FIB-SEM, XPS

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Development and characterisation of novel three-dimensional axisymmetric chiral auxetic structures

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Abstract Novel three-dimensional (3D) axisymmetric chiral structures with negative and zero Poisson's ratios are presented based on the existing 3D conventional chiral unit cell. The conventional tetra-chiral unit cell is mapped to the axisymmetric space to form the new 3D axisymmetric chiral structure. Two different structure designs are characterised depending on the period delay of the sine curve representing the horizontal struts of the structure. The structures are fabricated using additive manufacturing technology and experimentally tested under compression loading conditions. The digital image correlation methodology is used to determine the Poisson's ratio dependence on the axial strain. The computational model of axisymmetric chiral structures is developed and validated using the experimental data. The computational model is then used to evaluate the new virtual axisymmetric chiral structures with graded cell structures. The newly developed axisymmetric structures show enhanced mechanical properties when compared to the existing 3D chiral structures.

Keywords auxetic cellular structures, axisymmetry, chiral unit cell, experimental testing, computational simulations, mechanical properties, Poisson's ratio

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Mesoporous silica nanoparticles modified with N-rich polymer as a potentially environmentally-friendly delivery system for pesticides

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Abstract The focus of the article is on the design of environmentally-friendly nanocarriers for improved controlled pesticide release, which have low environmental toxicity and nitrogen elemental composition as the most important components of fertilisers. In this study, a novel delivery system was developed for post-loading a biopesticide to mesoporous silica nanoparticles (MeSiNPs) functionalised with N-rich derived polymer. Initially, MeSiNPs were synthesised by the template-assisted method, which yielded MeSiNPs in the nm range, together with highly ordered mesoporous channels with a pore size of 2.9 nm. Subsequently, the water-soluble branched polyethyleneimine (bPEI) was derived systematically with epoxy organosilicate, and functionalised on MeSiNPs to create a source of N-nutrients. The carefully designed novel nano-carrier was analysed by several physicochemical and structural analyses, which confirmed the successful attachment of the derived bPEI to MeSiNPs. Further, the novel nano-synthesised system was used as a delivery for the model biopesticide citridiol. The loading efficiency of citridiol in/on MeSiNPs@bPEI was 19%, while the loading capacity of citridiol was proven to be 5 mg biopesticide/1 mg MeSiNPs@bPEI. The MeSiNPs@bPEI with loaded citridiol was investigated for kinetic release. The system showed a fast initial release behaviour in the first 300 min, which was continued by slow release behaviour and started to reach equilibrium after 10 days. It has been shown that the MeSiNPs@bPEI showed an excellent potential for use in agrochemical applications, not only as a nanocarrier for controlled and slow pesticide release, but may also act as a soil improver by providing Si and N as key nutrient sources.

Keywords mesoporous silica nanoparticles, derived branched polyethyleneimine, pesticide nanocarriers, soil improver, citridiol

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Nano-strain resolution fiber-optic Fabry-Perot sensors compatible with moderate/low resolution VIS-NIR spectrometers

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Abstract This paper reports on nano-strain resolution fiber-optic Fabry-Perot sensors produced by an improved selective etching method. The presented sensors exhibit high spectral sensitivity, low intrinsic temperature response, small size and mounting comparable to conventional Fiber Bragg gratings. Furthermore, the proposed sensors can be read-out by a combination of cost-efficient and widely available VIS/NIR spectrometers and LEDs used in lighting/automotive applications. A strain resolution of 1 nε was demonstrated when using a high-end FBG signal interrogator, while the application of a cost-efficient VIS spectrometer still yielded a strain resolution of about 20-70 nε. When applying suitable temperature compensation, absolute measurements with the nano-strain range are also plausible.

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Optimizing nonlinear charging times of electric vehicle routing with genetic algorithm

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Abstract With the rising share of electric vehicles used in the service industry, the optimization of their specific constraints is gaining importance. Lowering energy consumption, time of charging and the strain on the electric grid are just some of the issues that must be tackled, to ensure a cleaner and more efficient industry. This paper presents a Two-Layer Genetic Algorithm (TLGA) for solving the capacitated Multi-Depot Vehicle Routing Problem with Time Windows (MDVRPTW) and Electric Vehicles (EV) with partial nonlinear recharging times (NL) – E-MDVRPTW-NL. Here, the optimization goal is to minimize driving times, number of stops at electric charging stations and time of recharging while taking the nonlinear recharging times into account. This routing problem closes the gap between electric vehicle routing problem research on the one hand and its applications to several problems with numerous real-world constraints of electric vehicles on the other. Next to the definition and the formulation of the E-MDVRPTW-NL, this paper presents the evolutionary method for solving this problem using the Genetic Algorithm (GA), where a novel two-layer genotype with multiple crossover operators is considered. This allows the GA to not only solve the order of the routes but also the visits to electric charging stations and the electric battery recharging times. Various settings of the proposed method are presented, tested and compared to competing meta-heuristics using well-known benchmarks with the addition of charging stations.

Keywords vehicle routing problem, electric vehicles, battery charging optimization, nonlinear charging function, genetic algorithm

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Applying *k*-vertex cardinality constraints on a Neo4j graph database

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Abstract As with any other database solution, graph databases also need to be able to implement business rules related to a given application domain. At the moment, aside from integrity constraints, there is a limited number of mechanisms for business rules implementation in Graph Database Management Systems (GDBMSs). The underlying property graph data model does not include any formal notation on how to represent different constraints. Specifically, this paper discusses the problem of representing cardinality constraints in graph databases. We introduce the novel concept of *k*-vertex cardinality constraints, which enable us to specify the minimum and maximum number of edges between a vertex and a subgraph. We also propose an approach, which includes the representation of cardinality constraints through the property graph data model, and demonstrate its implementation through a series of stored procedures in Neo4j GDBMS. The proposed approach is then evaluated by performing experiments on synthetic and real datasets to test the influence of checking cardinality constraints on query execution times (QETs) when adding new edges. Additionally, a comparison is performed on synthetic datasets with varying outgoing vertex degrees in order to gain an insight into how increasing the vertex degree affects QETs. In general, the results obtained for each test scenario show that the implemented *k*-vertex cardinality constraints model does not significantly affect QETs. Also, the results indicate that the model is dependent on the order of the underlying *k*-vertex cardinality constraints and outgoing vertex degree in the dataset.

Keywords k-vertex cardinality constraints, graph databases, property graph data model, procedures, business rules, graph schema

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2 Social sciences and humanities

Modeling compliance with COVID-19 prevention guidelines: The critical role of trust in science

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Abstract The coronavirus pandemic is one of the biggest health crises of our time. In response to this global problem, various institutions around the world had soon issued evidence-based prevention guidelines. However, these guidelines, which were designed to slow the spread of COVID-19 and contribute to public well-being, are (deliberately) disregarded by some individuals. In the present study, we aimed to develop and test a multivariate model that could help us identify individual characteristics that make a person more/less likely to comply with COVID-19 prevention guidelines. A total of 525 attentive participants completed the online survey. The results of structural equation modeling (SEM) show that COVID-19 risk perception and trust in science both independently predict compliance with COVID-19 prevention guidelines, while the remaining variables in the model (political conservatism, religious orthodoxy, conspiracy ideation and intellectual curiosity) do so via the mediating role of trust in science. The described model exhibited an acceptable fit ($\chi^2(1611) = 2485.84$, $p < .001$, CFI = .91, RMSEA = .032, SRMR = .055). These findings thus provide empirical support for the proposed multivariate model and underline the importance of trust in science in explaining the different levels of compliance with COVID-19 prevention guidelines.

Keywords COVID-19, COVID-19 prevention guidelines, compliance, adherence, predictors, trust in science

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A global analysis of the impact of COVID-19 stay-at-home restrictions on crime

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Abstract The stay-at-home restrictions to control the spread of COVID-19 led to unparalleled sudden change in daily life, but it is unclear how they affected urban crime globally. We collected data on daily counts of crime in 27 cities across 23 countries in the Americas, Europe, the Middle East and Asia. We conducted interrupted time series analyses to assess the impact of stay-at-home restrictions on different types of crime in each city. Our findings show that the stay-at-home policies were associated with a considerable drop in urban crime, but with substantial variation across cities and types of crime. Meta-regression results showed that more stringent restrictions over movement in public space were predictive of larger declines in crime.

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Critical review of the use of the Rorschach in European courts

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Abstract In relation to the admissibility of evidence obtained using projective personality tests arose in *F v. Bevándorlási és Állampolgársági Hivatam* (2018). The Court of Justice of the European Union has held that an expert's report can only be accepted if it is based on the international scientific community's standards, but has refrained from stipulating what these standards are. It appears timely for European psychologists to decide what standards should be applied to determine whether or not a test is appropriate for psycholegal use. We propose standards and then apply them to the Rorschach because it was used in this case and is an exemplar of projective tests. We conclude that the Rorschach does not meet the proposed standards and that psychologists should abstain from using it in legal proceedings even in the absence of a clear judicial prohibition.

Keywords psychology, law, forensic assessment, courts, professional standards, ethics, evidential value, acceptability, projective test, Rorschach

Publication Psychiatry, Psychology and Law, Volume 29, Issue 2, pp. 183-205

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A model of citizens' trust in intelligence services

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Abstract This article addresses a topic that has rarely been addressed in the available scientific literature, according to our knowledge. It comprehensively defines citizens' trust in the services, identifies the factors influencing this type of trust, and proposes a model for establishing and maintaining holistic trust. The research described in the article is based on the analysed publicly available literature in the field of trust (in general and specific types of trust) and intelligence services, while offering its definition of trust (in general) and holistic trust.

Keywords trust, intelligence service, model

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Building the ethnopôle: Eliciting and sharing ethnobotanical knowledge in tourism development

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Abstract With rising tourism interest in cultural heritage, destination management organisations, museums and other cultural institutions are seeking methods of unlocking the intangible cultural heritage of local residents and sharing that before it is lost. This is specific knowledge of the uses and practices of disappearing urban space, of plants and foodstuffs, of clothing and of work practices that were more in-tune with local, sustainable production. With the emergence of post-humanism, based on Deleuze's reading of Spinoza's ethics, this contribution outlines new methodologies in building the ethnopôle, and proposes a model for transmission that explores narrative knowing through literary travel writing for a new public.

Keywords tourism, travel writing, ethnobotany, development, ethnopôle

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Exceptional human experiences among pilgrims on the Camino de Santiago: A typology of experiences and transformative aftereffects

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Abstract The increasing popularity of pilgrimage at the Camino de Santiago is one of the most interesting developments in terms of religion and spirituality in the Western world. Based on qualitative and quantitative content analysis of 32 pilgrim travelogues, this study constructs an empirically grounded typology of Exceptional Human Experiences (EHEs) among pilgrims, whereby EHEs are understood as specific combinations of out-of-the-ordinary experiences during the pilgrimage and their transformative aftereffects (TAs). Combining different techniques of coding and statistical analyses, we identify seven basic types of EHEs. The most common type is denoted as the experience of interconnectedness with the main effect of a higher emphasis on unity and love. Together with six other identified types, it forms a coherent worldview that closely resembles the "Being-values" defined by Abraham Maslow. These values are at the core of the process of self-actualization of an individual and typically include notions of interconnectedness, unity, wholeness, simplicity, essentiality, just-rightness, spontaneity, effortlessness, benevolence, honesty, autonomy, and individuality. We conclude that the main effect of walking the Camino is a boost in self-actualization as understood in terms of humanistic psychology. It is also argued that the EHE perspective is a useful approach for studying the experiences of pilgrims at Camino de Santiago and for other aspects of late modern spirituality as well.

Keywords exceptional human experiences, pilgrimage, Camino de Santiago, transformative aftereffects

Publication Psychology of Religion and Spirituality, Advance online publication

Date 2022

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Changes in Online Distance Learning Behaviour of University Students during the Coronavirus Disease 2019 Outbreak, and Development of the Model of Forced Distance Online Learning Preferences

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Abstract Because of the Coronavirus Disease 2019 (COVID-19) outbreak, most universities were forced to choose Online Distance Learning (ODL). The study aimed to examine the response of university students to the new situation. A questionnaire was sent to the entire university student population. Based on responses from 606 students, it was revealed that use of all applications in ODL increased. However, only the use of MS Teams increased significantly, while the use of the other applications (email, Moodle, e-textbooks) increased in a range of low to medium in terms of effect sizes, and even nonsignificant for applications such as Padlet and Kahoot. Based on the replies of 414 respondents, a Model of Forced Distance Online Learning Preferences (MoFDOLP) based on Structural Equation Modeling was developed. With a chosen combination of predictors, we succeeded in predicting 95% of variance for Satisfaction, more than 50% for Continuance Preferences variance in MS Teams applications, and nearly 20% in the case of e-materials. Among hypothesized constructs, only Attitudes are a strong predictor of Satisfaction, while Organizational Support, Perceived Ease of Use and Learner Attitude toward Online Learning are not. Satisfaction is a good predictor of Continuance Preferences to use Information Technology after the lockdown ended.

Keywords higher education, online distance learning, continuance preferences, COVID-19, outbreak

Publication European Journal of Educational Research, Vol. 10, Issue 1, pp.393-411

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Climbing the wall around EU citizenship: Has the time come to align third-country nationals with intra-EU migrants?

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Abstract This article discusses legal migration in the EU, in particular labour migration. It addresses the following question: once migrant workers from non-EU countries have been admitted into the Union, should they be treated like workers from EU countries for purposes of free movement? The EU migration acquis is one of the most politically charged issues covered by the EU Treaties. As EU citizens, nationals of member states enjoy a set of free movement and political rights that can be exercised in other member states in accordance with the principle of non-discrimination on grounds of nationality affirmed in Article 18 TFEU. This principle is arguably not applicable to third-country nationals. Thus, member states are free to accord unequal treatment to third-country nationals as compared to privileged EU immigrants. The pressing question is whether it is desirable to maintain different levels of rights for third-country nationals who have been legally admitted and whose connection to the host member state does not otherwise differ from that of EU citizens who have exercised their mobility rights. To answer that question, this paper examines arguments for and against treating migrant workers from EU countries and non-EU countries equally for purposes of free movement. It will show how these arguments push in different directions depending on whether they concern the political, human, social, cultural or economic impact of such differential treatment. Our analysis strongly suggests that, on balance, there are convincing reasons for aligning the treatment of long-term resident migrant workers from non-EU countries with that of migrant workers from EU member states.

Keywords legal migration, third-country nationals, workers, long-term residents, the principle of non-discrimination

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3 Life sciences

Blind identification of the spinal cord output in humans with high-density electrode arrays implanted in muscles

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Abstract Invasive electromyography opened a new window to explore motoneuron behavior in vivo. However, the technique is limited by the small fraction of active motoneurons that can be concurrently detected, precluding a population analysis in natural tasks. Here, we developed a high-density intramuscular electrode for in vivo human recordings along with a fully automatic methodology that could detect the discharges of action potentials of up to 67 concurrently active motoneurons with 99% accuracy. These data revealed that motoneurons of the same pool receive common synaptic input at frequencies up to 75 Hz and that late-recruited motoneurons inhibit the discharges of those recruited earlier. These results constitute an important step in the population coding analysis of the human motor system in vivo.

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Ca2+ oscillations, waves, and networks in islets from human donors with and without type 2 diabetes

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Abstract Pancreatic islets are highly interconnected structures that produce pulses of insulin and other hormones, maintaining normal homeostasis of glucose and other nutrients. Normal stimulus-secretion and intercellular coupling are essential to regulated secretory responses, and these hallmarks are known to be altered in diabetes. In the current study, we used calcium imaging of isolated human islets to assess their collective behavior. The activity occurred in the form of calcium oscillations, was synchronized across different regions of islets through calcium waves, and was glucose dependent: higher glucose enhanced the activity, elicited a greater proportion of global calcium waves, and led to denser and less fragmented functional networks. Hub regions were identified in stimulatory conditions, and they were characterized by long active times. Moreover, calcium waves were found to be initiated in different subregions and the roles of initiators and hubs did not overlap. In type 2 diabetes, glucose dependence was retained, but reduced activity, locally restricted waves, and more segregated networks were detected compared with control islets. Interestingly, hub regions seemed to suffer the most by losing a disproportionately large fraction of connections. These changes affected islets from donors with diabetes in a heterogeneous manner.

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Development and validation of the type 2 diabetes mellitus 10-year risk score prediction models from survey data

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Abstract Aims

In this paper, we demonstrate the development and validation of the 10-years type 2 diabetes mellitus (T2DM) risk prediction models based on large survey data.

Methods

The Survey of Health, Ageing and Retirement in Europe (SHARE) data collected in 12 European countries using 53 variables representing behavioural as well as physical and mental health characteristics of the participants aged 50 or older was used to build and validate prediction models. To account for strongly unbalanced outcome variables, each instance was assigned a weight according to the inverse proportion of the outcome label when the regularized logistic regression model was built.

Results

A pooled sample of 16,363 individuals was used to build and validate a global regularized logistic regression model that achieved an area under the receiver operating characteristic curve of 0.702 (95% CI: 0.698–0.706). Additionally, we measured performance of local country-specific models where AUROC ranged from 0.578 (0.565–0.592) to 0.768 (0.749–0.787).

Conclusions

We have developed and validated a survey-based 10-year T2DM risk prediction model for use across 12 European countries. Our results demonstrate the importance of re-calibration of the models as well as strengths of pooling the data from multiple countries to reduce the variance and consequently increase the precision of the results.

Keywords type 2 diabetes mellitus, 10-years risk, prediction models, model calibration

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Specific Lactobacillus probiotic strains decrease transepithelial glucose transport through GLUT2 downregulation in intestinal epithelial cell models

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Abstract Although human clinical studies have suggested probiotic effects on blood glucose levels, knowledge about molecular mechanisms is still scarce. To test the hypothesis that selected *Lactobacillus* probiotic bacteria could regulate the activity of enterocyte glucose transporters, we aimed to measure in vitro effects of selected *Lactobacillus* probiotic bacteria on transcription and translation of intestinal glucose transporters sodium-dependent glucose cotransporter 1 (*SGLT1*) and glucose transporter 2 (*GLUT2*) as well as transepithelial glucose transport. Lactobacillus plantarum strains (PCS20 and PCS26), Lactobacillus rhamnosus GG (LGG) (ATCC 53103) and Lactobacillus acidophilus (L acidophilus) (ATCC 4356) were co-cultivated with noncarcinogenic porcine enterocytes (CLAB) and human epithelial colorectal adenocarcinoma cells (Caco-2) (ATCC HTB-37). Changes in transcription and expression of *SGLT1* and *GLUT2* were strain and cell line-specific. In CLAB, LGG was the most potent *SGLT1* up-regulator, and PCS26 the most potent down-regulator of *GLUT2* transcription, which was also reflected on the protein level. In Caco-2, all tested strains tended to downregulate *GLUT2* gene expression, while *Lacidophilus* most effectively reduced *GLUT2* protein levels. Statistically significant effect of PCS26 and *L acidophilus* on *GLUT2* molecular and protein levels in CLAB and Caco-2 cell lines, respectively, was also followed by a decreased rate of transepithelial glucose transport. Careful selection of specific *Lactobacillus* probiotic strains could be used to downregulate glucose absorption in intestinal epithelial cells and thereby could be beneficial as a support treatment of pathologies related to glucose homeostasis.

Keywords lactobacillus, cell models, SGLT1, GLUT2, glucose

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The development and characterization of bioactive coatings for local drug delivery in orthopedic applications

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Abstract Layer-by-layer bioactive coatings on AISI 316LVM and Ti90Al6V4 alloy were developed, showing great promise for biomedicine, especially as part of implantable metal-based composites. A corrosion study of the coated and uncoated samples was performed using electrochemistry. It was proven that such coatings do not increase the corrosion susceptibility of substrate materials. Controlled-release of a nonsteroidal anti-inflammatory drug (diclofenac) from the coatings as well as their positive influence on osteoblast growth for several days was proven. The layer-by-layer structure and drug loading were also investigated by means of surface analytical techniques, i.e. ATR-FTIR, ToF-SIMS, and AFM. Finally, the suitability of the prepared coatings for potential orthopedic applications was proven using various cell testing methods.

Keywords diclofenac, polymers, TiAlV, controlled drug release, electrochemistry

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4 Multidisciplinary

A survey of the life cycle assessment of food supply chains

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Abstract Food supply chains have substantial impacts on our environment, using large amounts of fossil fuel and other non-renewable resources, as well as water and land. Food supply chains are also complex systems, and their evaluation thus requires a study of the entire system, from primary production to end-of-life food-waste solutions. This paper examines the current state-of-the-art of the published food supply chains Life Cycle Assessment studies and their quality and coherency with the existing standards from the methodological perspective. In particular, we have followed the framework of the International Organization for Standardization, and considered the standard's requirements, emphasising goal and scope, inventory, life cycle impact assessment and interpretation. We have surveyed forty-nine research and review papers, sourced from the Web of Science. Additionally, we have carried out a content analysis, identifying research areas and existing research trends. The results identified possible improvements in terms of goals and scope, as well as inventory and life cycle impact assessment, to increase the consistency and reliability of studies. These studies, in turn, affect a transparent and sustainability-oriented decision-making process, which is essential at various levels – company, stakeholders, national and global. Concept maps reveal the most dominant research directions, which are production, use, system and packaging. Missing is a role of socio-economic effects, as food life-cycles include societal and economic functions as well as circular economy options, during production or end-of-life processes.

Keywords food supply chain, life cycle assessment, qualitative and quantitative survey, literature review, cooperation

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Sustainable renewable energy supply networks optimization–The gradual transition to a renewable energy system within the European Union by 2050

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Abstract In order to achieve the goal of a carbon neutral EU by 2050 and meet the climate targets of the Paris Agreement, a sustainable, efficient, competitive and secure energy system needs to be developed. This paper presents the synthesis of sustainable renewable energy supply networks within the EU-27, proposing a stepwise energy transition in the transport and power sectors, achieving a carbon net neutral target by 2050. A multi-period mixed-integer programming model is developed, with the objective of maximizing sustainability net present value, considering different biomass and waste resources for the production of biofuels, renewable electricity, hydrogen, food and bioproducts, employing different types of technologies. The results show that, with further development of existing technologies, the goal of a carbon-neutral EU can be achieved without compromising food production. Wind farms have proven to be the most promising solution at present for the rapid expansion of electricity generation from renewable energy sources, while the importance of solar photovoltaics is increasing over the years, reaching the 43% share of electricity generation from RES in 2050. Moreover, the energy transition within the EU could have a significant positive impact on the economic, environmental and also social aspects of sustainability, with more than 1.5 million new job opportunities created across the EU over the next 30 years.

Keywords energy transition, renewable energy, sustainability, biofuels, renewable electricity, supply network optimization, European Union

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Physical, geographical, technical, and economic potential for the optimal configuration of photovoltaic systems using a digital surface model and optimization method

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Abstract The main objective of this paper is to present a novel approach for determining PV potential through an optimization method. The novel approach considers the importance of technical and economic potential simultaneously for determining the optimal configuration of PV systems using a digital surface model. The integration of photovoltaic systems is conditioned mainly by the location and type of installation - configuration. Thus, more and more photovoltaic systems are being integrated into urban areas. For the further successful integration of photovoltaic systems into networks and the successful establishment of appropriate policies and directives, it is essential to properly assess the photovoltaic potential. Based on the described methodology, the potential determination is made for a completed area of 75,537 m^2 using a digital surface model of the observed area. The annual values of physical, geographical, technical, and economic potentials were 19.57 GWh, 7.54 GWh, 875.50 MWh, and 19.64 kWh, respectively. The methodologies presented in the paper are based on detailed meteorological data for 20 years, a digital surface model of the observed area, a novel optimization approach, and multi-year data of electricity prices on markets. The presented results can be an excellent basis for further analyzes of determining the photovoltaic potential.

Keywords photovoltaic potential, digital surface model, optimal configuration, optimization method, multi-objective optimization

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Embodied energy and GHG emissions of residential multi-storey timber buildings by height–a case with structural connectors and mechanical fasteners

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Abstract In recent years, interest in the construction of multi-storey timber buildings in the urban context has increased. The stability of any timber building depends on the structural connections that transfer and anchor the loads acting on the building, such as horizontal forces (wind, earthquake), which increase significantly with the building height. However, they are generally neglected in studies assessing their environmental performance. For this reason, the present study investigates the embodied energy and greenhouse gas (GHG) emissions of a residential multi-storey timber building with an increase in height by performing a life cycle assessment (LCA) with an integrated approach that considers structural behaviour and includes connectors and fasteners. The results presented as relative and absolute contributions of different building elements show that the embodied impacts per floor decrease as the building height increases, However, relative and absolute contributions of different building elements change with the variation in the number of storeys. While the building envelope is recognised as a critical element when considering GHG emissions, the load-bearing timber structure is a critical element when considering cumulative energy demand (CED). The results further revealed the importance of connectors and fasteners, as they account for up to 4.80% of the non-renewable CED at the building level, and up to 25.66% when assessing the load-bearing timber structure. Considering a significant contribution, it is suggested that their impact should be evaluated in the environmental impact assessments of timber buildings. In addition, the study highlights the relevance of certain design parameters regarding the embodied impact to achieve a more environmentally efficient building design.

Keywords life cycle assessment, multi-storey timber buildings, fasteners, connectors, embodied greenhouse gas emissions, embodied energy

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It takes two to tango: technological and non-technological factors of Industry 4.0 implementation in manufacturing firms

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Abstract It is commonly held that new technologies improve the productivity of organizations. However, technology acceptance does not happen instantaneously—it depends on complementary, non-technological changes in organizational behaviour. The lack of the latter may present a barrier to technology implementation and could even result in adverse effects on productivity. This is often the case in emerging economies that are deeply embedded in mature technological frameworks and with limited readiness for the adoption of new technologies. Using data from organizations in the manufacturing sector of an emerging European economy, we empirically tested the effects of technological and non-technological factors of the organizational implementation of Industry 4.0 principles on productivity. The results of the investigation, based on structural equation modelling, reveal the positive effects of technology-related Industry 4.0 factors—such as the Internet of Things, cyber-physical systems, and cloud computing—on productivity. The findings also reveal that these effects are enhanced by the mediating effect of non-technological changes to business models, organizational structures and cultures, strategies, and shifts in focus regarding customers, products, and services. This study adds to the existing body of knowledge in this area by revealing the relevance of the individual channels through which transitions towards Industry 4.0 can be enhanced, using traditional manufacturing environments often neglected in studies within this research field.

Keywords Industry 4.0, technological factors, non-technological factors, productivity, manufacturing

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1 Physical sciences and engineering

A gamma-ray pulsar timing array constrains the nanohertz gravitational wave background

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Abstract After large galaxies merge, their central supermassive black holes are expected to form binary systems. Their orbital motion should generate a gravitational wave background (GWB) at nanohertz frequencies. Searches for this background use pulsar timing arrays, which perform long-term monitoring of millisecond pulsars at radio wavelengths. We used 12.5 years of Fermi Large Area Telescope data to form a gamma-ray pulsar timing array. Results from 35 bright gamma-ray pulsars place a 95% credible limit on the GWB characteristic strain of 1.0×10^{-14} at a frequency of 1 year^{-1}. The sensitivity is expected to scale with t_{obs}, the observing time span, as $t_{obs}{}^{-13/6}$. This direct measurement provides an independent probe of the GWB while offering a check on radio noise models.

Keywords pulsar, gravitational wave, astrophysics
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Experimental study on ammonia/hydrogen/air combustion in spark ignition engine conditions

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Abstract The mitigation of climate change implies the increasing use of variable renewable energy sources. Energy storage and transport solutions will contribute to ensure the stability, reliability and flexibility of the energy systems in that context. Ammonia is a well-known chemical of formula NH3 and, amongst other electrofuels, a promising energy carrier and carbon-free combustible fuel. In the present experimental study, engine performance, combustion characteristics and pollutant emissions of a recent spark ignition engine fueled with premixed ammonia/hydrogen/air mixtures were assessed. Gaseous ammonia blends in a wide range of hydrogen fuel fractions and equivalence ratios were tested at two different engine loads. Results show performances comparable with conventional fuel operation when the appropriate promotion strategies are used. Specifically, blending up to 20% hydrogen in the fuel by volume improves the cyclic stability and avoids misfires, while granting the best work output and indicated efficiencies near stoichiometry. Higher hydrogen fractions result in depleted efficiency, attributed to higher wall heat losses. The combustion duration is directly correlated to the LBV of the mixtures, thus being accelerated by hydrogen blending. The accelerating effect of hydrogen is particularly remarkable during the initial stage of the combustion. Hydrogen appears therefore mainly as an ignition promoter. Increasing the engine load improves the furnished work and allows to extend the operating boundaries in terms of mixture composition.

Keywords pulsar, gravitational wave, astrophysics

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Cation insertion to break the activity/stability relationship for highly active oxygen evolution reaction catalyst

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Abstract The production of hydrogen at a large scale by the environmentally-friendly electrolysis process is currently hampered by the slow kinetics of the oxygen evolution reaction (OER). We report a solid electrocatalyst α-Li2IrO3 which upon oxidation/delithiation chemically reacts with water to form a hydrated birnessite phase, the OER activity of which is five times greater than its non-reacted counterpart. This reaction enlists a bulk redox process during which hydrated potassium ions from the alkaline electrolyte are inserted into the structure while water is oxidized and oxygen evolved. This singular charge balance process for which the electrocatalyst is solid but the reaction is homogeneous in nature allows stabilizing the surface of the catalyst while ensuring stable OER performances, thus breaking the activity/stability tradeoff normally encountered for OER catalysts.

Keywords hydrogen production, environment

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How Complex Is Your Classification Problem?: A Survey on Measuring Classification Complexity

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Abstract Characteristics extracted from the training datasets of classification problems have proven to be effective predictors in a number of meta-analyses. Among them, measures of classification complexity can be used to estimate the difficulty in separating the data points into their expected classes. Descriptors of the spatial distribution of the data and estimates of the shape and size of the decision boundary are among the known measures for this characterization. This information can support the formulation of new data-driven pre-processing and pattern recognition techniques, which can in turn be focused on challenges highlighted by such characteristics of the problems. This article surveys and analyzes measures that can be extracted from the training datasets to characterize the complexity of the respective classification problems. Their use in recent literature is also reviewed and discussed, allowing to prospect opportunities for future work in the area. Finally, descriptions are given on an R package named Extended Complexity Library (ECoL) that implements a set of complexity measures and is made publicly available.

Keywords classification, artificial intelligence

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Highly structured slow solar wind emerging from an equatorial coronal hole

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Abstract During the solar minimum, when the Sun is at its least active, the solar wind is observed at high latitudes as a predominantly fast (more than 500 kilometres per second), highly Alfvenic rarefied stream of plasma originating from deep within coronal holes. Closer to the ecliptic plane, the solar wind is interspersed with a more variable slow wind of less than 500 kilometres per second. The precise origins of the slow wind streams are less certain; theories and observations suggest that they may originate at the tips of helmet streamers, from interchange reconnection near coronal hole boundaries, or within coronal holes with highly diverging magnetic fields. The heating mechanism required to drive the solar wind is also unresolved, although candidate mechanisms include Alfven-wave turbulence, heating by reconnection in nanoflares ion cyclotron wave heating and acceleration by thermal gradients1. At a distance of one astronomical unit, the wind is mixed and evolved, and therefore much of

the diagnostic structure of these sources and processes has been lost. Here we present observations from the Parker Solar Probe at 36 to 54 solar radii that show evidence of slow Alfvenic solar wind emerging from a small equatorial coronal hole. The measured magnetic field exhibits patches of large, intermittent reversals that are associated with jets of plasma and enhanced Poynting flux and that are interspersed in a smoother and less turbulent flow with a near-radial magnetic field. Furthermore, plasma-wave measurements suggest the existence of electron and ion velocity-space micro-instabilities that are associated with plasma heating and thermalization processes. Our measurements suggest that there is an impulsive mechanism associated with solar-wind energization and that micro-instabilities play a part in heating, and we provide evidence that low-latitude coronal holes are a key source of the slow solar wind.

Keywords solar wind, Parker Solar Probe

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Aborted propagation of the Ethiopian rift caused by linkage with the Kenyan rift

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Abstract Continental rift systems form by propagation of isolated rift segments that interact, and eventually evolve into continuous zones of deformation. This process impacts many aspects of rifting including rift morphology at breakup, and eventual ocean-ridge segmentation. Yet, rift segment growth and interaction remain enigmatic. Here we present geological data from the poorly documented Ririba rift (South Ethiopia) that reveals how two major sectors of the East African rift, the Kenyan and Ethiopian rifts, interact. We show that the Ririba rift formed from the southward propagation of the Ethiopian rift during the Pliocene but this propagation was short-lived and aborted close to the Pliocene-Pleistocene boundary. Seismicity data support the abandonment of laterally offset, overlapping tips of the Ethiopian and Kenyan rifts. Integration with new numerical models indicates that rift abandonment resulted from progressive focusing of the tectonic and magmatic activity into an oblique, throughgoing rift zone of near pure extension directly connecting the rift sectors.

Keywords continental rift, geology

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2 Social sciences and humanities

Backtesting Marginal Expected Shortfall and Related Systemic Risk Measures

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Abstract This paper proposes an original approach for backtesting systemic risk measures. This backtesting approach makes it possible to assess the systemic risk measure forecasts used to identify the financial institutions that contribute the most to the overall risk in the financial system. Our procedure is based on simple tests similar to those generally used to backtest the standard market risk measures such as value-at-risk or expected shortfall. We introduce a concept of violation associated with the marginal expected shortfall (MES), and we define unconditional coverage and independence tests for these violations. We can generalize these tests to any MES-based systemic risk measures such as the systemic expected shortfall (SES), the systemic risk measure (SRISK), or the delta conditional value-at-risk (ΔCoVaR). We study their asymptotic properties in the presence of estimation risk and investigate their finite sample performance via Monte Carlo simulations. An empirical application to a panel of U.S. financial institutions is conducted to assess the validity of MES, SRISK, and ΔCoVaR forecasts issued from a bivariate GARCH model with a dynamic conditional correlation structure. Our results show that this model provides valid forecasts for MES and SRISK when considering a medium-term horizon. Finally, we propose an early warning system indicator for future systemic crises deduced from these backtests. Our indicator quantifies how much is the measurement error issued by a systemic risk forecast at a given point in time which can serve for the early detection of global market reversals.

Keywords backtesting, banking regulation, hypothesis testing, risk management, systemic risk

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The emergence of the metadiscursive marker *du coup*. From consequence to enunciative actualization

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Abstract This study, which deals with the connective *du coup* in oral French, is based on an exhaustive exploration of a sampled oral corpus of approximately 1.3 million words, extracted from the Enquêtes Socio-Linguistiques à Orléans (ESLO). The internal characteristics of this corpus, combined with a precise syntactic and semantic annotation of each of the occurrences of *du coup*, allow us to propose a description of its main linguistic properties and to map its usage according to a number of variables, notably diachronic, diaphasic and diastratic. On the one hand, we will be able to document, in real and apparent time, the quantitative development of this connective and, on the other hand, to argue in favour of an ongoing process of pragmaticalization, which transforms this connective which was marginal forty years ago, into a new discourse marker in vogue.

Keywords *du coup*, discursive marker, oral French, micro-diachrony, pragmaticalization

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Quand les artistes dessinaient les cartes / When artists drew the maps

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Abstract Il fut un temps où les cartes étaient rares et précieuses, dessinées et peintes à la main avec un grand soin esthétique, et où leur capacité à montrer le monde tel qu'il paraît importait plus que les calculs d'échelle et d'orientation précises. À l'aube de la Renaissance, les artistes furent ainsi les professionnels privilégiés pour la confection de cartes locales et régionales. Ils y mirent leur savoir-faire et leur ingéniosité, inventant un genre de représentation de l'espace tout à fait particulier. Celui-ci répondait aussi à la demande de leurs contemporains, car les cartes étaient commanditées dans un but pratique : résoudre des conflits judiciaires, tracer une frontière, analyser des fortifications, projeter des travaux, commémorer des événements historiques.

English translation: There was a time when maps were rare and precious, hand-drawn and painted with great aesthetic care, and when their ability to show the world as it appears was more important than calculations of precise scale and orientation. At the dawn of the Renaissance, artists were the professionals of choice to produce local and regional maps. They put their know-how and ingenuity to work, inventing a very special kind of spatial representation. This also met the demands of their contemporaries, for the maps were commissioned for practical purposes: to resolve legal disputes, to draw a border, to analyse fortifications, to plan works, to commemorate historical events.

Keywords Catalogue of the exhibition at the National Archives (25 September 2019-7 January 2020)

Publication Le Passage, 239 pages

Date 2019

3 Life sciences

A cationic motif upstream Engrailed2 homeodomain controls cell internalization through selective interaction with heparan sulfates

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Abstract Engrailed2 (En2) is a transcription factor that transfers from cell to cell through unconventional pathways. The poorly understood internalization mechanism of this cationic protein is proposed to require an initial interaction with cell-surface glycosaminoglycans (GAGs). To decipher the role of GAGs in En2 internalization, we have quantified the entry of its homeodomain region in model cells that differ in their content in cell-surface GAGs. The binding specificity to GAGs and the influence of this interaction on the structure and dynamics of En2 was also investigated at the amino acid level. Our results show that a high-affinity GAG-binding sequence (RKPKKKNPNKEDKRPR), upstream of the homeodomain, controls En2 internalization through selective interactions with highly-sulfated heparan sulfate GAGs. Our data underline the functional importance of the intrinsically disordered basic region upstream of En2 internalization domain, and demonstrate the critical role of GAGs as an entry gate, finely tuning homeoprotein capacity to internalize into cells.

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The actomyosin interface contains an evolutionary conserved core and an ancillary interface involved in specificity

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Abstract Plasmodium falciparum, the causative agent of malaria, moves by an atypical process called gliding motility. Actomyosin interactions are central to gliding motility. However, the details of these interactions remained elusive until now. Here, we report an atomic structure of the divergent Plasmodium falciparum actomyosin system determined by electron cryomicroscopy at the end of the powerstroke (Rigor state). The structure provides insights into the detailed interactions that are required for the parasite to produce the force and motion required for infectivity. Remarkably, the footprint of the myosin motor on filamentous actin is conserved with respect to higher eukaryotes, despite important variability in the Plasmodium falciparum myosin and actin elements that make up the interface. Comparison with other actomyosin complexes reveals a conserved core interface common to all actomyosin complexes, with an ancillary interface involved in defining the spatial positioning of the motor on actin filaments.)

Publication Nature Communications volume 12

Date March 2021

DOI 10.1038/s41467-021-22093-4

Microbial metabolites control the thymic development of mucosal-associated invariant T cells

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Abstract How the microbiota modulate immune functions remains poorly understood. Mucosal-associated invariant T (MAIT) cells are implicated in mucosal homeostasis and absent in germ-free mice. Here, we show that commensal bacteria govern murine MAIT intrathymic development, as MAIT cells did not recirculate to the thymus. MAIT development required RibD expression in bacteria, indicating that production of the MAIT antigen 5-(2-oxopropylideneamino)-6-d-ribitylaminouracil (5-OP-RU) was necessary. 5-OP-RU rapidly traveled from mucosal surfaces to the thymus, where it was captured by the major histocompatibility complex class Ib molecule MR1. This led to increased numbers of the earliest MAIT precursors and the expansion of more mature receptor-related, orphan receptor γt-positive MAIT cells. Thus, a microbiota-derived metabolite controls the development of mucosally targeted T cells in a process blurring the distinction between exogenous antigens and self-antigens.

Keywords metabolite control, immunology

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4 Multidisciplinary

Maximum entropy methods for texture synthesis: Theory and practice

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Abstract Recent years have seen the rise of convolutional neural network techniques in exemplar-based image synthesis. These methods often rely on the minimization of some variational formulation on the image space for which the minimizers are assumed to be the solutions of the synthesis problem. In this paper we investigate, both theoretically and experimentally, another framework to deal with this problem using an alternate sampling/minimization scheme. First, we use results from information geometry to assess that our method yields a probability measure which has maximum entropy under some constraints in expectation. Then, we turn to the analysis of our method and we show, using recent results from the Markov chain literature, that its error can be explicitly bounded with constants which depend polynomially in the dimension even in the non-convex setting. Finally, we present an extensive experimental study of the model, including a comparison with state-of-the-art methods and an extension to style transfer.

Keywords texture synthesis, information geometry, maximum entropy, Markov chains, Langevin algorithm, convolutional neural network

Publication SIAM Journal on Mathematics of Data Science (SIMODS), 3(1), 52-82

Date 2021

DOI 10.1137/19M1307731

Challenge to test reproducibility of old computer code

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Abstract We question whether analytical tools such as Common Workflow Language, which aim to make computational methods "reproducible and shareable", can stand the test of time (see Nature 573, 149–150; 2019). The long-term validity of computational results will not be testable if the original code cannot be run many years later.

Considering the rapidity of transformations in operating systems and programming languages, it is hard to predict the lifetime reproducibility of a particular code. We have therefore organized the Ten Years Reproducibility Challenge (see go.nature.com/2bwcukq). Researchers are invited to test code reproducibility by trying to rerun a code created for a scientific paper they published more than ten years ago. The codes can address any scientific domain (statistical analysis, numerical simulation or data processing, for example) and be written in any language.

The challenge closes in April 2020. Our hope is that the results will offer insights into long-term causes of non-reproducibility.

Keywords reproducibility, challenge, computer code

Publication Nature 574: 634

Date October 2019

DOI 10.1038/d41586-019-03296-8

Certifying Reproducibility with Confidential Data

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Abstract Many government data, such as sensitive information on individuals' taxes, income, employment, or health, are available only to accredited users within a secure computing environment. Though they can be cumbersome to access, such microdata can allow researchers to pursue questions that could not be addressed with only public data. However, researchers using confidential data are inexorably challenged with regard to research reproducibility. Empirical results cannot be easily reproduced by peers and journal referees, as access to the underpinning data are restricted. We describe an approach that allows researchers who analyze confidential data to signal the reproducibility of their research. It relies on a certification process conducted by a specialized agency accredited by the confidential-data producers and which can guarantee that the code and the data used by a researcher indeed produce the results reported in a scientific paper.

Keywords reproducibility, confidential data, economic studies

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Date July 2019

DOI 10.1126/science.aaw2825

University of Siegen

1 Physical sciences and engineering

Novel Methodologies for Multiaxial Strain Measurements with Piezoresistive Films based on Graphene Nanoplatelets

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Abstract Many recent investigations in the context of graphene nanoplatelets (GNPs) coatings report surface strain measurements by using piezoresistive sensing capabilities. An often underestimated problem is that the strain field is unknown and the principal strain components as well as their orientations must be determined. Herein, GNP films subjected to multiaxial strain are examined. Experimental results show that although the sensitivity to longitudinal strain is the highest, the ratio between transverse and longitudinal sensitivity exceeds 0.5. The sensitivity to shear strain is much lower. A model assisted study of a random network provides additional guidelines for the different electromechanical sensitivities. In practice, the GNP film is usually subjected to different strains simultaneously so that the multiaxial strain measurement becomes difficult. Therefore, two novel approaches for sensing plane strain components with circular GNP films are developed and successfully verified in experiments. The numerical approach is called strain-differential electrical impedance tomography (SD-EIT), where the proposed piezoresistive model elementwise in a finite element model is implemented and the strain components of a strain rosette are reconstructed. Moreover, an analytical approach is derived from SD-EIT and exhibits further the opportunity to detect anomalies within the piezoresistive sensing behavior of GNP films.

Keywords Graphene nanoplatelets, piezoresistive effect, spray deposition, strain-differential electrical impedance tomography

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Date 24 October 2021

DOI https://doi.org/10.1002/smsc.202100088

Investigation on wall and gas temperatures inside a swirled oxy-fuel combustion chamber using thermographic phosphors, O2 rotational and vibrational CARS

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Abstract Wall and gas phase temperatures inside a swirled oxy-fuel combustion chamber are important to characterize the combustion process. Wall temperatures were measured by thermographic phosphors and discussed in combination with gas phase temperatures. For gas phase temperatures an O2 vibrational coherent anti-Stokes Raman scattering (CARS) approach was compared to a N2/O2 rotational CARS (RCARS) system. The vibrational CARS (VCARS) setup was favorable due to higher signal strength at high temperatures. With this system gas phase temperature profiles inside a swirled oxy-fuel combustion chamber were measured and discussed for different operation conditions. The location of intermittent reaction zones could be determined. In order to provide a measurement tool for gas-assisted pulverized solid fuel flames the developed O2-VCARS system was successfully tested in such a harsh environment. Possible error sources related to particles within the probe volume are discussed.

Keywords vibrational coherent anti-stokes raman scattering (CARS); phosphor thermometry, temperature measurement, laser diagnostic, oxy-fuel combustion

Publication Fuel (2021) 289, 119787

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Heuristic list scheduler for time triggered traffic in time sensitive networks

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Abstract Time Sensitive Networks (TSN) are a novel technology that combines the larger bandwidth capabilities of Ethernet with determinism and fault tolerance for safety relevant real time systems. TSN offers bounded latency for the time triggered (TT) communication by transmitting messages according to a global schedule. Most of the scheduling algorithms in this context provide the solution only from the perspective of scheduling constraints and do not consider the impacts of routing on the scheduling problem. Therefore, these algorithms are not capable to provide effective results in the domain of many real time systems. To address interdependence of routing and scheduling constraints, we introduce a heuristic list scheduler (HLS). Our approach generates valid schedules using joint routing and scheduling constraints in one step. Due to this approach, ability to find feasible schedules is dramatically increased in comparison to the schedulers with fixed routing. In addition, HLS supports multi-cast communication, distributed real time applications and inter-flow dependencies. Experimental results shows the significant increase in the schedulability because of the task and message scheduling combined with routing.

Keywords Time Sensitive Networks, fault tolerance, safety relevant real time systems

Publication ACM SIGBED Review 16(1), p. 15-20

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DOI https://doi.org/10.1145/3314206.3314208

Balancing straight-line programs

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Abstract We show that a context-free grammar of sizem that produces a single string w of length n (such a grammar is also called a string straight-line program) can be transformed in linear time into a context-free grammar forw of size O(m), whose unique derivation tree has depth O(logn). This solves an open problem in the area of grammar-based compression, improves many results in this area, and greatly simplifies many existing constructions. Similar results are shown for two formalisms for grammar-based tree compression: top dags and forest straight-line programs. These balancing results can be all deduced from a single meta-theorem stating that the depth of an algebraic circuit over an algebra with a certain finite base property can be reduced to O(logn) with the cost of a constant multiplicative size increase. Here, n refers to the size of the unfolding (or unravelling) of the circuit. In particular, this results applies to standard arithmetic circuits over (noncommutative) semirings.

Keywords Grammar-based compression, balancing, straight-line programs, random access problem

Publication Journal of the ACM (JACM) 68 (4), 1-40

Date 30 June 2021

DOI https://doi.org/10.1145/3457389

Assessing uncertainty for decision-making in climate adaption and risk mitigation

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Abstract Future water availability or crop yield studies, tied to statistics of river flow, precipitation, temperature or evaporation over medium to long-term horizons, are becoming frequent in climate impact and risk analysis. During the last two decades, access to multisystem integration of climate models has given rise to the concept of using model ensembles to issue probabilistic climatological projections. These probabilistic projections have not yet been exploited to the full extent in decision support, and they are still mainly used to quantify uncertainty bands only for selected climate variables and indicators. One of the reasons of this limited use is the fact that the multi-system ensemble dispersion is sub-optimal and does not provide an accurate and reliable representation of the predictive probability density, which is essential for rational decision support under uncertain conditions. The aims of this paper are twofold. Firstly, it seeks to highlight the potential benefits of using climate projections in conjunction with Bayesian paradigms towards educated decision-making. Secondly, it discusses how to appropriately formulate probabilistic forecasts by coherently integrating information contained in climate projection ensembles with observations to improve the estimation of the probability density function of future climate states.

Keywords Climate projections, model ensembles, Bayesian forecasting, decision-making, risk assessment, uncertainty

Publication International Journal of Climatology 2021, 41: 2891-2912

Date 03 January 2021

DOI https://doi.org/10.1002/joc.6996

Mapping the broadband circular dichroism of copolymer films with supramolecular chirality in time and space

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Abstract Measurements of the electronic circular dichroism (CD) are highly sensitive to the absolute configuration and conformation of chiral molecules and supramolecular assemblies and have therefore found widespread application in the chemical and biological sciences. Here, we demonstrate an approach to simultaneously follow changes in the CD and absorption response of photoexcited systems over the ultraviolet−visible spectral range with 100 fs time resolution. We apply the concept to chiral polyfluorene copolymer thin films and track their electronic relaxation in detail. The transient CD signal stems from the supramolecular response of the system and provides information regarding the recovery of the electronic ground state. This allows for a quantification of singlet−singlet annihilation and charge-pair formation processes. Spatial mapping of chiral domains on femtosecond time scales with a resolution of 50 μm and diffraction-limited steady-state imaging of the circular dichroism and the circularly polarised luminescence (CPL) of the films is demonstrated.

Keywords Supramolecular chirality, Circular dichroism, Circularly polarized luminescence, Ultrafast spectroscopy, Thin films

Publication Nature Communications 13, 210 (2022)

Date 11 January 2022

DOI 10.1038/s41467-021-27886-1

Plasmon-Assisted Suppression of Surface Trap States and Enhanced Band-Edge Emission in a Bare CdTe Quantum Dot

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Abstract Colloidal quantum dots have emerged as a versatile photoluminescent and optoelectronic material. Limitations like fluorescence intermittency, nonradiative Auger recombination, and surface traps are commonly addressed by growing a wide-band-gap shell. However, the shell isolates the excitonic wave function and reduces its interaction with the external environment necessary for different applications. Furthermore, their long emission lifetime hinders their use in high-speed optoelectronics. Here, we demonstrate a high degree of control on the photophysics of a bare core CdTe quantum dot solely by plasmon coupling, showing that more than 99% of the surface defect-state emission from a trap-rich quantum dot can be quenched. Moreover, the band-edge state excitonic and biexcitonic emission rates are Purcell enhanced by 1460- and 613-fold, respectively. Our findings show how plasmon coupling on bare quantum dots could make chemical approaches developed for improving their optical properties unnecessary, with implications for nanoscale lasers, light-emitting devices, solar cells, and ultrafast single-photon sources.

Keywords Fluorescence, Gold, Lasers, Plasmons, Quantum dots

Publication The Journal of Physical Chemistry Letters, 10, 2874-2878 (2019)

Date May 14, 2019

DOI https://doi.org/10.1021/acs.jpclett.9b01083

Highly Precise MEMS Gyroscopes for Fully Automated Driving

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Abstract New developments in the area of automated driving, augmented reality and indoor- navigation require accuracy of micro-electromechanical (MEMS) inertial sensors far beyond what is presently available. Typically, the stability of an angular rate signal from a gyroscope is examined with the Allan variance method. In this thesis, the different noise components are analysed analytically and within a simulation model of vehicle during an automated driving emergency-stop manoeuvre. The so-called *bias instability* of an angular rate signal is shown to be a major source of the final position and orientation error. The central part of the research consists of extensive experimental, simulational and analytical investigations of sensor-internal drift sources and transmission paths of a next- generation, MEMS gyroscope. The findings show that the stability of frequency-matching between the mechanical drive and sense mode of the gyroscope plays a key role in creating the bias drift. It is demonstrated for the first time by what means Flicker noise on different control voltages effects the angular rate output. A further drift type called scale-factor instability was discovered and described in detail for the first time. The effect will be of particular importance in applications with high angular rates, like indoor navigation. An improvement in bias instability of up to a factor of 10 is achieved in experiment with real-world MEMS devices and read-out ASICs using a previously known method for measuring the mode-mismatch, called pilot-tones.

Keywords MEMS gyroscopes, automated driving

Publication PhD thesis at Siegen University

Date 2021

2 Social sciences and humanities

A gendered look at entrepreneurship ecosystems

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Abstract Underlying entrepreneurship ecosystems is the implicit assumption that all entrepreneurs have equal access to resources, participation, and support, as well as an equal chance of a successful outcome (venture start-up). However, in practice, this is not always the case. Research finds that when it comes to many aspects of the entrepreneurship ecosystem, women are at a disadvantage. In this paper, we offer a brief overview of current ecosystem frameworks pointing out where "gender" matters in ecosystems at the institutional, organizational, and individual levels. We go on to present a summary of the contributions to this special edition and conclude with suggestions for future research.

Keywords Entrepreneurship ecosystems, gender, institutional level, organizational level, individual level

Publication Small Business Economics (2019) 53:393-408

Date 14 February 2018

DOI https://doi.org/10.1007/s11187-018-9992-9

Optimization approaches for civil applications of unmanned aerial vehicles (UAVs) or aerial drones: A survey.

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Abstract Unmanned aerial vehicles (UAVs), or aerial drones, are an emerging technology with significant market potential. UAVs may lead to substantial cost savings in, for instance, monitoring of difficult-to-access infrastructure, spraying fields and performing surveillance in precision agriculture, as well as in deliveries of packages. In some applications, like disaster management, transport of medical supplies, or environmental monitoring, aerial drones may even help save lives. In this article, we provide a literature survey on optimization approaches to civil applications of UAVs. Our goal is to provide a fast point of entry into the topic for interested researchers and operations planning specialists. We describe the most promising aerial drone applications and outline characteristics of aerial drones relevant to operations planning. In this review of more than 200 articles, we provide insights into widespread and emerging modeling approaches. We conclude by suggesting promising directions for future research.

Keywords Drones, operations planning, optimization, survey article, UAVs, unmanned aerial vehicles

Publication Networks (2018) 72:411-458

Date 25 March 2018

DOI 10.1002/net.21818

Unintended Effects of Autonomous Driving: A Study on Mobility Preferences in the Future

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Abstract Innovations in the mobility industry such as automated and connected cars could significantly reduce congestion and emissions by allowing the traffic to flow more freely and reducing the number of vehicles according to some researchers. However, the effectiveness of these sustainable product and service innovations is often limited by unexpected changes in consumption: some researchers thus hypothesize that the higher comfort and improved quality of time in driverless cars could lead to an increase in demand for driving with autonomous vehicles. So far, there is a lack of empirical evidence supporting either one or other of these hypotheses. To analyze the influence of autonomous driving on mobility behavior and to uncover user preferences, which serve as indicators for future travel mode choices, we conducted an online survey with a paired comparison of current and future travel modes with 302 participants in Germany. The results do not confirm the hypothesis that ownership will become an outdated model in the future. Instead they suggest that private cars, whether conventional or fully automated, will remain the preferred travel mode. At the same time, carsharing will benefit from full automation more than private cars. However, the findings indicate that the growth of carsharing will mainly be at the expense of public transport, showing that more emphasis should be placed in making public transport more attractive if sustainable mobility is to be developed.

Keywords autonomous driving, shared autonomous vehicles, travel mode choice, user preferences, preference migration, rebound effects, indirect rebound effects, consumption shifting

Publication Sustainability (2018), 10: 2404

Date 10 July 2018

DOI https://doi.org/10.3390/su10072404

Online retailing across e-channels and e-channel touchpoints: Empirical studies of consumer behavior in the multichannel e-commerce environment

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Abstract This research contributes to broadening understanding of online retailing across electronic channels (e-channels, e.g., mobile devices) and e-channel touchpoints (e.g., mobile shopping apps) from a consumer perspective. Based on the multichannel retailing approach and theoretical considerations, the authors suggest an enhanced perspective on the online retailing environment and validate this multichannel e-commerce perspective by conducting both an online survey (N = 502) and an experimental study (N = 126). The results indicate that online retailing can be classified into four e-commerce categories that entail individual e-channel touchpoints, emphasizing the need for a more differentiated consideration of "the online channel." This work advances marketing research and practice by illustrating that both technology-related quality and context-related situational benefit affect consumers' utilization of e-channels. Further findings show that retailers can enhance consumers' shopping experiences by providing alternative e-channel touchpoints (i.e., specific digital shopping formats) that contribute differently to the online customer journey.

Keywords Internet retailing, online shopping, electronic channels, touchpoints, online customer journey, multichannel e-commerce

Publication Journal of Business Research (2020), 107:256-270

Date February 2020

DOI https://doi.org/10.1016/j.jbusres.2018.10.048

Absolute Herrschaftsrechte (*book, in German*)

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Abstract In the course of digitization, new goods and ways of exploiting them are constantly emerging, and their position in the system of property rights is the subject of intense debate. The book develops a unified model of the structure and functioning of property rights. In addition to tangible property rights and intellectual property rights such as copyright, patent or trademark rights, these also include personality rights. The model shows how the juridification of goods works on a fundamental level. Starting from the concept of 'information', it also makes the familiar subjective rights suitable for digitization. Inconsistently used concepts such as the 'absoluteness' of rights and rights 'in rem' are analyzed and condensed, providing a unified dogmatics for intellectual property rights and tangible property rights. This also includes a theory on the structure of licenses. All this is illustrated with numerous examples.

Keywords Property rights, rights in information, rights in data, IP-rights, personality rights, legal theory/dogmatics of private law, privcay

Publication Mohr Siebeck, JusPrivatum Bd. 266

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Getting Noticed by Many: On the Transformations of the Popular

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Abstract This article argues that the transformations of the popular, which began in Europe around 1800 and introduced the powerful distinction between low culture and high culture, have established a competitive distinction between the popular and the non-popular that has become dominant over the course of the 20th century. As a result, the popular is no longer either the culture of the 'lower classes' or the inclusion of the 'people' in the service of higher goals. The popular today is hardly the object of desired transgressions (Leslie Fiedler's "cross the border, close the gap") or an expression of felt or feared "massification" or "flattening". Rather, being popular now means getting noticed by many. Popularity is measured as well as staged, as rankings and charts provide information on what is popular while vying for popularity themselves. These quantifying formats do not speak to the quality or originality of the popular, only to its evident success across different scales of evaluation. People do not buy good products, they buy popular ones; they do not listen to the best music, but to popular music; they do not share, like, or retweet important, but popular news. Even the 'unpopular' can be popular: a despised politician, a hated jingle, an unpopular measure. The popular modifies whatever it affords with attention. Its quantitatively and hierarchically comparative terms ('bestseller,' 'outperformer,' 'high score,' 'viral') generate valences that do not inhere in the objects themselves. Conversely, the non-popular, which does not find any measurable resonance in these terms, risks being dismissed as irrelevant or worthless simply because it does not appear in any rankings or ratings. This can be observed particularly with artefacts whose relevance as part of high culture may be taken for granted even when they do not achieve mass resonance. The purpose of this article is to outline a theory of the popular that does justice to these developments by identifying two decisive transformations: 1. the popularization of quantifying methods to measure attention in popular culture around 1950; 2. the popularization of the internet around 2000, whereby the question of what can and cannot become popular is partially removed from the gatekeepers of the established mass media, educational institutions, and cultural elites and is increasingly decided via social media

Keywords Popular culture, high/low, pop, populism, digitalization, social media, elites, experts, mass media, societal self-descriptions, praxeology, rankings, charts

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From Festivals Films to Film Festivals: Korean Cinema at European Film Festivals

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Abstract Korean cinema has been exhibited at international film festivals since the late 1950s. Korean film 'auteurs' were mostly introduced in Europe through the major film festivals in the early 1960s and, after a pause, from the 1980s, reflecting the political and film-industrial dynamics specific to the Korean Peninsula and global Cold War politics. As Korean films were first screened at the Berlin International Film Festival around the establishment of Berlin Wall in 1961, this chapter examines the purpose, history and function of the Berlinale in comparison to other major film festivals such as the Cannes and Karlovy Vary film festivals. Based on the analysis of selected 'auteur' - and 'art-house cinema' from the 1950s (by Yi Pyŏngil, Kang Taejin, Shin Sang-ok) to 2000 (Korean New Wave with Im Kwon-Taek, Hong Sang-soo and Kim Ki-duk), this chapter aims to explore what kind of films appealed to European film professionals, festival curators, and the general public during the 20th century. While exploring the term 'festival film', it also examines why and in what historical context Korean cinema has begun only in recent decades to gain recognition on the film festival circuit, which in turn shapes global understanding of Korean cinema.

Keywords Film Festivals, Festival Film, Berlin International Film Festival, Korean Peninsula Cinema, Auteur film, Korean New Wave

Publication Publisher Routledge
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Handlungsorientierung im Fremdsprachenunterricht

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Abstract This theoretical research develops a theoretical model of action- and context-oriented foreign language teaching with the elements of situated linguistic-cultural education, multilingual-multicultural education, aesthetic education, multiliteracies and critical education. Learners are seen as autonomous and their (language learning) biographies, identities and linguistic actions are placed at the centre. At the same time, language learning is methodologically differentiated and understood as contextual. Teachers must be enabled to create meaningful learning situations. Goals include the development of agency, identity, discourse awareness, participation and reflexivity. The model is used for basic research as well as for classroom modelling and teacher training. The study provides a theoretical and empirical foundation with epistemological and pedagogical concepts. In addition to the notion of action in the context of language and communication concepts, learners are described as social actors with individual linguistic-cultural and socio-emotional learning dispositions. Mental processes of language work are illuminated and dimensions of instructional action are outlined. The understanding of action orientation is also transferred to the processes of lesson planning and vital teacher competences are examined. Overall, the study shows how action-oriented teaching can follow a postmodern, dynamic understanding of languages, cultures, identities and multilingual-multicultural educational processes.

Keywords Action orientation, Agency, Context sensitivity, Critical Education, Teacher Education

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3 Life sciences

Metacognition and Self-Control: An Integrative Framework

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Abstract Self-control describes the processes by which individuals control their habits, desires, and impulses in the service of long-term goals. Research has identified important components of self-control and proposed theoretical frameworks integrating these components (e.g., Inzlicht et al., 2021; Kotabe & Hofmann, 2015). In our perspective, these frameworks, however, do not yet fully incorporate important metacognitive aspects of self-control. We therefore introduce a framework explicating the role of metacognition for self-control. This framework extends existing frameworks, primarily from the domains of self-regulated learning and problem-solving (e.g., Schraw & Moshman, 1995; Zimmerman, 2000), and integrates past and contemporary research and theorizing on self-control that involves aspects of metacognition. It considers two groups of metacognitive components, namely, (a) individual metacognitive characteristics, that is a person's declarative, procedural, and conditional metacognitive knowledge about self-control, as well as their self-awareness (or metacognitive awareness), and (b) metacognitive regulatory processes that unfold before a self-control conflict (forethought and prevention), when a self-control conflict is identified, during a self-control conflict (regulation and monitoring), and after a self-control conflict (reflection and evaluation). The proposed framework integrates existing research and will be useful for highlighting new directions for research on the role of metacognition for self-control success and failure.

Keywords metacognition, self-control, self-regulation, individual differences, processes

Publication Metacognition and Self-Control: An Integrative Framework

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Factors influencing the implementation of decision support systems for antibiotic prescription in hospitals: a systematic review

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Abstract Background Antibiotic resistance is a major health threat. Inappropriate antibiotic use has been shown to be an important determinant of the emergence of antibiotic resistance. Decision support systems for antimicrobial management can support clinicians to optimize antibiotic prescription. Objective The aim of this systematic review is to identify factors influencing the implementation of decision support systems for antibiotic prescription in hospitals. Methods A systematic search of factors impeding or facilitating successful implementation of decision support systems for antibiotic prescription was performed in January 2022 in the databases PubMed, Web of Science and The Cochrane Library. Only studies were included which comprised decision support systems in hospitals for prescribing antibiotic therapy, published in English with a qualitative, quantitative or mixed-methods study design and between 2011 and 2021. Factors influencing the implementation were identified through text analysis by two reviewers. Results A total of 14 publications were identified matching the inclusion criteria. The majority of factors relate to technological and organizational aspects of decision support system implementation. Some factors include the integration of the decision support systems into existing systems, system design, consideration of potential end-users as well as training and support for end-users. In addition, user-related factors, like user attitude towards the system, computer literacy and prior experience with the system seem to be important for successful implementation of decision support systems for antibiotic prescription in hospitals. Conclusion The results indicate a broad spectrum of factors of decision support system implementation for antibiotic prescription and contributes to the literature by identifying important organizational as well as user-related factors. Wider organizational dimensions as well as the interaction between user and technology appear important for supporting implementation.

Keywords antibiotics, antimicrobial management, decision support systems, implementation

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µbialSim: Constraint-based dynamic simulation of complex microbiomes

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Abstract Microbial communities are pervasive in the natural environment, associated with many hosts, and of increasing importance in biotechnological applications. The complexity of these microbial systems makes the underlying mechanisms driving their dynamics difficult to identify. While experimental meta-OMICS techniques are routinely applied to record the inventory and activity of microbiomes over time, it remains difficult to obtain quantitative predictions based on such data. Mechanistic, quantitative mathematical modeling approaches hold the promise to both provide predictive power and shed light on cause-effect relationships driving these dynamic systems. We introduce µbialSim (pronounced "microbial sim"), a dynamic Flux-Balance-Analysis-based (dFBA) numerical simulator which is able to predict the time course in terms of composition and activity of microbiomes containing 100s of species in batch or chemostat mode. Activity of individual species is simulated by using separate FBA models which have access to a common pool of compounds, allowing for metabolite exchange. A novel augmented forward Euler method ensures numerical accuracy by temporarily reducing the time step size when compound concentrations decrease rapidly due to high compound affinities and/or the presence of many consuming species. We present three exemplary applications of µbialSim: a batch culture of a hydrogenotrophic archaeon, a syntrophic methanogenic biculture, and a 773-species human gut microbiome which exhibits a complex and dynamic pattern of metabolite exchange. Focusing on metabolite exchange as the main interaction type, µbialSim allows for the mechanistic simulation of microbiomes at their natural complexity. Simulated trajectories can be used to contextualize experimental meta-OMICS data and to derive hypotheses on cause-effect relationships driving community dynamics based on scenario simulations. µbialSim is implemented in Matlab and relies on the COBRA Toolbox or CellNetAnalyzer for FBA calculations. The source code is available under the GNU General Public License v3.0 at https://git.ufz.de/UMBSysBio/microbialsim.

Keywords Microbial communities, metabolic modeling, constraint-based modeling, cross-feeding, microbiome dynamics

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Modelling dynamic personality theories in a continuous-time framework: An illustration

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Abstract Objective: Personality psychology has traditionally focused on stable between- person differences. Yet, recent theoretical developments and empirical insights have led to a new conceptualization of personality as a dynamic system (e.g., Cybernetic Big Five Theory). Such dynamic systems comprise several components that need to be conceptually distinguished and mapped to a statistical model for estimation.
Method: In the current work, we illustrate how common components from these new dynamic personality theories may be implemented in a continuous time-modeling framework.
Results: As an empirical example, we reanalyze experience sampling data with N = 180 persons (with on average T = 40 [SD = 8] measurement occasions) to investigate four different effects between momentary happiness, momentary extraverted behavior, and the perception of a situation as social: (1) between-person effects, (2) contemporaneous effects, (3) autoregressive effects, and (4) cross- lagged effects.
Conclusion: We highlight that these four effects must not necessarily point in the same direction, which is in line with assumptions from dynamic personality theories.

Keywords autoregressive effects, between-person effects, contemporaneous effects, continuous-time modeling, cross-lagged effects, experience sampling, personality dynamics

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Effect of Life Review Therapy for Holocaust Survivors: A randomized controlled trial

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Abstract Despite the therapeutic needs of aging Holocaust survivors, no randomized controlled trial (RCT) of psychotherapy exists for this population, with very few on older adults in general. This RCT aimed to compare the efficacy of Life Review Therapy for Holocaust survivors (LRT-HS) relative to a supportive control group. Holocaust survivors with a probable diagnosis of full or subsyndromal posttraumatic stress disorder (PTSD) or depressive disorder were included. Exclusion criteria were probable dementia, acute psychotic disorder, and acute suicidality. The predefined primary endpoint was the course of PTSD symptom scores. In total, 49 of 79 consecutive individuals assessed for eligibility were randomized and included in the intent-to-treat analyses (LRT-HS: n = 24, control: n = 25; Mage = 81.5 years, SD = 4.81, 77.6% female). Linear mixed models revealed no statistically significant superiority of LRT-HS for PTSD symptoms at posttreatment, with moderate effect sizes, Time x Condition interaction: $t(75) = 1.46$, $p = .148$, dwithin = 0.70, dbetween = 0.41, but analyses were significant at follow-up, with large effect sizes, $t(79) = 2.89$, $p = .005$, dwithin = 1.20, dbetween = 1.00. LRT-HS superiority for depression was observed at posttreatment, $t(73) = 2.58$, $p = .012$, but not follow-up, $t(76) = 1.08$, $p = .282$, with moderate effect sizes, dwithin = 0.46–0.60, dbetween = 0.53–0.70. The findings show that even in older age, PTSD and depression following exposure to multiple traumatic childhood events can be treated efficaciously using an age-appropriate treatment that includes structured life review and narrative exposure.

Keywords Older adults, trauma, PTSD, life review, exposure, Holocaust

Publication Journal of Traumatic Stress

Date Date of the publication

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4 Multidisciplinary

Computational image enhancement for frequency modulated continuous wave (FMCW) THz image

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Abstract In this paper, a novel method to enhance Frequency Modulated Continuous Wave (FMCW) THz imaging resolution beyond its diffraction limit is proposed. Our method comprises two stages. Firstly, we reconstruct the signal in depth-direction using a sinc-envelope, yielding a significant improvement in depth estimation and signal parameter extraction. The resulting high-precision depth estimate is used to deduce an accurate reflection intensity THz image. This image is fed in the second stage of our method to a 2D blind deconvolution procedure, adopted to enhance the lateral THz image resolution beyond the diffraction limit. Experimental data acquired with a FMCW system operating at 577 GHz with a bandwidth of 126 GHz shows that the proposed method enhances the lateral resolution by a factor of 2.29 to 346.2 µm with respect to the diffraction limit. The depth accuracy is 91 µm. Interestingly, the lateral resolution enhancement achieved with this blind deconvolution concept leads to better results in comparison with conventional gaussian deconvolution. Experimental data on a PCB resolution target is presented, in order to quantify the resolution enhancement and to compare the performance with established image enhancement approaches. The presented technique allows exposure of the interwoven fiber reinforced embedded structures of the PCB test sample.

Keywords Terahertz, Frequency Modulated Continuous Wave (FMCW), resolution enhancement, deconvolution, parameter extraction

Publication Journal of Infrared, Millimeter, and Terahertz Waves (2019) 40:775-800

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Improving Deep Learning for HAR with shallow LSTMs

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Abstract Recent studies in Human Activity Recognition (HAR) have shown that Deep Learning methods are able to outperform classical Machine Learning algorithms. One popular Deep Learning architecture in HAR is the DeepConvLSTM. In this paper we propose to alter the DeepConvLSTM architecture to employ a 1-layered instead of a 2-layered LSTM. We validate our architecture change on 5 publicly available HAR datasets by comparing the predictive performance with and without the change employing varying hidden units within the LSTM layer(s). Results show that across all datasets, our architecture consistently improves on the original one: Recognition performance increases up to 11.7% for the F1-score, and our architecture significantly decreases the amount of learnable parameters. This improvement over DeepConvLSTM decreases training time by as much as 48%. Our results stand in contrast to the belief that one needs at least a 2-layered LSTM when dealing with sequential data. Based on our results we argue that said claim might not be applicable to sensor-based HAR.

Keywords Human Activity Recognition, Deep Learning, CNN-LSTMs

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Approach bias retaining through virtual reality in smokers willing to quit smoking: A randomized-controlled study

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Abstract Automatic approach biases toward smoking-related cues have been implicated in the development and maintenance of addictive behaviors. Studies aiming at modifying such biases have shown promise in changing maladaptive approach tendencies for smoking cues and reducing smoking behavior. However, training effects tend to be small and partly inconsistent. The present randomized-controlled trial incorporated virtual reality (VR) technology into Approach Bias Modification (ABM) to improve efficacy. One-hundred-eight smokers attended behavioral counseling for smoking cessation and were thereafter randomized to receive VR-ABM or VR- control training. During VR-ABM, participants trained to implicitly avoid smoking-related objects and to approach alternative objects, while no such contingency existed in the VR-control condition. Trainings were administered in six sessions within a two-week period. Assessments were conducted at baseline, post- intervention (three weeks after baseline), and at follow-up (seven weeks after baseline). VR-ABM did not change approach biases, nor other cognitive biases, but it was superior in reducing daily smoking. However, this effect was limited to the two-week training period. Both groups improved in other smoking- and health-related variables across time. Future work should continue to investigate working mechanisms of ABM, in particular crucial training ingredients. VR could prove valuable for public health as the potential of VR-based treatments is large and not fully explored

Keywords approach bias, approach bias modification, virtual reality, cigarette smoking, smoking cessation, nicotine addiction

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1 Physical sciences and engineering

Significant increase of global anomalous moisture uptake feeding landfalling Atmospheric Rivers

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Abstract One of the most robust signals of climate change is the relentless rise in global mean surface temperature, which is linked closely with the water-holding capacity of the atmosphere. A more humid atmosphere will lead to enhanced moisture transport due to, among other factors, an intensification of atmospheric rivers (ARs) activity, which are an important mechanism of moisture advection from subtropical to extra-tropical regions. Here we show an enhanced evapotranspiration rates in association with landfalling atmospheric river events. These anomalous moisture uptake (AMU) locations are identified on a global scale. The interannual variability of AMU displays a significant increase over the period 1980-2017, close to the Clausius-Clapeyron (CC) scaling, at 7 % per degree of surface temperature rise. These findings are consistent with an intensification of AR predicted by future projections. Our results also reveal generalized significant increases in AMU at the regional scale and an asymmetric supply of oceanic moisture, in which the maximum values are located over the region known as the Western Hemisphere Warm Pool (WHWP) centred on the Gulf of Mexico and the Caribbean Sea.

Keywords Atmospheric Rivers, Moisture Transport, Signal of Climate Change, FLEXPART model

Publication Nature Communications

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A holistic methodology for the non-destructive experimental characterization and reliability-based structural assessment of historical steel bridges

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Abstract Nowadays, several historical steel structures present damage and an advanced deterioration state induced by human or natural actions, causing fluctuations in geometrical, physical, and mechanical properties that dramatically affect their mechanical behavior. Due to the economic, cultural, and heritage value, these constructions must be comprehensively assessed to verify their current condition state. This work presents a holistic methodology aimed at the non-destructive experimental characterization and reliability-based structural assessment of historical steel bridges. It comprehends from the experimental data acquisition to the finite element model updating and the probabilistic-based structural assessment to obtain the reliability indexes of serviceability and ultimate limit states. Several sources of information are considered in the evaluation process, thus, results are more realistic and accurate and can be used for optimal decision-making related to maintenance and retrofitting actions. The feasibility of the methodology has been tested on O Barqueiro Bridge, an aging riveted bridge located in Galicia, Spain. The study first involved a comprehensive experimental campaign to characterize the bridge effectively at multiple levels: geometry, material, and structural system by the synergetic combination of different tools and methods: in-depth visual inspection, terrestrial laser scanner survey, ultrasonic testing, and ambient vibration test. Subsequently, a detailed FE model was developed and calibrated with an average relative error in frequencies of 2.04% and an average MAC value of 0.94. Finally, the reliability-based structural assessment was performed, yielding reliability indexes of 1.80 and 1.99 for the serviceability and ultimate limit states, respectively. Thus, the bridge could not withstand traffic loads with satisfactory structural performance in its current condition.

Keywords Aging steel bridge, Non-destructive experimental testing, Model updating, Reliability analysis.

Publication Engineering Structures

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Homogeneous and heterogeneous peroxymonosulfate activation by transition metals for the degradation of industrial leather dye

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Abstract Currently, the interest in eco-friendly treatments for the removal of pollutants has increased and more sustainable treatment solutions are required. In this study, the homogeneous and heterogeneous activation of peroxymonosulfate (PMS) was carried out for the degradation of an industrial dye. Initially, the homogeneous PMS activation by different transition metals (Co, Cu, Ni, Fe) was ascertained. Cobalt resulted in the best performance attaining removal levels around 100% in only 30 min. Then, the influence of operational parameters such as pH and pollutant concentration were evaluated. The results displayed a high efficiency in the degradation and mineralisation operating close to neutral pH. The mechanism of the reaction was also studied and the obtained results demonstrated that sulfate radical is the primary reactive specie involved in the pollutant degradation. The optimisation of the degradation process was then carried out by a response surface methodology and several variables (PMS and Co concentration and temperature) were evaluated. The optimisation was performed in order to maximise the degradation and minimise the consumption of catalyst resulting in values of Co concentration 0.0125 mM, temperature 40 °C and PMS concentration 0.895 mM. Finally, heterogeneous activation by Co-catalyst immobilisation using alginate beads (Co-AB) and amberlite (Co-A) was performed. The results showed the superiority of Co-AB maintaining a high removal level after four treatment cycles with low Co leaching.

Keywords Catalyst; Cobalt; Cobalt alginate bead; Cobalt amberlite; Leather dye; PMS

Publication Journal of Cleaner Production

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Simple security proof of twin-field type quantum key distribution protocol

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Abstract Twin-field (TF) quantum key distribution (QKD) was conjectured to beat the private capacity of a point-to-point QKD link by using single-photon interference in a central measuring station. This remarkable conjecture has recently triggered an intense research activity to prove its security. Here, we introduce a TF-type QKD protocol which is conceptually simpler than the original proposal. It relies on the pre-selection of a global phase, instead of the post-selection of a global phase, which significantly simplifies its security analysis and is arguably less demanding experimentally. We demonstrate that the secure key rate of our protocol has a square-root improvement over the point-to-point private capacity, as conjectured by the original TF QKD.

Keywords Quantum communication, quantum cryptography, quantum key distribution

Publication npj Quantum Information

Date 2019

DOI 10.1038/s41534-019-0175-6

Challenges and Opportunities for Renewable Ammonia Production via Plasmon-Assisted Photocatalysis

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Abstract Despite its severe operating con ditions, associated energy consumption, and environmental concerns, the manufacture of nitrogen-rich fertilizers still relies heavily on producing ammonia in centralized chemical plants via the Haber–Bosch process. A distributed and more sustainable scheme considers the on-site production of carbon-neutral fertilizers at ambient conditions in photocatalytic reactors powered by sunlight. Among the different strategies proposed to boost the nitrogen reduction ability of conventional catalysts, the incorporation of plasmonic nanomaterials is gaining widespread interest owing to their unique optical tunability and their potential to improve the efficiency and selectivity of many chemical transformations. This Perspective examines the state-of-the-art for the nitrogen reduction reaction via plasmon-driven photocatalysis and discusses design principles for advancing it. The different physical mechanisms underlying the operation of plasmonic materials in a catalytic setting, and the dimensions along which the catalysts can be tuned to harness them are detailed. Paths to overcome current frontiers in the field, including design strategies of plasmonic photocatalysts, the development of complementary characterization techniques, the standardization of the reaction conditions and ammonia quantification methods, and the possibilities offered by theoretical methods to drive material discovery, identifying fundamental bottlenecks, and proposing directions for the advancement of this emerging field are outlined.

Keywords heterogeneous catalysis, multiscale models, nanomaterials, nitrogen fixation, nitrogen reduction, photocatalysis, plasmon

Publication Advanced Energy Materials

Date 2022

DOI 10.1002/aenm.202103909

Total synthesis of nahuoic acid A *via* a putative biogenetic intramolecular Diels–Alder (IMDA) reaction

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Abstract Inspired by the biogenetic proposal of an intramolecular Diels–Alder (IMDA) cycloaddition, the total synthesis of natural product nahuoic acid A, a cofactor-competitive inhibitor of the epigenetic enzyme lysine methyl transferase SETD8, has been carried out. A non-conjugated pentaenal precursor was synthesized with high levels of stereoselectivity at seven stereogenic centers and with the appropriate control of double bond geometries. Although the IMDA reaction of the non-conjugated pentaenal using Me2AlCl for catalysis at −40 °C selectively afforded the *trans*-fused diastereomer corresponding to the *Re-endo* mode of cycloaddition, under thermal reaction conditions it gave rise to a mixture of diastereomers, that preferentially formed through the *exo* mode, including the cis-fused angularly-methylated octahydronaphthalene diastereomer precursor of nahuoic acid A. The natural product could be obtained upon oxidation and overall deprotection of the hydroxyl groups present in the *Si-exo* IMDA diastereomer.

Keywords DFT, natural products, total synthesis, epigenetic.

Publication Chemical Science

Date 2021

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On vortex and dark solitons in the cubic–quintic nonlinear Schrödinger equation

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Abstract We study topologically charged propagation-invariant eigenstates of the 1+ 2-dimensional Schrödinger equation with a cubic (focusing)–quintic (defocusing) nonlinear term. First, we revisit the self-trapped vortex soliton solutions. Using a variational ansatz that allows us to describe the solutions as a liquid with a surface tension, we derive a simple formula relating the inner and outer radii of the bright vortex ring. Then, using numerical and variational techniques, we analyse dark soliton solutions for which the wave function density asymptotes to a non-vanishing value. We find an eigenvalue cutoff for the propagation constant that depends on the topological charge l. The variational profile provides simple and very accurate results for l≥ 2. We also study the azimuthal stability of the eigenstates by a linear analysis finding that they are stable for all values of the propagation constant, at least for small l.

Keywords Nonlinear optics, optical vortices, solitons

Publication Physica D: Nonlinear Phenomena

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Performance analysis of a small-scale electrostatic precipitator with biomass combustion

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Abstract Biomass is commonly used for heat production in small-scale and domestic facilities. Particulate matter (PM) emissions from the combustion of solid biomass are a concern because of hazards to human health. Electrostatic precipitators (ESPs) have been supported as the most promising mitigation technology, although there is a lack of consolidation to provide and promulgate a solution. The currently published studies on small-scale biomass do not offer a deep performance analysis of an electrostatic precipitator; instead, different designs have been presented and validated through efficiency measurements. In this work, an easily attachable ESP design is tested to more deeply analyse its performance with emissions from a pellet boiler, measuring its retention efficiency as a function of the PM sizes generated by the boiler, and under the influence of the supplied voltage and the geometry considering different discharge electrode diameters. Increasing voltage give higher separation efficiencies until 90% are reached, and further improvements are not remarkable. This efficiency value is influenced by the limitations of the particle analyser. A thinner discharge electrode achieves both better efficiencies and stable operation at lower voltage than a thicker electrode. Regarding the PM size, the retention capacity of the ESP is lower for particles between approximately 0.17 μm and 0.7 μm due to the reduced ability of the charging mechanisms. The formation of agglomerates during re-entrainment is also observed.

Keywords Biomass combustion; Electrostatic precipitation; Particulate matter; Pollution reduction; Small-scale

Publication Biomass and Bioenergy

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Accurate EMC Engineering on Realistic Platforms Using an Integral Equation Domain Decomposition Approach

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Abstract This article investigates the efficiency, accuracy and versatility of a surface integral equation (SIE) multisolver scheme to address very complex and large-scale radiation problems including multiple scale features, in the context of realistic electromagnetic compatibility (EMC)/electromagnetic interference (EMI) studies. The tear-and-interconnect domain decomposition (DD) method is applied to properly decompose the problem into multiple subdomains attending to their material, geometrical, and scale properties, while different materials and arbitrarily shaped connections between them can be combined by using the so-called multiregion vector basis functions. The SIE-DD approach has been widely reported in the literature, mainly applied to scattering problems or small radiation problems. Complementarily, in this article, the focus is placed on realistic radiation problems, involving tens of antennas and sensors and including multiscale ingredients and multiple materials. Such kind of problems are very demanding in terms of both convergence and computational resources. Throughout two realistic case studies, the proposed SIE-DD approach is shown to be a powerful electromagnetic modeling tool to provide the accurate and fast solution which is indispensable to rigorously accomplish real-life EMC/EMI studies.

Keywords Domain decomposition, electromagnetic compatibility, electromagnetic interference, fast solvers, method of moments, surface integral equations

Publication IEEE Transactions on Antennas and Propagation

Date 2019

DOI 10.1109/TAP.2019.2950862

Late Quaternary sedimentary evolution of the distal Galician continental margin (north-west Iberian Peninsula) based on palaeoclimatic, palaeoproductivity and diagenetic evidence

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Abstract This study analyzes sediment cores obtained from the Iberian Margin to investigate changes in the palaeoclimatic, palaeoproductivity, and diagenetic properties that have occurred over the past 172,000 years. The sediment record consists of four units, with low sedimentation rates during cold periods and the presence of detrital facies associated with ice-rafted debris events during Heinrich Stadials. The succession of these units and facies is influenced by the superposition of the Milankovitch and Dansgaard-Oeschger cycles.

Palaeoproductivity was evaluated using several parameters, including total organic carbon, calcium carbonate content, biogenic barium, and organic phosphorus. A sequential extraction was performed to explore the different phases of barium within the sediments. The findings suggest that there are limitations in the use of biogenic barium and phosphorus due to the contribution of detrital barium during Heinrich Stadials. Only calcium carbonate fluctuates in response to glacial/interglacial cycles.

In addition, some diagenetic proxies reveal oxidation fronts of different generations, suggesting continuous oxygenation of the sediment and non-steady-state conditions caused by erosional activity. These results provide insight into the long-term environmental changes that have occurred in the Iberian Margin and contribute to our understanding of the factors that influence these changes over time..

Keywords Bottom-current activity, early diagenesis, Galician continental margin, palaeoclimatic changes, palaeoproductivity, sedimentary evolution.

Publication Sedimentology Open Access

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DOI 10.1111/sed.12914

Changes in Cu accumulation and fractionation along soil depth in acid soils of vineyards and abandoned vineyards (now forests)

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Abstract This study investigated changes in copper accumulation and fractionation based on the depth of soils obtained from active and abandoned vineyards. Soil samples were collected at different depths in three areas with active and abandoned vineyards, and the concentrations of total copper and copper fractions were measured in these soil samples. Results revealed that in active vineyards, total copper accumulation was the highest in the first layer of soil (depth = 0–2 cm), with concentrations (193–892 mg kg-1) considerably higher than those in the deepest soil layer (depth = 40–50 cm; concentration = 63–71 mg kg-1). This accumulation was significantly correlated with the total carbon concentration in the soil. However, the total copper concentration in abandoned vineyards (84–374 mg kg-1) was the highest in the subsurface layers (depth = 10–15 cm) and was not significantly correlated with the total carbon content. Moreover, the percentage of available copper was lower in abandoned vineyards than in active vineyards. In terms of copper fractionation, the main fraction in active vineyard soil was copper bound to organic matter, whereas the main fraction in abandoned vineyard soil was residual copper. Therefore, vineyard abandonment and its transformation into forest changed the distribution and fractionation of copper based on soil depth, thus decreasing the amount of available copper and improving the soil quality, which could enable new ecosystems.

Keywords Copper aging, Fractionation, Land use change, Pollution, Vertical distribution, Vineyard

Publication Agriculture, Ecosystems and Environment

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Programmable Modular Assembly of Functional Proteins on Raman-Encoded Zeolitic Imidazolate Framework-8 (ZIF-8) Nanoparticles as SERS Tags

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Abstract Zeolitic imidazolate framework-8 (ZIF-8) is a metal organic framework with exceptional intrinsic properties, high tunability, cost effectiveness, and producibility, which has boosted the research development of the field. ZIF-8-based materials have shown high capabilities for multiple purposes as catalysts, capacitors, electrodes, drug delivery systems, or adsorption/separation membranes. Herein, we report the synergistic combination of ZIF-8, plasmonic nanoparticles, and rationally designed protein adaptors and antibodies for fabricating novel surface-enhanced Raman scattering (SERS) tags with enhanced sensing capabilities. The SERS tags consist of Au@Ag core–shell nanorods individually encapsulated within a multifunctional ZIF-8 matrix encoded with Raman reporters. While the role of the plasmonic core is to enhance the Raman, the ZIF-8 traps the Raman active molecules and, more importantly, facilitates the active targeting of the SERS tag surface through the modular assembly with conventional (i.e., immunoglobulins) and recombinant antibodies (i.e., nanobodies) mediated by the specific interaction of Zn2+ with polyhistidine-tagged protein G and SpyCatcher. Evidence of the capabilities of the Au@Ag@ZIF-8 nanotags for the SERS detection of EGFR and CD44 cell surface receptors in vitro illustrates the potential of these optical nanoprobes for imaging and multiplex biodetection. The reported modular assembly approach for the functionalization of ZIF-8 SERS nanotags with different classes of antibodies based on polyhistidine-tagged peptides and protein–protein interactions can not only be applied to the ever-increasing number of reported MOFs structures but also can be further exploited as a universal means for the functionalization of other transition metal surfaces.

Keywords Biopolymers, Metal organic frameworks, Nanoparticles, Peptides and proteins, Raman spectroscopy

Publication Chemistry of Materials

Date 2020

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2 Social sciences and humanities

From efficiency-driven to low-carbon operations management: Implications for labor productivity

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Abstract We use 9 years of dynamic panel data (4,090 observations) to explore how decarbonization moderates the association between a selection of efficiency-driven shop-floor initiatives and labor productivity. The results are mixed: the relationship between materials efficiency and labor productivity is positively moderated by decarbonization, but the relationship between increases in inventory turnover or the average firm wage as a multiple of average sector wages are negatively moderated by decarbonization. Overall, we find that decarbonization leads to an average drop in sales of 1.8% per worker. This evidence therefore suggests that climate change goals impacting industrial firms might be difficult to accomplish if managers expect to achieve decarbonization for free with current organizational best practices.

Keywords climate change, decarbonization, efficiency wages, industry, labor productivity, low-carbon operations, management, materials efficiency, stock turnover.

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Spatial heterogeneity in Spain for senior travel behavior

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Abstract Travel patterns are becoming more differentiated, influenced by new variables resulting from changes in lifestyle. The relevance of the senior segment for this industry, with the continuous aging population and their economic status, made this segment a very attractive group for the sector, and even more so in a country that is characterized by its aging, such as Spain. Spatial effects are considered a key element to understand this process, but there are only a few studies focusing on cross-cultural influences and the neighborhood context. For this purpose, the technique of geographically weighted principal component analysis (GWPCA) is applied in a novel way for the sector, showing different behavior patterns according to area of origin. The GWPCA is a localized version of the principal component analysis (PCA) used when there is a certain spatial heterogeneity in the structure of a multivariate data set. The results confirmed that GWPCA is an effective statistical methodology to research spatial heterogeneity for travel behavior, with clearly differentiated scenarios for the north, center and south of Spain, where the most determining factors in each case were hygiene and cleanliness, medical coverage and transport facilities.

Keywords GWPCA; Senior travel; Spatial heterogeneity; Tourism

Publication Tourism Management

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Objectifying women's bodies is acceptable from an Intimate Perpetrator, at least for female sexists

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Abstract Objectification of the female body is generating much research. Nevertheless, this has revealed little about whether women's evaluations depend on the level of psychological intimacy with the perpetrator of that objectification. Intimacy theory predicts that objectifying comments would seem more acceptable coming from a close partner, especially for sexist women. The present study begins to fill these gaps by analyzing responses from 301 heterosexual/bisexual adult women in the United States (M_{age} = 37.02, range = 18-72) to appearance and sexual body comments made by four different male perpetrators: strangers, colleagues, friends, or partners. Measures assessed women's perceptions of objectification, as well as reported enjoyment of these comments. As long as they were not negative, comments from heterosexual partners were perceived as the least objectifying and enjoyed the most; comments from colleagues, strangers, and friends were linked with greater objectification and less enjoyment. Additionally, sexist attitudes toward men and women-but more clearly toward men-linked with objectification and enjoyment. Future research directions and practical implications are discussed.

Keywords Objectification; body image; heterosexuality; romantic relationship; sexual harassment; sexualization

Publication Sex Roles

Date 2018

DOI 10.1007/s11199-017-0862-8

Reality Monitoring: A meta-analytical review for forensic practice

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Abstract Reality Monitoring (RM) criteria has been proposed as a forensic tool in order to discern between perceived and imagined memories. However, no systematic evidence has been provided on its validity for use in testimony evaluation. Thus, a metaanalytic review was designed to study its validity in forensic setting. A total of 40 primary studies were found, yielding 251 effect sizes. Random-effects meta-analyses correcting the effect size for sampling error and criterion unreliability were performed. The results showed that the total RM score discriminated, d = 0.542 (δ = 0.562), between imagined and perceived memories of events. In relation to individual criteria, the results showed support for the model's predictions (more external attributes in perceived memories) for clarity, d = 0.361 (δ = 0.399), sensory information, d = 0.359 (δ = 0.397), spatial information, d = 0.250 (δ = 0.277), time information, d = 0.509 (δ = 0.563), reconstructability of the story, d = 0.441 (δ =0.488), and realism, d = 0.420 (δ = 0.464), but not for affective information, d = 0.024 [-0.081, 0.129]. Nevertheless, except for temporal information, the results are not generalized (negative effects may be found). For cognitive operations, the results corroborated, although the magnitude of the effect was lower than small, the hypothesis (more cognitive operations in imagined memories), d = -0.107 [-0.178, -0.036] (δ = -0.119). The moderating effects of age (more cognitive operations on imagined memories in adults, and on perceived memories in underage), evocation type (external attributes discern between imagined and perceived memories, in both self-experienced and non-experimented accounts), and criteria score (the results varied by score) moderators were studied. As conclusions, forensic implications for the validity of the RM technique in court proceedings are discussed

Keywords Imagined memories; Perceived memories; Forensic assessment; Witness credibility; Reality monitoring

Publication The European Journal of Psychology applied to Legal Context

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What public-service agents think interpreters should know to work with gender violence victims. The 'Speak Out for Support' (SOS-VICS) project

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Abstract The academic community is showing keen interest in Public Service Interpreting (PSI) due to its importance in ensuring fair treatment and human rights' protection in an increasingly mobile world population. The importance of good interpreter training and provision of pro-fessional services is therefore an essential requisite for ensuring quality language mediation. PSI in gender violence (GV) settings is one such service that needs close attention. Commu-nication of public service agents with foreign victims in the different areas (courts, police, forensic medicine, etc.) and stages of GV assistance involves specific features, and therefore the need for specialised training. Speak Out for Support (SOS-VICS) is an EU funded pro-ject that has created resources to provide specialised training for interpreters assisting GV victims. The project first ascertained the communication needs of all stakeholders (service providers, victims and interpreters) and then prepared a set of resources aimed at enhancing such communication. This paper addresses service providers' perceptions of the training needs of interpreters and presents the main topics raised, such as specific knowledge on GV and of the field (legal, medical, etc.), understanding of the gender perspective or manage-ment of ethics, trauma and stress issues

Keywords Public Service Interpreting (PSI); Gender Violence (GV); Violence Against Women; Community Interpreting; Victims

Publication Sendebar

Date 2018

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Accessible Filmmaking. Integrating translation and accessibility into the filmmaking process

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Abstract Translation, accessibility and the viewing experience of foreign, deaf and blind audiences has long been a neglected area of research within film studies. The same applies to the film industry, where current distribution strategies and exhibition platforms severely underestimate the audience that exists for foreign and accessible cinema. Translated and accessible versions are usually produced with limited time, for little remuneration, and traditionally involving zero contact with the creative team. Against this background, this book presents accessible filmmaking as an alternative approach, integrating translation and accessibility into the filmmaking process through collaboration between translators and filmmakers. The book introduces a wide notion of media accessibility and the concepts of the global version, the dubbing effect and subtitling blindness. It presents scientific evidence showing how translation and accessibility can impact the nature and reception of a film by foreign and sensory-impaired audiences, often changing the film in a way that filmmakers are not always aware of. The book includes clips from the award-winning film Notes on Blindness on the Routledge Translation Studies Portal, testimonies from filmmakers who have adopted this approach, and a presentation of the accessible filmmaking workflow and a new professional figure: the director of accessibility and translation.

This is an essential resource for advanced students and scholars working in film, audiovisual translation and media accessibility, as well as for those (accessible) filmmakers who are not only concerned about their original viewers, but also about those of the foreign and accessible versions of their films, who are often left behind.

Keywords Accessible filmmaking, media accessibility, audiovisual translation, disability

Publication Accessible Filmmaking. Integrating translation and accessibility into the filmmaking process, London: Routledge.

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The Maritime Labour Convention, 2006 and the ILO Decent Work Agenda: A Work in Progress

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Abstract The Maritime Labour Convention (MLC), 2006, is celebrating ten years in force on August 20, 2023, having been produced to ensure decent working and living conditions for seafarers and to establish a system of fair competition among shipowners. During these years, the Convention has navigated through very rough waters, including a major economic crisis and a global pandemic that have especially hit these essential workers, providing that it is equipped with a framework capable of addressing the governance gap that is the trademark of global supply chains. However, it is time to revisit the legal and political success that it undoubtedly represented when approved in 2006, especially after the shock waves sent into the sector by the COVID-19 pandemic that triggered a "humanitarian crisis" in terms of the United Nations agencies most directly involved in addressing it. To this end, this paper seeks to assess the Convention's performance against the ILO Agenda on Decent Work grounded on four pillars: employment, rights at work, social protection, and social dialogue. Inseparable, interrelated and mutually dependent, these four objectives help identify in a systematic (although not exhaustive) manner grey areas in the Convention's commitment to decent employment in shipping. They also help understand the difficulties faced by the MLC, 2006 in triggering a race to the top in labor standards that is actually far from happening. Against this backdrop, the recommendation is made to intensify global social dialogue as the way forward to address not only new challenges to the seafaring profession, but also those that have remained unsolved since its inception.

Keywords Maritime Labour Convention, 2006; decent work agenda; regulatory competition; maritime employment

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3 Life sciences

Nutrient limitation suppresses the temperature dependence of phytoplankton metabolic rates

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Abstract Climate warming has the potential to alter ecosystem function through temperature-dependent changes in individual metabolic rates. The temperature sensitivity of phytoplankton metabolism is especially relevant, since these microorganisms sustain marine food webs and are major drivers of biogeochemical cycling. Phytoplankton metabolic rates increase with temperature when nutrients are abundant, but it is unknown if the same pattern applies under nutrient-limited growth conditions, which prevail over most of the ocean. Here we use continuous cultures of three cosmopolitan and biogeochemically relevant species (*Synechococcus* sp., *Skeletonema costatum* and *Emiliania huxleyi*) to determine the temperature dependence (activation energy, E_a) of metabolism under different degrees of nitrogen (N) limitation. We show that both CO_2 fixation and respiration rates increase with N supply but are largely insensitive to temperature. E_a of photosynthesis (0.11 ± 0.06 eV, mean $\pm$ SE) and respiration (0.04 ± 0.17 eV) under N-limited growth is significantly smaller than E_a of growth rate under nutrient-replete conditions (0.77 ± 0.06 eV). The reduced temperature dependence of metabolic rates under nutrient limitation can be explained in terms of enzyme kinetics, because both maximum reaction rates and half-saturation constants increase with temperature. Our results suggest that the direct, stimulating effect of rising temperatures upon phytoplankton metabolic rates will be circumscribed to ecosystems with high-nutrient availability

Keywords marine photosynthesis, nutrients, ocean warming, phytoplankton

Publication The ISME Journal

Date 2018

DOI 10.1038/s41396-018-0105-1

Historical legacies of river pollution reconstructed from fish scales

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Abstract Many rivers have been impacted by heavy metal pollution in the past but the long-term legacies on biodiversity are difficult to estimate. The River Ulla (NW Spain) was impacted by tailings from a copper mine during the 1970–1980s but absence of baseline values and lack of subsequent monitoring have prevented a full impact assessment. We used archived fish scales of Atlantic salmon to reconstruct levels of historical copper pollution and its effects on salmon fitness. Copper bioaccumulation significantly increased over baseline values during the operation of the mine, reaching sublethal levels for salmon survival. Juvenile growth and relative population abundance decreased during mining, but no such effects were observed in a neighbouring river unaffected by mining. Our results indicate that historical copper exposure has probably compromised the fitness of this Atlantic salmon population to the present day, and that fish scales are suitable biomarkers of past river pollution.

Keywords Atlantic salmon, Copper mine, Scales, Fish growth, Bioaccumulation

Publication Environmental Pollution

Date 2018

DOI 10.1016/j.envpol.2017.11.057

Differential Role of Hypothalamic AMPKα Isoforms in Fish: an Evolutive Perspective

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Abstract In mammals, hypothalamic AMP-activated protein kinase (AMPK) α1 and α2 isoforms mainly relate to regulation of thermogenesis/liver metabolism and food intake, respectively. Since both isoforms are present in fish, which do not thermoregulate, we assessed their role(s) in hypothalamus regarding control of food intake and energy homeostasis. Since many fish species are carnivorous and mostly mammals are omnivorous, assessing if the role of hypothalamic AMPK is different is also an open question. Using the rainbow trout as a fish model, we first observed that food deprivation for 5 days did not significantly increase phosphorylation status of AMPKα in hypothalamus. Then, we administered adenoviral vectors that express dominant negative (DN) AMPKα1 or AMPKα2 isoforms. The inhibition of AMPKα2 (but not AMPKα1) led to decreased food intake. The central inhibition of AMPKα2 resulted in liver with decreased capacity of use and synthesis of glucose, lipids, and amino acids suggesting that a signal of nutrient abundance flows from hypothalamus to the liver, thus suggesting a role for central AMPKα2 in the regulation of peripheral metabolism in fishes. The central inhibition of AMPKα1 induced comparable changes in liver metabolism though at a lower extent. From an evolutionary point of view, it is of interest that the function of central AMPKα2 remained similar throughout the vertebrate lineage. In contrast, the function of central AMPKα1 in fish relates to modulation of liver metabolism whereas in mammals modulates not only liver metabolism but also brown adipose tissue and thermogenesis.

Keywords Trout, hypothalamus, AMPK isoforms, food intake, hepatic metabolism

Publication Molecular Neurobiology

Date 2018

DOI 10.1007/s12035-018-1434-9

Climatic constraints on the biogeographic history of Mesozoic dinosaurs

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Abstract Dinosaurs dominated Mesozoic terrestrial ecosystems globally. However, whereas a pole-to-pole geographic distribution characterized ornithischians and theropods, sauropods were restricted to lower latitudes. Here, we evaluate the role of climate in shaping these biogeographic patterns through the Jurassic–Cretaceous (201–66 mya), combining dinosaur fossil occurrences, past climate data from Earth System models, and habitat suitability modeling. Results show that, uniquely among dinosaurs, sauropods occupied climatic niches characterized by high temperatures and strongly bounded by minimum cold temperatures. This constrained the distribution and dispersal pathways of sauropods to tropical areas, excluding them from latitudinal extremes, especially in the Northern Hemisphere. The greater availability of suitable habitat in the southern continents, particularly in the Late Cretaceous, might be key to explaining the high diversity of sauropods there, relative to northern landmasses. Given that ornithischians and theropods show a flattened or bimodal latitudinal biodiversity gradient, with peaks at higher latitudes, the closer correspondence of sauropods to a subtropical concentration could hint at fundamental thermophysiological differences to the other two clades.

Keywords Dinosauria, biogeography, thermophysiology, Sauropoda, Ornithischia, Theropoda, macroecology, macroevolution, Mesozoic, paleoclimate

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Assessment of Glyphosate Impact on the Agrofood Ecosystem

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Abstract Agro-industries should adopt effective strategies to use agrochemicals such as glyphosate herbicides cautiously in order to protect public health. This entails careful testing and risk assessment of available choices, and also educating farmers and users with mitigation strategies in ecosystem protection and sustainable development. The key to success in this endeavour is using scientific research on biological pest control, organic farming and regulatory control, etc., for new developments in food production and safety, and for environmental protection. Education and research is of paramount importance for food and nutrition security in the shadow of climate change, and their consequences in food production and consumption safety and sustainability. This review, therefore, diagnoses on the use of glyphosate and the associated development of glyphosate-resistant weeds. It also deals with the risk assessment on human health of glyphosate formulations through environment and dietary exposures based on the impact of glyphosate and its metabolite AMPA –(aminomethyl)phosphonic acid– on water and food. All this to setup further conclusions and recommendations on the regulated use of glyphosate and how to mitigate the adverse effects.

Keywords AMPA; Cancer risks; Glyphosate use; Herbicide research; Resistant weed

Publication Plants Open Access

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1 Physical sciences and engineering

Influence of the electrode material on ROS generation and electroporation efficiency in low and high frequency nanosecond pulse range

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Abstract Electroporation is a widely-used methodology for permeabilization of cells using pulsed electric field (PEF). In this paper, we compare the electroporation efficiency in terms of molecular transport and the generated reactive oxygen species (ROS) between low (1 Hz) and high (1 MHz) frequency nanosecond range PEF bursts. We used aluminum, copper and stainless-steel electrodes and evaluated the influence of electrode material on ROS generation and electroporation. Bursts of 25 or 50 pulses of 7–14 kV/cm amplitude and 200 ns duration were applied, and the results were compared to those obtained using electroporation with pulses of equivalent energy in conventional microsecond range. It was determined that electroporation efficiency scales with ROS generation and is highly affected by the material of electrodes and by the applied pulsing protocols. We present experimental evidence that metal ions, and not the pH fronts near the electrodes, play a major role in generation of ROS during electroporation.

Keywords Electroporation, Membrane permeabilization, MHz, Reactive oxygen species

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Advanced machine learning approaches to personalise learning: learning analytics and decision making

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Abstract The aim of the paper is to present methodology to personalise learning using learning analytics and to make further decisions on suitability, acceptance and use of personalised learning units. In the paper, first of all, related research review is presented. Further, an original methodology to personalise learning applying learning analytics in virtual learning environments and empirical research results are presented. Using this learning personalisation methodology, decision-making model and method are proposed to evaluate suitability, acceptance and use of personalised learning units. Personalised learning units evaluation methodology presented in the paper is based on (1) well-known principles of Multiple Criteria Decision Analysis for identifying evaluation criteria; (2) Educational Technology Acceptance & Satisfaction Model (ETAS-M) based on well-known Unified Theory on Acceptance and Use of Technology (UTAUT) model, and (3) probabilistic suitability indexes to identify learning components' suitability to particular students' needs according to their learning styles. In the paper, there are also examples of implementing the methodology using different weights of evaluation criteria. This methodology is applicable in real life situations where teachers have to help students to create and apply learning units that are most suitable for their needs and thus to improve education quality and efficiency.)

Keywords Learning Analytics, Decision Making, Personalisation, Learning Units, Evaluation of Suitability, Acceptance And use

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Prediction of meander delay system parameters for Internet-of-Things devices using Pareto-optimal artificial neural network and multiple linear regression

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Abstract Meander structures are highly relevant in the Internet-of-Things (IoT) communication systems, their miniaturization remains as one of the key design issues. Meander structures allow to decrease the size of the IoT device, while maintaining the same operating parameters of the IoT device. Meander structures can also work as the delay systems, which can be used for the delay and synchronization of signals in IoT devices. The design procedure of the meander delay systems is time-consuming and cumbersome because of the complexity of the numerical and analytical methods employed during the design process. New methods, which will accelerate the synthesis procedure of the meander delay systems, should be investigated. This is especially relevant when the procedure of synthesis must be repeated many times until the appropriate configuration of the IoT device is found. We present the procedure of synthesis of the meander delay system using the Pareto-optimal multilayer perceptron network and multiple linear regression model with the M5 descriptor. The prediction results are compared with results, which were obtained using the commercial Sonnet © software package and with the results of physical experiment. The difference between the experimentally achieved and predicted results did not exceed 1.53 %. Moreover, the prediction of parameters of the meander delay system allowed to speed up the procedure of synthesis multiple times from hours to only 2.3 s.

Keywords Delays, Antennas, Conductors, Microstrip, Delay lines, Internet of Things

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Thermal and geometric error compensation approach for an optical linear encoder

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Abstract Linear displacement measuring systems, like optical encoders, are widely used in various precise positioning applications to form a full closed-loop control system. Thus, the performance of the machine and the quality of its technological process are highly dependent on the accuracy of the linear encoder used. Thermoelastic deformation caused by a various thermal sources and the changing ambient temperature are important factors that introduce errors in an encoder reading. This work presents an experimental realization of the real-time geometric and thermal error compensation of the optical linear encoder. The implemented compensation model is based on the approximation of the tested encoder error by a simple parametric function and calculation of a linear nature error component according to an ambient temperature variation. The calculation of a two-dimensional compensation function and the real-time correction of the investigated linear encoder position readings are realized by using a field programmable gate array (FPGA) computing platform. The results of the performed experimental research verified that the final positioning error could be reduced up to 98%

Keywords Measuring scale; Thermoelastic deformation; Coefficient of thermal expansion

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Nanosecond electrochemotherapy using bleomycin or doxorubicin: Influence of pulse amplitude, duration and burst frequency

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Abstract Electroporation is a pulsed electric field (PEF) induced phenomenon, which effectiveness varies dependent on pulse parameters. This work focuses on nano-electrochemotherapy with bleomycin and doxorubicin to derive protocols as effective as European Standard Operating Procedures on Electrochemotherapy (ESOPE), which employ conventional microsecond range pulses. As a model, murine Lewis lung carcinoma (LLC1) cell line was used. The effects of pulse duration (100–500 ns), PEF amplitude (6–10 kV/cm) and pulse repetition frequency (10 kHz, 100 kHz, 1 MHz) were studied. A total of 75 ns protocol variations have been used. For detection of cell permeabilization, Yo-Pro-1 and flow cytometry were employed. Cell viability was evaluated 24-, 48-, or 72-hours post-electroporation. Nanosecond parametric protocols resulting in comparable treatment efficiency as ESOPE (1.3 kV/cm × 100 μs × 8) have been proposed. It was shown that high-frequency nanosecond electrochemotherapy with bleomycin or doxorubicin could be an alternative for established ESOPE protocols.

Keywords ESOPE, Nanosecond electroporation, Membrane permeabilization, Cancer, Drugs, nsPEF, High frequency

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Exergy Analysis of the Air Handling Unit at Variable Reference Temperature

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Abstract This book explore how exergy analysis can be an important tool for assessing the sustainability of buildings.

Building's account or around 40 percent of total energy conditions depending on local climatic conditions. Due to its nature, exergy analysis should become a valuable tool for the assessment of building sustainability, first of all considering their scope and the dependence of their energy demands on the local environmental and climatic conditions. Nonetheless, methodological bottlenecks do exist and a solution to some of them is proposed in this monograph. First and foremost, there is the still-missing thermodynamically viable method to apply the variable reference environment temperature in exergy analysis. The monograph demonstrates that a correct approach to the directions of heat exergy flows, when the reference temperature is considered variable, allows reflecting the specifics of energy transformation processes in heating, ventilation, and air conditioning systems in a thermodynamically viable way. The outcome of the case analysis, which involved coordinated application of methodologies based on the Carnot factor and coenthalpies, was exergy analysis indicators – exergy efficiency and exergy destroyed – obtained for air handling units and their components. These methods can be used for the purposes of analysing and improving building technical systems that, as a rule, operate at a variable environment temperature.

Exergy analysis becomes more reliable in designing dynamic models of such systems and their exergy-based control algorithms. This would improve the possibility to deploy them in building information modelling (BIM) technologies and the application of life cycle analysis (LCA) principles in designing buildings, thus improving the quality of the decision-making process. Furthermore, this would benefit other systems where variable reference environment plays a key role.

This book is relevant to academics, students and researchers in the field of thermodynamic analysis considering HVAC equipment, building energy systems, energy efficiency, sustainable development of technical systems of energy, mechanics, and construction, as well as preservation of natural resources. Planners, designers, engineers of HVAC equipment, building energy systems, and developers of appropriate simulation tools (e.g., BIM) will also find it of use.

Keywords Exergy Efficiency, Variable Reference Temperature, Air Handling Unit, Heat Pump for HVAC, Seasonal Exergy Efficiency

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2 Social sciences and humanities

Decision tree modelling of econsumers' preferences for internet marketing communication tools during browsing

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Abstract The successful development of internet marketing is based on scientifically proven decisions designed for the comprehensive analysis and evaluation of internet marketing communication tool selection. Different layers of internet marketing phenomena, such as communication tool profiles and characteristics of customers and strategies for different stages of purchase models, are widely analysed. However, it has been noted that modern management theories lack scientific research on the comprehensive analysis and evaluation of internet marketing communication tools, including the relevant characteristics of electronic consumers profiles based on their generational aspects and their life cycle stages. It is therefore necessary to analyse the stages of an electronic consumer's journey and define the most relevant communication tools and application uses during every stage by aiming to improve customer satisfaction and marketing performance. The goal of this research is to determine the most significant internet marketing communication elements in the purchase phase of the electronic consumer journey cycle using the mathematical decision tree approach for different types of customers, using the generation theory as a segmentation tool. The literature analysis on electronic consumer's behaviour, generation theory application possibilities in marketing and internet marketing communication tools was carried out. The research methodology includes eye-tracking and descriptive and comparative statistical analysis methods (decision tree models), which create the preconditions for the evaluation of electronic consumers' explicit and tacit reactions to the use of internet marketing communication tools during the purchase phase of an electronic consumer´s journey. It was established that comparable statistically significant different preferences for internet marketing communication tools, at the purchase phase during a browsing task, exist for baby boomers, X, Y and Z generations.

Keywords Internet marketing, communication, customer behaviour, internet marketing communication tool, e-commerce

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Factors affecting knowledge sharing in virtual teams

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Abstract The development and use of information and communications technology (ICT) are growing at a rapid speed across the world. ICT has been the cause for new types of work arrangements, such as virtual organizations, virtual teams, teleworking, etc. Virtual teams provide organizations with competitive advantage by enabling them to hire talented people across the world and eliminating the need for physical availability in the office. However, one major issue hindering the productivity of the virtual team is knowledge sharing. The lack of proper knowledge sharing between team members may cause organizations to fail with regards to the implementation of successful strategies. The research into understanding knowledge sharing in virtual teams (VT) in the Middle East is lacking. While such studies have been done in the United States and Europe, the Middle East has been overlooked. In this study, the authors assume that there are some specific behavioral aspects of VT in the Middle East that create the need for specific scientific solutions. Accordingly, this study was conducted in the Middle East in order to gain scientific knowledge on the region's specificity. The objective of this article is to create a model for the evaluation of the effect on knowledge sharing in virtual teams in the Middle East. For analysis, the selection of companies includes United Arab Emirates (UAE)-based companies in the IT industry whose businesses engage in VT. The results show that the following factors have a direct effect on knowledge sharing in VT: Culture, motivation, conflict, ICT, trust, and leadership. Conversely, the results do not demonstrate that language has any impact on knowledge sharing. The methodology used is as follows: Literature review, survey methods, and structural equation modeling.

Keywords information and communications technologies; ICT; virtual organization; virtual teams; knowledge sharing; performance

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Quality of life of the youth: assessment methodology development and empirical study in human capital management

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Abstract Based on existing approaches to assessing the quality of life and similar concepts in human capital management, a quality of life index for young people is proposed. It takes into account the factors of four groups that determine the subjective satisfaction with the quality of life: Economic environment; Socio-political environment; Social environment; Natural environment. Partial factors and their corresponding quality of life indicators are adapted to the assessments of young people, whose needs and interests differ significantly from other age groups due to differences in the values of generations and features of economic activity at a young age. The methodology developed by the authors is based on taking into account subjective assessments of the level of satisfaction with quality of life factors, as well as their importance based on the determination of weights. As a result of testing the methodology, it was found that the most important factors for a positive perception of quality of life are the social environment, in particular, family relationships and health. Economic and environmental factors have approximately the same effect. Socio-political environment factors have the least influence. Due to material well-being and the quality of socio-political life, satisfaction with the life of employed youth is slightly higher (by 3%). Instead, respondents who do not work are more satisfied with social comfort. The integrated index of quality of life of the interviewed youth is 3,438 points out of 5 maximum. The methodology and results of the assessment are useful for the development of national and regional programs and strategies of human capital development due to increase the level of satisfaction of material, spiritual and cultural needs of young people.

Keywords Quality Of Life, Human Capital Management, Sociological Survey, Well-being, Youth

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Comparison of the environment of EU countries for sharing economy state by modern multiple criteria methods

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Abstract The rapid growth of the sharing economy attracts attention from scientists, businesses, and governments. The European Commission acknowledges the benefits of the sharing economy and emphasises that European countries should be open to the new opportunities that the sharing economy brings. The sharing economy makes an essential contribution to job creation and growth in the European Union. The sharing economy creates new markets and expands existing ones. It makes the use of resources more efficient due to the extensive sharing of assets. Sharing improves resource conservation and efficiency of use, reformats consumption patterns, raises the spirit of entrepreneurship and responsibility of every capital owner, and improves social trust among people worldwide. Despite the focus of researchers on the sharing economy, there is still a lack of research on conditions that stimulate the sharing economy's growth. The article lays the foundation for creating a more comprehensive methodology for assessing the growth of the sharing economy. The authors apply multi-criterion decision-making methods for research purposes, such as EDAS and PROMETHEE II, and recently developed CILOS and IDOCRIW for criteria weight calculation. A hierarchy structure of criteria for evaluating sharing economy growth was created and presented in the paper. The resulting weights of criteria of performance of sharing economy growth were obtained. The prominent features of hierarchy structures and the methodology for calculating ultimate weights are described and demonstrated. The results reveal that the environment is more favourable for sharing economy growth in the Netherlands, Germany, and Sweden among the chosen European countries.

Keywords sharing economy, multicriteria evaluation, environment, factors, EDAS, PROMETHEE

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In between communication theories through one hundred questions

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Abstract This book takes the form of a dialogue. It presents two authors, specialized in the phenomenology, posing questions to each other and offering complex answers for critical discussion. The book includes both presentation of different communication schools and philosophizing on the issues of communication. The authors debate numerous topics by providing the definition and etymology of communication, examining the limits of communication, and using a poli-logical base of communication. The issue which pervades all domains is that of mediation: how things, such as identities, styles, and bodies are mediated by culture, history, and tradition, and what the limits are of such mediation. This question leads to more complex issues of "mediated mediations" such that an explication of one medium is framed by another medium, leading to a question of meta-language as a fundamental, unmediated medium. This involves some fine points of mediation: perspectivity, discursivity, ethics of communication, ideology, private and public. Throughout the mutual, interrogative dialogue, the authors touch upon, but avoid the daunting commitment to, a theory of metacommunication, as well as the "transcendental" problematic of accessing the numerous theoretical, thematic, and historical aspects of communication.

Keywords Communication Theories, Metacommunication, Ethics of Communication, Bodyness, Philosophical Dialogue, Phenomenology of Communication, Communication Schools, discourse analysis

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Creating chaos online: Disinformation and subverted post-publics

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Abstract Denial describes information operations that allow for the achieving of strategic goals. This book is set to expose efforts to justify Russian trolling. Specifically, this book documents patterns and frames of systematic denialism used to justify Russian trolling that circulated in two unrelated contexts and periods of time. This book not only uncovers justification arguments and the way they are constructed but also provides explanations of their origins and what led them to become so pervasive online. Furthermore, through the concept of post-publics, this book exemplifies how the public spheres are disrupted by employing discursive means of denialism, despite rational evidence grounded in facts.

I am compelled to examine the characteristics of Russian trolling across online platforms for a range of reasons. Russian trolling has been exposed as an ideological weapon employed to manipulate public opinion aided by disinformation (Berghel & Berleant, 2018). Manipulation was found to be adopting tactics typical for astroturfing trolling such as disruption and distrust (Berghel & Berleant, 2018), and deflection of attention to irrelevant issues (Zelenkauskaite & Niezgoda, 2017), thus creating chaos online.

This book is further driven by questions such as, What makes it so difficult to render Russian trolling visible despite unequivocal evidence? How does the justification of Russian trolling interference challenge democratic Page 2 →beliefs and institutions? Such questions have become critical after the initial warnings about Russian trolling that received mainstream press coverage, as exemplified by Adrian Chen's story in the 2015 June 3 issue of the New York Times Magazine. The story exposed Russian trolling at work and its proliferation in online spaces to circulate propaganda on a global scale—how it sows the seeds of discord and blurs the lines between multiple constructions of reality. Chen's (2015) report on a Russian trolling factory was breaking news that catalyzed a global chain reaction.

Keywords Disinformation, subverted post-publics

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3 Life sciences

Highly sensitive amperometric biosensor based on alcohol dehydrogenase for determination of glycerol in human urine

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Abstract In this paper we report the development of a highly sensitive amperometric glycerol biosensor based on alcohol dehydrogenase from Pseudomonas putida immobilized on graphite electrode modified with carbon nanotubes and a redox mediator tetrathiafulvalene. The designed biosensor demonstrates very high sensitivity towards glycerol (29.2 ± 0.9 µA mM–1 cm–2), low limit of detection (18 µM), linear range from 0.05 to 1.0 mM, high selectivity and satisfactory stability. Biosensor has been successfully used for the determination of glycerol concentration in buffer solutions as well as in the human urine samples. Received results shows a satisfactory agreement with the control measurements carried out using colorimetric commercially available glycerol determination assay kit, thus developed biosensor can be successfully applied for measurements of glycerol concentration in human urine and may be a fast, attractive and non-invasive tool for the determination of glycerol.

Keywords Amperometric biosensor, Alcohol dehydrogenase, Carbon nanotubes, Glycerol, Tetrathiafulvalene

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Immobilisation of metal(loid)s in two contaminated soils using micro and nano zerovalent iron particles: evaluating the long-term stability

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Abstract The aim of this study was to compare the immobilisation of metal(loid)s in two differently contaminated soils using micro zerovalent iron (ZVI) and nano zerovalent iron (nZVI) particles. Chromated copper arsenate-contaminated soil contained high amounts of As, Cu, Cr, and Zn, whereas mining-contaminated soil contained high amounts of As, Cu, and Pb. Contaminated soils were amended using 2% ZVI and nZVI. As determined by the leaching procedures, nZVI was more efficient in immobilising all the studied metal(loid)s in the soils compared to ZVI. The greatest immobilisation was achieved for As in both soils. The long-term stability of immobilised metal(loid)s was studied in mining-contaminated soil by performing thermal oxidation (ageing). In the ZVI and nZVI-treated soils, high retention results were achieved for As and Cu, whereas in the ZVI and nZVI-treated soils, significant desorption of Pb was observed. The results also showed that retention of metal(loid)s over a long period of time could be more effective in soils treated with ZVI, as the crystallisation of Fe in ZVI-treated soil was to a lesser extent compared to the crystallisation of Fe in nZVI-treated soil.

Keywords Chromated copper arsenate, Sequential extraction, Availability, Arsenic, Thermal ageing, Mining-contaminated soil

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A direct electron transfer formaldehyde dehydrogenase biosensor for the determination of formaldehyde in river water

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Abstract In this work, we report the construction of a direct electron transfer (DET) biosensor based on NAD-dependent formaldehyde dehydrogenase from Pseudomonas sp. (FDH) immobilized on the gold nanoparticle-modified gold electrode. To the best of our knowledge, a DET for FDH was achieved for the first time – the oxidation of formaldehyde started at a low electrode potential of −190 mV vs. Ag/AgCl and reached a maximum current density of 1100 nA cm−2 at 200 mV vs. Ag/AgCl. Also, the designed electrode was insensitive to substrate inhibition (in comparison to the free enzyme) and operated in solutions with formaldehyde concentrations up to 10 mM. The electrode was used and characterized as a mediatorless biosensor for the detection of formaldehyde. The biosensor demonstrated a limit of detection (0.05 mM), linear range from 0.25 to 2.0 mM, the sensitivity of 178.9 nA mM cm−2, high stability and selectivity. The biosensor has been successfully tested for the determination of added formaldehyde concentration in river water samples, thus the developed electrode could be applied for a fast, inexpensive and simple measurement of formaldehyde in various media.

Keywords Formaldehyde, Biosensor, Formaldehyde dehydrogenase, Gold nanoparticles, Direct electron transfer

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Epigenetics and proteomics of leukemia. A synergy of experimental biology and computational informatics

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Abstract This book reviews the current state of epigenetics and proteomics of leukemia and introduces the methods that are important to process and evaluate these factors in leukemia. In particular, epigenetic modifiers and their inhibitors in leukemia treatment as well as approaches to the epigenetic treatment of leukemia are covered. Various computational methods for proteome analysis are also described in detail, including 2DE fractionation and visualization, proteomic data processing, image acquisition and data anlaysis, and more. Protein localization in leukemia is also covered, in addition to the future of leukemia therapy.
Epigenetics and Proteomics of Leukemia is an ideal book for advanced biomedical scientists and students, medical doctors and students, bioinformatics and health informatics researchers, computational biologists, structural biologists, systems biologists, and bioengineers.

Keywords Epigenetics, Proteomics, Leukemia, Chromatin, 2DE, Protein Visualization, Computational Biology

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4 Multidisciplinary

Contractor selection for renovation of cultural heritage buildings by PROMETHEE method

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Abstract Cultural heritage buildings have architectural, historical and cultural values creating one of the most dominant features, which is related to the local identity. Its preservation requires consideration, liability, know-how, know-why and experienced employee. Cultural heritage buildings' performance is complicated work, therefore selecting a contractor for heritage buildings' protection and restoration is a difficult assignment. The improper contractor's choice could activate cost overruns, lag, conflicts, declines, imperfect performance or added expenditure for project administration and accomplishment. This paper submits the quantitative and qualitative criteria setting for selecting heritage's contractor. The Analytic Hierarchy Process technique is applied to decide important criteria and to get the weighting for each criterion. The PROMETHEE (Preference Ranking Organisation Method for Enrichment Evaluation) technique is applied for the selection of the most efficient cultural heritage contractor's alternative.

Keywords Cultural heritage, Building renovation, Contractor selection, Multi-criteria decision making (MCDM)

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A new fuzzy approach based on BWM and fuzzy preference programming for hospital performance evaluation: A case study

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Abstract Hospital performance evaluation (HPE) has a major role in improving the quality, safety, and effectiveness of health care services, so it is indispensable for proper and continuous operation of hospitals. Although several studies have been performed on HPE, few have used group decision-making (GDM). This study presents a comprehensive multi-criteria GDM model for HPE under uncertain conditions. In this model, we have combined the group best–worst method (GBWM) and fuzzy preference programming (FPP) method to create an applicable framework for GDM in which members of a decision-making group including decision-makers (DMs) have different expertise and the importance of criteria and DMs opinions are determined by a supervisor. The advantages of the proposed method include the integration of the GDM process in the form of a single model and there is no need to calculate separately the consistency of the decisions of the decision-making team members. Finally, a case study conducted on 5 hospitals in Tehran is presented to demonstrate the applicability and effectiveness of the proposed method. The results show that Sina Hospital, Baharloo Hospital, and Tehran Heart Center were ranked first to third, respectively. Also, we can conclude from this study that the proposed integrated framework is capable to address the HPE problem by using a GDM and considering the uncertainty of the comparisons made by decision-making team members.

Keywords Group decision-making, Best–worst method, Fuzzy preference programming, Hospital performance evaluation

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EMG based analysis of gait symmetry in healthy children

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Abstract The purpose of this study was to examine the changes in muscular activity between the left and right lower legs during gait in healthy children throughout temporal parameters of EMG and symmetry index (SI). A total of 17 healthy children (age: 8.06 ± 1.92 years) participated in this study. Five muscles on both legs were examined via the Vicon 8-camera motion analysis system synchronized with a Trigno EMG Wireless system and a Bertec force plate; onset–offset intervals were analyzed. The highest occurrence frequency of the primary activation modality was found in the stance phase. In the swing phase, onset–offset showed only a few meaningful signs of side asymmetry. The knee flexors demonstrated significant differences between the sides ($p < 0.05$) in terms of onset–offset intervals: biceps femoris in stance, single support, and pre-swing phases, with SI values = −6.45%, −14.29%, and −17.14%, respectively; semitendinosus in single support phase, with SI = −12.90%; lateral gastrocnemius in swing phase, with SI = −13.33%; and medial gastrocnemius in stance and single support phases, with SI = −13.33% and −23.53%, respectively. The study outcomes supply information about intra-subject variability, which is very important in follow-up examinations and comparison with other target groups of children.

Keywords Gait symmetry; gait in children; surface EMG; muscular activation

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The development of nature-inspired gripping system of a flat CFRP strip for stress-ribbon structural layout

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Abstract The elegant stress-ribbon systems are efficient in pedestrian bridges and long-span roofs. Numerous studies defined corrosion of the steel ribbons as the main drawback of these structures. Unidirectional carbon fiber-reinforced polymer (CFRP) is a promising alternative to steel because of lightweight, high strength, and excellent corrosion and fatigue resistance. However, the application of CFRP materials faced severe problems due to the construction of the anchorage joints, which must resist tremendous axial forces acting in the stress-ribbons. Conventional techniques, suitable for the typical design of the strips made from anisotropic material such as steel, are not useful for CFRP strips. The anisotropy of CFRP makes it vulnerable to loading in a direction perpendicular to the fibers, shear failure of the matrix, and local stress concentrations. This manuscript proposes a new design methodology of the gripping system suitable for the anchorage of flat strips made from fiber-reinforced polymers. The natural shape of a logarithmic spiral Nautilus shell describes the geometry of the contact surface. The continuous smoothly increasing bond stresses due to friction between the anchorage block and the CFRP strip surface enable the gripping system to avoid stress concentrations. The 3D-printed polymeric prototype mechanical tests proved the proposed frictional anchorage system efficiency and validated the developed analytical model.

Keywords Anchorage system, FRP, spiral grips, 3D printing, polymers, mechanical tests

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Diurnal emotions, valence and the coronavirus lockdown analysis in public spaces

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Abstract A large-scale analysis of diurnal and seasonal mood cycles in global social networks has been performed successfully over the past ten years using Twitter, Facebook and blogs. This study describes the application of remote biometric technologies to such investigations on a large scale for the first time. The performance of this research was under real conditions producing results that conform to natural human diurnal and seasonal rhythm patterns. The derived results of this, 208 million data research on diurnal emotions, valence and facial temperature correlate with the results of an analogical Twitter research performed worldwide (UK, Australia, US, Canada, Latin America, North America, Europe, Oceania, and Asia). It is established that diurnal valence and sadness were correlated with one another both prior to and during the period of the coronavirus crisis, and that there are statistically significant relationships between the values of diurnal happiness, sadness, valence and facial temperature and the numbers of their data. Results from the simulation and formal comparisons appear in this article. Additionally the analyses on the COVID-19 screening, diagnosing, monitoring and analyzing by applying biometric and AI technologies are described in Housing COVID-19 Video Neuroanalytics.

Keywords Diurnal emotions, Valence and facial temperature, COVID-19, Public spaces, Remote biometric technologies, Large-scale data analysis, Worldwide comparisons

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Impact of portland cement type on bacterial viability in biological concrete

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Abstract Biological concrete combines the advantages of traditional concrete and autonomous crack repair. As the self-healing ability of biological concrete is ensured by bacteria-induced calcium carbonate precipitation, long-term bacterial viability becomes critical. Unfortunately, the viability of bacteria tends to drop drastically within the first several days after their incorporation into biological concrete, complicating the healing process. Bacterial mortality is most often related to either the high pH values of early age concrete or mechanical stress during the mixing and hardening of the concrete. In this paper, we report a detailed analysis of the influence of cement type on bacterial viability. We reveal that a particular cement type used for concrete production is of paramount importance to bacterial viability as it directly correlates with the chemical composition of concrete and, subsequently, the environment that bacteria thrive in. We demonstrate that specific metal oxides present as impurities in cement, namely CuO and ZnO, act as bactericidal agents. To achieve the best healing effect, we suggest that the chemical composition of a given cement type is analyzed, and the inhibitory activity of each detected compound on bacteria is studied before the production of biological concrete.

Keywords Biological concrete, Bacterial viability, Cement type

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Development of smart context-aware services for cargo transportation. An operational management approach

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Abstract This chapter presents research background and research areas that are going to be investigated in this monograph. The authors revise the dynamism of the environment which is important for operational freight transportation. Also, herein the separate attention is given to the ongoing digitalization initiatives and their new opportunities for transport management. Later on, in the chapter some ongoing researches in their area and the overview of European Commission focus directions are presented. Further, the development of contextual systems and the discussion on context meaning are introduced. Finally, the chapter ends with the presentation of research object.

Keywords Background of research, Context-sensitive systems, Environment in freight delivery processes

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1 Physical sciences and engineering

Shear behavior of fiber-reinforced ultra-high performance concrete beams

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Abstract Twenty I-shaped beams made of ultra-high performance concrete (UHPC) with different steel fiber content (up to 2% by volume) and with varying degrees of shear reinforcement (no stirrups or with diameter 10mm stirrup, 125–300mm spacing) were tested in shear. The mean compressive strength of the concrete was around 170 MPa. All tests failed in shear. The study investigated the effect of the traditional transverse shear reinforcement and the effect of the fiber reinforcement on the shear behavior as well as the interaction of both parameters, considering the failure mechanisms and the shear capacity. The cracking process was monitored by a digital image correlation (DIC) measurement system and the results of the evaluation are presented. The measured ultimate shear capacity of the different setups was compared to the current AFGC design approach.

Keywords UHPC, Shear design, Fiber reinforcement, Shear reinforcement, DIC measurement

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Date 2018

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Are concrete-concrete bond tests comparable?

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Abstract The effectiveness and durability of a concrete repair or retrofit is mostly affected by its bond and compatibility to the existing substrate. Although our understanding of concrete-concrete bond has advanced greatly, there remains a major uncertainty in the adoption of a proper methodology to assess the quality of bond, comprising the accuracy of reproducing the stresses that the interface undergoes in a structural application, the problem of disturbed stress paths, size & rate effects, drilling-induced damage, and the possibility of conversions between
shear and tensile bond. A discussion on comparability of bond tests in tension and shear is presented. The study is based on a roundrobin-like test program in two independent labs in Canada and Austria (UBC, CUAS) and encompasses normal strength, high strength, and fiber reinforced concretes. The raw data comparison is complemented with an investigation of semi-empirical methods and predictive models, conversions between shear and tension coefficients, and suitability/limitations of various methodologies for assessing the effects of fiber reinforcement on bond.

Keywords Bond, Repair, High strength concrete, Fiber reinforced concrete, Adhesion, Friction

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Date 2019

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Experimental Quantification of the Variability of Mechanical Properties in 3D Printed Continuous Fiber Composites

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Abstract The material properties of 3D printed continuous fiber composites have been studied many times in the last years. However, only a minimal number of samples were used to determine the properties in each of the reported studies. Moreover, reported results can hardly be compared due to different sample geometries. Consequently, the variability of the mechanical properties (from one sample to the other) is a crucial parameter that has not been well quantified yet. In the present work, the flexural properties of 3D printed continuous carbon fiber/nylon composite specimens were experimentally quantified, using batches of 15 test specimens. In order to account for the possible influence of the quality of the prepreg filaments on the observed variability, three different filament rolls were used to manufacture the different batches. Also, two configurations were tested, with a fiber direction parallel (longitudinal) or perpendicular (transverse) to the main axis of the specimens. The results show moderate to high variabilities of the flexural modulus, flexural strength and maximum strain. The coefficient of variation was more than twice as high in the transverse case as in the longitudinal case.

Keywords continuous fiber composites; anisotropy; optimization; ultra-lightweight components; design method; flexural properties

Publication Appl. Sci. 2021, 11(23)

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Comparison of allogeneic and autogenous bone grafts for augmentation of alveolar ridge defects—A 12-month retrospective radiographic evaluation

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Abstract Objectives: The aim of this study was to compare three-dimensional alterations following the use of autogenous versus allogeneic onlay grafts for augmentation at single tooth defects. Materials and methods: Alveolar bone width at specific implant sites were assessed using sagittal and cross-sectional CBCT images prior grafting and at three subsequent time points. Twenty-one patients received autogenous bone blocks harvested from the retromolar region and another 21 patients received freeze-dried cancellous allogeneic bone blocks.

Results: The vertical and horizontal dimensions did not significantly differ between autogenous and allogeneic bone grafts at any time point. In addition, there were no statistically significant differences in graft remodeling rates between autogenous (mean shrinkage rate after 12 months: 12.5% ± 7.8%) and allogeneic onlay grafts (mean shrinkage rate after 12 months: 14.4% ± 9.8%).

Conclusions: Freeze-dried cancellous allogeneic bone blocks showed equivalent volumetric shrinkage rates as autogenous bone blocks when used for treating circumscribed bone defects classified as Type-II to Type-IV according to the ITI-treatment guide categories. Therefore, it is not necessary to over-contour the alveolar ridge when using allogeneic blocks for treating single tooth defects, but to apply the same procedure as when using autogenous blocks.

Keywords allogeneic, alveolar ridge defect, augmentation, autogenous, dental implants, graft remodeling

Publication Clin Oral Impl Res. 2018;29:1163–1175.

Date 2018

DOI 10.1111/clr.13380

Risk Factors for Complications Following Staged Alveolar Ridge Augmentation and Dental Implantation: A Retrospective Evaluation of 151 Cases with Allogeneic and 70 Cases with Autogenous Bone Blocks

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Abstract Purpose: the aim of this study was to identify potential risk factors favoring complications by assessing the number and types of complications associated with allogeneic or autogenous bone
blocks applied as onlay grafts for alveolar ridge augmentation prior to implantation. Methods: A retrospective chart review on the success of 151 allogeneic and 70 autogenous bone blocks in a cohort
of 164 consecutive patients, who were treated over a period of 6 years by the same surgeon, was conducted. Statistical conclusions were based on ROC curves and multiple logistic regression models.
Results: Complications were observed more frequently with autogenous bone blocks (14 out of 70 cases; 20%) compared to allogeneic bone blocks (12 out of 151 cases; 7.9%; $p = 0.013$). However, these complications were minor and did not impact the successful dental rehabilitation. In a multiple logistic regression model, the risk of a complication was increased by the use of an autogenous bone block (OR = 3.2; $p = 0.027$), smoking (OR = 4.8; $p = 0.007$), vertical augmentation above a threshold of 2.55 mm (OR = 5.0; $p = 0.002$), and over-contouring (OR = 15.3; $p < 0.001$).
Conclusions: Overall, the complication rate of ridge augmentations carried out with autogenous or allogeneic bone blocks was low. Despite previous recommendations, over-contouring and a vertical augmentation above a threshold of 2.55 mm should be avoided.

Keywords alveolar ridge augmentation; bone allograft; allogeneic; bone autograft; oral bone grafting; dental implant; retrospective evaluation

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An in-depth analysis of the mitochondrial phylogenetic landscape of Cambodia

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Abstract Cambodia harbours a variety of human aboriginal populations that have scarcely been studied in terms of genetic diversity of entire mitochondrial genomes. Here we present the matrilineal gene pool of 299 Cambodian refugees from three different ethnic groups (Cham, Khmer, and Khmer Loeu) deriving from 16 Cambodian districts. After establishing a DNA-saving high-throughput strategy for mitochondrial whole-genome Sanger sequencing, a HaploGrep based workflow was used for quality control, haplogroup classification and phylogenetic reconstruction. The application of diverse phylogenetic algorithms revealed an exciting picture of the genetic diversity of Cambodia, especially in relation to populations from Southeast Asia and from the whole world. A total of 224 unique haplotypes were identified, which were mostly classified under haplogroups B5a1, F1a1, or categorized as newly defined basal haplogroups or basal sub-branches of R, N and M clades. The presence of autochthonous maternal lineages could be confirmed as reported in previous studies. The exceptional homogeneity observed between and within the three investigated Cambodian ethnic groups indicates genetic isolation of the whole population. Between ethnicities, genetic barriers were not detected. The mtDNA data presented here increases the phylogenetic resolution in Cambodia significantly, thereby highlighting the need for an update of the current human mtDNA phylogeny.

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A −40 dB EVM, 77 MHz Dual-Band Tunable Gain Sub-Sampling Receiver Front End in 65-nm CMOS

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Abstract Abstract— In this paper, the first dual-band sub-sampling receiver front end with sampling frequency optimization to meet the ultimate receiver error vector magnitude (EVM) of −40 dB over wide input power range of 19 dB is proposed. A systematic sub-sampling receiver chain EVM optimization with respect to major system-level impairments, such as noise folding, sampling frequency, IQ mismatches, phase noise of the sub-sampling clock, and unit capacitor value realizable at the decimation filter, is presented. The proposed dual-band sub-sampling receiver has a 26–41 dB continuously tunable gain for 2.4 GHz and 26– 38.5 dB for the 5 GHz WLAN band. Continuously tunable gain ensures the ultimate receiver EVM performance over wider input power levels. In addition, the 5 GHz band is continuously tunable from 4.5 to 5.7 GHz. An active balun feedback low noise amplifier followed by a sub-sampling down-conversion mixer is implemented to down-convert both WLAN bands to an intermediate frequency in the range from 445 to 538 MHz. Sub-sampling frequency optimization proposed in this paper down-converts both WLAN bands with the sampling frequency from 1.78 to 2.15 GHz to reach the target EVM. Additionally, a switched capacitor decimation filter running at 90 MHz is implemented to provide dual functionalities of down-conversion to baseband and band selection. A test-chip is implemented in a 1.2 V 65-nm CMOS technology. The proposed dual-band subsampling receiver occupies a total active area of 0.72 mm2 and has a total power dissipation of 55.6 mW. The overall receiver chain shows a noise figure of 11.5 dB at the highest gain and an IIP3 of −8 dBm at the lowest gain.

Keywords Sub-sampling receiver, dual-band receiver, noise folding, decimation filter, WLAN, CMOS technology.

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Date 2019

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A −40-dB EVM 20-MHz subsampling multistandard receiver architecture with dynamic carrier detection, bandwidth estimation, and EVM optimization

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Abstract In this work, a reconfigurable multistandard subsampling receiver with dynamic carrier frequency detection and system-level EVM optimizations is proposed. Ideal software defined radio (SDR) receivers promise complete flexibility at the expense of high-performance analog-to-digital converters (ADCs) that are challenging to implement in current technologies for low-power applications. This scenario leads to the research of digital intensive sampling receivers with discrete-time signal processing (DTSP) implemented in analog domain. This approach makes it feasible to move channel selection filtering and dynamic gain adaptability from analog to digital domain. The proposed receiver employs subsampling down-conversion along with subband filters to dynamically detect the carrier frequency of the incoming signal, estimate its bandwidth, and identify if the signal is present in one of the target standard bands. This carrier detection provides a unique capability to reconfigure the receiver dynamically. Additionally, in this work, system-level EVM optimization is proposed considering frequency synthesizer phase noise, IQ mismatch, sampling frequency selection and block-level gain, noise, and nonlinearity. The RF front end of the proposed receiver is modeled in Verilog-AMS whereas the digital signal processing is implemented in Simulink-Matlab. The complete receiver has been verified to detect and process three different bands belonging to three different standards (GSM, UMTS, and WLAN) with the carrier frequency ranging from 0.9 to 2.5 GHz. Test signals with 4-QAM modulation, maximum bandwidth of 20 MHz, and input-dynamic range from –109 to –20 dBm is utilized to demonstrate the receiver performance including an EVM of –40 dB.

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Flexural Strengthening with Fiber-/Textile-Reinforced Concrete

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Abstract The use of textile-reinforced concrete (TRC) in retrofit applications has proven to be an effective and viable solution. Many parameters, however, can affect the outcome, strongly inhibiting its potential. An experimental campaign was performed to assess the efficiency of TRC in strengthening reinforced concrete (RC) beams against bending with different varying parameters such as cementitious materials, number of textile layers, mechanical anchorages, and addition of short dispersed steel fibers. Results show how each parameter affects both the capacity increase and the failure mode, pointing out the beneficial effect of introducing both anchorage systems and short dispersed steel fibers.

Keywords beams; bending; digital image correlation (DIC); mechanical anchorage; retrofit; textile-reinforced concrete (TRC); ultra-high-performance fiber-reinforced concrete (UHPFRC).

Publication ACI Structural Journal/July 2021

Date 2021

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2 Social sciences and humanities

Distributed Experiments and Distributed Learning

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Abstract The paper, an enhanced version of conference key presentation, investigates, how the development of new needs in education and developments in IT triggered technology enhanced learning. Online labs play an important in that area. Federation of labs is the new direction to answer the challenges, which come from the intensive use of online labs in the modern learning environments. VISIR Federation is a concrete attempt to implement such a federation. Distributed labs in a federation need commitments from the participants in organization, sharing lab and learning resources.

Keywords Online labs, pocket abs, RLMS, VISIR, learning

Publication Journal of Online and Biomedical Engineering

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Identifying global leadership potential

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Abstract Purpose – This article investigates which criteria and processes are used to identify global leadership potential (GLP) in multinational corporations. Design/methodology/approach – First, the literature at the intersection between leadership potential and global leadership is reviewed to identify a set of criteria that can be used for assessing GLP. The findings are then validated in a qualitative study against a sample of nine global corporations. Findings – Several traits (integrity and resilience), attitudes (learning orientation, motivation to lead, change orientation, drive for results, customer orientation and a global mindset) and competencies (cognitive complexity and intercultural, interpersonal, leadership, learning, change and business competencies) are associated with GLP. The core steps in the GLP identification process are nomination, assessment and confirmation. These steps can be complemented by a preassessment phase and a subsequent talent dialogue. Practical implications – The results of this research can inform human resource (HR) management practitioners in their endeavor to successfully identify and assess potential future global leaders.
Originality/value – Prior research has focused either on defining global leadership or on assessing leadership potential in general, without a clear focus on identifying global leaders. In this article, the two concepts of global leadership and leadership potential are combined, thus providing an integrated content and process model that indicates how global corporations select their future global leaders.

Keywords Global leadership, Leadership potential, Talent management, Identification process

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Business excellence for SMEs: motives, obstacles, and size-related adaptations

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Abstract Several national European Foundation for Quality Management partner organisations have launched an initiative to develop an entry-level approach to business excellence (BE) specifically targeted to small and medium-sized enterprises (SMEs). Eleven SMEs were taking part in a first pilot project in Austria. A longitudinal qualitative research design including multiple methods (observation, written surveys, and telephone surveys) was used to study motives, obstacles, and implementation results of the SMEs that participated in this project. This exploratory study reveals that in addition to active (related to strategic business and market development) and passive (responding to customer and market requirements) external motives, SMEs are also strongly driven by both active (striving for operative excellence) and passive (adaptation of structures and processes to changing requirements) internal motives. The main obstacles for SMEs to adopt a BE approach relate to resource constraints, managerial and employee attitudes, and conceptual concerns. First implementation results show support for a more gradual approach to SME immersion into BE thinking and methods.

Keywords business excellence; EFQM; SMEs; motives; obstacles; implementation

Publication Total Quality Management & Business Excellence Volume 30, 2019 – Issue 1-2

Date 2019

DOI http://dx.doi.org/10.1080/14783363.2017.1300054

Community Counts: Rural Social Work in East Africa

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Abstract The community plays a significant role in everyday life in rural African contexts, particularly in terms of coping and in times of crisis. In the East African region, rural communities are diverse and complex, yet most share similar vulnerabilities such as widespread poverty, lack of infrastructure and basic services, and exclusion from broader economic and political developments. They are also highly affected by processes of modernization, globalization, and rural-urban migration. Social work as a profession that deals with social problems is deemed suitable to support rural communities in their struggle for survival. In order to understand the link between community-based forms of problem solving and social work practice, a qualitative study was conducted in five countries (Burundi, Kenya, Rwanda, Tanzania, and Uganda). A total of 155 qualitative interviews and 55 focus group discussions with key informants were conducted. The research revealed a variety of indigenous knowledge systems and innovative coping mechanisms. For rural social work to be relevant and effective, such models should be thoroughly analyzed and integrated into its professional concepts and practice. In this article, some case examples are presented and critically discussed against the background of the African philosophical concept of *ubuntu*, which is regarded as the ethical backbone of communal life.

Keywords Africa; East Africa; rural communities; social work; rural social work; rural development; indigenous knowledge; *ubuntu*

Publication World 3(4), 1053–1066.

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Social innovations in rural communities in Africa's Great Lakes region. A social work perspective

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Abstract In Africa's Great Lakes region, many rural communities face serious challenges including chronic poverty, lack of infrastructure, high unemployment, inadequate education systems and healthcare services, as well as a fundamental absence of public social protection mechanisms. In some contexts, rural dwellers suffer from the additional burden of armed conflict and political violence. Yet, rural populations show remarkable indications of resilience and exhibit innovative ways of handling their problems by themselves. Some of these approaches can be qualified as social innovations.

With its focus on the role of social work in rural social innovation processes, this article aims to contribute to some under-researched aspects at the intersection of social innovation, rural studies, and social work practice. Empirical evidence of rural social innovations is based on a regional study on indigenous and innovative models of problem solving in five African countries. Here, the focus is on two case examples from Uganda and Rwanda. For Uganda, a community-based concept of household clusters to promote rural development called *akabondo* is presented. The example from Rwanda is called *umugoroba w'ababyeyi* and refers to a family strengthening and community development program that has been mainstreamed into government policies. This model is located in the challenging context of a post-genocide society.

A critical analysis of these models refers to the question whether they fall into the category of a social innovation; to major players in implementing such innovations; to their impact on rural communities and the wider society; as well as to challenges facing such innovations.

Keywords Africa, indigenous knowledge, rural communities, social innovation, social work

Publication Journal of Rural Studies 99, 262–271.

Date April 2023

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Management Perception of Digital Innovation: How Innovation Managers Perceive Digital Innovation in their Organisational Setting in Austria

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Abstract The rapid advancement of digital technologies has fundamentally shaped business in all sectors. Therefore, organisations must find strategies for responding to this advancement through digital innovation. In this context, the perspective of innovation managers and their perception of digital innovations in practise are underrepresented in previous research. Therefore, using semi-structured interviews, this study examines the perceptions of 13 innovation managers towards digital innovation and organisational factors in Austria. Results showed that digital innovation is perceived positively and has the potential to solve current societal, economic and environmental challenges. However, a proactive strategy is required for organisations. Finally, in terms of conductive factors, agility, mindset adjustment, innovation culture, open innovation approach and ecosystem usage appear to be important in practise in Austria. This suggests that managers who are aware of the impact of digital innovation and consider conductive factors in their leading strategy may be successful in handling digital innovation.

Keywords Digital Transformation; Economy; Society; Environment; Organisation; Expert Opinion; Innovation Management.

Publication Journal of Innovation Management
10(3), 75-90

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Organisational resilience: a qualitative study about how organisations handle trends and their effects on business models from experts' views

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Abstract Purpose – Organisations need to tackle emerging trends that affect business models (BM) by modifying, changing or re-designing their models. Attending this complex environment by understanding trends and the strategies actors use to handle these competing demands is strategically important for innovation management and sustaining organisations. Therefore, this study aims to investigate how organisations assess and deal with these complex and relevant challenges. Design/methodology/approach – A total of 18 higher management experts between the ages of 27 and 59 years participated in this four-month qualitative interview-based study. The interviews were analysed by using systematic, qualitative content analysis. Findings – Results showed that all elements of a BM are influenced by emerged trends, and how organisations deal with them can decide whether the impact poses as risk or offers opportunities. Trends trigger two different strategies – reactive and proactive resilience strategies – which are closely related to the change sensitivity of the attributional resilience model, thereby presenting a crucial factor for enhancing resilience. Nevertheless, the proactive resilience strategy seems to be more promising for enhancing organisational resilience regarding the influence of trends on their BM. Moreover, this study found that the usage of foresight methods might be suitable as an important tool for proactive resilience strategy to modification, change or re-design of BM and consequently anticipate trends. Originality/value – Overall, this study is one of the first that explains how BMs are influenced by trends and how organisations handle them by using organisational resilience strategies.

Keywords Foresight; Resilience; Business model; Innovation management; Future trends; Proactive; Reactive;

Publication International Journal of Innovation Science
Vol. 12 No. 5, pp. 525-544

Date November 2020

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The Limits to Growth – 50 Years Ago and Today

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Abstract The Limits to Growth was published 50 years ago. Ordered by the Club of Rome, the study was a milestone in the analysis of the economic, demographic, technical and ecological effects of the existing economic system. In industrialised Western countries in particular, the critical examination of the development model of continuous economic growth led to a broad discussion about the far-reaching implications of a global economy focusing on growth, on a planet with finite natural resources.

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3 Multidisciplinary

Phasic heart rate variability and the association with cognitive performance: A cross-sectional study in a healthy population setting

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Abstract Introduction: Sympathovagal balance measured by heart rate variability is a core component of psychophysiological research. Through the close link of physiological and psychological aspects, often a reduced heart rate variability is associated with impaired cognitive function. A better understanding of the associations between cognitive and cardiovascular dysfunctions is necessary to prevent the manifestation of diseases. Therefore, this study investigated phasic heart rate variability using rest, anticipatory, stress, and recovery periods and the association with high and low cognitive performance in a generally healthy population setting. Methods: 114 healthy individuals (40 males, 74 females) aged 20 to 70 participated in the cross-sectional study. The heart rate variability based on standard deviation of NN intervals (SDNN), and the root means square of successive differences (RMSSD), low frequency (LF), high frequency (HF) and LF/HF ratio and its association with high and low cognitive performance measured by the California Verbal Learning Task II were examined. Results: The results of this study indicate that the paradigm was successful in producing stress and showed a significant association between phasic heart rate variability (SDNN) and verbal episodic memory performance, irrespective of age and sex. Discussion: The results of this study suggest that a reduced heart rate variability is associated with reduced cognitive function regardless of age and sex and seem to be an early indicator of sympathovagal disbalance. Conclusion: This leads to the conclusion that differences between high and low cognitive performance might show differences in heart rate variability at an early stage, where no diseases are yet manifest.

Keywords heart rate variability; standard deviation of NN; sympathetic nervous system; parasympathetic nervous system; cognitive performance; memory; episodic verbal learning; California Verbal Learning Task II;

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What Moves People Living With Dementia? Exploring Barriers and Motivators for Physical Activity Perceived by People Living With Dementia in Care Homes

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Abstract There is a lack of intervention promoting physical activity targeted toward people living with dementia because their input has not been prioritized in the development of exercise programs. The aim of this study is to investigate motivators and barriers concerning physical activity in people living with dementia in care homes and to give recommendations for intervention development. Qualitative semi-structured interviews were conducted; transcripts were analyzed using qualitative content analysis. Following a tailored procedural model, inductive and deductive category development was applied. The value of Cohen's $\kappa = .94$ indicates the high intercoder reliability of the category system developed. Ten interviewees reported 24 different barriers and 12 motivators concerning physical activity in the context of the social-ecological model. The strong impact of intrapersonal factors and the living environment became apparent. Points of reference for how people living with dementia can overcome barriers and activate their motivators to achieve more physical activity are provided.

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How Do Lay People Identify Knee Swelling and What Would They Do About It: Survey Results in the Context of an Event on the Topic of Knee Osteoarthritis

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Abstract Objective: Besides pain, joint stiffness and muscle weakness, swelling is a common symptom of knee osteoarthritis. According to the literature, there are clinical tests such as the bulge sign or circumference measurement as part of the clinical examination to identify knee swelling. Pharmacological interventions, knee bandages, temporary sports bans and physical interventions are effective decongestant measures. In the conservative treatment of knee osteoarthritis, the promotion of self-management principles is crucial. However, the general population´s level of knowledge regarding the identification and treatment of knee swelling is unknown. To get directly in contact with lay people, a crowdsourcing approach is appropriate. Consequentially, the aim of our crowdsourcing-based study is to get an inside of how lay people identify knee swelling and which measures they would adopt. Methods: Under the assumption that crowdsourcing-based methods can further develop conservative osteoarthritis treatment- in our case especially in the context of knee swelling-, a cross-sectional survey on knee swelling in osteoarthritis was carried out as part of a lecture including a workshop organised in a rural Austrian community. The 26 participants answered two open questions about characteristics and decongestant measures of knee swelling. A content structuring qualitative content analysis with a combined deductive and inductive approach followed by a frequency analysis was used to evaluate the data. Results: The participants determine knee swelling primarily based on at least one of the cardinal symptoms of inflammation (f=26), as well as an undefined optical increase in circumference (f=9). Physical (f=24), pharmacological (f=14) and complementary interventions (f=16) with partly unclear evidence are mentioned as decongestant measures. Conclusion: Identifying knee swelling and applying appropriate decongestant measures challenges lay people. Due to the deficits found, the chosen research method considering a continuous participation of lay people has the potential to further develop and possibly improve outcomes of existing conservative osteoarthritis care programs.

Keywords Swelling, Osteoarthritis, Treatment, Self-management, Physical examination, Diagnosis, Crowdsourcing

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Geometric correction and stabilization of images collected by UASs in river monitoring

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Abstract While the field conditions and the choice of an image velocimetry technique usually have the largest impact on the accuracy of unmanned aerial systems (UAS) velocimetry, significant errors can be associated with the UAS hardware. Three such sources of errors are usually considered and accounted for: (1) errors related to the imperfections of the camera optics and sensor, (2) errors introduced by the UAS motion relative to the water, and (3) projection errors related to the positioning of the camera relative to the region-of-interest. The first source produces geometric distortions whose intensities depend on the type of the camera and quality of its manufacturing. The second source of errors is related to the UAS platform itself—even in favorable weather conditions the platform and thus the camera as well usually exhibit unwanted motion as a result of its (electro)mechanics, which reduces the overall velocimetry accuracy. Once the camera distortions have been minimized and the images are stabilized, the mapping of the information from images to the real-world coordinates can begin. A specific procedure—orthorectification—aims to ensure that the image coordinate system is aligned with the water surface. This technique emulates nadir positioning of the camera (even in cases when camera is not in perfect nadir) and thus stabilizes the ratio between image and real-world distances. The accuracy of velocity estimation greatly benefits from the reduction of the geometric distortion, orthorectification, and the reduction of residual motion of the camera, which are commonly performed in the preprocessing stage of UAS velocimetry. This chapter explains various sources of errors in the acquired optical data along with the effects they can have on the final velocimetry results, and the corresponding methods for their reduction/removal. Finally, a list of tips and good practices is provided which can facilitate the reduction of UAS velocimetry errors.

Keywords Geometric correction, image stabilization, river monitoring

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Geospatial technologies for an automated holistic risk assessment of UAS operations

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Abstract The rising number of UAS operations in the European airspace poses a safety issue. The key problem is to ensure safe drone traffic management and their integration into the existing air traffic environment. Thus, risk assessment becomes an integral part of every UAS operation and its automation is of great importance when dealing with growing numbers of flights. There exist many attempts to support such risk assessment, but an optimal solution is yet to be found. This paper presents a prototype of a web application, which automates strategic risk assessment of open and specific UAS operations in Austria with the use of open government geodata. Risk assessment results are visualized on a map, showing spatial distribution of classified risks in the operational area. This prototype is the first attempt to combine the functions of a "drone map" representing relevant geodata and a questionnaire usually used to support specific operation risk assessment. There is a potential to turn it into a tool which is used to create a comprehensive pre-flight safety portfolio or to support the automatic risk assessment performed by a UTM before a UAS operation is checked in. Simplifying the creation of safety portfolios and automating UAS operation risk assessment are important factors in promoting a wider and safer use of UAS.

Keywords UAS, risk assessment, UTM, SORA, U-Space

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Rapid Detection of the Change in Surface Flow Patterns Near Fish Passages at Hydropower Dams With the Use of UAS Based Videos Under Controlled Discharge Conditions

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Abstract The importance of keeping river environments healthy drives the scientific community towards the improvement of sustainable and validated environmental monitoring approaches. Accurate data on the state of the ecosystems provided rapidly are key in order to correctly assess, which interventions and management decisions are suitable, and which must be avoided. This paper analyses a rapid non-intrusive approach to change detection in surface flow patterns near fish passages at hydropower dams with the goal to improve the understanding of factors influencing fish passage discoverability. This, in turn, is of great relevance to the sustainability of migrating riverine fish populations from both ecological and economical perspectives. The present study includes three unique experiments performed at a large-scale hydropower dam site with an integrated fish passage under controlled discharge conditions. The analysis is performed with the use of the freely available KLT-IV software. The use of an Unmanned Aerial System (UAS) as a camera carrier platform provides the key flexibility in terms of any study site selection. The use of KLT-IV speeds up and simplifies flow pattern analysis, especially when compared to labour-intensive modelling relying on point-based ground truth data. In this paper, we demonstrate that the selected approach can be effectively applied to identify changes in surface flow patterns both in terms of flow velocity magnitudes and in terms of flow directions. It shows that the identification of actual flow patterns near the fish passage entrance provides more information on the potential discoverability of the fish passage than traditionally measured bulk discharge values alone.

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Environmental DNA-Based Methods in Biodiversity Monitoring of Protected Areas: Application Range, Limitations, and Needs

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Abstract Novel methods for species detection based on collection of environmental DNA (eDNA) are not only important in biodiversity assessment in a scientific context, but are also increasingly being applied in conservation practice. The eDNA-based biodiversity detection methods have significant potential for regular use in biodiversity status assessments and conservation actions in protected areas (PAs) and other effective area-based conservation measures (OECMs) worldwide. Species detection based on DNA from environmental samples, such as water, sediment, soil, air, or organic material, has a broad application scope with precise, comprehensive, and rapid species identification. Here, we provide an overview of the application range of eDNA-based methods for biodiversity monitoring in PAs, evaluate environmental assessments in which this technology has already been implemented for nature conservation, and examine the challenges that can hamper further application in real world practice. Based on the outcomes of two projects, practical experience, and current scientific literature focusing on their application, we conclude that eDNA-based species detection methods provide promising novel approaches that have strong potential as supplement methods, or in some cases even as substitutes for the conventional monitoring methods used for PAs. This advancement is expected to affect decision-making in biodiversity conservation efforts in PAs and OECMs.

Keywords eDNA; eDNA metabarcoding; biodiversity assessment; nature conservation; protected area management

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Transnational water resource management in the Karawanken/Karavanke UNESCO Global Geopark

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Abstract The management of cross-border natural resources has been the focus of research in different disciplines. Nonetheless, beyond theoretical insights, empirical evidence of successful cross-border management or governance of natural resources is still limited, even in the European Union (EU), where a range of instruments are provided to foster cross-border cooperation between its Member States. This is where our paper departs, providing evidence from an example of cross-border cooperation between two Member States of the EU, Austria, and Slovenia, adding to the analytical framework to identify the drivers of successful cross-border cooperation. METHODOLOGY:Drawing from the example of the European Grouping of Territorial Cooperation (EGTC) Geopark Karawanken we evaluate the success factors and limits for transboundary cooperation encompassing different forms of cooperation. Furthermore, based on empirical evidence of workshops with local, regional, and national stakeholders, we investigate the potential of the EGTC organizational framework to provide for the successful cross-border management of water resources within the Geopark area. FINDINGS: Our analysis of project bundles, joint ventures/consortia, and EGTCs as possible forms of transboundary cooperation indicates that EGTCs have various advantages over looser forms of cooperation. Higher operational costs for the organization are contrasted by enhanced governance of transboundary activities, in accordance with legal frameworks and representation on both sides of the border. This increases acceptance and facilitates decision-making. Furthermore, it increases the potential for receiving funds in accordance with planned activities and regional requirements, while decreasing the individual financial risk for partners. The genesis of the Karawanken/Karavanke UNESCO Global Geopark (Geopark Karawanken) indicates that looser forms of organization, for instance, project bundles, enable stakeholders to get to know each other without great institutional effort. In the course of increasing integration, the organizational form can be more complex. The experience in developing transboundary, water management instruments shows that even in a more sophisticated form of cooperation like an EGTC, there are remaining obstacles in managing transboundary natural resources.

Obstacles result from e.g., national laws and regulations, data standards, monitoring techniques, and soft factors such as language barriers. IMPLICATIONS: The example of the Geopark Karawanken shows that cross-border public authorities can be significantly supported with the introduction of an EGTC. Still, an EGTC tends to exclude private companies or societal actors because they cannot be active members of the Board. Exploring further options for closer integration of the private sector in Public-Private-Partnership (PPP) models may be useful to maintain the opportunity to include much-needed private skills and resources. The experience of the Geopark Karawanken suggests that EGTCs can and will be a significant form of organization in Europe for a number of activities, for example, in the field of cross-border resources, cross-border protected areas, or cross-border predicate regions. This will support the achievement of the goals of EU programs to face the climate and biodiversity crises through transnational agreements, e.g., the Green Deal or the Biodiversity Strategy. ORIGINALITY AND VALUE: This article provides a concise overview on transnational water resource management in the European Union in the context of an EGTC, and raises points for practitioners about potential challenges for the successful introduction of an EGTC. While the analysis of common experiences of various EGTCs could lead to the development of a European standard and guideline for the successful foundation of this territorial cohesion tool, this paper provides the first step, paving the road for future research.

Keywords European Grouping of Territorial Cooperation, Karawanken/Karavanke UNESCO Global Geopark, transnational cooperation, European Union, water resources management

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Chapter 3

Student Contributions

A Delphi-based Analysis to Identify Barriers and Solutions in Adoption of Electric Vehicles Sharing System

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Abstract. *Electric vehicles and shared mobility services are regarded as the means of reaching a transition to sustainable low-carbon emission transportation systems This study aimed to identify and assess the barriers in adoption of electric vehicle sharing system (EVSS) and the potential policy measures that can aid in improving the demand of EVSS. We employed a Delphi-method based expert opinion survey in order to characterise the selected barriers and policy measures with respect to EVSS demand using three parameters – expected probability of occurrence of each barrier while selecting EVSS as transport mode, impact of barrier in choice and that of policy measure in overcoming barrier, and desirability in framing policies. Our results depict barriers related to technological, policy & governance, and infrastructure related aspects are most impactful in hindering EVSS demand. Further, the potential policy measures were identified which can help city authorities to improve the EVSS mode-share.*

Keywords. Shared mobility, electric mobility, consumer adoption, sustainable transportation, Delphi

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1 Introduction

Large metropolitan cities around the world have been facing an exacerbating growth of trips through fossil fuel-powered vehicles which is often cause for the urban traffic congestion, climate change, and depletion of the natural resources [1]. This has led the global economies to think towards restructuring the urban mobility systems and regulations. Electric vehicles and shared mobility services are regarded as the means of reaching a transition to sustainable low-carbon emission transportation systems [2].

The challenges involved in this process are not only to look for innovative vehicle design and service models, but to also understand the demand and adaptation of such services, which is imperative to ease effective market penetration. There are still only a small number of trips currently made using the electric vehicle sharing services (EVSS) [3]. The city authorities currently have little knowledge on how to efficiently systematise the EVSS system. This study tries to find the potential barriers affecting the demand and adaptation of EVSS and to recognize the possible policy measures to overcome the barriers. Specifically, this paper presents the early results achieved using the Delphi-based experts' opinion survey. We adopted a modified Delphi-method in which selected experts were asked to assess the barriers and policy measures with respect to the expected probability of occurrence in real case scenarios, impact, and desirability at strategic level of planning, and experts' confidence level in this assessment. This is particularly valuable in policy making and analysis since it is possible to understand the variance in the opinions of different experts.

2 Data Collection and Analysis

The Delphi method has proven to be an efficient survey method when there is a limited amount of data is available [4]. It seeks to achieve consensus and stable results on an issue by the structured group of experts. In this study, we have identified thirty-seven sub-barriers based on an extensive literature review, which are then categorized into five major category barriers namely, behavioural, policy & governance, infrastructural, technological, and external barriers based on their characteristics. Subsequently, twenty-three possible solutions and policy measures were identified which can aid in overcoming the barriers in the adaptation of EVSS. A panel of experts identified for this study were selected from – academic institutions, city authorities, and industry representative bodies. We approached 22 such experts who have minimum 5 years of associated experience (looking to the newness of the topic) associated with the subject matter while 10 of them agreed (response rate of 45%) and responded to our questions. In the questionnaire, experts were asked to assess each sub-barrier regarding their expected probability (EP) of occurrence which depicts whether a particular barrier will arise against the users when they consider travelling with EVSS (scaled on 0-100%), impact (I) of sub-barrier on user's choice and that of solution to aid the adaptation of EVSS (5-point Likert scale), desirability (D) in strategic level of planning (5-point Likert scale). For solutions, similar questions were asked except EP. Additionally, experts were asked to rate their confidence level in assessing sub-barriers and potential solutions. A similar Delphi-based approach is frequently adopted in studies related to market behaviour and risk

analysis [5], however the application of the same in context of travel behaviour analysis has not been explored before.

Table 1 and Table 2 respectively demonstrate the list of sub-barriers and solution adopted and their quantitative evaluations. We show the mean values of the assessments for estimated EP and geometric weighted average for I and D since it showcases more logical aggregated value than mean [6]. Please note that in Likert's scale, a set of rating {1,2,3,4,5} corresponds to the linguistic set {Not-so, Less-so, Neutral, More-so, Most-so}.

Table 1. Quantitative Evaluation of the EVSS Sub-barriers

Barriers	Code	EP	I	D
Behavioural Barriers	**B1**			
Poor tech-savvy level – little awareness about the EVSS technology	B11	70.56	3.58	4.14
Negative perception towards the EVSS	B12	62.22	2.90	2.91
Habit of using private modes – stigma to not giving up the private-vehicle ownership or use (Due to personal or household circumstances)	B13	67.78	3.67	3.73
Social stigma – thinking about others' views, showing-off wealthy status, etc.	B14	38.89	2.60	2.76
Lack of sustainability awareness	B15	36.11	2.05	3.12
Performance and Range anxiety among users	B16	68.89	3.96	4.46
Higher perceived cost to the users – generally compared with public transport	B17	71.67	3.67	4.19
Lack of knowledge of perceived benefits among users	B18	54.44	3.09	3.27
Policy & Governance Barriers	**B2**			
Lack of future visions, priorities, and coherent & nationwide policy – limited growth prospects	B21	66.67	3.70	3.70
Lack of marketing strategies to promote the use	B22	66.67	3.52	3.85
Poor interventions with the local authorities and regulations	B23	67.78	3.70	3.79
Lack of required capital investments for developments and operations	B24	73.33	3.91	3.77
Difficulties in incentivizing users	B25	64.44	3.34	3.24
Poor team and government involvements in implementation	B26	66.67	3.15	3.13
Time based tariffs limit the use – multiple stops enroute incur higher costs	B27	46.67	2.53	2.70
Infrastructural Barriers	**B3**			
Unsuitable city infrastructure at current levels	B31	86.67	4.39	4.28
Lower utilization rate – due to charging layover – limits the supply	B32	73.89	3.91	3.91
Reliability of vehicles as well as operator support	B33	66.11	3.45	3.74
Uncertain availability – availability in real time when needed	B34	73.33	3.96	4.39
Access to and availability of EVSS at origin	B35	73.33	3.84	3.93
Access to and availability of EVSS at destination	B36	71.11	3.84	3.93
Unavailability of required space – stations, charging points, separate lanes (where needed)	B37	68.89	3.65	3.77
Poor/Unsuitable physical conditions of roads and Road network (including terrain) – safety	B38	62.78	3.13	3.47
Poor intersection management – safety	B39	52.78	2.53	2.84
More number of cross streets – safety and travel time	B310	41.11	2.15	2.01
Higher land-use density	B311	36.11	1.74	1.66

Barriers	**Code**	**EP**	**I**	**D**
Highly congested road network	B312	52.22	2.81	2.46
Technological Barriers	**B4**			
Lack of know-how for planning EVSS	B41	67.78	3.67	3.72
Inefficient charging infrastructure (when vehicles are not in working order) – limits the supply	B42	66.67	3.31	3.51
Poor integration with public transport systems – accessibility and fare system	B43	73.33	3.82	3.91
Unavailability of real-time vehicle data – evaluation and improvement of system	B44	60.00	2.33	2.97
Easiness of using service – IT based services	B45	75.00	3.84	3.93
External Barriers	**B5**			
Less suitable according to the individuals' demographics	B51	59.44	3.47	3.07
No fulfilments of trip requirements – higher trip length, greater travel time, multiple destinations enroute	B52	74.44	3.44	3.47
Unfavourable weather conditions	B53	71.11	3.17	3.36
Increasing levels of pollution	B54	50.00	2.46	2.39
Concerns about cleanliness of sharing vehicles	B55	44.44	2.47	2.36

Table 2. Quantitative Evaluation of the EVSS Solutions

Solutions/Policy Measures	Code	I	D
Provisions for congestion pricing / road pricing strategies for private vehicles	P1	3.67	3.69
Establishment of parking restriction policies	P2	3.88	3.98
Creating awareness campaigns for sustainable transport amongst the citizens	P3	2.94	3.76
Making people aware of the benefits of using electric shared-vehicles – at individual and societal levels	P4	3.01	3.86
Perform initial assessments and benchmarks from the foreign (other successful) examples	P5	3.26	3.45
Prior assessment for the optimal locations for EVSS stations – access/egress to O&D, PT locations, mobility needs & demand	P6	4.39	4.61
Provision for High taxations for private vehicle ownership – include environment and CO2, NOx emission taxes	P7	3.67	3.79
Formulating transport pricing on the basis of the 'polluter-pays' and 'user pays' principles – to ensure fair treatment of PV users, shared users and PT users	P8	3.27	3.21
Improvements in charging infrastructure and its availability – to decrease the layover (The idle time between trips when it is required to charge the vehicles)	P9	3.61	3.91
Established policies towards transit-oriented development and 15-minutes city	P10	3.19	3.60
Development of financial strategies to implement qualitative network for micro-mobility routes and to eliminate missing links	P11	3.38	3.17
Establishment of PPP mechanisms for infrastructural works	P12	2.71	2.79
Provisions to obtain real time data of service use to ensure quality and reliability	P13	3.58	3.72
Develop tools & techniques to evaluate the services at frequent time intervals	P14	3.00	3.13
Improving digital accessibility to EVSS services	P15	3.65	3.68
Provisions for supportive local authorities and policies for effective operations	P16	3.70	3.62

Solutions/Policy Measures	Code	I	D
Consideration of social equity while planning new infrastructure – to ensure the transport needs of communities irrespective of their social and economic characteristics	P17	3.05	3.15
Ensure tuning between the federal policies and local & regional level policies	P18	2.92	3.07
Decent coordination between local authorities and operators to better understand the market conditions and requirements and efficient operations	P19	3.61	3.65
Provisions should be in favour of the unified planning and control systems at authority level	P20	2.98	3.05
Provision of single fare policy	P21	3.65	3.91
Increased accessibility to low/medium income households	P22	3.33	3.47
Increased accessibility to the areas with mobility issues (not well served by PT)	P23	3.25	3.38

3 Results and Discussion

The quantitative estimations in the Tables 1 and 2 express the perceptions of different experts towards various sub-barriers and policy measures. On the basis of these data, planners and policy makers can develop strategies and measurements to aid the adaptation of EVSS. It is to be noted that all the parameters i.e., EP, D, and I should not be considered separately, rather it is imperative to assess them conjointly for an appropriate derivation of strategies. For example, a parameter with high probability (i.e., higher EP) with low impact value would make it less desirable to be considered. On the other hand, a parameter with similar EP and high impact value would be required due attention and thorough examination.

Table 1 reveals that technological barriers have the highest probability of occurrence overall (mean value) in users' travel decisions regarding the choice of EVSS followed by the policy & governance barriers and infrastructural barriers which have nearly similar EP values. Behavioural barriers and external barriers have been rated lowest by the experts in their overall judgements. However, looking at the individual level, it is seen that eight infrastructure sub-barriers have EP values greater than 60% with the highest EP value of 87% for B31. The sub-barrier B45 is rated as second most influencing barrier in EVSS demand. Along with the higher EP values, it can be noted that the associated impact values are also higher (i.e., above 3), which states the relevance of those sub-barriers while conducting a detailed examination for the policy framework. It is noteworthy that, though the EP values are comparatively lower for the behavioural barriers, the impact values are relatively higher. It means that the effect of behavioural barriers can act as a decider when users consider riding with shared e-mobility options, which can also be supported by past studies [7]. In terms of desirability factor, our results show that policy & governance barriers are most desirable to be considered for strategies formulation which can corroborate a systematic market penetration and operations of EVSS. The mean of desirability values of technological barriers seems to closely be following the policy & governance barriers.

Our study also considers the potential policy measures (Table 2) that city authorities can adopt to overcome the above discussed barriers. It can be noticed that the measure P6 has the highest impact and desirability values, both being above 4, showing the importance of selecting optimum locations of EVSS stations which ultimately affects the access/egress characteristics of

the EVSS. Better the access/egress characteristics of EVSS, higher the usage of the services [8], [9]. Apart from this, P2, P4, P9 and P21 have been rated as more impactful and desirable solutions which can help in increasing EVSS demand by means of – restricting private car usage, raising awareness, availability of shared vehicles when required, and single fare policy to avoid series of payments and inconvenience respectively.

Overall, we focused our research on the contribution of Delphi-method based analysis to understand how to improve the market share of the EVSS through the expert opinion survey. We identify the highly impactful barriers hindering the EVSS adoption and the possible solution to overcome them, which can be further examined in-detail to help achieving the target mode-share of EVSS.

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Application of Electronic Waste Cable Sheathing as Secondary Use Sound Insulation

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Abstract. *Cable is the main component of electronic equipment which leads to increasing amounts of hollow sheaths after the removal of cores: metals with insulation layers. The continuously growing dependence on technology makes it more important than ever to reuse electronic waste that outlived its primary function, conserving the non-renewable resources and promoting secondary use. Tests done on different heights of 5 cm, 7 cm, 10 cm round structures (d = 30 mm) filled with different homogenous sheathings. The sound absorption coefficient measurements done with Kundt Tube were analysed according to length, hardness and number of strands: samples included single-stranded (soft (0.8 mm)); single-stranded (hard (0.6 mm)), double-stranded (hard (0.6 mm)); triple-stranded (soft (0.9 x 0.4 mm) sheaths. The results showed that the single stranded hard sheathing (0.6 mm) from 1600 Hz to 5000 Hz had the highest absorption values (αs = 0.31 - 0.69), corresponding to sound absorption class C/D.*

Keywords. Cable sheathing, sound absorption coefficient, Kundt Tube, hollow covers

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1 Background and Motivation

Currently, technology is changing and improving drastically to adapt to the constant shift in the public and industry needs, but most do not know - what happens and what is done when electronic appliances, equipment go obsolete or in the end simply break down. Usually they become growing waste piles in dumps that are difficult to recycle or in worst case scenario hard to get rid of without doing detrimental damage to the environment/ human health. And since most e-waste components are made from non-renewable natural resources including the main focus of this contribution (plastic cable sheaths), it makes it more important than ever to promote secondary use of electronic equipment that has outlived their primary function, conserving valuable resources and taking care of the electronic waste pollution. This two-year project funded by ATHENA could be a first step in spreading green ideas on how to work with the complicated e-waste leftover parts problem.

2 Introduction

The continuously growing dependence on digital, electronic technology who's rapid expansion comes with not only incredible innovations but also exponentially growing piles of already useless electronic equipment/components that couldn't compete anymore with the yearly big news. This constant cycle of growth leaves humanity with uncontrollable e-waste streams that never stop growing as the usage of electronics keeps spreading into new frontiers. And with that comes many unique waste types that make up the wide array of electronic devices: from cables to microchips. At this case, cable sheathing, the main connecting part of electronic equipment, was chosen since there are increasing amounts of hollow sheaths after the removal of cores in recycling waste centres: metals with insulation layers. These sheaths are tested to check whether it is possible to reuse them to deal with noise pollution.

2.1 The Work Process

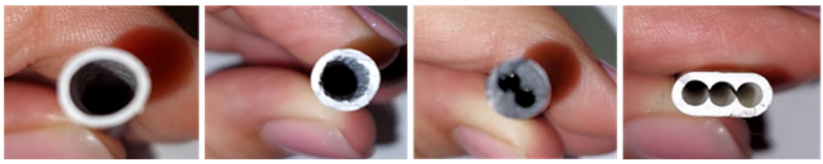
At the beginning of the research, the main tasks and requirements to fulfil the objective were discussed with mentor. Then samples were taken from Vilnius "EMP Recycling" facility where an educational tour around the different e-waste management and sorting facilities in the company was done before collection. Then preparations were made for the prototype structures: separation of metal and insulating layers from cable sheathing and creation of 3D printed round tubes for insertion into the Kundt Tube. With the use of the "Acousti studio" software, sound absorption measurements were carried out on three different heights (5 cm, 7 cm, 10 cm) with 4 different homogenous sheathing combinations. The end results were displayed graphically in EXCEL after measurements have been examined with MATLAB sound absorption coefficient code.

3 Methodology

The objects of research are round structures made using e-waste hollow sheathing. As the cables were only tested for their ability to provide sound insulation by observing their length and hardness and the number of cores, the samples selected were single-stranded (soft sheath (0.8 mm); hard sheath (0.6 mm)), double-stranded (0.6 mm) and triple-stranded (0.9 x 0.4 mm) cables (Fig. 1).

Figure 1. Samples selected for analysis

The waste cables shown in Figure 1 have their cores - the metals (copper) with the insulating sheaths - removed by cutting across them. The prepared hollow cable coating is then used in the test (Fig. 2).



a b c d

Figure 2. The cross-cut hollow cables used in the study: a) single-stranded (hard (0.6 mm)); b) single-stranded (soft (0.8 mm)); c) double-stranded (hard (0.6 mm)); d) triple-stranded (soft (0.9 x 0.4 mm)

The test is carried out with a Kundt tube in which we insert 3D printed tubes (d = 30 mm) of different heights: 3 cm, 7 cm, 10 cm (Fig. 3).

Figure 3. 3D printed tubes in heights of 3 cm, 7 cm, 10 cm

The test measures the sound absorption coefficient of four sample combinations at three heights from 160 Hz to 5000 Hz range using the “Acousti studio” software (Fig. 4).

Figure 4. Round structures with cable sheathing filling

The measurements are examined with the help of "MATLAB" code and in the end represented in line graphs by height cm.

4 Measurements

The tests are repeated 3 times to measure the sound absorption coefficient at different heights using only one type of cable sheathing. The average of the values of the 4 samples is then calculated and plotted on a dot plot (Fig. 5, 6, 7).

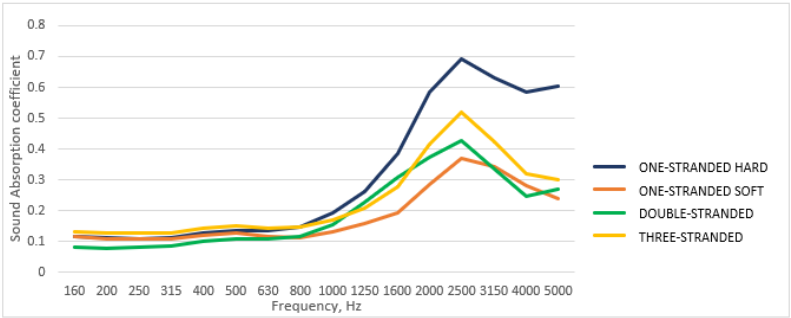


Figure 5. Sound absorption coefficient values of 3 cm height round structures

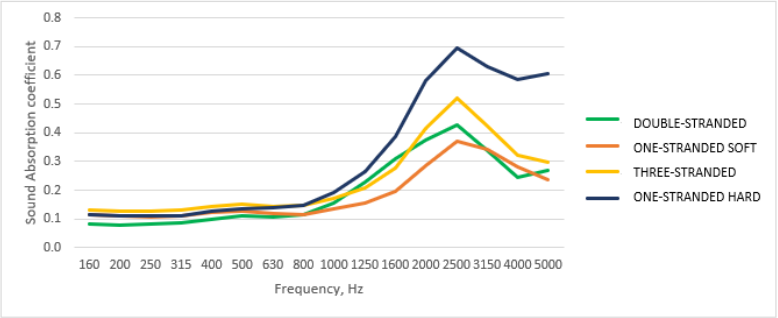


Figure 6. Sound absorption coefficient values of 7 cm height round structures

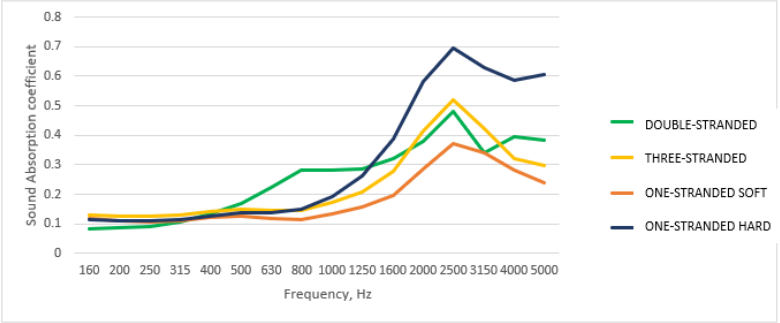


Figure 7. Sound absorption coefficient values of 10 cm height round structures

4.1 Results

The graphs show that the plastic cable sheathing does not have good absorption at lower frequencies (only from 1600 Hz do most structures reach a value of $\alpha s = 0.3$), but there was an exception to this – double-stranded in a 10 cm structure had $\alpha s = 0.29$ at 800 - 1250 Hz, which proves that, with the appropriate cable material, it is possible for the cable coating to be utilized at even lower frequencies.

It was also found that the hardness/stiffness of the sheathing had a significant effect on sound absorption capabilities - the harder/stiffer the coating, the better the sound absorption: **one-stranded hard > three-stranded semi hard > double-stranded flexible > one-stranded very soft**. There was also not a huge difference between the values based on the length of the structure, there were only small deviations (around 0.02 to 0.04) between the measurements of the different heights, but it cannot yet be fully established that length does not affect the sound absorption capacity of the structure (exception: double-stranded in a 10 cm structure). And the main advantage of the cable coatings was their ability to absorb higher frequency levels, as the strongest sound absorption in all cables was recorded on average between 2000 and 5000 Hz.

However, in order to assess the sound insulation performance of the constructed structures, it is important to refer to performance standard ISO 11654:1997 [1] for all sound-absorbing materials, which classifies such materials into classes A to E according to their ability to absorb sound (Table 1).

Table 1. Sound absorption class of the material according to ISO 11654:1997

A	B	C	D	E	NOT CLASSIFIED
SOUND ABSORPTION COEFICIENT VALUE (αs)					
1.00 – 0.90	0.85 – 0.80	0.75 – 0.60	0.55 – 0.30	0.25 – 0.15	0.10 - 0

Based on the classification given in the standard, it can be stated that at high frequencies from 2 kHz, all types of coating structures (3 cm, 7 cm, 10 cm) are classified as:

- One-stranded hard $\alpha s = 0.38 – 0.69$ (absorption class C/D)
- Three-stranded $\alpha s = 0.30 – 0.52$ (absorption class D)
- Two-stranded $\alpha s = 0.31 – 0.43$ (absorption class D)
- One-stranded soft $\alpha s = 0.28 – 0.37$ (absorption class D)

The results showed that for all designs, the one-stranded hard web cable sheathing from 1600 Hz to 5000 Hz had the highest absorption values ($\alpha s = 0.31$ - 0.69), which corresponds to sound absorption class C/D.

5 Future Plans

Finally, once the metals and insulating layers have been removed, the cable covering has the potential to provide effective sound insulation at higher frequency levels. And by selecting appropriate lengths and hardness's, it is possible to create a cheap and effective noise reduction that will reuse unwanted cable coatings and lessening its streams. While seeing good results related to the cables, a question has been raised: Can there be a possibility to better the absorption mechanism by mixing different cable sheathing materials creating a bigger obstacle for the sound waves/vibrations to go through? With this question in mind first result analysis has been done to start the development of new structures with heterogenous fillings for future testing.

Acknowledgements

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Automatic Concept Explanation for Deaf Users

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Abstract. *In the learning process, concept explanation plays a crucial role, especially for languages with limited vocabulary like sign languages such as the Portuguese Sign Language (LGP). Due to the small lexicon of LGP, when compared to Portuguese, deaf users face difficulties when encountering words like "Nanotechnology" that have no corresponding sign in their mother language. Available tools, like online dictionaries in Portuguese, are not ideal because they explain the concepts in Portuguese, a distinct language from LGP. The work described in this paper solves this issue using machine learning, summarization, and automatic translation techniques to generate explanations of words or expressions that do not exist in the lexicon of LGP. The solution relies on web scrapping and summarization to gather explanations for a given concept in Portuguese, that are then translated to LGP and produced by a 3D avatar. This approach aims to overcome the limitations of reduced vocabulary, mainly in technical study fields.*

Keywords. Sign language, text summarization, automatic concept explanation, online technical glossary, low-resource languages

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1 Introduction

Concept explanation plays a crucial role in the learning process, especially for languages with small lexicons like sign languages. In Portugal, the official language of the deaf community is Portuguese Sign Language (LGP), which has a limited lexicon that cannot represent all words in Portuguese. The lexicon of LGP is com- posed by multiple signs where each one represents a word or an expression in Portuguese. However, the opposite is not true. There are numerous words in Portuguese that don't have a sign that translates them. Thus, LGP users have to rely on tools made for Portuguese speakers to understand certain concepts. To address this problem, a project was developed that utilizes machine learning, summarization, and automatic translation to generate explanations of words or expressions in LGP that are not in its lexicon.

The project comprises three main components: an API for generating explanations, a formula for calculating LGP readability scores, and a web app that displays the generated explanation in plain text and in LGP translation with the help of an avatar. The project is expected to generate accurate LGP explanations and readability scores. The paper is divided into four more sections that provide deeper explanations of the partial solutions available, the developed solution, the project's contributions, and the conclusions.

2 Related work

As previously stated, there is currently a lack of a comprehensive solution capable of translating concepts from Portuguese to LGP. However, there are some partial solutions available that attempt to address this issue. In this section, the researchers will describe these partial solutions, as well as the Portuguese readability metrics that were analyzed in order to create the LGP readability metric.

2.1 Online Dictionaries

One of the most known online dictionaries with LGP content is the Spread the Sign [1]. In this dictionary a user can search for a word and if there is a previously recorded video translation for that word, in the site database, it will be displayed for the user. The search results only display the video of a person performing the corresponding sign, and the possibility to look at the same word in another sign language.

Another online dictionary that provides content for the LGP users is the Infopedia [2]. Although this is a Portuguese dictionary, it also contains a section for searching words in LGP. Here the search results, not only provide a video translation of the word, but also an explanation in Portuguese in how to reproduce the sign shown in the video.

Online dictionaries as a solution are limited by the database of prerecorded videos, and the LGP lexicon. The latter is a problem because they focus on a direct translation, word to sign, instead of trying to translate the meaning of the word.

2.2 Sign Language Interpreter

Regarding the sign language interpreters in Portugal there is CTILG [3], a company that provides professional LGP translation services in workshops, classes, congresses, events and more. This company is responsible for the live translation of some morning TV shows.

A more affordable solution for a regular LGP user is the Serviin [4] which is a service that provides an interpreter to work as a middleman between a deaf person and a targeted service/company. This solution is available as a mobile app, with a very low cost for the deaf user, or through a web app that is free.

This solution is limited by the interpreter's own knowledge and their cost. Also, by utilizing this solution the LGP user is sacrificing some of his autonomy.

2.3 Portuguese Readability Metrics

Readability metrics are used to calculate a score that relates to the level of education a reader will need to fully understand the context of a given text. There are some widely known and used metrics for the English language, such as Flesh Reading Ease, New Dale-Chall, SMOG, Flesh-Kincaid, Gunning Fog and so on.

In 2019, Antunes and Lopes published an article [5] that adapted the values of the metrics used to calculate the readability of text in English so it could be applied to Portuguese. The adapted readability metrics are presented in table 1.

Table 1. Adjusted Portuguese formulas.

	Formula
SMOG	$16.830 \times \sqrt{CW} \times 30 \div SE - 23.809$
Flesch-Kincaid	$0.883 \times \mathrm{WO} \div \mathrm{SE} + 17.347 \times \mathrm{SY} \div \mathrm{WO} - 41.239$
ARI	$6.286 \times CH \div WO + 0.927 \times WO \div SE - 36.551$
Coleman Liau	$5.730 \times CH \div WO - 171.365 \times SE \div WO - 6.662$
Gunning Fog	$0.760 \times WO \div SE + 58.600 \times CW \div WO - 12.166$

CH - characters, CW - complex words, SY - syllables, WO - words, SE – sentences.

3 Automatic Concept Explanation

In order to solve the previously mentioned problems Automatic Concept Explanation was created. The main functionality of this solution is to allow the LGP users to search for a word or expression in Portuguese and display its explanation as well as the respective LGP translation.

All the components can be seen in Figure 1.

A user interacts with the web application that was developed in React, an open-source JavaScript framework for building user interfaces. Here the user can search of the desired concept as well as changing the page language. This is also the place where the generated explanation is shown in plain text or in LGP by the avatar. After each explanation, it is also presented their LGP Readability Score, which is presented more in depth in the following subsection as well as feedback options. If one of the presented explanations is not acceptable, it is possible for the user to request a new one.

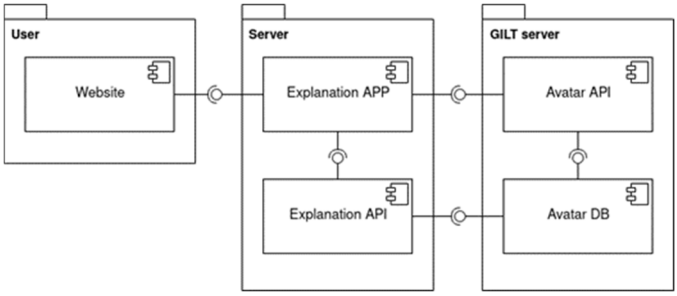

Figure 1. Component Diagram.

When a concept is searched for, the input is sent to an API that was developed in Flask, a lightweight open-source Python web framework. This API will generate a list of explanations using Text Mining, Information Scraping and Information Retrieval techniques. The list is sorted based on each explanation LGP Readability Score.
The avatar and its database are projects that were previously developed by GILT and that are used to enhance this project.

3.1 LGP Readability Score

The API generates multiple explanations, especially for words with different meanings depending on the context. These explanations must be sorted to provide the best options to the user. For regular languages, readability score metrics can be used to classify and sort each expression based on how easily readers can comprehend them. Although there are several readability formulas for Portuguese (shown in Table 1), there is no such formula for LGP. However, after analyzing LGP signs, the common variables in every written text were identified, with the goal of creating a new readability calculation formula:

- Hand configurations (CF) - The hand shape in a particular moment.
- Moments (MT) - The position of the hand in relation to the body.
- Hands (HS) - Both hands or only the dominant hand.
- Facial expressions (FE) - Motion or position of the face muscles.

Using those variables, the following formula was created:

$$(0.7 \times \mathrm{CF} + 0.3 \times \mathrm{MT} + 1 \times \mathrm{FE}) \times (0.5 \times \mathrm{HS}) \quad (1)$$

The formula was tested using the signs from the avatar database and the constant values, that initially were set to 1, were manually adjusted to produce a more compact interval of results. However, the constant value for the facial expressions were unaltered due to the current version of the avatar not supporting them. In table 2 is shown an example of some signs and its readability score.

Table 2. Readability scores example.

Sign	CF	MT	HS	Score
Javali	1	1	1	1.00
Fornecedor	2	6	1	2.09
Auxílio	2	4	2	3.59
Consumo	4	6	2	5.60
Esclarecer	7	7	2	8.00

4 Conclusion and Future Work

This article provides an overview of a project that is currently in development, with additional features yet to be implemented to better serve its target audience. The primary functionality yet to be integrated is the avatar responsible for translating explanations from plain text to LGP. In addition, the project will include displaying the LGP readability score for each explanation and the ability for users to request a new explanation if needed.

Looking ahead, future work on the project could expand its reach by adding support for other languages, with the avatar capable of translating from plain text to the corresponding sign language. Additionally, the API developed for this project could potentially enhance the capabilities of other GILT projects, both present and future.

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Bidirectional Sign Language Translation System - bookstall

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Abstract. *Currently, there is a huge difficulty in the deaf community to establish direct communication between people or to obtain information, and with the advance of technology, new methods have emerged to make their daily lives easier, a concrete case is VirtualSign. However, this technology needs to be implemented in different areas. The main objective of this project is the development of an inclusive application, to be implemented in a bookstall, where it is possible to make bidirectional translations of texts into sign language and vice versa. The creation of this application uses VirtualSign technology as a sign language recognition system, for this task a camera is used to capture movements and the respective screen to clearly present the respective information. It will serve for better integration of the deaf community. The project developed here was based on the suggestion of Professor Paula Escudeiro and in cooperation with GILT/ISEP. In summary, this project aims to develop an application for a bookstalls that allows bidirectional translations between texts and sign language. It uses VirtualSign technology for sign language recognition. The application aims to improve the integration of the deaf community.*

Keywords. Inclusive application, bookstall, sign language, VirtualSign, hearing impairment

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1 Introduction

The project, documented in this report, was developed as part of the Thesis/Dissertation/Internship (TMDEI) curricular unit, in the Master's degree in Computer Engineering, in the specialization area of Graphics and Multimedia Systems, at the Superior Institute of Engineering in Porto. It tries to improve the inclusion of the deaf community in a bookstall environment using VirtualSing technology.

Since currently, according to data provided by the Portuguese Association of the Deaf (APS), there are about 30,000 deaf people who have the ability to communicate through Portuguese Sign Language (LGP). Its use may facilitate this community in some day-to-day operations such as ordering a book or an article, for example.[1]

1.1 Problem

With the evolution of technology in recent years, customer service has improved significantly with the integration of new emerging technologies. However, the needs of a small but significant population of hard-of-hearing individuals are often overlooked in these advancements.

Unfortunately, many individuals in the general population are unfamiliar with LGP, which makes communication difficult for those who rely on it. This lack of understanding can have significant consequences, as it can make everyday activities like acquiring a book or communicating with others challenging and time-consuming. While some hard-of-hearing individuals can read and write, this is not always a feasible alternative.

The use of sign language, on the other hand, is not that simple. Just like phonetic languages have differences between them, there are numerous variations among different sign languages, including different ways of expressing meaning through various gestures in LGP.

To overcome this issue, it's crucial to promote greater awareness and understanding of LGP among the general population. Educational programs and initiatives can be introduced to help people learn the language and communicate more effectively with hard-of-hearing individuals.

It's essential to recognize that sign language is not a universal language, and different countries and regions have unique sign languages with their own grammar and syntax. Likewise, LGP has its nuances and subtleties that are not always understood by those who are not familiar with it.

Therefore, it's crucial to consider the needs of hard-of-hearing individuals when designing new technologies and customer service systems. By incorporating features like captioning, interpreting, and voice recognition software, companies can create a more inclusive environment that caters to everyone's needs.

We must strive to create a world that is more inclusive for hard-of-hearing individuals. This includes recognizing the importance of LGP as a language and incorporating features that make communication easier for everyone. By doing so, we can ensure that no one is left behind and that everyone can access the same opportunities and experiences.

1.2 Objective

This project aims to address a gap in terms of social inclusion for the deaf community in a bookstore. The intention is to develop an application for this context. The application will use VirtualSign[5] to interpret gestures captured through a camera and data collected from a glove,

in order to present the transmitted message in text format. Additionally, the inverse process will be developed so that users who do not know LGP can also communicate with other users.

1.3 Existing restrictions

Throughout this project, we may encounter problems, in this specific case, monetary problems due to the high cost of hardware components required for gesture recognition.

Another restriction is that this system is not portable. To improve the system's functionality and performance, it will always be necessary to introduce new gestures to train the system, thus reducing the number of translation errors that may occur.

2 Research on the Deaf Population

At the moment, it is not possible to determine with great accuracy the exact number of people who have this type of limitation, but it is possible to get an idea that the number of cases has been decreasing, perhaps also due to advances in technology in the medical sector as well as in early prevention.We can verify through the 2001 Census, 84,172 hearing-impaired individuals were registered. However, these data are not specific to the cause of the disability, whether it is due to health, age, or accidents.[2]

2.1 About VirtualSign

As previously mentioned, this is a bidirectional translation system that works automatically and in real time between text and sign language. It can be used in different situations, however, the necessary equipment for its correct functioning and possible improvements in the gesture library should be considered.[3] The application's operation is very simple regarding the translation of text to sign language. The program will check the text and make a reproduction through an animated avatar.[4] In the reverse translation process, the application will recognize the gestures made by the user through a camera (Kinect) and smart gloves. After this process, the information is presented in text format.

2.2 Kinect

The Kinect[6] is a device developed by Microsoft, initially developed for the X-Box 360 console. With this device, it became possible to detect and interpret user movements. It has an RGB camera, a monochrome camera, and an infrared sensor, what makes it possible to recognize a 3D scene and thus recognize all movements in the scene. However, the device is not prepared for sign language recognition, and therefore other devices are needed. The camera does not support face recognition, which is also a crucial tool in sign language.

2.3 Smart gloves

These gloves serve to capture hand and finger movements. The gloves are equipped with various sensors, such as accelerometers, which will interpret all movements made. Currently, these devices have some problems, such as the time it takes to put them on, and the price, which can vary considerably depending on the material used.

3 Conclusion

In conclusion, this project highlights the need for greater inclusivity for the hard-of-hearing community, particularly those who use LGP to communicate. The lack of awareness and understanding of LGP in the general population can create significant barriers for those who rely on it, making everyday activities challenging and time-consuming. To address this issue, educational programs and initiatives can be introduced to promote greater awareness and understanding of LGP.

Moreover, incorporating features such as captioning, interpreting, and voice recognition software in new technologies and customer service systems can create a more inclusive environment that caters to everyone's needs. This project aims to contribute to this effort by developing an application using VirtualSign to interpret LGP gestures and present them in text format, making it easier for hard-of-hearing individuals to communicate in a bookstore environment. By recognizing the importance of LGP as a language and designing technologies that cater to the needs of hard-of-hearing individuals, we can create a world that is more inclusive for everyone.

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Conceptual Design of a UHPC Footbridge in the City of Villach in Southern Austria

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Abstract. *Ultra-high performance concrete (UHPC) has many advantages compared to other building materials if it is used in a proper way. To show the potential of UHPC for slender constructions, the purpose of this work was to design a UHPC-footbridge as an alternative structure to an existing bridge crossing the river Drau in the city of Villach in Southern Austria. The new bridge is a box girder bridge, constructed from fibre reinforced UHPC combined with internal and external post-tensioning. The calculation is based on the final draft of the new Austrian guideline for UHPC, the final version of which has since been published in 2023.*

Keywords. UHPC, ultra-high performance concrete, UHPFRC, ultra-high performance fibre reinforced concrete, steel fibres, prestressing, post-tensioning, footbridge, box girder

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1 Introduction

The compressive strength of Ultra-high performance concrete is 3 to 5 times higher compared to Normal Strength Concrete (NSC). Ductility and post-cracking tensile strength can be reached by the addition of steel fibres [1]. Prestressing or post-tensioning makes it possible to take full advantage of the concrete's compressive strength. The design of slender structures with a minimized self-weight can be reached with UHPC in combination with prestressing or post-tensioning and / or conventional reinforcement. This approach leads to a reduction of needed resources for associated structures, transport and storage as well. Considering the whole life cycle of UHPC, the material has the advantage of a long durability and robustness while the effort of maintenance is low.

UHPC is used as a common building material in many countries worldwide already. In Europe, France was one of the first countries implementing a national standard to regulate the usage of the material. Missing standards and regulations for UHPC in Austria lead to low usage and difficult structural application of the material. The design and calculation as well as the manufacturing and handling of UHPC are significantly different from Normal Strength Concrete (NSC). Therefore, it is important that engineers have the correct design codes and guidelines available. The first guideline for design and construction with UHPC in Austria has been published recently. This will make the application of UHPC finally easier for designers, for manufacturing companies and for contractors.

To figure out the potential of UHPC and the applicability of the new Austrian guideline for a long-span footbridge, an alternative to an existing steel bridge in the city of Villach, Southern Austria was designed. The bridge over the river Drava has to span a length of nearly 90 metres. The conceptual design is based on the valid European and Austrian design codes as well as on the final draft of the Austrian guideline for UHPC ("Österreichische Richtlinie UHPC") [1].

2 Conceptual Design

A box girder was chosen for the cross-section of the UHPC footbridge, according to the hollow box steel cross-section of the existing bridge. The chosen cross-section has also the advantageous characteristics against torsional effects, which was a fundamental requirement for the bridge. During events in the city, as for example a yearly firework, crowds of people may gather only on one side of the bridge, which results in high torsional forces in the structure. The dimensions of each part of the box girder were calculated separately and in a step by step iterative process. This resulted in a 2.75 metre high cross-section, with a bridge deck thickness of 12.5 cm, a bottom plate and box walls with the thickness of 10 cm, illustrated in Fig. 1. Compared to Normal Strength Concrete, where the dimensions would be at least between 20 and 25 centimetres according to the current regulations [2], about half as much material is needed by volume.

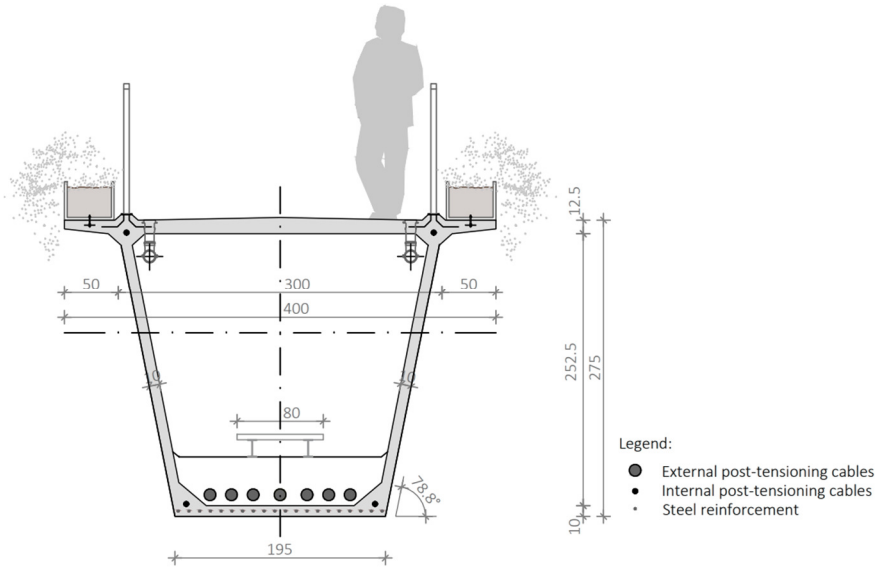

Figure 1. Cross-section of the bridge in the middle

To deal with the high positive mid-span moments of the bridge caused by the dead load and the required traffic load, post-tensioning has to be implemented into the construction. The post-tensioning is achieved on the one hand by four horizontal internal steel cables and on the other hand by seven external steel cables. One external cable is routed horizontally, while six cables are routed in a polygonal shape, following the main bending moments. The bridge can be prefabricated from several parts that can then be transported. On site, they can be connected with the internal post-tensioning cables. Afterwards, the external post-tensioning can be installed and then the whole bridge can be moved into its final position. The achieved span-to-height ratio of 31.5 is outstanding for a single-span bridge made of concrete. The bridge deck is slightly inclined in the shape of a roof, with the highest point in the middle of the deck to drain the water, which is then collected by pipes inside the hollow box girder.

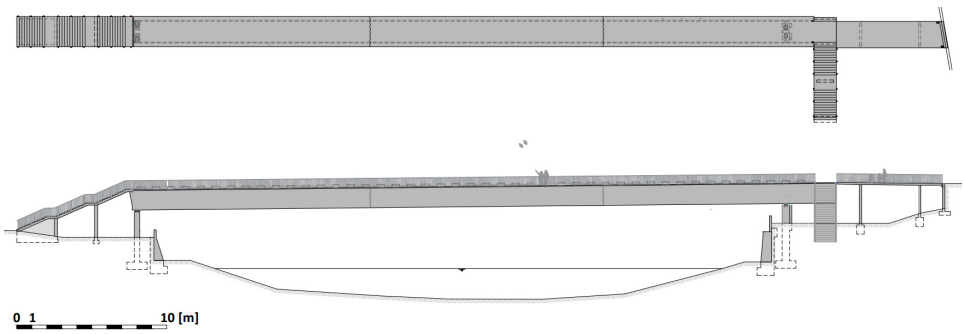

Figure 2. Top and side view of the bridge

3 Conclusion

The conceptual design of a long-span footbridge based on the new, recently published Austrian guideline for ultra-high performance concrete was successful. It has been shown that the material can be used to span large distances while keeping the dimensions of the various bridge sections such as the deck, the walls and the bottom plate of the box girder extraordinarily slender. It was also possible to reduce the height of the cross-section of the UHPC bridge compared to the mid-section of the original steel bridge by 15 %, thus achieving a span-to-height ratio of 31.5. The lower amount of material required can lead to a reduction in CO_2 emissions as well, despite the large amount of cement needed for UHPC. There is also a big difference in the dead load between both constructions. The alternative bridge is 37 % lighter than the existing steel bridge. In practice, this would in addition have a positive effect on the dimensions of the supports, which would have to bear less load.

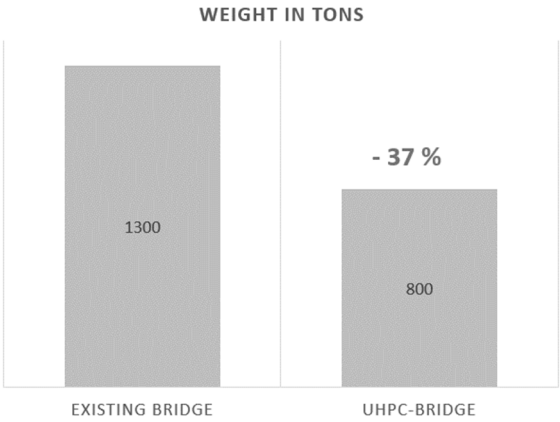

Figure 3. Comparison of the construction weight of both bridges

The work has shown that UHPC is already a promising high-strength material that can be used to design complex long-span structures based on the existing design codes. In practice, some research on certain applications is still needed, as well as companies that are prepared to work with UHPC. A first step towards was the publication of the Austrian UHPC guideline.

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Conflating SCRUM with micro-Project Based Learning. An HMU Application in an IoT Device Development

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Abstract. *Project Based Learning has been well established in the scientific literature as a useful pedagogy tool. The same is true for SCRUM framework with respect to Industry and Education as well. Recent studies have revealed the potential of applying SCRUM methodology in a PjBL setting with very promising pedagogical results. In this work we provide further support for this active area of research by applying SCRUM in a micro-PjBL setting. It involves a small group of Erasmus Students assigned to develop a meteorological station in a short timeframe using SCRUM but, in this case, applied in a step-by-step approach (micro). The outcome of this quasi-experiment supports the effectiveness of SCRUM once more as an indispensable pedagogy tool for Active Learning purposes.*

Keywords. Active learning, project-based learning, micro-PjBL, SCRUM, IoT

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1 Introduction

Active learning, meaning the set of pedagogies that promotes self-directed, student-centered and hands-on experience by engaging students in the learning process, has revolutionized the field of Education. It was conceived as an ambitious educational reform back in the early 1900s and has since then evolved into a coherent corpus of methodologies such as: Problem-based learning (PBL), Project-Based learning – PjBL, Flipped classroom, Collaborative learning, Case-based learning, Game-based learning, Video-based learning, Experiential learning, and Service learning, among the most prevalent ones [1].

In this short report, we follow the micro-Project-based approach adjusted with the application of Scrum methodology to make the case and provide support in the rising bibliographical evidence that Scrum is a profoundly useful pedagogy tool [2][3].

Micro project-based learning (micro-PjBL) shares the same core principles and mechanisms with PBL but features a shorter learning cycle. It is recognized as a lightweight alternative with the desirable characteristics of being short, precise, and highly applicable. In comparison with PBL, micro-PjBL is efficient, flexible, and practical. It retains the advantages of PBL by helping students to develop skills covering collaboration, communication, and problem-solving in collective exploration. Moreover, due to its characteristic of "micro", a micro-PjBL cycle can be completed within a shorter time period relative to a full semester. In education, micro-PjBL is a comparatively new topic. The learning processes of micro-PjBL, such as how to design a mini project which can include the core concept and involve task introduction, implementation, presentation, evaluation and reflection, feedback and adjustment, and effectiveness are depicted also in our study.[3][4]

In particular, the case study involves a team of Erasmus students doing their study mobility at HMU that took on the project to build, in a period of three months. Their project focused on developing a meteorological station able to connect with the Web and able to share information with a web platform via pc or cellphones.

We discuss the results in the final sections of this report.

2 SCRUM methodology and its application in the learning process

Scrum framework is one of various Agile methodologies, that provides a structured approach to project management and collaboration. It is widely used in software development, but its principles and practices are adapted to many other fields, including education.

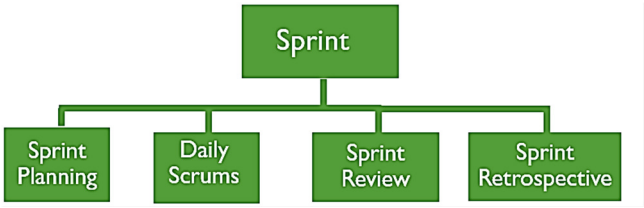

Figure 1. Sprint structure in the Scrum framework

Very briefly, it involves dividing a project into small, manageable pieces called Sprints. Each Sprint typically lasts 1-4 weeks with a specific set of tasks. Each Sprint starts with the Sprint Planning meeting where all the necessary jobs or tasks are written in the Product Backlog. At the end of each Sprint, the team gets together in the Sprint review meeting to review progress, with the feedback of the stakeholders. If the Sprint is successful, then the team has an Increment and can proceed to the next event which is the Sprint Retrospect. In this meeting the team members identify any issues or obstacles and decide on ways of improving their work on the next Sprint. This discovery of obstacles and issues is made every working day during a very short stand-up meeting, the Daily Scrum. Fig. 1 depicts the Sprint structure.

As for the team, it consists of three distinct roles, the Product Owner, the Scrum Master, and the Developers. The Product Owner has the sole responsibility for the outcome of the project. The Scrum Master makes sure the Scrum events are held and helps the working team (the Developers) to embrace the pillars and values along with removing any possible obstacles. The Developers, a term borrowed from the software development industry, are the people doing the actual hands-on work to develop the final product. The Scrum framework establishes this way, in an apt manner, collaboration, communication, and self-organization among team members [2]

We have already tested the use of Scrum as a pedagogy tool and soft skills development, in teaching Physics II course in HMU. The results and conclusions can be found in another publication of our research group [5].

The use of Scrum methodology in a project-based learning setting brings notable innovations. Scrum methodology, originally developed for software development projects, has gained popularity and proven to be effective in various domains, including project-based learning (PBL) settings. Scrum's iterative and incremental approach, focus on collaboration, and emphasis on delivering value align well with the goals and requirements of PjBL. Specifically:

1. Improved Project Management: Scrum provides a structured framework for managing projects, enabling students to better plan, organize, and track their progress. It emphasizes the use of user stories, product backlogs, and sprint planning, which helps students break down complex projects into manageable tasks and prioritize them effectively.[7]
2. Enhanced Collaboration: Scrum promotes collaboration among team members, which is a crucial aspect of PjBL. It encourages frequent communication, transparency, and cross-functional teamwork. Students work together in self-organized teams, sharing their knowledge, skills, and responsibilities, which leads to better learning outcomes and a sense of ownership. [6]
3. Adaptability and Flexibility: PBL often involves addressing complex, ill-defined problems that may require frequent changes and adaptations. Scrum's iterative nature, with short development cycles called sprints, allows students to respond to changes and incorporate feedback effectively. It fosters a mindset of continuous improvement and adaptability, which is valuable in dynamic project settings. [8]
4. Empowered Learning Environment: Scrum empowers students by giving them autonomy and accountability over their projects. They have the freedom to make decisions, self-organize, and take ownership of their learning journey. This sense of empowerment fosters intrinsic motivation and active engagement in the learning process. [9]

In brief, we argue that the Scrum methodology can be applied by dividing the project into sprints. Each sprint is then focused on a specific aspect of the project, such as research, design, or documentation. It would be useful here to refer to the term "micro-Pjbl", regarding each component of the project that needs a different problem-solving approach(step-by-step). The short learning cycle of the project and the need for high precision makes this approach even more suitable [3]. Scrum methodology fits in PjBL environments so well since many aspects of the projects are highly unpredictable, with various degrees of uncertainty, and Scrum manages to diminish high -risk perception by dividing into smaller and more attainable tasks [6].

3 Using Scrum in a PjBl setting at HMU with Erasmus Students

The students were required to develop a meteorological station under the Internet of Things-IoT concept with a specific description regarding the use of the final product, but with no technical details on how it is supposed to be built, leaving therefore the technical aspect of the project to be solved by the team, along the process. The given deadline was three months, and the requirement was to use commercially available components (off the shelf). The result of their work is shown in Fig. 2.

The structure of the weather station separates the system into three working fields: sensors, PV-battery-system and online connectivity. The main component is the Raspberry Pi. The weather station features sensor BME280 for measuring the air humidity, temperature and air pressure. An analog sensor for the wind speed is connected to the Raspberry Pi using an analog-digital-converter. A rainfall sensor measures the amount of precipitation. Three solar panels are connected to the battery using a respective self-built unit.

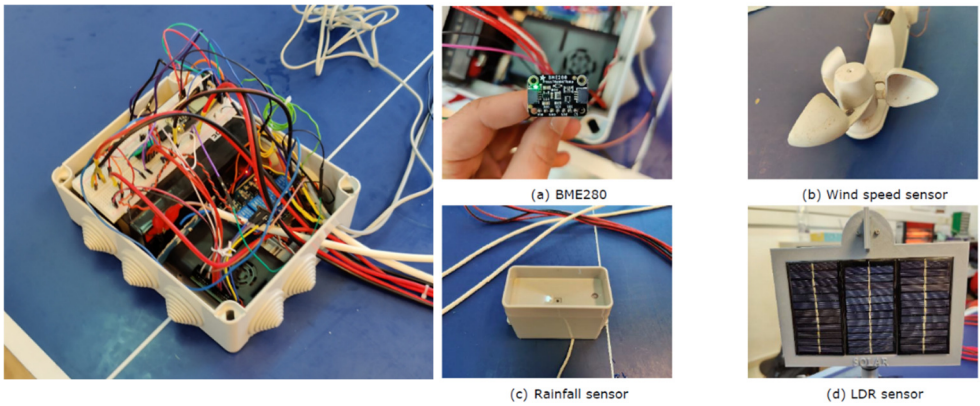

Figure 2. The completed device and the sensors

The raw measurement data from the sensors is uploaded and stored in a database which connects to a website, where the user can access the data in visualized graphs. The Raspberry Pi is powered via a normal power socket. For easy mobility and during outages the backup power will be delivered by the PV-charged battery of the system.

An online database was built to host all the measurement data from the sensors of the weather station. The provider used is called phpMyAdmin. The database "weatherstation" hosts the seven parameters "temperature", "humidity", "pressure", "light", "rainfall", "windspeed" and "date". This database was interlocked with the open-source program "Grafana" which is an application that displays graphical representations of raw data from online databases. The user tailored website for the weather station redirects the user to "Grafana" where the relevant graphs are show. This includes the following parameters : Light intensity (%), Temperature (°C), Pressure (hPa), Windspeed (km/h), Rainfall (ml/m^2) and Humidity (%).

The team was also required to develop the project using the Scrum framework. The framework was introduced by the PhD student, having the role of the Scrum Master in a four-hour session. The supervising Professor had the role of the Product Owner, and the students were respectively the Developers.

The duration of the project was divided into three sprints of 20 days each and lasted from November 4th 2021, until the 26th of January 2022. The timeframes of work were flexible each week accommodating for other student engagements. There were on average three working timeframes per week, lasting on average five hours each. The separate Scrum events such as Sprint Planning, Sprint Review and Sprint Retrospect were held according to the Scrum Guide [7] at the start and at the end of each sprint and lasted on average half an hour each.

The student engagement was constant throughout the project because each working timeframe produced an incremental step towards the final product. The observation was done by the Scrum Master who monitored the daily scrums and by the Product Owner who verified the production of the Increments on each Sprint Review.

After the completion of the project, the student's opinion was asked in the form of an anonymous questionnaire, in order for the researcher – PhD student – to track the effect of Scrum on the micro- PjBL format.

The micro-PjBL approach helped them fulfill all the necessary aspects of the product such as Research, Development and Documentation. The Scrum framework specifically helped them manage their deadlines, collaborate smoothly with their peers and present aptly their work as it is shown in Fig. 3.

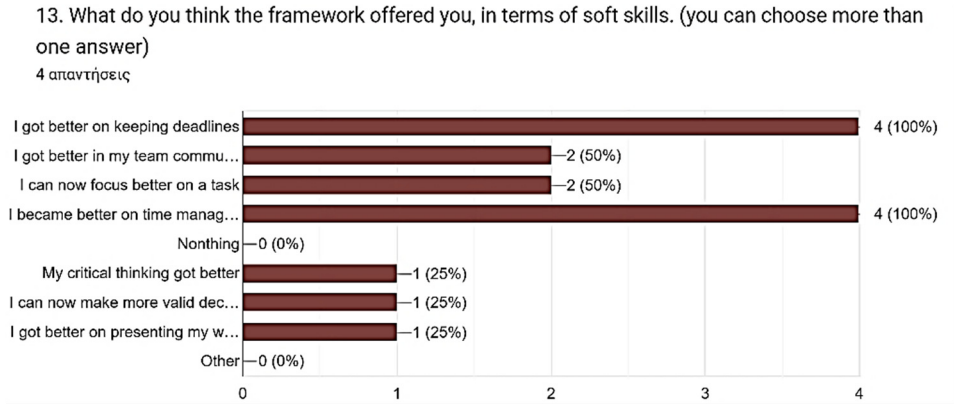

Figure 3. Students' responses on the question of how much the Scrum framework, helped them to get better in soft skills like time management and communication.

Although the students didn't have experience in project management, the overall impression was that Scrum is easy enough to apply, provided you have a Scrum Master and the time to familiarize with the framework described in the Definitive Scrum Guide [6].

4 Conclusion

The application of the Scrum methodology to PrBL, analyzed into micro-PjBl steps as defined and showed above, can provide a better structured and organized approach to project management and collaboration, helping students to develop necessary skills and achieve their learning goals.

Our work argues in favor of deepening the role of the Scrum framework in the learning process especially in highly technical and innovative fields such as applied physics, engineering, electronics, computer science, and STEM in general. Further research and classroom tests are going to enhance the effectiveness of these pedagogy tools.

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Development of a Prototype for a Smart Bracelet that Detects Falls for Multiple Sclerosis Patients using SCRUM Framework

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Abstract. *This thesis presents the development of a smart bracelet prototype for Multiple Sclerosis patients that can detect falls using an accelerometer and fall detection algorithm. Collaboration between students from different universities was facilitated by the SCRUM Framework, allowing for efficient project management and a focus on user needs. User testing demonstrated the prototype's effectiveness in detecting falls and location data integration increased caregiver response time. The prototype shows promise in improving patient safety and independence, with potential for implementation at the National MS Centre Melsbroek to improve patient care quality.*

Keywords. Smart bracelet, fall detection, multiple sclerosis, SCRUM, API, hardware design, software development, patient safety, medical technology

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1 Introduction

Multiple Sclerosis (MS) is a chronic neurological disease that affects the central nervous system, causing mobility and balance impairments that increase the risk of falls [1,2]. Falls are a common cause of injury and hospitalization in MS patients, and they can lead to reduced quality of life, loss of independence, and increased healthcare costs. To address this problem, this thesis presents the development of a smart bracelet prototype that can detect falls in MS patients and alert caregivers in real-time [3].

2 Methodology

The development of the smart bracelet prototype was guided by the SCRUM Framework, a flexible and iterative project management methodology that emphasizes collaboration, communication, and continuous improvement [4]. The project was implemented in the context of the ATHENA project, a collaborative initiative that involved students from three universities (Hellenic Mediterranean University, AP Hogeschool Antwerpen, and Instituto Superior Politécnico Gaya) working together in a blended intensive program.

The prototype is based on an ESP32-WROOM-32 microcontroller and integrates an accelerometer to monitor the patient's movements and employs a fall detection algorithm to distinguish between normal activity and falls. When a fall is detected, the prototype sends an alert to a caregiver via a text message, providing information about the patient's data and exact location. Additionally, an API is included to keep track of all the patients' fall data and manage the hospital's nursing staff at the National MS Centre Melsbroek. Fig. 1 depicts the overall function of the bracelet.

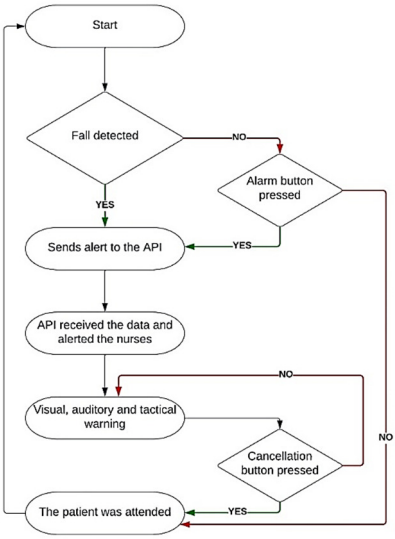
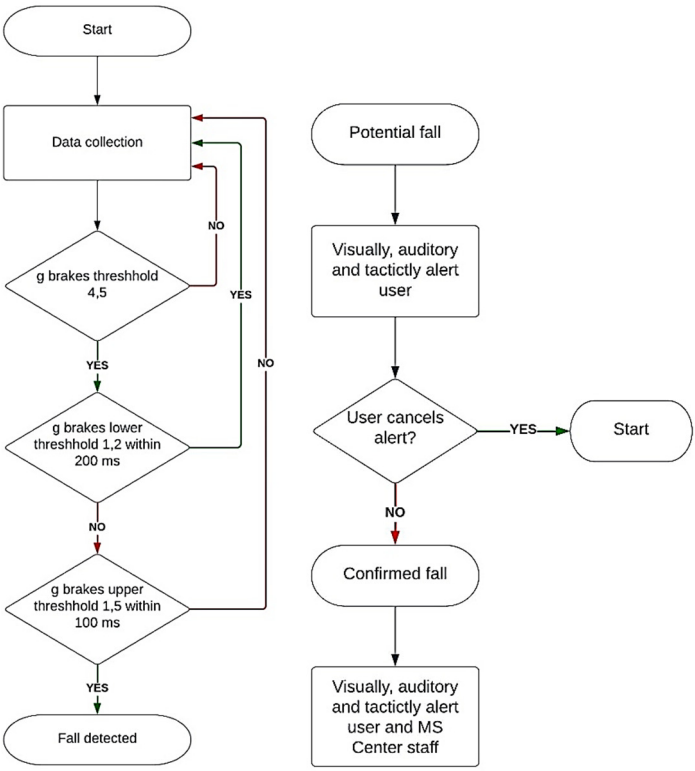


Figure 1. Bracelet Operation Flowchart

Fig. 2 (a) shows the fall detection algorithm, while Fig. 2 (b) represents the post-fall process.



(a) (b)

Figure 2. Fall detection algorithm (a) and Post fall process (b)

The development process was divided into sprints, each focused on a specific aspect of the project, such as hardware design, software development, and testing. The SCRUM framework allowed for effective communication, efficient project management, and a focus on user needs. User testing demonstrated the prototype's effectiveness in detecting falls in MS patients, providing a promising solution for improving patient safety and independence.

3 Results

The fall detection system implemented in the smart bracelet prototype showed promising results in the tests carried out, with an estimated effectiveness of around 70%~80% in detecting falls. However, the accuracy of these values cannot be fully verified due to the need for more exhaustive tests in a real-world setting, such as inside the MS center where the prototype was intended to be used. Nonetheless, these initial results suggest that the smart bracelet has the potential to be a feasible solution for improving patient safety and independence, particularly for individuals with MS who may be at increased risk of falls.

The integration of location data proved crucial in enhancing the response time of caregivers. The precise location information provided by the bracelet enabled swift assistance, reducing the potential risks associated with delayed intervention. Caregivers praised the efficiency of the alert system, as it facilitated timely response and improved overall patient safety.

The API developed for managing patient data and coordinating nursing staff at the National MS Centre Melsbroek proved to be a valuable asset. The API streamlined data tracking and analysis, allowing healthcare providers to monitor patients' fall incidents more effectively. The API's capabilities extended beyond fall detection, providing insights into patient behavior, needs, and overall well-being.

4 Discussion

The smart bracelet prototype developed in this thesis has the potential to improve the quality of life and care for MS patients, as well as reduce healthcare costs and hospitalization rates. The prototype's API also has the potential to streamline care management and improve efficiency in hospital settings. The SCRUM Framework proved to be a successful project management methodology for the collaborative development of the prototype, enabling efficient communication and agile development. Limitations of the study include the small sample size and the need for further refinement of the fall detection algorithm.

5 Conclusion

In conclusion, this thesis presents a successful collaboration between students from different universities in the development of a smart bracelet prototype for MS patients using the SCRUM Framework. The prototype provides a promising solution for improving patient safety and independence, and its implementation at the National MS Centre Melsbroek has the potential to improve the quality of care provided to MS patients. The results of this project demonstrate the effectiveness of a collaborative and iterative development approach in addressing complex healthcare challenges and highlight the importance of user-centered design and testing in developing technology solutions for patients.

6 Possible Future Work

There are several avenues for future research and development of the smart bracelet prototype. One potential area is the optimization of the fall detection algorithm by more testing and refining, including the integration of additional sensors such as a gyroscope or magnetometer, to improve accuracy and reduce false positives. Additionally, expanding the API to include more features, such as data visualization, patient management tools, and caregiver alerts and to integrate with other healthcare technologies and electronic health records could improve care management and provide a more comprehensive view of patient health. User-centered design and testing could also inform the development of a more comfortable and customizable smart bracelet for patients, as well as improve the usability of the API for healthcare providers. Finally, conducting cost-benefit

analyses and exploring potential partnerships with healthcare providers and insurers could further validate the feasibility and scalability of the smart bracelet prototype as a solution for improving patient safety and reducing healthcare costs.

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Development of an Innovative Lattice Boltzmann Hydraulic Model for Shallow Water Flows

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Abstract. *The development of an innovative Lattice Boltzmann hydraulic model for shallow water flows is presented. The model (CaLB) uses a multi relaxation time (MRT) approach and a cascaded collision operator based on central moments, different from the standard linear collision operator generally used. CaLB is considered for different purposes: reproducing the dynamics of multilayer shallow water flows and modeling large-scale urban floods. Although a variety of models allowing numerical investigation of single and multi-layer shallow water flows, based on continuum and particle approaches, have been widely discussed, there are still some computational aspects that need further investigation. The use a multilayer model (CaLB-N) allows obtaining a description of the vertical variation of hydrodynamic quantities of large-scale geophysical flows and deepening the computational aspects of the density layered shallow water flows. The simulation of flood events in urban areas risk is also investigated, introducing a new porosity approach, aimed at developing technical solutions for the assessment and mitigation of flood risk. The model is validated through comparisons with experimental and numerical results from test cases available in literature, yielding very promising results.*

Keywords. Lattice-Boltzmann cascaded model, multi-layer shallow water flow, gravity currents, idealized dam break flows, large-scale urban floods, porosity

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1 Introduction

A multi relaxation time (MRT) cascaded (CaLB) Lattice-Boltzmann model (LBM) [1] is developed and enhanced to reproduce the dynamics of a multilayered liquid, made of immiscible shallow-layers of different density, bounded by a free surface and to model large-scale urban floodings.

The LBM, based on a first-order linear partial differential equation, it is used to solve the shallow water equations (SWE), derived from depth averaging Navier–Stokes equations, which offer nonlocal second order terms; hence the method is advantageous from a computational point of view and allows to obtain stratified horizontal flow velocities at various depths.

The inclusion of a collision operator based on central moments, which is distinct from the typical BGK (Bhatnagar Gross Krook) [2] of recent models reported in literature, is an essential novelty of the present study.

In the cascaded model, the use of central moments as a basis allows to overcome the Galilean invariance defects of the original MRT method to improve stability and accuracy and the use of a MRT collision operator allows to increase the number of adjustable parameters.

The multi-layer Shallow Water Equations method (MSWE) leads to have a description of the planar velocity along the vertical profile, neglected in the case of a single layer. As the number of layers increases, greater accuracy is achieved tending towards an almost three-dimensional model.

At first, to verify the accuracy and robustness of the model, only two layers are taken in account (CaLB-2). Then, the two-layer model was extended to represent a n-layer flow (CaLB-N) and simulate free surface currents where the three-dimensional aspects of the flow are not negligible, introducing a new formulation of the interchange forces between layers.

The validation phase is conducted considering various experimental and numerical results available in literature [3], [4].

On the other side, the LBM is employed to simulate large-scale urban inundation modeling, solving the traditional SWE on grids. Although CFD methods have already been employed to simulate flow in estuaries and coastal lagoons, capturing localized flow features in large scale is still a challenge, especially when dealing with very shallow flow, temporary submergence and time-dependent flow domains, and complex morphology. The time required for the resolution of the equations is still very long and gets longer with the increase of the spatial resolution and, therefore, of the required accuracy.

The introduction of new a porosity-based Lattice Boltzmann model could allow to capture the effects imposed by structures and small-scale obstructions, providing an accurate representation of the source term to simulate realistic shallow water flows, while at the same time exhibiting a notable reduction in computational times.

2 Mathematical model

The mathematical model proposed solves the SWE, where the fluid motion description is based on the evolution of the particles distribution functions (PDFs), through the discrete Boltzmann equation for individual layers, adopting the two-dimensional nine-speed reticle (D2Q9).

The PDFs $f_i(x,t)$ represent the probability of finding the fluid particle in the neighbourhood of a given position with a given velocity [5]:

$$f_i(\mathrm{t}+\Delta\mathrm{t},\mathbf{x}+\boldsymbol{e}_i\Delta\mathrm{t})-f_i(\mathrm{t},\mathbf{x})=\boldsymbol{\Omega}+\boldsymbol{F}+\boldsymbol{S_p} \qquad i=1,\dots,n \tag{1}$$

Where $\mathbf{x}$ represents the particle position in discrete space at the time t, $\mathbf{e}_i$ the set of speeds allowed along the n directions of the lattice, $\boldsymbol{\Omega}$ the collision operator, based on the use of central moments [6] and $\mathbf{F}$ the external force acting on the individual layers, depending on gravity and the bottom friction [3]. The source term $\boldsymbol{S_p}$ includes the interchange forces $\boldsymbol{\Phi}$ between layers, the formulation of which was obtained experimentally, taking into account the pressure exerted by the upper layers on the lower ones and the influence of the friction exerted by the lower layers on the upper ones.

Considering n layers, with the same density ρ, the force $\boldsymbol{\phi}^s$ exerted on each single layer s, with thickness $h_s$becomes:

$$\boldsymbol{\phi}^s=-gh_s\frac{\partial}{\partial_x}(h_{tot}-h_s)\mathbf{i}-gh_s\frac{\partial}{\partial_y}(h_{tot}-h_s)\mathbf{j} \tag{2}$$

Where $h_{tot}=\sum_{s=1}^{n}h_s$.

Regarding large scale urban inundation modelling, the introduction of a new porosity-based Lattice Boltzmann model is made considering the storage porosity $\boldsymbol{\phi}$ (Dewals), in the SWE (Guinot) and introducing it in the source term $\boldsymbol{S_p}$ of the eq. 1:

$$\boldsymbol{S_p}=-\frac{h}{\phi}\left(u\frac{\partial\phi}{\partial_x}+u^2\frac{\partial\phi}{\partial_x}+vu\frac{\partial\phi}{\partial_x}\right)\mathbf{i}-\frac{h}{\phi}\left(v\frac{\partial\phi}{\partial_y}+uv\frac{\partial\phi}{\partial_y}+v^2\frac{\partial\phi}{\partial_y}\right)\mathbf{j} \tag{3}$$

Where *h, u, v* are respectively the water surface elevation and the velocity components along the x and y axes.

3 Results, conclusions and ongoing developments

Some of the results obtained to validate the model are reported. The correctness of the model has been first verified with the classical Riemann problem (Fig. 1), where the fluid domain is constituted of a tank filled with the same fluid at different levels.

The results, compared with Stoker's analytical solution, show a correct implementation and that the water depths and velocity magnitude recovered are satisfactory. We also consider the case of a gravity current originating from two liquid layers, separated by a rigid bulkhead in a tank half-filled with the fluid with density ρ_1 and half-filled with the fluid with density ρ_2, ($\rho_1 > \rho_2$), both at the same height h_0. The results obtained from the model is compared with those got by La Rocca et al. [3], for different values of density ratio ρ_1/ρ_2, highlighting a good correspondence of results.

The model was also tested with the case of an asymmetrical ideal dam break, consisting of simulating a wave generated by the partial collapse of a dam, and the results have been compared with those deriving by a continuous 2-D shallow water approach [7].

The results obtained in reproducing the dynamics of shallow water flow_are satisfactory and very promising for the new CaLB-N, demonstrating that the model is well established and ready for the most varied engineering applications.

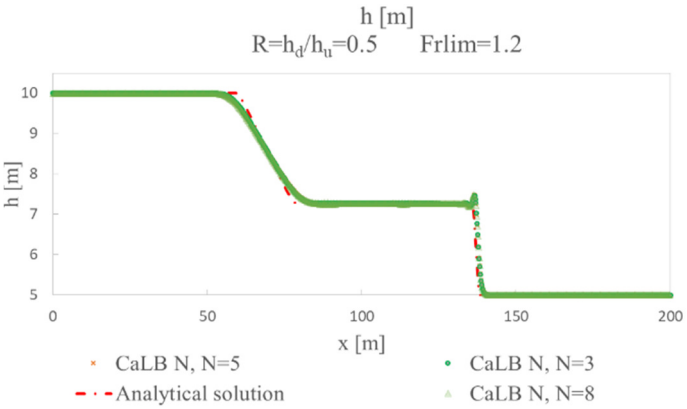

Figure 1. Comparisons between analytical solution and results obtained from the CaLB-N, for the one-dimensional Riemann problem, in terms of levels h [m] for h_d/h_u=0.5 ($h_{u=}$ upstream level; h_d=downstream level).

In future works author will make the model suitable in simulating multilayer flows also in high resolution domains and effective for the most varied engineering applications (e.g. modeling dispersion of pollutants, sediment transport and salinity distribution, wastewater effluents and thermal discharges in riverine and coastal waters).

At least the introduction of the porosity approach could give a more accurate representation of the dynamic of flood events in areas with complex geometries and topography, for a better management of hydraulic risk.

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Development of Fibrous Systems for Environmental Applications

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Abstract. *Recently, nanofibers have been considered as one of the sustainable routes with enormous applicability in various fields, such as biomedical and environmental ones. They have promising properties, including interconnected porous structure, lightweight, high porosity, and large surface area, and can be easily modified with the addition of specific nanofillers to enhance their suitability for specific applications. This work is focused on the development of fibrous systems for application in the environmental sector. In particular, functionalized polylactic acid (PLA) fibres were produced for the removal of heavy metals in the environmental sector.*

Keywords. Fibers, biopolymers, electrospinning technique, heavy metals, water purification

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1 Introduction

In the environmental field, toxic heavy metal contamination of the aquatic ecosystem is a significant problem at a global scale [1,2]. This leads to irreversible accumulation of the heavy metals in the various tissues of sea animals, thus endangering the entire aquatic biota [3,4]. The conventional methods currently employed to adsorb these contaminants are precipitation, membrane filtrations and adsorption [5,6]. Nowadays nanotechnologies and nanomaterial sciences have a focus on fabricating nanomaterials that can be used in various water purification applications.

Recently, nanofibers have been considered as one of the sustainable routes with enormous applicability in various fields, such as biomedical and environmental [7].

They have promising properties, e.g., interconnected porous structure, lightweight, high porosity, and large surface area, and can be easily modified with other polymeric materials or nanomaterials to enhance their suitability for specific applications. Electrospinning is one of the most important techniques utilized for their production [7]. Indeed, the electrospinning is a simple technique that allows the production of small diameter fibers. It is a process by which a polymer in solution can be spun into small diameter fibers, thanks to a high potential electric field. A typical electrospinning setup (Fig.1) consists of a syringe pump, a syringe containing the solution/suspension and supplied with a needle, a high voltage generator, and a metallic collector [7].

In this context, fibrous systems were developed for the application in the environmental (e.g., removal of heavy metals) sector, using poly(lactic acid) (PLA), due to biocompostable and biodegradable properties in order to obtain a lower environmental impact (Figure 1). It can be easily electrospun and the obtained fibers were used as supports for the alginate and chitosan deposition. Alginate derived from brown algae is a highly popular material for the biosorption of heavy metals due to its low cost, and high affinity to metals via gelation. Indeed, it is characterised by the presence of carboxy and hydroxy groups which can crosslink with cations. Thus, due to the negatively charged carboxyl groups, it can electrostatically adsorb heavy metal ions by chelation [8]. Similarly, the chitosan, a low- cost natural polysaccharide produced from the deacetylation of chitin, has been used in many studies for the heavy metal ions adsorption [9].

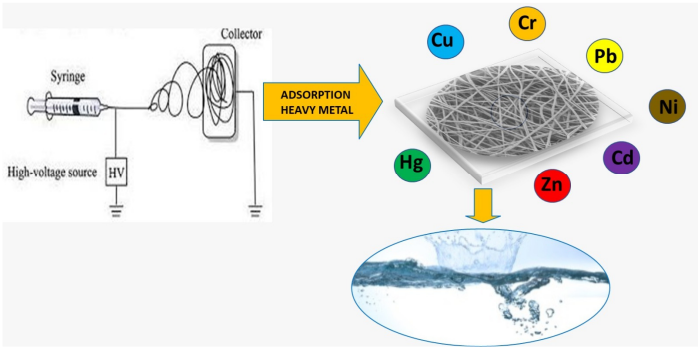

Figure 1. Electrospun fibrous membranes for the heavy metals adsorption

2 Materials and method

Polylactic acid (PLA) electrospun fibres, covered with alginate or chitosan, were produced, as promising heavy metals absorbers. The polylactic acid (PLA) nanofibers were made using the electrospinning technique. The process parameters of PLA nanofibers are the following ones: applied voltage 12 kV, flow rate 0.5 ml/h and needle-target distance 15 cm [10]. Successively, the coating procedures were set up, by dipping, respectively, the obtained nanofibers in chitosan (PLA@CS) and alginate (PLA@Alg) solutions, and then left dry.

As references, alginate and chitosan beads and films were prepared by ionic reticulation and solvent casting techniques,respectively.

The obtained fibers, bead and films were fully characterized from a chemical-physical characterisation. In particular, he produced beads were observed at optical microscope, whereas the films and fibers at scanning electron microscope (SEM). Swelling and solubility tests were carried out for the beads and films, respectively.

3 Results

The morphology of the electrospun PLA fibers was observed at SEM, evidencing the obtainment of uniform and randomly oriented defect free fibers. The obtainment of defect free chitosan and alginate coatings on the PLA fibers was demonstrated by means of SEM, as well as through water contact angle measurements, that evidenced a lower hydrophobicity due to the presence of the coating. The produced alginate and chitosan films looked homogeneous and uniform on the surface, without cracks and defects, as well as the obtained polysaccharide beads. Swelling tests carried out on alginate beads showed a slow water absorption in the initial phase, and the maximum water absorption (250 %) after 5 hours, reaching an equilibrium between 240 and 360 minutes, with an increase in size as high as 60 % of the initial diameter.

4 Conclusions

Homogeneous fibrous systems were successfully produced and the efficacy of the set up procedure for the polysaccharides coating was demonstrated by observation at SEM and contact angle measurements. Moreover, the not performed tests have shown that the developed fibrous systems present the physico-chemical characteristics appropriate for the heavy metals absorption. Future perspectives include the production of coated systems, in order to properly tailor their permeability, and of composite and blend systems, using selected inorganic fillers and also other biopolymers, as well as the demonstration of the heavy metals absorption capability by means of innovative analytical techniques.

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Development of Machine Learning Enabled Chatbot for Promoting Eating Habits Changes

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Abstract. *Unhealthy eating habits are one of the most important health problems in the world and are addressed in various ways, including digital technologies. The aim of this research is to develop a chatbot that allows tracking food consumption and monitoring the dynamics of nutrient intake in a non-intrusive way. For this purpose, we used a design science research approach. The chatbot uses multiple machine learning models (ML) with semantic similarity algorithms and enables human feedback to improve its performance. We developed it using the Serverless framework and deployed it on the Amazon Web Services (AWS) platform. Our goal is to create an innovative and user-friendly method for tracking food consumption and nutrient dynamics to promote healthier eating habits.*

Keywords. Healthy eating, grocery store receipt, nutritional analysis, daily intake monitoring, machine learning, chatbot

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1 Introduction

This research aims to address the problem of promoting healthy eating habits by developing a user-friendly chatbot using a string of machine learning models. Unhealthy eating habits are among most important risk factors for cardiovascular diseases (CVD), which are the leading cause of death worldwide, claiming an estimated 17.9 million lives each year [1]. We derive our thesis from the idea that changing the user's eating habits can be stimulated by providing feedback information using non-intrusive digital technology. While the market for health-tracking applications is saturated, with Google Play listing over a hundred apps when searching for “calorie counter” [2], most of these apps rely on recording every meal as the primary method for tracking food consumption. This approach demands willpower and discipline from users, requiring them to log their meals 4-5 times a day. In contrast, our aim is to support the users (individual or household) to change their habits by providing a long-term feedback on the grocery purchases by scanning their receipts from grocery stores or restaurants. The limitation of the proposed approach is in calorie calculation accuracy, as it cannot track unpaid non-receipt meals (food purchased but not eaten; food purchased but eaten by others; food eaten in an environment where there was no receipt, such as at a picnic). Thus, we propose the following research question, "How can we use open source ML models and ML services in order to make consumption tracking more user friendly?".

The use of digital technologies in healthcare and well-being has increased dramatically in recent decades. An important body of research focused on healthier lifestyles, behaviour change, and healthier food consumption has approached this problem with different ideas and methods. Some of them focused on the point-of-sale nutrition scoring systems and nutrition-information applications to guide consumers towards healthier food choices [3], [4]. Others focused to providing insights into the quality of nutrition content (using mobile apps) and the influence of external factors like in-store marketing on consumers' decisions [5]–[8] further demonstrated that monitoring eating behaviour and consistent health behaviour tracking can lead to healthier habits and significant long-term weight loss. Vu et al. [9] examined the complexity of automatic diet monitoring, leading to a focus on semi-automatic methods. Pioneering studies by Ransley et al.[10] and Martin et al.[11] on non-intrusive methods for estimating food consumption by analysing grocery receipts found a strong correlation between the share of product rich in fat purchased and being overweight or lean. Current research takes one step further to enable the tracking of purchase dynamics. Appelhans et al. [12] investigated the relationship between socioeconomic indicators and the energy cost and nutritional content of supermarket food purchases. Their research introduces valuable metrics that can be utilized by our chatbot for user engagement through gamification, thereby influencing food-purchasing patterns across various populations.

2 Research methodology

General approach used in this research is the design science research (DSR) [13], in which the real-life problem is solved (relevance cycle) on the basis of existing knowledge (rigor cycle) by developing an IT artefact (design cycle), which in this case is the chatbot based on several interconnected ML models and services (Figure 1). In the design cycle we follow the Cross-industry standard process for data mining (CRISP-DM)[14].

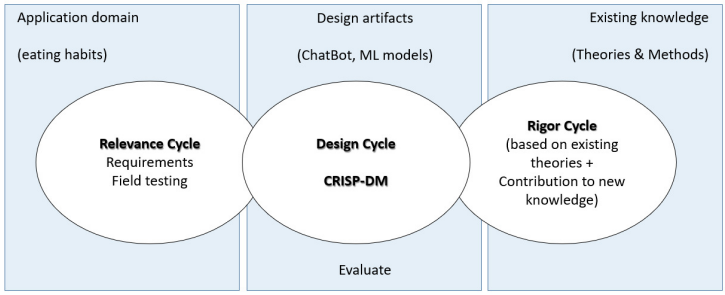

Figure 1. General design science research cycles (adapted from [13])

In the course of artefact development, the following data collection and analysis methods have been used:

- collecting grocery store receipts (from the author's family and friends),
- utilizing AWS Textract to recognize text and bounding boxes in receipt images,
- manual labelling of the text within these boxes,
- accessing open nutritional data from publicly available databases [15],[16] and
- employing semantic similarity search algorithms to map receipt entries to the database.

3 Results

Figure 2 presents the architecture of chatbot consisting of three ML-enabled components: AWS Textract for receipt optical recognition, AWS Sagemaker for fine-tuned model for labelling of bounding boxes, AWS Sagemaker built-in algorithms for mapping the product name against product database. The final evaluation is done by human experts based on 20 receipts, which haven't been used during the development.

The employed approach integrates proprietary services and open-source solutions:

- AWS Lambda (proprietary)
- AWS Sagemaker (proprietary)
- Amazon API Gateway (proprietary)
- Telegram (proprietary)
- LayoutLMv3 (open source)
- Serverless framework (open source)
- AWS Textract (proprietary)
- BlazingText (proprietary).

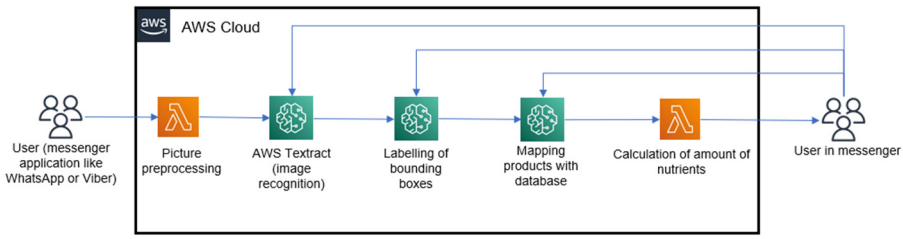

Figure 2. Chatbot architecture

The shift from a purely open-source architecture was driven by the need for enhanced development bandwidth for the researchers. While all the proprietary tools listed above have open-source counterparts, transitioning to an exclusively open-source framework would have demanded considerably more time.

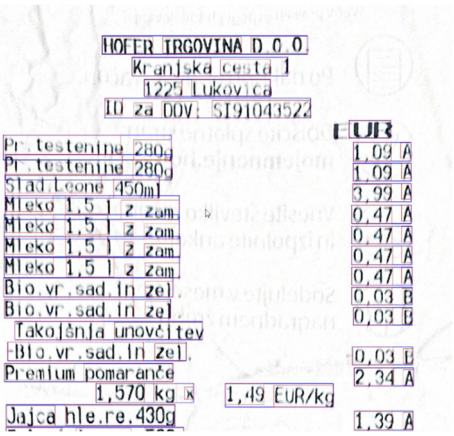

Figure 3. Part of the receipt with bounding boxes

Extraction and Recognition of Receipt Text

Paper receipts (data sources) are processed using AWS Textract, which replaced the initially tried Tesseract library due to superior results. Receipt images are stored in an AWS S3 bucket, categorized by user IDs and timestamps. When a user uploads a receipt image via Telegram, it is saved in the S3 bucket, processed by Textract, and the results are stored as {user_id}/{timestamp}/bounding_boxes.json.

Bounding Box Labelling

Receipt images undergo text and bounding box recognition using AWS Textract (Figure 3). The text within these boxes is then manually labelled with the open-source ML model, LayoutLMv3, on AWS Sagemaker. An annotation tool was developed for manual labelling, enriching the model's training data. The labelled data, which includes product names, quantities, and prices, aids in user spending analysis.

Product Name Mapping and Analysis

We access open nutritional data from public databases [16]–[21]. A semantic similarity search algorithm maps receipt entries to database records. However, the accuracy of this crowdsourced data isn't always guaranteed. The app uses AWS Sagemaker's "BlazingText" to map recognized product names to the database. It then calculates the total nutritional value of products on the receipt by multiplying quantities with nutritional data.

4 Conclusions

We addressed the problem of promoting healthy eating habits by designing a chatbot for receipt analysis. For this purpose, we used several ML models and services following the principles of the CRISP-DM process. The models and services were linked together and deployed as a web service. The developed chatbot uses AWS serverless architectures for optimal performance, the database is user-augmented for accuracy and ensures data security through encryption and anonymization. Integrated with Telegram, the chatbot offers a more streamlined consumption tracking compared to the "record every meal" method. Answering the research question, the chatbot supports a user-friendly experience by combining resource efficiency, user engagement, and robust data security. In the future we aim to test an alternative approach, by passing raw text output from OCR technology directly to a fine-tuned large language model (LLM), such as GPT-3.5. Fine-tuning GPT-3.5 [17] to recognize and interpret receipt information might enable it to handle both text extraction and semantic similarity tasks simultaneously. Despite the potential benefits, trade-offs in accuracy and computational resources required for training and deploying GPT-3.5 must be carefully assessed and compared with the current multi-modal approach. Furthermore, we aim to test the user acceptance in the field and develop a sustainable business model.

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Elaboration of Self-Organized and Perforated Polymeric Thin Films for Precise Localization of Electrochemical Etching of Silicon

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Abstract. *Porous silicon is a nanostructured material resulting from the partial electrochemical etching of crystalline silicon. Localization of electrochemical silicon etching on a silicon wafer could be achieved without the use of hard mask. For that purpose, a polymer mask, and in particular a polystyrene (PS) mask was prepared using a thin film of polymer blend based on PS, which exhibits a lateral phase separation. After a selective extraction of the other polymer, the polymeric mask exhibits discreet domains of PS of less than 2 µm in diameter. Electrochemical etching through this mask allow to localize porous silicon on a silicon substrate and opens the ways to a large range of localization of porous silicon on a silicon surface.*

Keywords. Polymer blend, thin film, polymer template, electrochemical etching, porous silicon

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1 Context and Motivation

Porosification of silicon enlarges the applications of this semiconductor material. Due to its porosity, this material becomes a thermal and electrical insulator [1], presents a large specific area leading to sensing applications for example [2] or turns biodegradable paving the way for biomedical applications [3].

Porous silicon (PSi) formation is carried out by electrochemical etching in the hydrofluoric acid-based electrolytes and results from the competition between silicon electrochemical oxidation and dissolution of this oxide. It is generally formed in electrochemical cells filled as represented in fig. 1.

For many applications, it is necessary to localize the PSi area on the silicon substrate. Hard masks are generally used for this purpose. It involves a photolithography step followed by a plasma etching to open the mask with the desired forms [4]. This step can be time-consuming, expensive and above all, limits the minimal mask aperture at 2 µm in conventional photolithography step. To override this technological barrier, we propose to localize PSi with a polymeric mask which can present apertures smaller than 2 µm in diameter. Such structured polymeric masks were used to localize plasma etching of silicon in 2015 [5]. This mask must resist to the electrochemical etching conditions, hence resist to highly concentrated hydrofluoric acid. In addition, the mask must be easily deposable on the substrate and removable without damaging the formed PSi.

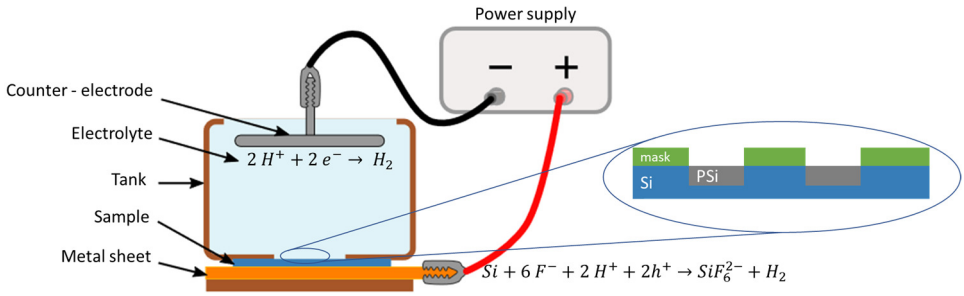

Figure 1. Single tank electrochemical cell typically used to make porous silicon and the half-reactions occurring during the etching [6]

2 Polymeric mask elaboration

2.1 Principle

The principle chosen to elaborate the perforated mask is the phase separation of a polymeric blend (cf. Figure. 2). At first, two non-miscible polymers (A and B) were dissolved in a common solvent (α). During solvent evaporation, the polymers separate and polymer B is selectively dissolved using another solvent (β) and leaving only polymer A at the surface. Polymer blend in thin film can present, after adapted phase separation process, a lateral phase separation with domains of one polymer perpendicular to the substrate embedded in a matrix of the other polymer.

A selective extraction of one polymer leads to a perforated polymeric mask. The general procedure is schematized in Figure 2.

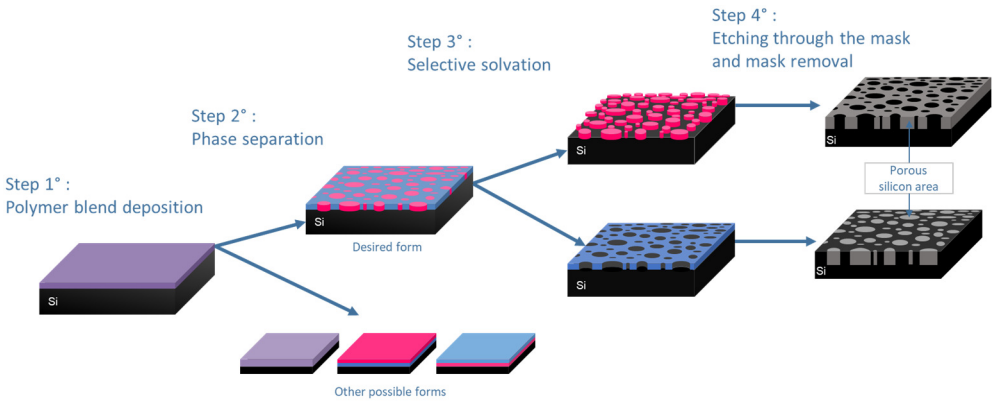

Figure 2. Schematic principle of the polymeric blend and phase separation followed by a selective solvation for localizing silicon etching

The polymers potentially suitable for the mask must be resistant to HF. Polystyrene (PS), THV Dyneon 221, Poly (vinyl chloride) and Poly (vinylidene fluoride-hexafluoropropylene) were selected.

In order to predict the suitable solvent for the blend and the suitable solvent to extract one polymer of the blend, the Flory-Huggins parameter $\chi_{Polymer,Solvent}$ is used. This empirical parameter is related to the Hansen's solubility parameters : the dispersive δ_d, polar δ_p, and hydrogen bond δ_{hb} Hansen's solubility parameters used in equation (1) and gives an indication of miscibility of a polymer and a solvent [7].

$$\chi_{P,S} = 0.6\ \frac{V_{m,S}}{RT}\left[\left(\delta_{P,d} - \delta_{S,d}\right)^2 + 0.25\left(\delta_{P,p} - \delta_{S\,p}\right)^2 + 0.25\left(\delta_{P,hb} - \delta_{S,hb}\right)^2\right] \qquad (1)$$

The lowest the parameter is, the highest is the miscibility. A value of $\chi_{P,S}$ inferior to 0.5 suggests that the studied polymer is soluble in the solvent.

The Hansen's solubility parameters could be also compared to evaluate the affinity of two polymers and their mixing or separation ability. Two polymers with very different solubility parameters will preferably unmix rapidly and will reduce their interface by forming large domains.

The suitable solvents were chosen among the authorized solvent in microelectronics industry (acetic acid, acetone, 2-butanone, ethyl acetate…).

Table 1 and 2 summarize the of Flory Huggins and Hansen solubility parameters to choose an appropriate set of polymers and solvents compatible with the use of PS. Poly vinyl acetate (PVAc) could be selected since Hansen solubility parameters for PS and PVAc are sufficiently different to PS and PVAc being immiscible.

Table 1. Hansen's solubility parameters of the polymers and solvents studied[1] in $MPa^{1/2}$

Polymer	δ_d	δ_p	δ_{hb}	δ_t
Polystyrene (PS)	19.4	4	2.5	20.0
Polyvinyl acetate (PVAc)	18.4	8.7	8.4	22.0
Butan-2-one	16	9	5.1	19.1
Acetic acid	14.5	8	13.5	21.4

Table 2. Flory-Huggins parameter calculated with eq.1

Polymer	$\chi_{polymer,\ Butan-2-one}$	$\chi_{polymer,\ Acetic\ acid}$
Polystyrene	0.4	0.8
Polyvinyl acetate	0.2	0.3

In Table 2, the Flory-Huggins parameter inferior to 0.5 for polystyrene, polyvinyl acetate and Butan-2-one indicates the possibility of blending for PS, PVAc in Butan-2-one (solvent α). Flory-Huggins parameter for PS / acetic acid of 0.8 and PVAc / acetic acid of 0.3 predict that the PS is not soluble in acetic acid contrary to the PVAc. It is consequently possible to create a PS mask opened by the selective extraction of PVAc with acetic acid (solvent β).

The structuration of the polymer blends thin films can be tuned by a large array of parameters such as the affinity of the polymers, the affinity with the solvent or the substrate [12]. The features of the polymers such as the their molecular mass and the characteristics of the blend solvent play a major role in mask structuring [13].

2.2 Structuration of polymeric mask and localized etching of silicon

The structuration of a polymer blend thin film and the etching localisation method were tested on a blend of 70:30 PS (Mw = 35 000 g/mol) / and PVAc (Mw = 100 000 g/mol) in Butan-2-one, at 30 mg/mL and is presented *vide infra*.

After depositing this blend by spin-coating on a silicon substrate, the blend thin film (Figures 3.a) exhibited a lateral phase separation with discrete domains of PS (bumps in the AFM image) and a matrix of PVAc. After dissolving the PVAc fraction in acetic acid, the PS mask is obtained and structured as cylindrical domains with a population of 1 to 1.5 µm in diameter, a thickness of 220 nm and a second population of smaller domains of 100nm in diameter as shown in AFM and SEM image Figure 3. AFM measurements are performed with a partial polymer strip confirming that there is no wetting layer of PS and the silicon surface is available for electrochemical etching (Figure 3.a). SEM images were then performed to get a scope of the sample (Figure 3.b).

The electrochemical etching was then performed in a tank filled with an electrolyte containing 30%wt. HF and 25 %wt. acetic acid and by applying 15 $mA.cm^{-2}$ during 15 sec. This electrochemical etching was followed by the dissolution of the PSi in a diluted solution of 5 %wt. potassium hydroxide (KOH) [14].

[1] The polymers Hansen's solubility values are the average of different sources [8], [9], [10], [11] and the values for solvents come from [11]. Those values are empirical and don't take into account the molar masse of the polymer neither the terminal functions, for this reason, we averaged the values found. The molar volumes are respectively 90.1 cm^3/mol and 57.1cm^3/mol for the butan-2-one and the acetic acid.

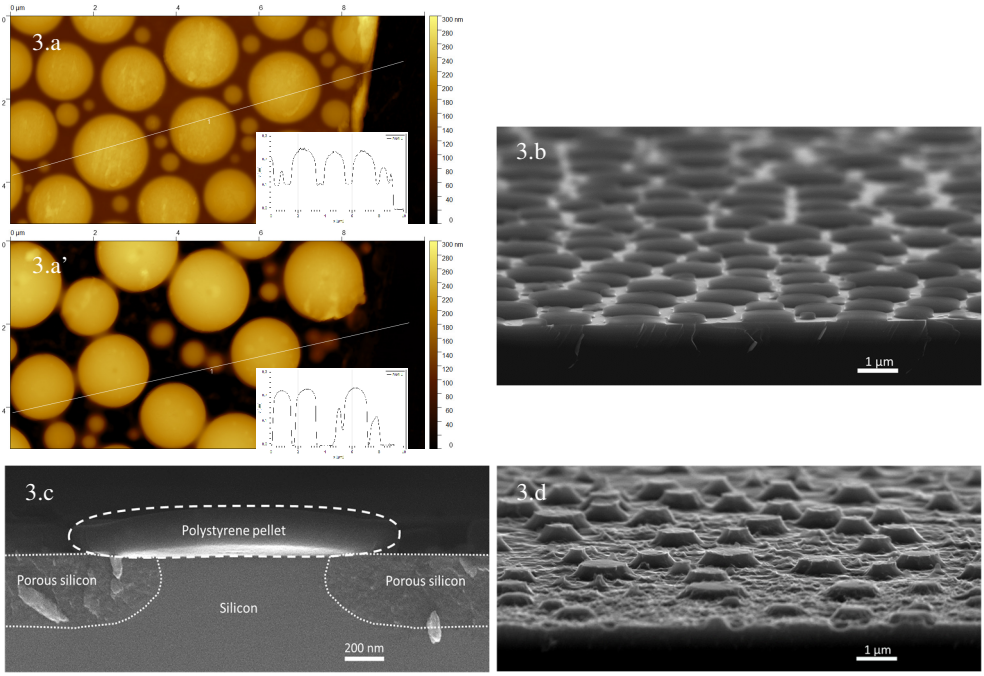

Figure 3. a) AFM images before and after a specific solvation of polyvinyl acetate with acetic acid and associated profiles, **b)** SEM image of the polystyrene mask after polyvinyl acetate removal, **c)** SEM image of silicon after the electrochemical etching through the polystyrene mask, **d)** SEM image of silicon after PSi dissolution by a KOH solution

The Figure 3.c shows the sample after the etching through the mask. It shows one PS domain. Below this domain, the silicon is not porous while the open areas on either side are porous up to a depth of about 350 nm. Figure 3.d presents the sample after dissolution of the porous silicon by the KOH solution. Small plateaus of non-porous silicon are visible. Figure 3.c and 3.d demonstrate that the silicon substrate could be protected from the electrochemical etching with a polystyrene mask.

3 Conclusion

Porous silicon area was localized on a silicon substrate using a polymeric mask composed of discreet domains of polystyrene. This mask was obtained from a structured PS : PVAc polymer blend thin film structuration due to lateral phase separation followed by a selective extraction of PVAc. This method enables to obtain a large variety of morphologies by optimizing several parameters of the blend such as the blend composition, solvent and the features of polymers. This method allows to avoid the use of hard masks structured by photolithography by an “all chemical way” which is cheaper, faster and enables smaller mask pattern.

Acknowledgements

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Interaction Between Laser Irradiation Nd:YAG (at 1064 nm) and Ultramarine Blue Pigment

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Abstract. *Mural paintings located outdoor are exposed to the action of different deterioration agents that cause, among other forms of deterioration, the formation of superficial crusts. Among the cleaning methods used in cultural heritage, laser ablation is approaching to be a technique capable to ensure a success removal of these crusts, avoiding risks to the historical-artistic value of the substrate. As the literature on laser cleaning of mural paintings is scarce, this study aims to advance in understanding interactions between laser radiation and the pigments of the paintings. In this work, ultramarine blue is irradiated with a nanosecond pulsed Nd:YAG laser operating at 1064 nm and four different fluences. Modifications on colour, chemical composition and micromorphology were evaluated by means of stereomicroscopy, colour spectrophotometry and scanning electron microscopy.*

Keywords. Laser, Nd:YAG, pigment, ultramarine blue, laser cleaning, conservation, cultural heritage

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1 Introduction

Laser ablation is a physical process based on interaction matter-laser radiation, which in the field of heritage conservation has many applications: chemical analysis, structural diagnostics, optical imaging, and cleaning. In fact, laser cleaning shows a several advantages [1] over other methods, since no additional substances are incorporated, no mechanical contact with the object, it allows precision removal of thin layers of material (contamination, paint, corrosion, etc.), the method is automated and self-controlled and the technique is environmentally friendly.

The pigment ultramarine blue is used as artificial pigment since 1828 to nowadays [2,3], therefore present in many wall paintings. Studies on laser cleaning of paintings are mainly focused on removal of varnishes [4], remains of previous conservation treatments [5], pigments [6], spray paint on stone sample [7]. Due to the difficulty in understanding why some pigments are more susceptible to laser radiation than others, this study aims to investigate what happens to ultramarine blue using a commercial nanosecond pulsed Nd:YAG laser at different fluences operating at 1064 nm.

2 Materials and Methods

2.1 Ultramarine blue pigment

The pigment ultramarine blue (UL hereinafter) ($3Na_2O \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot 2Na_2S$) was supplied by Kremer Pigments GmbH & Co, KG (Germany). Pellets of 4 cm diameter and 0.3 cm thickness were prepared in aluminium moulds of 4 cm diameter and compacted with a 30-tonne pressure press.

2.2 Laser irradiation

The equipment used in this study was a Q-switched pulsed Nd:YAG laser (Quanta Ray, INDI) operating at 1064 nm. The laser system delivered pulses of 6 ns duration at a constant repetition rate of 10 Hz. The beam reached the surface using a spherical plane-convex lens with a focal length of 250 mm.

Methodology of irradiation was first based on the identification of the fluence at which damages started to become visible on the surface of the sample (UL_D). It was decided to lower the fluence starting to induce visible damage 5% to bring it closer to the damage threshold (UL_{th} hereinafter). A fluence 40% above and below UL_D were selected to investigate the effect of the laser on the pellet. A horizontal overlap of 80% and a vertical overlap of 50% were set for each area. Then, four areas of 1.2 cm x 1 cm were irradiated setting 0.4 cm between adjacent irradiations. The following areas were performed:

- Area UL_D: fluence of 1.4 $J.cm^{-2}$ and a spot diameter of 0.30 cm.
- Area UL_{th}: fluence of 1.3 $J.cm^{-2}$ and a spot diameter of 0.31 cm.
- Area UL-40%: fluence of 0.8 $J.cm^{-2}$ and spot diameter of 0.39 cm.
- Area UL+40%: fluence of 2.0 $J.cm^{-2}$ and a spot diameter of 0.25 cm.

2.3 Analytical techniques

2.3.1 Pigment characterisation

The mineralogical composition of ultramarine blue was determined using X-ray diffraction (XRD, X´Pert PRO PANalytical B.V.). The identification of the minerals was carried out using Xpowder software. The microtexture and elemental composition was studied by means of FEI QUANTA 200 scanning electron microscopy with energy dispersive X-ray spectrometry (EDS) and working in secondary electron (SE) and backscattered electron (BSE) detection modes.

2.3.2 Irradiated areas characterisation

For the characterization of each irradiated area, the following techniques were applied:

Stereomicroscopy before and after irradiation using an SMZ800 NIKON® to detect the physical changes.

The colour of each irradiated area was characterised using a Minolta CM-700d spectrophotometer obtaining the CIELab and CIELCH colour spaces parameters L^* (lightness), a^* (colour position between red and green), b^* (colour position between yellow and blue), C^*_{ab} (chroma) and h_{ab} (hue) [8]. Measurements were made in specular component excluded (SCE) mode, for a spot diameter of 8mm, using a D65 illuminant and an observer angle of 10°. A total of three measurements for each irradiated area were made. ΔL^*, Δa^*, Δb^*, ΔC^*_{ab} and ΔH^* colour differences and total colour change (ΔE^*_{ab}) were calculated following [8], taking the data colour of the pellet before irradiation as reference.

Micromorphological and compositional analysis, via scanning electron microscopy (SEM) with energy-dispersive X-ray spectrometry (EDS) using the equipment previously described.

3 Results and Discussion

3.1 Pigment characterisation

The mineral phases identified by means of XRD in ultramarine blue were the sodalite-group phases such as lazurite (Na3Ca(Al3Si3O12)S) and sodalite (Na8Al6Si6O24Cl2), as well as nepheline (NaAlSiO4) and kaolinite (Al2Si2O5(OH)4). SEM micrographs depicted particles very small in size (1-5 µm) (Fig. 1a) composed, following EDS, of Si, Al, Na and S (Fig. 1b). Additionally, other particles, bigger in size (15-40 µm) and irregular morphology, and composed of Ca and S (Fig. 1c) were found. Kaolinite presence was confirmed by the detection of Al and Si rich particles (Fig. 1d).

3.2 Irradiated areas characterisation

By means of stereomicroscopy, morphological differences regarding the fluence per pulse irradiation were found. When the threshold fluence was exceeded, deterioration caused to the pellet by the laser irradiation was more evident, as it became rougher (Fig. 2b) compared to the not irradiated surface (Fig. 2a).

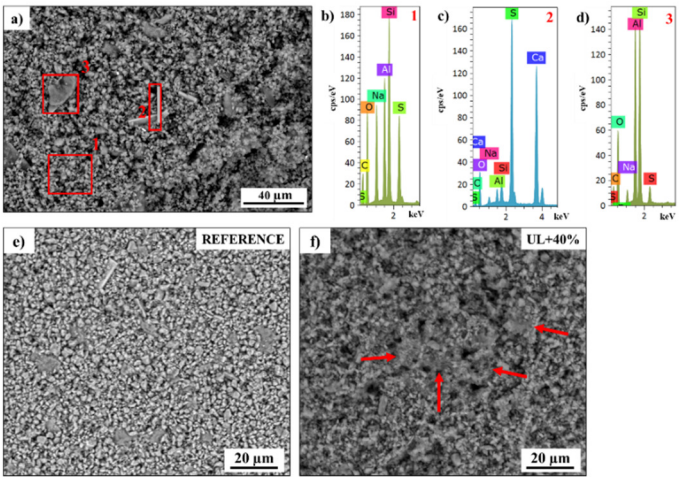

Figure 1. SEM micrographs in BSE mode and EDS spectra. (a) micrograph of ultramarine blue pigment; (b-d) EDS spectra of ultramarine blue pigment, (e) micrograph of the not-irradiated area, (f) micrograph of the surface irradiated at the highest fluence with Nd:YAG at 1064 nm; red arrows indicate crust melting.

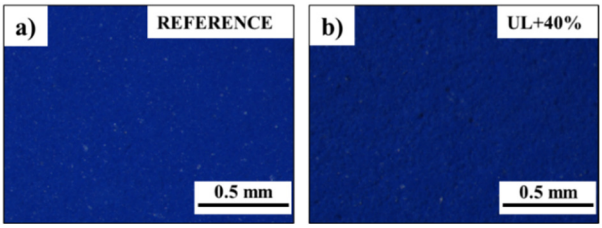

Figure 2. Micrographs under stereomicroscopy of some areas of the sample: (a) reference not-irradiated area, (b) UL+40% irradiated area with Nd:YAG at 1064 nm.

Table 1 shows the CIE colour differences and the global colour change (ΔE^*_{ab}) calculated after the irradiation under the four laser conditions. In fact, taking into account the ΔE^*_{ab}, only the colour change produced under UL+40% condition was visible to the human eye, as shown by the ΔE^*_{ab} obtained for that area, which was higher than 3.5 CIELab units, threshold at which an unexperienced observer can perceive changes in colour [9]. Table 1 also shows that: 1) as the fluence increases, ΔE^*_{ab} also increases and 2) the colour after UL+40% irradiation tends towards yellow by having positive Δb^*.

Table 1. ΔL^*, Δa^*, Δb^*, ΔC^*_{ab} and ΔH^* and global colour change (ΔE^*_{ab}) in each one of the irradiated areas. Each value is accompanied by its standard deviation.

	ΔL^*	Δa^*	Δb^*	ΔC^*_{ab}	ΔH^*_{ab}	ΔE^*_{ab}
UL_D	1.60 ± 0.48	-1.98 ± 0.68	-0.54 ± 0.31	-0.14 ± 0.52	-2.05 ± 0.74	2.61 ± 0.89
UL_{th}	1.54 ± 0.46	-1.76 ± 0.65	-0.58 ± 0.31	-0.04 ± 0.52	-1.85 ± 0.89	2.41 ± 0.86
UL-40%	1.24 ± 0.46	-0.39 ± 0.65	-1.37 ± 0.31	1.15 ± 0.52	-0.82 ± 0.88	1.88 ± 0.86
UL+40%	1.70 ± 0.49	-5.73 ± 0.67	3.03 ± 0.31	-4.67 ± 0.52	-4.49 ± 1.12	6.70 ± 0.89

SEM allowed to confirm that melting crusts appeared after irradiation at the highest fluence (Fig. 1f comparing with Fig. 1e-not irradiated-).

4 Conclusion

Ultramarine blue pigment is susceptible to suffer deterioration by laser irradiation. Irradiated areas experienced greater colour changes as the fluence increased and appeared to become rougher. Fluence of 2 $J.cm^{-2}$ caused a colour change visible to the human eye towards yellowish tones and at the same fluence, SEM showed that crust melting started to appear.

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Measuring Foot Clearance Through Video-Based Methods: A Metrological Comparison

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Abstract. *In health care and sports, gait analysis and the evaluation of its kinetic parameters are widely used tools. Among them, we evaluated an important parameter for the assessment of drop foot event: foot clearance. In this study, two video-based methods for estimating heel clearance were compared. In the experiment, a healthy subject walked on a treadmill at 3.6 km/h while being recorded by two RGB cameras. One was positioned sagittal to the treadmill and the other at 45°. Two video-based algorithms were used to extrapolate the 2D heel trajectories for each recording. The first algorithm uses a deep learning approach (TC-Former), and the other a passive marker approach (blob analysis). Subsequently, an algebraic triangulation was performed. A 6-camera optoelectronic system was used as the gold standard for comparing the results. TC -Former performed worse than blob analysis with a root mean square error of 32.1±13.0 mm, while blob analysis had Blob Analysis showed a root mean square error of 20.1±6.1 mm. In all gait cycles, the mean and standard deviation of the maximal foot clearance was 32.1±12.8 mm for TC -Former and 20.1±13.0 mm for Blob Analysis.*

Keywords. Metrological assessment, computer vision, deep learning, gait analysis, foot clearance

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1 Introduction

Human motion tracking, gait analysis and its kinetic parameters are one of the most commonly used indicators to determine the health status of a person, as any deviation from normal gait may indicate an underlying problem [1]. In particular, foot clearance assessment is an important tool for evaluating the risk of falls, especially in older people. Foot clearance is a key parameter in the assessment of the drop foot event in stroke survivors [2]. Several studies focused on new affordable and reliable clinical solutions for human motion tracking and gait analysis, but it is still quite a challenging task.

2 Background and Motivation

For motion tracking and estimation of human kinematic parameters, infrared marker-based motion capture (MoCap) systems are considered the gold standard. However, these systems can be costly and occasionally intrusive, require skilled personnel and need to be placed in a limited and controlled space [3]. Nowadays, wearable inertial sensors are validated tools for estimating human kinematic parameters and can be a cost-effective alternative to Mocap systems, including outdoor assessment. However, in recent years, there has been increasing interest in developing methods for measuring human kinematics based on vision systems. The clinical potential of video-based systems for gait analysis is promising because they are non-invasive, low-cost, and can be used in a variety of environments. One of the simpler approaches to assess the 2D trajectory of key human points based on an RGB camera is blob analysis [4]. However, no studies have yet been conducted to compare the measurement accuracy of gait analysis methods based on blob analysis with methods based on Deep Learning. This study aims to evaluate the accuracy of two video-based methods for analysing 3D heel trajectories to measure foot clearance. Specifically, a metrological comparison was performed to evaluate the performance of a markerless algorithm based on a Deep Learning neural network for pose estimation (TC -Former) [5] with a marker-based method based on a colour threshold filter and blob analysis [4].

3 Materials, Methods and Preliminary Results

A healthy adult (age: 26 years, weight: 72 kg, height: 172 mm) participated in the experiment, walking on a treadmill at 3.6 km/h while being recorded by two RGB cameras. As shown in Figure 1c, the first camera was pointed at the subject's sagittal plane, which was at (-2000, 0) mm with respect to the origin. The second camera was positioned at an angle of 45° behind the subject at (-1500, -1500) mm with respect to the origin s0. Using a Vicon optoelectronic system as the gold standard, we placed 39 markers on the participant according to the plug-in gait model. For the marker technique, we implemented a colour threshold filter in HSV colour space, which allowed us to identify the centres of six green passive markers positioned on the joint centres of the left limb using blob analysis. In this study, we only used the passive marker of P4 and reflective markers on the heel.

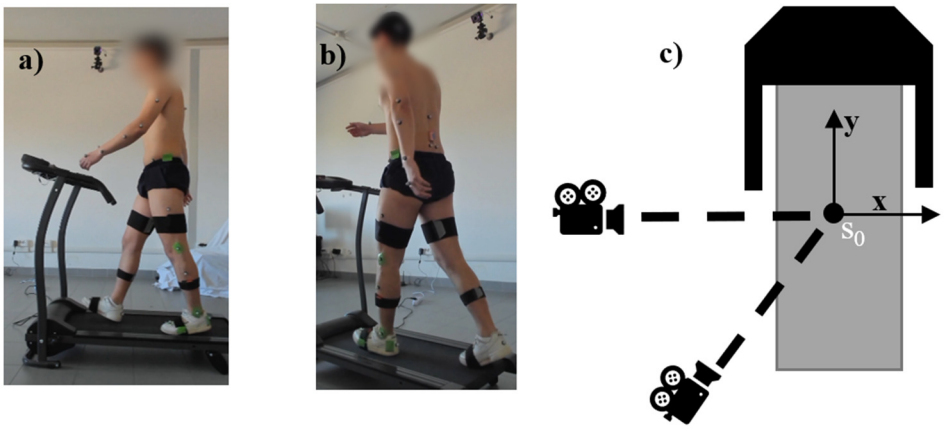

Figure 1. a) Sagittal camera view of the subject displaying the reflective and six green passive markers, b) 45° Posterior camera view, c) Camera positioning

Matlab (v.2022b, The Mathworks Inc., Natwick, USA) and the Stereo Camera Calibration app were used to calibrate the stereo camera and calculate the intrinsic and extrinsic camera parameters. The Matlab Stereo Camera Calibrator toolbox implements the calibration algorithm developed by Zhang Z [6]. To calibrate the desired volume, an 8x10 chessboard with 20 mm squares was taken by the two cameras during the calibration process. The chosen markerless algorithm uses a hierarchical strategy and is composed of two different neural networks. The first neural network acts as a detector and has the task of surrounding the object with an anchor box. The second neural network then acts as a pose estimator and determines the keypoints based on the image that is inside the anchor box. We used a faster R-CNN model [7] as the detector and the TC -former [5] as the pose estimator. After extrapolating the 2D heel trajectories using the two video-based methods, we performed an algebraic triangulation to determine the 3D heel pose. To calculate the heel clearance, we first segmented the trials into the gait cycle and considered the heel contact from OS.

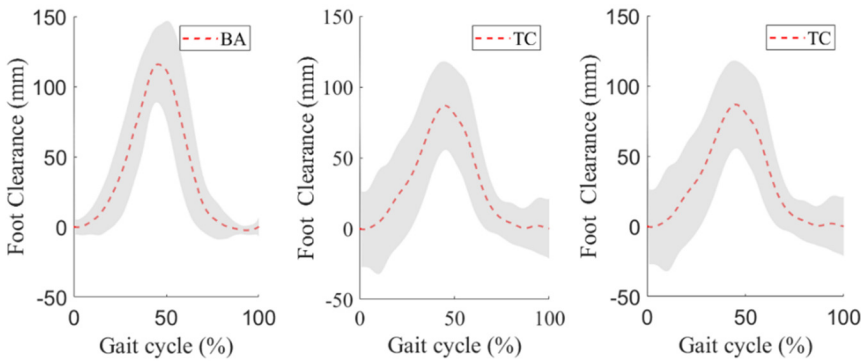

Figure 2. a) Foot clearance from Blob Analysis (BA); b) Foot clearance from TC-Former (TC); c) Foot clearance from Optoelectronic system (OS). The red dashed line represents the mean along the gait cycle, while the standard deviation is represented by the grey-shaded areas.

To compare the three systems, the offset above the heel height was removed for each heel contact. TC -Former performed worse than Blob Analysis with a root mean square error of 32.1±13.0 mm, while Blob Analysis had a root mean square error of 20.1±6.1 mm. The average mean and standard deviation of the extracted maximal foot clearance in all gait cycles was 32.1±12.8 mm for TC -Former and 20.1±13.0 mm for Blob Analysis.

4 Conclusions

Two video-based algorithms were used to extrapolate the 2D heel trajectories for each recording. Algebraic triangulation was then performed for 3D heel pose estimation. According to the literature [8], the marker-based algorithm provides an affordable and cost-effective clinical tool for estimating foot clearance. In contrast, the video-based method based on TC -Former does not provide reliable results and proves that the markerless algorithm for 3D estimation of the keypoints of the foot needs further research and investigation.

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Mechanical Characterization of Low-Cost Piezoresistive Fabrics for Sensors Design

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Abstract. *Thanks to their intrinsic properties of stretchability, flexibility and lightweight, wearable piezoresistive sensors are remarkable devices to capture physiological parameters and joint motion monitoring. Many sensors' designs were evaluated since the discover of piezoresistivity but repeatability and hysteresis persist to be the most crucial parameters. The aim of the study is to characterize conventional low-cost sheets of piezoresistive fabrics in terms of mechanical properties. We laser cut two types of conductive sheets (Eeontex and Velostat) in according to ASTM D882 and tested them with a tensile machine (MTS Insight Electromechanical 50 kN). Differences between two orthogonal directions of the same fabric in break stress, elongation and Young's modulus was statistically evaluated with a t-test.*

Keywords. Wearable sensors, piezoresistive, low-cost, tensile test, statistics

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1 Introduction

In the past years, wearable devices held great significance in several areas, such as rehabilitation, clinical evaluation and sports [1]. The exploration of smart fabric interfaces offers the opportunity to integrate wearable technology into daily life and access data generated by the body. The ability to connect ordinary objects and obtain data from them in real time has the potential to increase and improve decision making. Sensors are the main element of wearable technology. Wearable sensors based on the detection of small changes in resistance are universally recognized as piezoresistive. The most used piezoresistive textile are typically carbon filled Low Density Polyethylene (LDPE) [2]. Polymerized conductive silicon treated with high temperature is also used for such sensors [3]. However, the fabrics that seems to be more promising in terms of sensitivity, hysteresis and responsiveness are the sheets made by *Eeonyx* [4].

2 Background and Motivation

Smart textile sensors can rely on several configurations but the most common and used ones are sandwich or multilayer and machine sewn. The first class is based on piezoresistive sheet placed between two layers of conductive elements and it's the simplest one. Knitting conductive yarns with elastic ones is a solution but textile equipment is required, and they are more expensive. Recent studies pushed the upper limit by developing weft-knitted sensors capable of reaching extremely low hysteresis values [5]. Sewing multiple conductive threads was used to develop multilayer matrix structure, confirming that hysteresis is the main drawback of piezoresistive soft materials [6]. Simplest and low-cost sensors were investigated for real time pressure sensing profiles in prosthetic socket [7], and wearable tactile dataglove [8]. Stretchable wearable sensors can also be used to measure human body joint kinematics [9], or to detect inappropriate sitting posture [10]. In sports applications, design and size are crucial and the responsiveness of this fabrics to sweat is something to evaluate [11]. It's clear that the main problematics of low-cost multilayer sensors is their hysteresis and repeatability. Despite the high research interest in this type of sensors, there's still no exhaustive study on the mechanical characterization of these smart fabrics. A more in-depth analysis of the mechanical characteristics of these piezoresistive materials may be necessary for the improvement of the performance of textile sensors. Attaching and combining different sheets to make a reliable device needs to be supported by a well-defined evaluation of their properties. In this paper two different types of piezoresistive fabrics were tested, by cutting them with laser along two directions and by pulling them with a tensile machine. Ensuring the highest reliability and repeatability, the samples were compared in terms of break stress, elongation and Young's modulus.

3 Materials, Methods and Preliminary Results

We studied and compared two types of piezoresistive sheets of fabrics, both low-cost (around 10 € for a 30 x 30 cm^2). The first one is called Eeontex NW170-PI-20 and it is composed of a filament blend of polyester and nylon 6 (70/30), 0,8 mm thick. The second one is called Velostat and it is

a carbon filled polyethylene, 0,1 mm thick. A laser cutting machine (SnapMaker Original 1,6 mW*)* was used to ensure the highest repeatability of the samples. Preliminary cutting tests were made to define the suitable parameters for the laser cutting process. Eeontex was cut with 100 mm/min work speed, 50 % of max power with three passes. Velostat was cut with 550 mm/min work speed, 75 % of max power with one pass. For both materials the original design was 5 x 120 mm^2. For the tensile test we used MTS Insight Electromechanical 50 kN and we observed ASTM-D882 (Figure 1a). Unlike Eeontex samples, Velostat ones were tested considering PLA plates to improve grasping. In fact, in preliminary tests, the gripping of the Velostat to the machine showed slipping phenomena and tears near the hangers (Figure 1b), making the tests not compliant with the standards. The width of the samples was also doubled (from 5 to 10 mm) to avoid grip issues. Break stress, elongation and Young's modulus were acquired from five samples per direction of cut. For Eeontex, it is possible to define a wale and a course direction. As it is not possible to give the same definition for Velostat, the two directions will be defined: direction 1 and direction 2 (Figure 2). Wale and course are orthogonal as well as direction 1 and direction 2. To assess differences in mechanical characteristics of fabrics, unpaired t-tests were conducted between directions. For both fabrics there's a significant difference between values of Young's modulus. Eeontex shows differences in direction also for the Elongation parameter. In addition, it is evident from Figure 2 that there is a difference between Velostat and Eeontex for all parameters reported.

a

b

Figure 1. a) Velostat during the tensile test with PLA plates. b) Tears appeared after the test without PLA plates in 3 samples with different width.

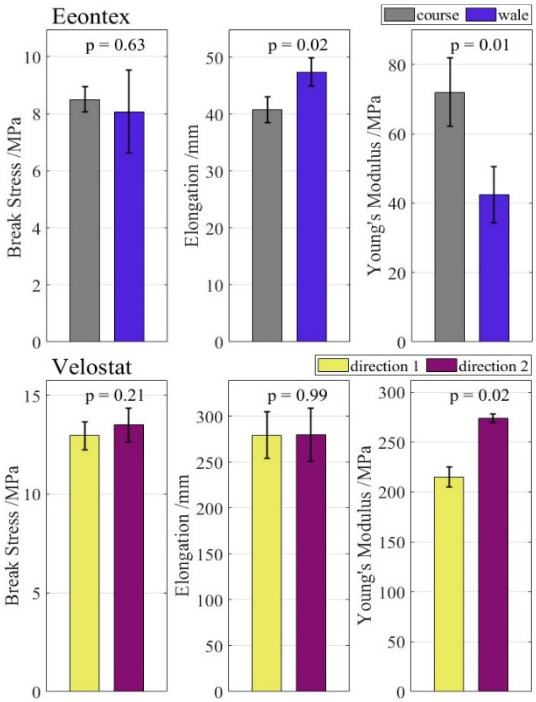

Figure 2. Statistic test results for Eeontex and Velostat.

4 Conclusions

Piezoresistive sheets of Eeontex and Velostat were evaluated with a tensile test for improving future sensors' design. The testing technique has reported problems regarding Velostat and needs to be improved in terms of grip with the hangers. Although on a small sample of material, preliminary results showed a difference between the two types of material and between the directions of weaving. Preliminary results are nevertheless shown to be interesting in terms of differences between Young's modulus: for Eeontex the value is almost doubled between directions. Future developments will aim to validate this result on a larger sample set, refine the test technique and verify the relevance of the design directions of textile-based wearable sensors.

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Numerical and Experimental Study of High-Pressure Gas-Jet Targets for Ion Acceleration in the Near-Critical Density Regime

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Abstract. *Ion acceleration in the near-critical density regime is a captivating research area in high-energy physics and plasma physics. High-pressure gas jets have gained popularity as targets for ion acceleration experiments, due to their potential to offer debris-free ion sources that support high repetition rates. The purpose of this research is the design and fabrication of such gas targets for future ion acceleration experiments in the near-critical density regime. The optimization of two nozzle geometries has been studied using the ANSYS Student simulation program. The Computational Fluid Dynamics (CFD) problem is efficiently solved, and the determination of their cubic particle density maps is achieved. In addition, these nozzle geometries were fabricated using 3D printing and characterized in a vacuum environment, using Mach-Zehnder interferometry. These results make a significant contribution to the production of high-pressure gas targets for ion acceleration experiments and offer valuable insights for the design of future experiments.*

Keywords. Near-critical density regime, ion acceleration, 3D printing, CFD simulations, high-pressure gas-jet targets

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1 Introduction

Laser-induced ion acceleration is achieved by the interaction of a laser beam with a solid target. After each irradiation, these targets are destroyed, and replacement is required. As a result, they are not able to support high repetition rates. Near-critical density targets are considered a promising alternative for high-repetition-rate and debris-free ion sources. Several methods have been explored for the creation of near-critical density plasmas, including carbon nanotubes, liquids, water droplets, or gas jets [1]. Among these options, high-pressure gas targets have gained significant attention in ion acceleration experiments due to their numerous advantages [2].

The purpose of this study is to conduct an interferometric characterization of one cylindrical and one conical nozzle geometry within the vacuum. This parametric investigation initiates with the design and simulation of these two nozzle geometries to assess their potential as near-critical density targets. To experimentally validate the simulation findings, an experimental setup was developed to generate the consequent particle densities. The study finishes by presenting significant findings and drawing important insights.

2 Computational modelling

In laser-plasma interaction experiments, achieving the optimal density profile is crucial [3]. Two nozzle geometries, one cylindrical nozzle with $800\mu m$ diameter throat and one conical nozzle with $400\mu m$ minimum diameter demonstrated interesting characteristics [2, 4]. The CFD problem was efficiently solved using ANSYS Student, and its associated processor, ANSYS Workbench.

When determining the geometry for the flow analysis, the proper computational mesh was chosen. The mesh was divided into three distinct areas, as illustrated in Fig. 1 for the $800\mu m$ cylindrical nozzle. Fig. 1 depicts the computational design of the nozzle along with a reservoir and a $6mm \times 6mm$ chamber for gas expansion. The triangular mesh was employed, and the inflation-layer meshing was implemented near the walls.

Once the computational mesh was generated, the CFD analysis was set up. Its set of governing equations was chosen to be solved until a steady-state solution is achieved. Helium (as an ideal gas) was selected, and appropriate boundary conditions were specified. The inlet pressure was set to be $55 \times 10^5 Pa$, while the outlet pressure was set to be $25Pa$. The adiabatic expansion was assumed. By following this procedure for both nozzle geometries, numerous simulation results were obtained.

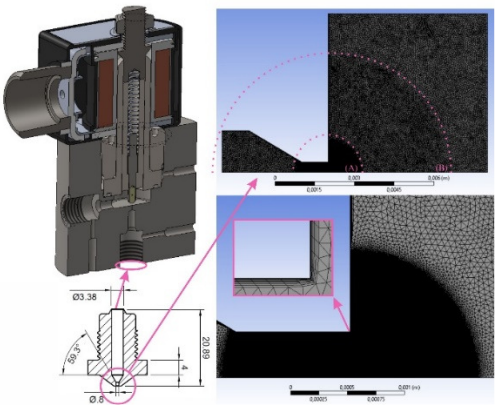

Figure 1. Each nozzle geometry is placed within the inner section of the solenoid valve. The computational mesh contained a reservoir positioned at the back of the nozzle, along with a chamber for gas expansion. The three distinct regions, that the mesh was separated into, are visible, along with the inflation-layer meshing near the walls.

3 Numerical simulations of the flow

By defining the key parameters, the prediction of the particle densities and velocity magnitudes was achieved. The program computed the helium particle densities across the whole domain for the case of the $800\mu m$ cylindrical nozzle, and at the exit of the nozzle the particle density was approximately $8.3 \times 10^{20} cm^{-3}$ (which corresponds to electron density $n_e = 0.48 n_{cr}$ for a $800nm$-wavelength laser system, where n_{cr} is the critical density). As far as the $400\mu m$ conical nozzle is concerned, the maximum helium particle density at the exit was determined to be approximately $9.3 \times 10^{20} cm^{-3}$ ($n_e = 0.55 n_{cr}$ for a $800nm$-wavelength laser system).

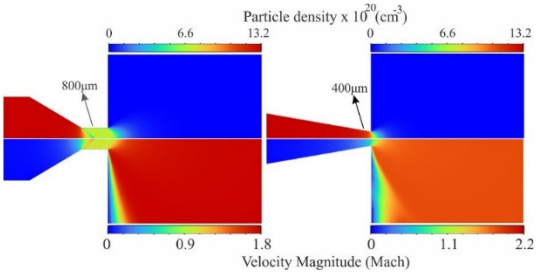

Figure 2. The particle density (top line) and the velocity magnitude contour maps (bottom line) at the exit of the nozzle for the $800\mu m$ cylindrical (left row) and the $400\mu m$ conical nozzle (right row), at inlet pressure of $55 bar$, using helium expanding inside the vacuum.

During the setup process, a steady-state solution was chosen for each velocity contour map, in order to depict the final, unchanging pattern of flow. At the exit of the nozzle, for the $800\mu m$ cylindrical nozzle, the velocity is approximately $1 Mach$. For the case of the $400\mu m$ conical nozzle, the velocity magnitude at the exit of the nozzle is approximately $0.9 Mach$.

4 Methodology of the interferometric analysis

Following the simulation of the cubic density profiles, an experimental setup was developed. This experiment was conducted inside the laboratories of the Institute of Plasma Physics and Lasers (IPPL), in Rethymnon, Greece. The Mach-Zehnder interferometry was employed and the experimental configuration is depicted in Fig. 3. Upon employing the necessary experimental apparatus, the interferometric characterization of the gas-jet targets was successfully executed.

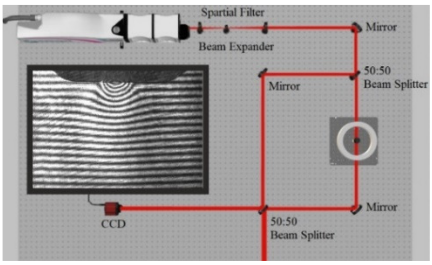

Figure 3. Schematic of the experimental setup that was employed for the interferometric characterization of the gas-jet targets.

5 Experimental results and analysis

The cubic particle density maps were calculated for both helium, and nitrogen, expanding within the vacuum, for each of the two nozzle geometries. Simulation investigation using nitrogen was not carried out due to limitations of ANSYS Student. The first experimental measurements were conducted using the $800\mu m$ cylindrical nozzle. Fig. 4(a) and (b) illustrate the cubic particle density contour maps for the case of helium and nitrogen respectively. The maximum particle density using helium was calculated to be $5.91 \times 10^{20} cm^{-3}$ ($n_e = 0.35 n_{cr}$ for an $800nm$-central-wavelength laser system), at the edge of the nozzle. Correspondingly, when nitrogen was employed, the maximum particle density was $3.66 \times 10^{20} cm^{-3}$ ($n_e = 0.21 n_{cr}$ for an $800nm$-central-wavelength laser system) at the exit of the nozzle.

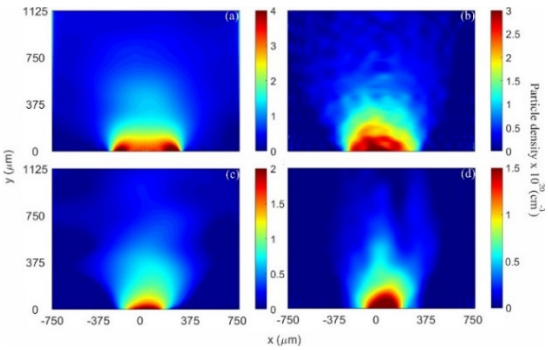

Figure 4. Cubic particle density contour maps for the $800\mu m$ cylindrical nozzle ((a) and (b)) and the $400\mu m$ conical nozzle ((c) and (d)), using helium ((a) and (c)) and nitrogen ((b) and (d)) expanding within a vacuum of $200mTorr$, at a static pressure of $55bar$.

An analytical investigation was carried out for the $400\mu m$ conical nozzle, as depicted in Fig. 4(c) and (d). The maximum particle density in this situation is equal to $2.41 \times 10^{20} cm^{-3}$ at the edge of the nozzle ($n_e = 0.14 n_{cr}$ for an $800nm$-central-wavelength laser system). As far as nitrogen is concerned, the calculated maximum particle density equals to $1.86 \times 10^{20} cm^{-3}$ (corresponding to $n_e = 0.11 n_{cr}$ for an $800nm$-central-wavelength laser system).

In these experimental findings, helium exhibited higher particle densities compared to nitrogen, for all nozzle shapes. However, nitrogen possesses more electrons compared to helium, making it a better donor of electrons. For full ionization of nitrogen, which can be achieved with the Zeus laser system (critical density $1.7 \times 10^{21} cm^{-3}$, and intensity $4.5 \times 10^{20} W/cm^2$) which is located inside the laboratories of the IPPL, the consequent plasma electron density equals to $1.51 n_{cr}$. For the same experimental conditions, for full ionization of helium, the consequent plasma electron density equals to $0.35 n_{cr}$. Taking these factors into consideration, the selection of the ideal gas for an experiment should be based on its specific requirements.

6 Comparison of the simulation and experimental results

Following the acquisition of the experimental and the simulation contour maps illustrating the helium particle density, a comparative analysis was conducted for both nozzle geometries. Specifically, a density lineout comparison between the experimental and simulation results was performed at a distance of $100\mu m$ from the exit of each nozzle. The results of this comparison are presented in Fig. 5, with the particle density axis being in a logarithmic scale.

It is clear that the simulation and experimental semilogarithmic particle density lineouts follow the same trend for each of the nozzle geometries. In the case of the $800\mu m$ cylindrical nozzle (left), the gas has a top-hat density profile, while for the $400\mu m$ conical nozzle, the gas exhibits a Gaussian-type density profile. Depending on the demands of the experiment, each nozzle geometry can be selected.

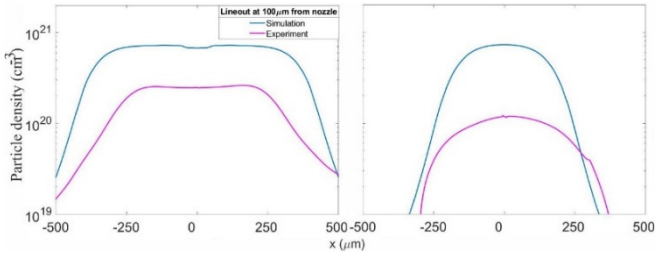

Figure 5. Semilogarithmic density lineout comparison at a distance of $100\mu m$ from the exit of the nozzle between simulation and experiment for the cylindrical (left) and the conical (right) nozzle, using helium expanding within a vacuum of $200mTorr$, and an inlet pressure of $55bar$.

Another interesting observation is that the peak particle densities for the $800\mu m$ cylindrical and the $400\mu m$ conical nozzles are lower in the experimental data than in the ANSYS Student calculations. This is attributed to the fact that the particle density lineout in the experimental data does not correspond to the actual distance of $100\mu m$ above the exit of the nozzle. This is

due to the tilt of the system, especially the gas jet, that caused shadows to the experimental data. Nonetheless, the simulated and the experimental results are in agreement.

7 Concluding remarks

In this study, the simulation of two nozzle geometries, one cylindrical and one conical, was performed with the use of ANSYS Student. The aim was to investigate the resulting particle densities and profiles. Subsequently, these nozzle geometries were 3D printed and characterized within the vacuum using the Mach-Zehnder interferometry.

The most significant outcome of this study is that these gas-jet targets can be provided as near-critical density gas targets for dynamic ion acceleration experiments using a laser of $800nm$ central wavelength. For an $800nm$-wavelength laser system, the critical zone is from $1.72 \times 10^{20} - 1.72 \times 10^{22} cm^{-3}$. These peak particle densities were achieved using both types of nozzles and gases, at a static pressure of $55bar$. Consequently, the next step involves the further optical tailoring of these gas-jet targets, i.e., their optical shaping with ns laser pulses, for future ion acceleration experiments.

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On the Use of Gee for Management and Monitoring of Flood Events

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Abstract. *This work analyzes the phenomenon of the dynamic variation of thewater bodies surface under extreme climatic events. The Apollo hurricane, that affected the Mediterranean Area in 2021 was considered as input condition for the delineation of flood area in Simeto Basin in Sicily. The studywas conducted through the use of SAR (Synthetic Aperture Radar) satellite remote sensing systems treated with the aid of the online platform Google Earth Engine, and can be considered as a contribution in the field of monitoring tools and techniques, management and protection of the territory.*

Keywords. Flood events, remote sensing, sentinel 1, SAR, Google Earth Engine, surface of water bodies, Medicane Apollo, EMS Copernicus, PAI

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1 Introduction

The management and monitoring of flood events is a topical issue due to the systematic interchange between flood phenomena periods and extreme drought events, leading to further aggravate the hydrogeological instability and the water crises of territory.

The identification of solutions dedicated to land protection, management and preventionof flood events is crucial to mitigate damage to both economic and cultural/environmental heritage and to reduce the risks associated with loss of life. Hydraulic monitoring activitiescarried out with remote sensed data can make a significant contribution to this issue.

The research is focused on the potential role of satellite remote sensing systems in the field of monitoring, management and protection of territory.

Specifically, an attempt was made to define a methodological and applicative approach which would allow the monitoring of catastrophic events, such as floods, in conditions of absent solar irradiation or insufficient (night hours or cloud cover).

The procedure foresee the use of Synthetic Aperture Radar (SAR) images classifying the different surfaces on the basis of the values deriving from the difference in reflection of thesignal towards the sensor and in particular the recognition of water [1]. For this purpose, the COPERNICUS Earth observation program (promoted by ESA - European Space Agency) Copernicus was taken into consideration.

The Sentinel-1 satellite is a Copernicus mission including a constellation of two satellites (sentinel-1A and sentinel-1B) placed in the same sun-synchronous and near-polar orbit at amean altitude of 693 km, phased at 180° to each other.

Both Sentinel-1 platforms are equipped with SAR providing continuous all-weather, day-and-night imagery at C-band.

2 Methods

The remote sensed data processing was performed using Google Earth Engine environment, with the purpose of identifying the pixels covered by water in a SAR-type satellite image.

The code, implemented in Javascript, has the following structure:

a) Selection of ROI and reference time interval
b) Uploading the SAR Sentinel 1 image collection
c) Application of anti-noise filters (speckle) of the focal median type
d) Classification of pixels by identification of suitable backscattering thresholds
e) Creation of an interactive graph with a callback function of the SAR image corresponding to the point clicked on the graph itself

A complex problem is the calibration and tuning of the application, to determine correct parameters of polarization, back scattering and speckle effect for the evaluation of the surfaces covered by water. It is conditioned by many variables, thus we adopted a heuristic approach, based on 2 consecutive phases:

a) Changes to the speckle effect of the images
b) classification method of water pixels (identification of the threshold value)

3 Case study

Between October 24 and 25, 2021 a Mediterranean hurricane called "Apollo " had a significant impact on the territory, causing victims and extensive damage to infrastructure and productive activities located in the catchment area of the Simeto river and Gornalunga stream (eastern Sicily, Italy).

The flood event is reconstructed in GEE environment [2] by considering sentinel 1 datain the Reference period (14/10/2021-31/10/2021) with the following characteristic Polarization: VV Backscattering threshold: -14 Focal_median filter: Radius: 45m, Proximity: circle

The Sentinel-1images analyzed are:

- image acquired on 10/19/2021, 16:56:28 (fig.1a) represents the situation few daysbefore the storm event;
- image acquired on 10/25/2021 at 05:05:02 in the morning. (fig 1b) represents the situation d a few hours after the storm event.
- Image acquired on 10/25/2021 at 16:55:44, (fig.1c) the situation detectable in thearea several hours after the event.

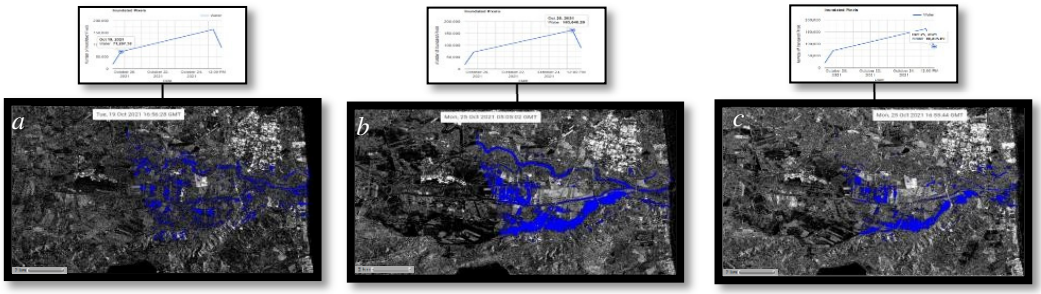

Figure 1. Sentinel-1 images elaborations

The surface covered by water, due to the storm event on the ROI, was approximately 1,400 Ha. This value, after about 12 hours, reduces significantly as is evident from the comparison between the two calculations of 10/25/2021 (05:05 - 16:55 approx.)

From a rough estimate, it can be deduced that, during the day, the outflow of water affected approximately 50% of the surfaces, leaving a residue of surfaces covered by water, equal to approximately 700 hectares compared to normal conditions

The results obtained from the modeling were compared with PAI data from the Simeto Basin [3]. Most of the flooded areas fall into medium and moderate risk zones (R1 and R2),

i.e. with low impact on infrastructure and anthropic settlements. From the analysis of the images it also emerges that the event can be classified with a medium-high probability level (P3/P2) which can be approximated with $50 \leq TR \leq 100$ years (Figure 2).

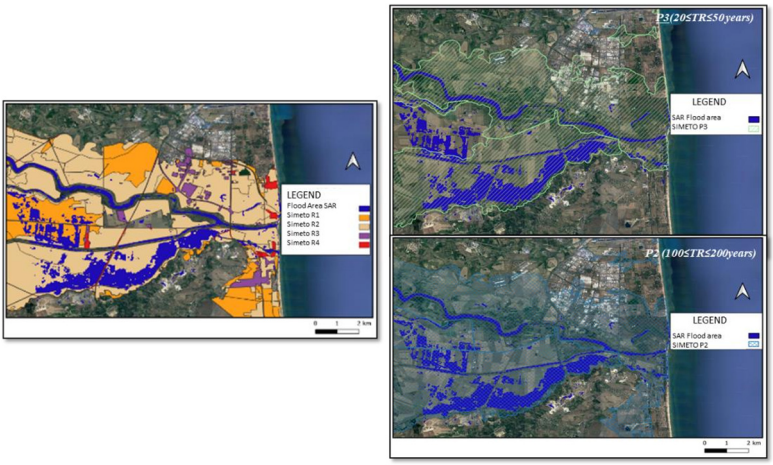

Figure 2. Comparison between risk maps and flood areas

4 Conclusions

The SAR remote sensing is able to ensure the relief of the land in any environmental andirradiance condition and is therefore, in certain contexts and for certain types of event, a discriminating factor of primary importance. The GEE platform constitutes a tool extremelyinteresting thanks to the free and unlimited access to a large catalog of satellite images and the possibility of implementing applications for the treatment and processing The procedureimplemented on the Google Earth Engine platform, with appropriate adjustments and calibrations, has shown an overall validity for the recognition of water bodies. It can be considered a support tool for the evaluation and validation of the effects of a catastrophic flood event, for the ex-post monitoring phases, the estimation of damage to production activities and the impact on infrastructures and anthropic activities.

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Optimization of the Fused Deposition Modelling Process Parameters for the Production of Biopolymeric Scaffolds

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Abstract. *The advent of additive manufacturing has opened a bunch of possibilities in terms of research and advantages in various fields, starting from automotive, aerospace, to biomedical sector. Focusing on the last one, this kind of technology allows to study and design medical implants, in order to overcome limits that occur during traditional manufacturing methods, like long time and multiple steps production high cost, tissue inflammation and necrosis. The present work reports the optimisation of the printing parameters for selected biopolymers, i.e. poly(lactic acid) (PLA), polymethyl methacrylate (PMMA), poly(caprolactone) (PCL), poly(etheretherketone) (PEEK), to be used for the production of scaffolds and implants for craniomaxillofacial applications, by Fused Deposition Modelling Technology (FDM).*

Keywords. Biopolymers, biocomposites, additive manufacturing, 3D printing, craniomaxillofacial applications

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1 Introduction

Additive manufacturing technologies are achieving a lot of interest [1-3] and are employed in several industries. The main fields that have adopted the additive manufacturing approach are the aerospace, automotive and medical ones. In the medical sector it is mainly to produce custom made prostheses in order to replace damaged parts of the bone tissue, properly setting the level of hierarchical porosity within the piece [4]. Thus, the additive manufacturing technology has been proposed as a promising alternative to the traditional manufacturing methods of biopolymeric implants, that consist in the production of hand mallable pastes, allowing to overcome the associated criticisms, such as the obtainment of dense structures, the low mechanical properties, the induction of inflammation [5,6].

In this framework, in the present work, the printing parameters by fused deposition modelling (FDM) for three selected biomaterials, i.e. poly(lactic acid) (PLA), poly(caprolactone) (PCL), polymethyl methacrylate (PMMA), poly(etheretherketone) (PEEK) [7,8], with the final aim to design medical devices such bone scaffold, fixation system for craniomaxillofacial application and cranial implants, were properly selected. Microstructural, thermal and mechanical characterisations were performed by observation at optical and scanning electron microscopies, differential scanning calorimetry (DSC) and tensile and compression tests, respectively.

2 Materials and methods

Two different FDM printers were used, namely Creality Ender 3 Pro and and Intamsys Funmat HT. PCL filament from Facilan, PLA filament from Filoalpha, PMMA filament from TreedFilament and PEEK filament from ThermaX were employed. Different FDM printing parameters were tested, in terms of extrusion and bed temperatures, and printing speed. Six different textures were investigated setting the percentage of empty of the samples nearly to 70% (Line, Triangle, Grid, Gyroids, Octet, Zig-Zag,), in order to emphasise the influence of the pattern on mechanical strength. Mechanical characterisation was made in order to study the effective influence of the deposition patterns in terms of mechanical resistance, . In details, tensile and compression tests were made with MTS Insight 5 testing machine, following the D1708-02a and ASTM D695-15 standards, respecively, with a load cell of 2.5 kN. The samples were preloaded with 20 N and pulled with a tensile speed of 1.2 mm/s. Thermal characterization by differential scanning calorimetry (DSC, Q2000, *TA instruments*) was made to demonstrate the possible process influence on the materials thermal properties. The DSC measurements were performed on both filaments and printed materials, in the following conditions: temperature range -50–300 °C, heating and cooling rates 10 °C /min, nitrogen flux 50 ml/min, for two cycles.

3 Results

The observation at optical microscope allowed to identify the optimal printing parameters.

DSC analysis demonstrated a significant influence of the printing process on the polymer thermal properties. For example, in the case of PMMA printed disks, a decrement of around 10

°C for the glass transition temperature (T_g) with respect to the PMMA filament was revealed in the first heating scan, whereas the values were comparable in the second cycle, due to the removal of the thermal history, as expected [9].

Concerning the mechanical characterization, as expected and evident from the comparison among the acquired stress-strain curves, (Figure 1), PEEK presented the highest mechanical properties with a maximum value recorded nearly to 70 MPA, followed by PMMA and PLA with comparable behavior, whereas PCL showed the lowest performance.

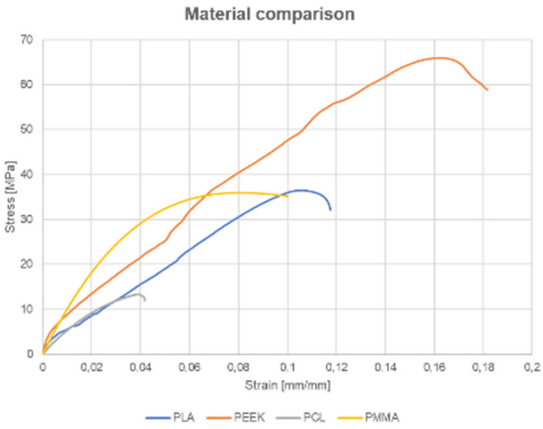

Figure 1. Stress-strain curves of PEEK, PMMA, PLA and PCL printed samples.

Moreover, a significant influence of the selected deposition pattern on the material tensile strength was evidenced (Figure 2), whereas comparable values were obtained in the compression tests. As an example, in Figure 2, the stress-strain curves of PMMA printed using different deposition patterns by maintaining constant the level of porosity (70%), were compared. More specifically, Line and Gyroids patterns offered the highest mechanical strength due to the same orientation of fibers and applied load.

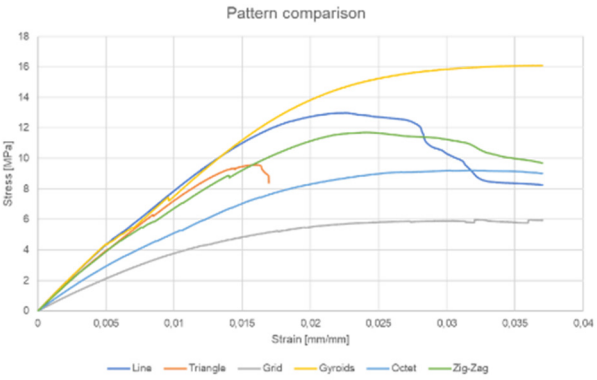

Figure 2. Stress-strain curves of PMMA samples printed using different deposition patterns (porosity level: 70%

Using the selected optimal printing parameters, both supports for the tissue regeneration (i.e. scaffolds) and cranial implant prototypes were produced (Figure 3) [10,11].

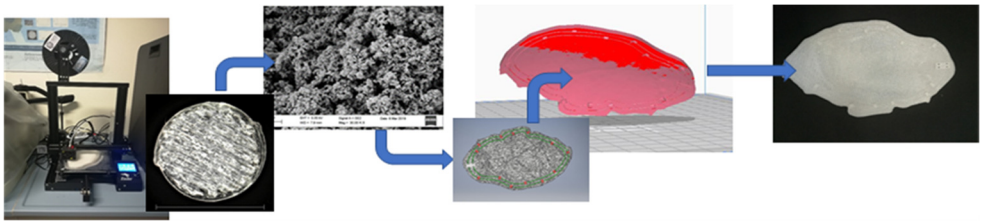

Figure 3. Towards the 3D printing of a cranial implant prototype

4 Conclusions

Optimal printing parameters of different materials for FDM technology were found, fill pattern Line and Gyroids offered the best mechanical tensile strength; but no infill has been found that provides significative mechanical reinforcement in terms of compression. Effective influence of the process on the thermal properties of the material was demonstrated. Future developments will involve the study of the printed supports mechanical properties after the sterilisation process, as well as biological characterisations.

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PLA Deposition on HDPE Substrates for Hybrid Additive Remanufacturing

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Abstract. *Additive remanufacturing can realize the integrated repair of structures or functions, add new features, or apply to simple or complex geometries. It can significantly reduce use, maintenance, labour, and time costs. Additive remanufacturing can be used to produce discontinued replacement parts or emergency guarantee of spare parts, accelerating the green development of product life cycle. This study investigates the technological feasibility for the remanufacturing of high-density polyethylene (HDPE) components by depositing polylactic acid (PLA) through Fused Deposition Modelling3D printing technique. The resulting shear lap tensile strength was evaluated according to the ASTM D3163 standard to define the adhesive or cohesive failure. The tests were performed on as-cut smooth HDPE samples. The results showed an adhesive failure for all the samples, highlighting a poor joining between HDPE and PLA. However, the best performance of around 200 N was achieved for the joint obtained between PLA and HDPE with a dimples' textured surface with a 1 mm diameter made by CNC machining. This finding can be addressed to the greater dimension of the texture, allowing to accommodate a greater amount of fused PLA within the texture itself.*

Keywords. PLA, HDPE, FDM, hybrid components, remanufacturing

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1 Introduction

Additive manufacturing is a production approach based on addition of material allowing manufacturing of customized parts with complex geometry, which are very difficult to be produced by traditional techniques [1]. Components' structures can be also optimized to limit waste production, weight, and costs, while ensuring the proper performance [2].

Among the many solutions, Fused Deposition Modelling (FDM) is the most popular technique thanks to its low cost, high prototyping accuracy, and high printing speed [3]. It is mainly intended for thermoplastic materials, e.g., PLA, ABS, PA, TPU, etc. [4], and it hasbeen successfully applied in many fields, from chemical, to pharmaceutical, food, biomedical, automotive, aeronautics, aerospace, etc. [5].

Recently, the concept of additive remanufacturing/replacement has gained great interestthank to the environmental and economic benefits that can arise by using low-impact additive manufacturing techniques [6]. Moreover, the combination of different materials, aswell as different fabrication technologies, can allow the production of hybrid components with new features and improved performance [7]. But, due to high number of materials andmachines, there is the need of a guideline for parts remanufacturing or replacement.

The present study investigates the technological feasibility for the remanufacturing of high-density polyethylene-based components (HDPE) by depositing PLA through FDM onexisting parts and evaluating their shear strength on the basis of their surface treatment.

2 Materials and Methods

The experimental activity concerned four main steps: (i) preparation of starting plates by CNC cutting; (ii) surface texturing by CNC or laser; (iii) PLA deposition by FDM; (iv) mechanical characterization by shear strength tests. In the following the details.

The selected material to use as substrate is a commercial sheet made of High-Density PolyEthylene (HDPE), by RS, while a commercial PolyLactic Acid (PLA) filament, by SUNLU, was adopted for the FDM processing. The thickness of the sheet is 3.8 mm, whilethe PLA filament has a diameter of 1.75 mm.

The samples were prepared according to the ASTM D3163 standard for shear strength evaluation. The substrates, as well as the FDM counterparts, were designed as plates of 25x70x3.8 mm in dimensions. The HDPE plates were cut by using the Stepcraft D840 CNC,while the PLA plates were fabricated by using the Creality Ender 3 FDM. The CNC operations were designed by using Fusion 360 CAM software by Autodesk, while the 3D fabrication by using Cura slicing software by Ultimaker while adopting the default printingparameters for PLA extrusion. Figure 1 shows the plate geometry with the resulting shear test sample. The thickness depends on the starting material. For the FDM, a support structurewas needed to avoid deflection since the overlapping of the samples was limited to 20 mm.It is worth noting that to guarantee the adhesion of the HDPE on the building plate of the FDM, a sacrificial layer of 0.2 mm was fabricated for the substrate bonding.

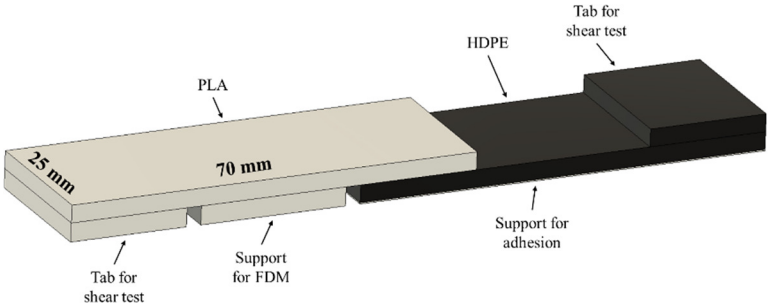

Figure 1. Final geometry of the test samples

The investigation dealt with the evaluation of the shear strength of the joints depending on the surface topography. The samples were tested as built, and after texturing the surface by means of the Stepcraft D840 CNC and the 1.6 W Snapmaker Original Laser system. The modified area is the overlapping one of 20x25 mm. The textures were lines, 90° nets and dimples, with 1 mm and 0.4 mm dimension for the CNC and the laser respectively. Accordingly, the spacing between geometries was set at 1 mm and 0.4 mm as well.

Finally, the shear lap tensile strength tests were carried out by using the 50 kN Universal MTS Insight Electromechanical Testing System according to the ASTM D3163 standard which provides the procedure and the sample geometry to be adopted. Specifically, the tests were performed with a crosshead speed of 1.27 mm/min while registering the applied load and crosshead displacement.

3 Results and Discussion

The results are listed in Table 1. As shown in the latter, the best strength results are achieved with the dimple texturing type, for both machining methods. In particular, the realization of the texture by means of the CNC allows reaching a maximum load of around 199 N before failure, against 62 N obtained for the laser texturing. This can be due to the dimension of the grooves, which is greater for the CNC and therefore able to accommodate a greater amount of fused PLA during deposition, which is extruded through a nozzle of 0.4 mm in diameter. It is worth noting that without any surface treatment, no adhesion is obtained due to the smoothness of the substrate. Among the texturing geometries, the dimples ensured the best performances. This result can be addressed to the more homogeneous deposition of PLA between dimples. In fact, with lines and nets there is a greater empty area underneath, thus compromising an appropriate and smooth deposition of PLA. In any case, the observed failures were all of the adhesive type, underlying therefore a poor joining between the adopted materials.

Table 1. Experimental results

Texturing	None	CNC			Laser		
		Lines	90° Net	Dimples	Lines	90° Net	Dimples
Max. Load, N	-	36	122	199	-	42	62

4 Conclusions

This study was aimed at verifying the joining between HDPE and PLA by means of Fused Deposition Modelling for hybrid components remanufacturing. After successfully fabricating new plates on existing substrates to obtain shear lap testing sample geometry according to the ASTM D3163 standard, the samples were tested to evaluate the shear strength depending on the surface treatment, i.e., none, lines, 90° nets or dimples, obtained with CNC or laser. In general, adhesive type failure between the materials was observed, thus proving a poor joining. In spite of this, the best results were obtained for the dimple texturing through CNC up to around 199 N. This can be due to the greater size of grooves that can accommodate more material during deposition and the shape of can allow a more homogeneous deposition since the empty areas are less extensive. Future developments willaim to test new texturing geometries and deposition condition to promote a stronger adhesion between the materials.

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PRISMA "Super Resolution" Images: Hyperspectral Multispectral Data Fusion with Sentinel-2

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Abstract. *This article addresses the problem of improving the spatial resolution of PRISMA (Hyperspectral Precursor of the Application Mission) Hyperspectral (HS) data, mission with 30-meter ground sampling distance (GSD) To achieve this goal, higher spatial resolution data from the Sentinel-2 (S2) mission are exploited. In particular, ten S2 bands at 10 and 20 m spatial resolution are used to process the PRISMA super-resolution (SR) image. The procedure is applied to real images downloaded from the PRISMA and Copernicus reference portals and then processed by Erdas Imagine software. The first step involves the coregistration of two images to correct georeferencing errors. The second step consists in the fusion between PRISMA and Sentinel-2 data. In the last step, the spectra of some materials are analysed and the Spectral Angles are calculated to assess the effectiveness of the operation performed.*

Keywords. PRISMA, Sentinel-2, hyperspectral (HS), multispectral (MS), super-resolution (SR), coregistration, data fusion

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1 Introduction

The PRISMA (Hyperspectral Precursor of the Application Mission) mission, managed by Italian Space Agency (ASI), is composed of the few satellite missions with a hyperspectral (HS) sensor that acquiring narrow and contiguous images arranged from visible to mid-infrared spectrum (400 to 2500nm) reaching a spectral resolution of 239 bands. PRISMA can provide valuable information to support the prevention of natural risks, such as hydrogeological hazards and anthropogenic risks (including soil pollution), the monitoring of cultural heritage, agricultural activities, up to material mapping or detection operations [1,2,3].

Since its main objective is to provide data at several bands, the HS PRISMA sensor has a limited spatial resolution, 30 m, and this low value can reduce the range of potential applications [4]. The aim of this research is focused on data fusion between an HS and a higher spatial resolution multispectral (MS) image to improve the performance of PRISMA data. This approach is called HS-MS image fusion, or HS super-resolution (SR) [5].

The MS image used for the fusion was acquired from Sentinel-2 (S2) satellite, part of the Copernicus programme managed by the European Commission. In particular, ten S2 bands with a spatial resolution of 10 m (B2-B4, B8) and 20 m (B5-B7, B8a, B11-B12) cover the same spectral range as PRISMA sensor (239 bands).

The software used for the Data Fusion operation is ERDAS IMAGE, produced by Hexagon Geospatial and licensed thanks to the valuable collaboration with Planetek Italia. ERDAS IMAGE is a complete software suite, specifically developed for classification, orthorectification, mosaicing, reprojection and photointerpretation operations.

2 Methods and Results

The images were downloaded from their respective portals. For PRISMA an image of Cagliari area was selected, one of the few images pre-processed with the new encoding algorithm based on GCP - Gran Control Points. This new algorithm allows a geocoding error of less than 15m (compared to the previous one of 200m).

Once the PRISMA image in .he5 format has been imported into the ERDAS software using a special plug-in developed by Planetek, the acquisition date and View Zenith Angle were extracted from the metadata file, information that is fundamental to download a Sentinel-2 image with similar features, in our case the image acquired on March 9, 2022.

The downloaded images were co-registered to correct georeferencing errors. The procedure was carried out within the ERDAS suite via the AutoSync Workstation and the APM (Automatic Point Managment) Strategy command.

In order to achieve the fusion operation between the two images, the sensor bands with common wavelength (nm) values must be identified; the overlap between the nominal spectral response functions (SRFs) of the S2 bands and those of the PRISMA sensor is shown in figure 1.

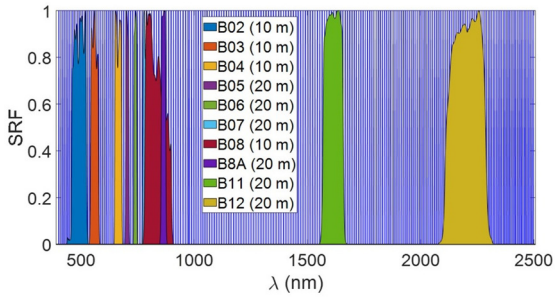

Figure 1. Central wavelengths of the PRISMA bands (blue bars) and SRF of the Sentinel-2 bands

Ten separate images were obtained using the HPF (High Pass Filter) Resolution Merge algorithm, an optimal method for preserving the spectral information of the images. The ten images were superimposed by means of a 'Layer Stack' operation to obtain the super-resolution HS (SR) image (Figure 2).

Figure 2. Left Sentinel-2 image, centre PRISMA image, right HS super resolution (SR) image

In order to investigate the performance of data fusion results, a spectral analysis was conducted using the Spectral Angle value compute on selected materials. The spectral similarity is obtained by considering each spectrum as a vector in q-dimensional space, where q is the number of bands [6].

$$\alpha = cos^{-1}\left[\frac{\sum_{i=1}^{n}(T_i \cdot R_i)}{(\sum_{i=1}^{n} T_i^2)^{\frac{1}{2}} \cdot (\sum_{i=1}^{n} R_i^2)^{\frac{1}{2}}}\right] \quad (1)$$

A set of nine points marked by homogeneous material was examined; the Spectral Angle value between the spectrum of the original PRISMA image and that of the super-resolved HS (SR) image was calculated (Table 1). The results demonstrate good agreement between the two analysed spectra (Figure 3).

Spectral Angle values tend to zero especially in areas characterised by a larger surface area with homogeneity of material present within the area. Therefore, the result obtained can be considered acceptable.

Table 1. Set points, descriptions and values Spectral Angle

ID-Point	Latitude	Longitude	Description	α (Spectral Angle)
1	39°15'13.98"N	9° 3'30.22"E	Airport (tarmac)	0.032
2	39°16'32.21"N	9° 3'2.03"E	Parking area (tarmac)	0.045
3	39°16'58.90"N	9° 3'13.99"E	Farmland (in a rural area)	0.022
4	39°15'28.98"N	9° 3'53.12"E	Industrial shed roofing	0.089
5	39°17'8.62"N	9° 4'26.01"E	Brick-making furnace	0.085
6	39°14'51.55"N	9° 5'55.97"E	Farmland (in an urban area)	0.023
7	39°15'34.68"N	9° 4'22.71"E	Photovoltaic system	0.126
8	39°15'32.28"N	9° 4'56.13"E	Shopping center roofing	0.052
9	39°16'23.61"N	9° 4'3.93"E	Dense vegetation area	0.124

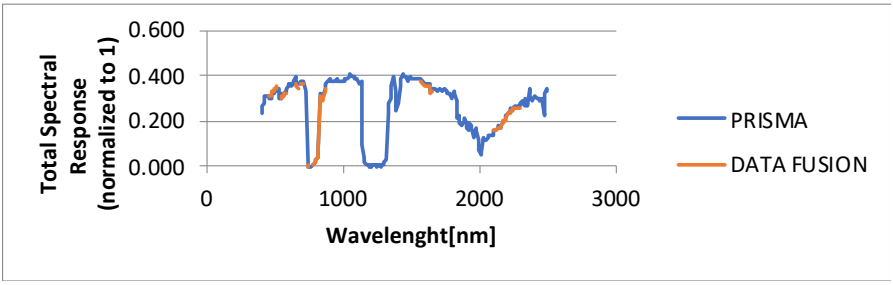

Figure 3. Comparison of spectral signatures: PRISMA and HS-SR image (ID-Point:1)

3 Conclusions

This article presents an end-to-end procedure called PRISMA SR (super-resolution) capable of increasing the spatial resolution of PRISMA HS-HyperSpectral data. The proposed procedure is based on the idea of exploiting the Sentinel-2 data acquired with a spatial resolution of 10 and 20 m to obtain a super-resolved PRISMA image with a pixel size of 10 m. The two images were co-registered to correct georeferencing errors, then the fusion operation was carried out with the HPF (High Pass Filter) Resolution Merge algorithm, indicated in the existing literature as the most effective method for preserving the spectral information of the images. The results were then discussed on the basis of the values of the Spectral Angle, considered as a parameter to measure the similarity between the two PRISMA and PRISMA SR spectra.

The method described encourages future efforts to test new fusion algorithms in order to obtain super-resolved images for Material Mapping or Material Detection by fully exploiting the enormous potential of hyperspectral sensors.

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Application of Human Kinetic Energy to the Power Supply for Wearable Devices

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Abstract. *This research project aims to investigate the feasibility of using an integrated electromechanical transducer to convert the kinetic energy of arm movements into electrical energy for charging wearable devices. The project includes a literature review, an analysis of the transducer's construction and functioning, and an exploration of other relevant experiments. The ultimate goal is to design a compact generator that can store sufficient energy for wearable device charging. The results include an overview of the transducer's principles of operation, efficiency, and potential design solutions, as well as a discussion of encountered challenges. This work contributes to the growing field of energy harvesting and offers insights for developing practical solutions for powering wearable electronics.*

Keywords. Kinetic energy, electromechanical transducer, wearable devices, efficiency, generator

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1 Introduction

Over the last decade, the field of wearable technologies has received increasing attention from industry and academia. This can be seen in the growing amount of research being written and the expanding services available in this area. Most wearable devices have become tools in the wellness field, with many applications in the sports domain that are directly linked to the mobile phone. The main disadvantage of wearables is the limited battery life, the devices need to be constantly recharged, usually every day or every few days. This charging frequency is increasing for more intelligent devices, with a larger sensory field or access to raw data. Ideally, devices could be completely energy independent, so that people can use them conveniently and forget about constant charging. Sadly, the energy consumption of the latest devices is still far from this. To improve devices, a new generation of batteries should be explored or the use of methods such as energy storage should be extended.

There are many ways to harvest energy from the human body, movement, electromagnetic radiation, light or heat. Harvesting energy from environmental sources such as light or human movement is among the most promising. Even small movements in everyday human activities generate a lot of energy that can be stored.

There have been many recent attempts to embed generators in the soles of shoes to generate energy while walking, or to generate energy through the movement of a backpack to charge smart devices. However, it has been concluded that smaller gauges are needed to store kinetic energy.

Energy harvesting is attracting attention as a technology that can replace or improve batteries in the development of various portable electronics. To achieve this, energy storage and electromechanical generators must be used and must be of a weight and size that can be accommodated in a human device. For such devices, a self-charging system should be developed using the stored energy. And they should collect energy from the environment and store it in batteries or supercapacitors. This would be extremely useful and efficient.

2 Related works

The initial prototype is a self-winding mechanical clock mechanism that oscillates when the hand is moved. An analysis of the design solutions and the performance achieved for this type of energy converter described in the scientific literature showed the possibility of obtaining 4.8 mW [3] or even 10.4 mW [2], but the mock-ups described in both papers were too large, with diameters of 65 mm and thicknesses of 18 mm. Given that such a bulky add-on is certainly too large and the power generation benefits it offers will not outweigh the inconvenience of use. Therefore, the aim is to construct the mock-up under investigation with a diameter of 40 mm and a thickness of 5 mm, and a weight of about 20 g, to make the generator analogous to the size of a wristwatch.

3 Experimental results

The main part of the research work is to investigate the applicability of an integrated electromechanical transducer of an electrical device that converts the kinetic energy of hand movements into electrical energy, to analyse the energy quantities obtained and the possible design solutions. It was decided to use coils attached to the housing to capture the energy. Above them, a magnet is used, rotating around the axis from the motion, with a smaller central magnet influencing the glow. This creates an electromagnetic induction. The magnet is known to be a very important component in this phenomenon, as it is partly responsible for the electrical voltage generated. This is also known as the induced electric current.

The generator body was designed in software (AutodeskFusion360). And printed using a 3D printer. For the designed kinetic energy converter to generate electricity, coils are required. During the project, it was discovered that coils of the desired size were not commercially available, so the coils were hand-coiled. For the coils, 3D-printed models of the housing were printed and wrapped with lacquered copper wire (0.12 mm diameter). The generator uses four coils with a circumference of 150 mm diameter and 35 mm thickness. Additional metal cores were inserted in the centres of the twisted coils. These reinforce the magnetic field, allowing more energy to be generated. A steel wire with a diameter of 1mm and a length of 17 mm is used. By using a metal core throughout the coil, the magnet rotating above the coils kept stopping at them from time to time. By shortening the length of the cores to half the length of the coil, the magnet could continue to rotate freely. Also, the total number of windings per coil is estimated to be 780 times. Neodymium magnets are used in the layout as they are very strong. As a result, a higher electric current is generated than with weaker magnets. Two magnets are used in total, a central cylindrical magnet (5x5 mm) placed in the layout of the inverter and a "second cylindrical magnet (10x1.5 mm) rotating around the central cylindrical magnet. To induce an electromotive force, the movement of the magnet is required, which creates a variable magnetic field. To extract it, the magnet needs to be in constant motion with the coils, in this case rotating around a central magnet.

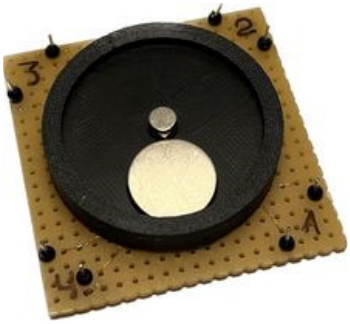

Figure 1. Model of the inverter constructed

Figure 2. Variable speed adjustment testing device

After generator construction is finished the parameters of the coils were measured: inductance, complex circuit resistance and active resistance using a Hioki 3522-50 LCR HITESTER at a fixed frequency of 1 kHz and 1 V output voltage.

Inductance is a property of electric circuits that describes the creation of magnetic flux due to the flow of electric current. It is given by the formula $\Phi = L^*I$, where Φ is the magnetic flux, I is current, and L is the inductance, which depends on the dimensions, shape, and magnetic permeability of the circuit. Complex resistance is a concept used in AC circuits to describe the resistance to alternating current. It considers not only the amplitude relationship between voltage and current but also their phase relationship, which refers to the relative timing between them. In other words, complex resistance extends the concept of resistance to AC circuits by describing not only the relationship between voltage and current amplitudes but also their interrelated phases. Active resistance is a fundamental property of conductors and semiconductors that limits the flow of current. It is independent of voltage and current but depends on the physical properties of the conductor and temperature. Active resistance does not consume electricity and exists naturally in conductors and semiconductors. In contrast to reactive components like inductors and capacitors, which store and release energy over time, active resistance converts electrical energy into heat, which is dissipated into the surrounding environment. The active resistance is always constant and does not depend on either voltage or current, but it depends on the physical properties of the conductor itself and temperature.[1]

Table 1. Information about coils

	Inductance	Complex circuit resistance	Active resistance
First	3.18mH	37.37Ω	31.58 Ω
Second	3.42mH	39.03 Ω	32.56 Ω
Third	3.57mH	40.19 Ω	33.30 Ω
Fourth	2.85mH	34.59 Ω	29.56 Ω
General	13.750mH	154.89 Ω	128.56 Ω

For further energy estimations, it was decided to build an appliance that could provide controlled, and stable motion. The adjustable speed device was designed using AutodeskFusion360 software and assembled using 3D-printed parts. The converter fits perfectly into a recessed square space under the propeller and is clamped on all sides, providing stability without movement. A 6 V micro-DC motor with a reduction gear is mounted on top of the converter, capable of rotating at speeds up to 300 rpm. A PWM-type controller capable of 3–35 VDC and 5 A is used to control the motor speed, and the PWM signal allows for easy control of the torque and speed of the DC motor. The device is powered by a power supply that delivers 6 V and 800 mA. An amplitude measurement experiment was performed at different magnet rotational speeds and with different loads. The calculated power output is presented in Table 2.

Table 2. Power output in mW at different load resistances

	100 Ω	130 Ω	135 Ω	140 Ω	145 Ω	150 Ω	160 Ω	200 Ω	300 Ω	500 Ω
72 rpm	0.05	0.04	0.05	0.05	0.10	0.04	0.04	0.06	0.04	0.02
126 rpm	0.12	0.11	0.13	0.15	0.12	0.13	0.12	0.17	0.10	0.07
162 rpm	0.21	0.22	0.23	0.24	0.40	0.26	0.25	0.24	0.18	0.15
192 rpm	0.42	0.41	0.38	0.41	0.41	0.43	0.38	0.45	0.35	0.24
252 rpm	0.59	0.60	0.59	0.62	0.61	0.60	0.63	0.59	0.50	0.34

The results show how the power output varies with different loads and how the increase in power depends on the rotation speed. The chart reveals that the highest power output is achieved with the insert between 145 Ω and 200 Ω. This insert demonstrates the greatest increase in power output compared to the other loads tested.

As the constructed electromagnetic energy generator produces alternating current, a rectifier is required to convert it to direct current. To prevent voltage drop, MOSFET transistors were selected for this purpose. Two n-channel SI2302 transistors with threshold voltages ranging from 0.65 V to 1.2 V are used for low-voltage applications. The remaining two p-channel SI2377 transistors are for high-current applications, with threshold voltage ranges from 0.4 V to 1 V. To store the voltage at the correct level, the ADP5090-2-EVALZ energy harvesting board is used to store the voltage up to 3.3 V. This voltage level was chosen for its reliability and safety, as it is suitable to power most digital components without risk of damage. Furthermore, 3.3 V is the standard voltage for most electronic devices. To measure the signal values at different connection points, a four-channel oscilloscope is connected. The first two channels are connected to the input to measure the differential potentials of the signals, the third channel is connected to the output of the bridge, and the fourth channel is connected to the output of the energy harvesting board, which measures the voltage stored in the supercapacitor. The results indicate that the minimum input voltage to the board must be 236 mV at 17.64 Hz, requiring a current of 1.35 mA. Once the input voltage reaches this limit, the ADP5090-2-EVALZ evaluation board amplifies the input voltage and stores it in the supercapacitor. When fully discharged, the supercapacitor can be recharged to the desired 3.3 V using the minimum set voltage within 145 minutes, as shown in Figure 3. The onboard supercapacitor has a capacitance of 0.1 F and can hold up to 5 V. By connecting a 5 kΩ load to the output, a constant voltage can be maintained across the capacitor if the input voltage is at least 650 mV. With a 1 kΩ load connected to the discharge, the capacitor is fully discharged to 3.3 V in 8.43 minutes.

Also, a study was carried out to see the amount of voltage build-up in the panel using human kinetic energy. The generator was attached to a person's wrist while running on a treadmill at a speed of 7 km/h. The result was recorded using a DMM 506 multimeter, which recorded the variation of the capacitor output voltage every 3 seconds 400 times.

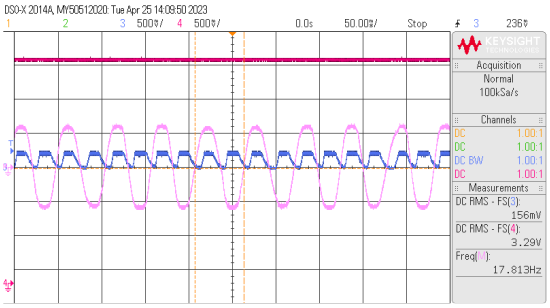

Figure 3. Voltage levels during the test. The pink sinusoid represents the input signal, the blue signal depicts full wave rectification, and the red line indicates the voltage of the storage capacitor

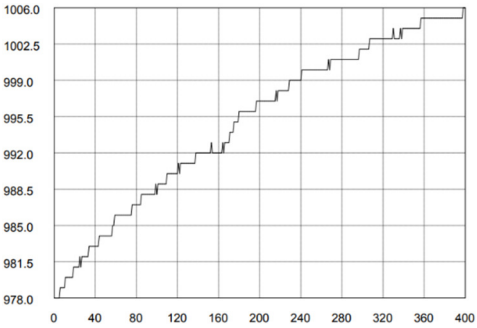

Figure 4. Voltage variation (in mV) in capacitor while running

The measurement started when the capacitor on the board was already charged to 978 mV. From this reference, the increase of 28 mV was obtained over 20 minutes, which is 1.4 mV per minute. Also, the average voltage and current entering the board were measured. The voltage was 143.17 mV and the current was 0.21 mA. This gives a power of 0.03 mW. The energy stored in the capacitor Wc can be calculated over this time using the following formula:

$$Wc = 0.5 * C * (\Delta V)^2 = 0.5 * 0.1 * (0.028)^2 = 39.2\ \mu J. \quad (3)$$

Here C is the capacitance (F) and ΔV is the voltage difference (V).

4 Conclusions

While the designed generator was not able to generate sufficient voltage to fully and independently charge wearable electronic devices, the results of the experiment provide valuable insights into the capabilities of energy harvesting from human movement. The voltage output of 143.17 mV and current of 0.21 mA achieved after the MOSFET rectifier and the 1.4 mV per minute generated by the supercapacitors demonstrate the potential for further improvements and optimizations in the design. These findings can inform future research and development in the field of wearable technology and energy harvesting.

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The architecture of the Seimas Palace

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Abstract. *This research paper examines the architecture of the Seimas Palace, which houses the Lithuanian Parliament, and the historical significance of the events of January 13th. The research objective is to create a 3D model of the Seimas Palace, using archival documents and digital tools to recreate the original form of the building. The research methodology includes the analysis of historical records and photographs, as well as measurements and consultations with a mentor. The paper presents the results of the study, including the creation of the 3D model and the identification of the main architectural features. The study's contribution to our understanding of the Seimas Palace and its place in Lithuanian cultural heritage is what makes it significant.*

Keywords. The Seimas Palace, architecture, multifunctionality, 3D model, analysis

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1 Introduction

The architecture of the Seimas of the Republic of Lithuania is the project's principal goal. The objective of this study was, first and foremost, to collect data on the architectural values and historical context of the Seimas Palace in the 1980s and 1990s, as well as to research images, architectural projects, and artworks from various eras and analyse written materials. Based on the information acquired, it was decided to expand the project and create a 3D model of the Seimas buildings, identifying the elements and temporary roles of the fortifications from historical and archival material.

The project workflow can be described as a series of steps taken to achieve the project goals. Throughout the workflow, regular meetings with the mentor were conducted to discuss progress and challenges and to seek guidance and feedback. We worked together towards a common goal, and the mentor's experience and knowledge were valuable resources for the project.

It is worth mentioning that this project was implemented with the financial support of the ATHENA project. We are grateful for their contribution to our research.

2 Results of the research work

The work began with a process of collecting and analysing photographs and literary sources, which helped to reveal the multifunctionality of the Seimas Palace during the events of the 1990s. The information gathered shows that the building and its surroundings were not only a meeting place for people but also a defensive fortress that served a variety of purposes.

The analysis identified the following main functions of the building during the events of January 13th:

- The gathering spot for people to eat.
- Ambulance point.
- Construction of parliamentary fortifications and barricades.
- Chapels on the Parliament grounds.
- Drawings exhibition.
- Destruction of Soviet documents.
- The living barricade.

The gathering spot for people to eat

People were willing to spend extended periods of time outside the Parliament, often without going home or having regular meals, highlights the urgency and importance of the issues at stake.

People eating food supplied by their family [1, p. 25], friends, or complete strangers while sitting on stacked building blocks is a monument to the sense of camaraderie and community that developed during this period. Such events in Lithuania attracted the attention of the world's media [2], and foreign countries donated food and other necessities to Lithuania [3].

Figure 1. The spot for people to eat. Photo: Rolandas Ginaitis

Figure 2. Volunteers in the ambulance Photo: Alfredas Girdziušas

Ambulance point

The hard work, the construction of Parliament's fortifications and barricades, and the defense against the enemy were not without various injuries and wounds [4, p. 117, 3]. For this reason, the nearby Lithuanian National Martynas Mažvydas Library in the Lithuanian National Library, an ambulance station was set up in the Lithuanian National Library [1, p. 117], where people were people could donate blood to the injured and, throughout the Parliament's territory, there were always people on duty to help in the event of an accident or injury.

Construction of parliamentary fortifications and barricades

Seeing how everyone worked together to help build the walls and barriers around the Parliament was inspiring. People were preparing to fend off the enemy both outside and inside the Parliament [1, p. 117], underscoring the significance of being ready for any circumstance and taking precautions to ensure safety and security [3]. This level of readiness and adaptability can be beneficial not just in times of emergency but also in regular life, and it can assist both individuals and communities in overcoming obstacles and achieving their goals.

Figure 3. The barricade. Photo: Vilius Jasinevičius

Chapels on the Parliament grounds

It is heartening that even those who could not physically help have found other ways to support them. This kind of support and encouragement can be just as valuable as physical contributions and can help foster a sense of unity and common purpose. The presence of chapels [1, p. 118] and the celebration of Mass from the balcony of the Parliament [1, p. 36] further highlights the importance of faith and spirituality in times of crisis, and how they can provide a source of comfort, strength, and hope.

Figure 4. The celebration of Mass from the balcony of the Parliament. Photo: Vilius Jasinevičius.

Figure 5. Children's drawings. Photo: Seimas Palace photo archive.

Drawings exhibition

People created posters to display on the barricades, and kids in kindergarten and schools created artwork [1, p. 16] that was later brought by teachers and displayed in front of the Parliament. This was a means of demonstrating trust in and support for the Parliament-facing defenders who were on duty.

A book of 5772 children's artworks honoring the events of January 1991 was created from the children's drawings. All the pieces were produced in 1991 for various educational and competition projects [5].

Destruction of Soviet documents

The act of using Soviet documents on rebar rods near the barricades is a powerful symbol of defiance and resistance against the Soviet government [1, p. 33]. By using their Soviet documents in this way, they are also risking potential consequences from the authorities, which further underscores the bravery and determination of the protesters.

Figure 7. The Soviet documents on rebar. Photo: Rolandas Ginaitis.

The living barricade

The fact that there is a large, living barricade in front of Parliament is a testament to the determination and courage of the protesters, as evidenced by the many photographs that have survived. It shows that they were willing to risk their lives to defend their homeland. Such collective action can be crucial for social and political change and underlines the importance of solidarity and mutual support in the face of oppression.

Figure 8. The living barricade. Photo: Seimas Palace photo archive.

Creating a 3D model of the Seimas building

Creating a 3D model of the building is an excellent way to preserve the architectural and historical value of the Seimas Palace. The research has shown that there are not many surviving drawings or models of the building [6], which makes this work even more difficult but also very important. By creating a 3D model, we want to provide a visual representation of the building and create a valuable educational resource for future generations. Such a project can also help raise awareness of the building's historical and cultural significance and inspire people to learn more about their heritage. In general, the creation of a 3D model of the Seimas Palace is a complex task and not always as quick as one would like.

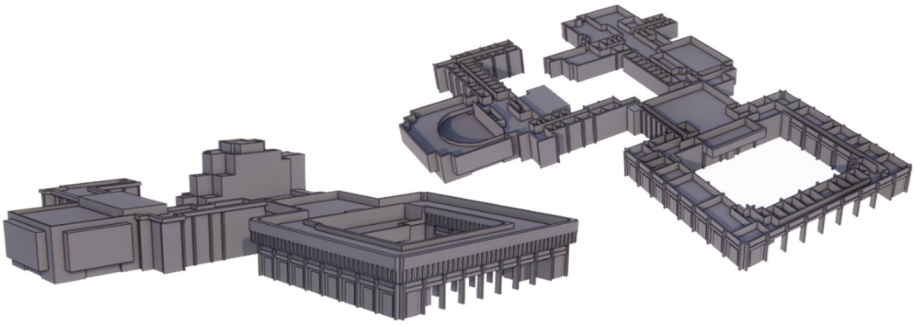

Figure 9. 3D model of the Seimas building.

3 Societal importance

The 3D model of the Seimas of the Republic of Lithuania would be a useful educational and informative tool for the public. It would be great to create an exclusive 3D model of the blockades of time, showing how the entrances were blocked and the grounds protected.

The 3D model could be used by schoolchildren and educators to learn about the architectural style, ornamentation, and historical significance of the Palace. It could also be used by visitors to the palace to better understand the layout and features of the building. In addition, the 3D model could be made accessible to people who, for various reasons such as physical disability, distance, or lack of time, are unable to physically visit the Palace.
Overall, the 3D model of the Parliament would be a valuable educational and cognitive resource for the public, enabling a better understanding and appreciation of Lithuania's cultural heritage.

4 Conclusions and further work

The dedication to completing the continuing 3D model of the Seimas Palace effort is notable. There is a lot of potential for improvement in the pursuit of greater precision. It is accepted that further investigation into the intricate architectural details within this outstanding structure is anticipated. Participating in projects of this kind offers a practical way to

challenge oneself and develop one's skills—an aim that is persistently pursued. This endeavor is seen as a promising opportunity for insightful experience and learning.

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Towards Developing Parallel Corpora for Portuguese and Portuguese Sign Languages

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Abstract. *Low-resource languages, including sign languages, are a challenge for machine translation research. Given the lack of large-scale parallel corpora, researchers must use small parallel corpora for training an automatic translation system. This article aims to address this problem by building artificial parallel corpora for Portuguese sign language in automatic translation systems. In this work, we obtained small parallel corpora of Portuguese text and Portuguese Sign Language gloss from the Metro of Porto. We used these corpora to learn grammar rules in translation between Portuguese text and Portuguese Sign language gloss. Ap- plying obtained rules to our data, we generated artificial parallel corpora for Portuguese and Portuguese sign language gloss.*

Keywords. Sign language, low-resource languages, natural language processing, parallel corpora, machine translation

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1 Introduction

Sign languages are natural languages that use the visual-manual modality to convey meaning through manual articulations and non-manual elements. They have their own grammar and lexicon and are not universal or mutually intelligible. Each sentence in sign language is composed of signs arranged according to a syntax governed by spatial and temporal logics, and each sign characterized by five parameters: configuration, orientation, location, movement, and facial expressions. To represent signs in text form, glossing is used, which involves capturing the essence of signs in written form.

This paper proposes a new approach to building parallel corpora for automatic translation systems by transforming a part of Portuguese speech sentences to Portuguese Sign Language (LGP) gloss. Related work, methodology, and conclusions are presented in Sections 2, 3, and 4 respectively.

2 Background

The lack of linguistic resources for Portuguese sign language poses a challenge for automatic processing such as machine translation and knowledge extraction [1]. Various studies have focused on collecting corpora for different sign languages, ranging from linguistic and humanistic to automatic translation. While some sign languages, such as American Sign Language (ASL), have rich linguistic resources [2],[3],[4], others, including Portuguese Sign Language, have limited annotated corpora, making it challenging to develop translation resources. Projects such as the Virtual Sign Translator [5] aim to address this issue by providing a translator between written Portuguese and Portuguese Sign Language. Other sign languages such as German, British, Spanish, French, and Irish also have their own annotated corpora – some projects focus on unique signs, and others focus on sentences and complete speeches. However, to the best of the authors' knowledge, there are no existing resources that can be used to build parallel corpora in text format for Portuguese sign language translation.

3 Parallel Corpora Collection

A parallel corpora is a collection of large and structured texts aligned between source and target languages, which is commonly used for statistical analysis and to validate linguistic rules within a specific domain. The process of acquiring a parallel corpora for statistical analysis usually involves several pre-processing steps. However, in our case, there is a lack of sufficient data available for Portuguese texts and Portuguese Sign Language.

The paper describes a methodology for creating a parallel corpora between Portuguese and Portuguese Sign Language (LGP) gloss using data from the Europarl dataset and a small parallel corpora from Porto's metro. The Europarl dataset [6] is a multilingual corpora that contains parallel text for 21 European languages, including Portuguese, extracted from the proceedings of the European Parliament. The researchers extracted Portuguese text from the Europarl dataset to create the parallel corpora.

The small parallel corpora from Porto's metro was translated by experts from the deaf community to ensure the correctness of sentences. The researchers used this corpora to extract rules for transforming Portuguese text into LGP gloss. They defined the translation problem as a series of sub-problems related to the order of words, word form changes, and lexical form changes due to gender in some languages. They obtained two sets of rules that can be seen as a mapping function, where the input is a representation of language, and the output shows the changes in input. Figure 1 shows the structure of the proposed system for rule extraction, which is composed of three predominant levels.

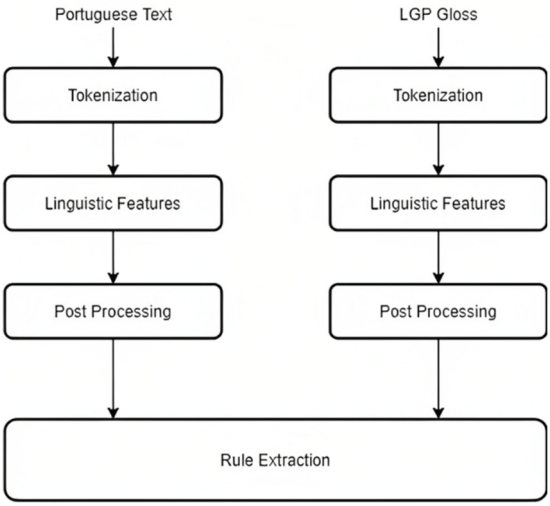

Figure 1. Extracting Grammar Rules.

The LGP gloss uses Portuguese words for each sign or phrase that can be labeled. The researchers describe the implementation phase, which involves pre-processing and lexical analysis, segmenting the text into sentences and words, and generating several analysis levels. The first pre-processing operation is called "tokenization," which precisely transforms the input string into tokens, as follows:

[“Como”; “abrir”; “uma”; “loja”; “no”; “Metro”; “?”]

Then, all characters are converted to lowercase, obtaining the following:

[“como”; “abrir”; “uma”; “loja”; “no”; “metro”; “?”]

From the lexical analysis, the researchers proceed to the grammatical analysis of each token. Syntactic analysis is the association of a grammatical category (noun, verb, adjective, adverb, proper noun, etc.) for each word of our input sentence.

In this step of the process, the SpaCy Part-Of-Speech Tagger is used to label grammatical features in the input text. The same process is applied to the LGP gloss to determine the grammatical features of each word in each sentence. The featurized sentences are then passed to a post-processing step that removes non-essential parts of the sentence, such as extra spaces

and symbols. The output of this process is a set of featurized sentences. The focus of the translation between Portuguese and LGP is on the first sub-problem of how the order of words changes. Rules are then extracted to indicate how the order of words changes, which are referred to as order-mapping. An example of the original sentence and the resulting order-mapping is provided:

Words	como	abrir	uma	loja	no	metro	?
Indices	0	1	2	3	4	5	6

Words	loja	metro	abrir	como	?
Indices	3	5	1	0	6

Given the example sentence and its corresponding LGP gloss, it is possible to translate the original sentence to LGP by analyzing how the order of indices changes. In this particular case, it was observed that the word at index 3 in the original sentence is located at index 0 in the LGP gloss, the word at index 5 in the original sentence is located at index 1 in the LGP gloss, and the word at index 2 in the original sentence does not exist in the LGP gloss. Based on this analysis, the researchers draw an order-mapping, which serves as a guide for translating sentences between Portuguese and LGP.

Indices of the original sentence	3	2	-1	0	-1	1	5

The obtained rule for mapping can be used to reorder the words in the original sentence into an LGP sentence. However, the issue is that the rules are too specific to the given sentence. Instead, using features of the sentence, such as lemmas and postags, can create a more general map that can be applied to similar sentences. By using postags instead of words, the obtained map can be used for any new sentence with the same pattern (same postags).

The second sub-problem of the translation process involves transforming words between the original language and LGP. This is necessary because a word in the original text might not have a direct equivalent in LGP. To find pairs of similar words, the researchers used word embeddings to transform words into vectors of real numbers, and then measured their similarity using cosine similarity, a metric that measures the orientation between two vectors. This metric is independent of vector magnitude and can help find pairs of similar words in both languages.

In this step, the focus is on using cosine similarity to understand how a specific word is used differently across different corpora. The Glove word embedding model [7] is used to obtain vector representations for words in Portuguese language [8]. A cosine similarity of above 0.9 is used to determine word pairs. A dictionary of word mapping is created to indicate which words are translated to which words. Finally, an artificial parallel corpora is built using the rules extracted in the previous steps, and patterns are compared to generate LGP gloss for new Portuguese text. If any match is found, then it will be mapped to its counterpart mapping pattern, and the LGP gloss is generated in this way.

4 Conclusion

Sign Language Translation is a new research theme since it combines two complex scientific problems: translation and the transcription of Sign Languages. Studies on Sign Languages should include the linguistic, cognitive, and grammar aspects until creating the corpora, automatic translation, and real-time synthesis. Sign Languages are not universal, and in general, the studies are focused on one community of deaf and do not share the same syntactic structures, phonological, lexical, morphological, and semantic aspects. Despite existing tools for transcription and annotation, each presents drawbacks. However, for the textual annotation in gloss, we proposed an approach that uses the grammatical order of words to generate its counterpart LGP translation. We generated these texts automatically using rule-based approaches using the words' grammatical orders. The accuracy of these texts can be improved with getting access to the LGP dictionary and using linguistic guidance by experts in the future.

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Upgrading of Mather-type Dense Plasma Focus Machine for Advanced Plasma Dynamic Studies

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Abstract. *The plasma focus machine is a powerful tool for studying plasma dynamics and harnessing its potential in various applications like medicine and industry. In this paper, we present an upgrade version of the Mather-type plasma focus machine, focusing on the technical characteristics. The aim of the upgrade was to improve the performance of the machine, achieving a deeper understanding of the plasma behaviour. We investigate the plasma dynamics, more specifically the plasma expansion and compression velocity, through the three operating phases (breakdown, axial and radial phase) of the Mather-type plasma focus machine. Our results show the improvements achieved through the upgrade, highlighting the enhanced capabilities and potentials for further research and applications in the field of plasma physics.*

Keywords. Plasma physics, plasma focus, Mather-type machine, plasma dynamics, plasma speeds

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1 Introduction

Plasma exhibits unique properties that make it a subject of great interest in scientific research and technological advancements. Following the groundbreaking scientific accomplishment of laser fusion achieved at the National Ignition Facility (NIF), which resulted in the implosion generating a total of 3.15 megajoules (MJ) of fusion energy using 2.05MJ of input energy, the scientific community has experienced an increased emphasis on plasma studies. The plasma focus machine has been widely studied as a device for generating and accelerating plasma. Mather-type Plasma focus machines consist of two coaxial electrodes, where a high-voltage pulse is applied to generate and accelerate the plasma in order to focus it at the top of the anode, creating the pinching. Over the years, several studies have been made to improve the performance of plasma focus machines, aiming to achieve higher plasma densities, temperatures and more controlled plasma dynamics. In this paper, we focus on the upgrade of the Mather-type plasma focus machine of the Institute of Plasma Physics and Lasers (IPPL) of the Hellenic Mediterranean University (HMU) [1], highlighting the technical characteristics of both the old and the upgraded version. The upgrade was designed to overcome the limitations of the old machine and enhance its capabilities. Our object was to achieve better control over the plasma behaviour and improved overall performance. In this study, we specially investigate the plasma dynamics and the speeds of the plasma generated by the upgraded machine. By analysing the temporal and spatial evolution of the plasma, we aim to investigate the behaviour of the plasma and the improvements achieved through the upgrade. This will lead to a better understanding of the plasma physics and its possibilities for practical applications. This paper is organized as follows: Firstly, an overview of the technical characteristics of the old Mather-type plasma focus machine is presented. The next part is the presentation of the upgraded version of the machine, focusing on the modifications that were made. The next section describes the experimental setup and methodology used to measure the plasma dynamics and speeds. The following part of this paper is the presentation of the results obtained from the experiments and finally, in the last part there are the conclusions.

2 The old version of the machine

In Fig. 1A, a schematic design [2] of the electric circuit for the previous version of the Mather type plasma focus machine is depicted. The circuit comprises the energy bank, the pseudo spark switch, the pulse shaping circuit, 16 coaxial lines and the vacuum chamber. The energy bank includes a high voltage energy supply and 4 capacitors with the following specifications: $C = 200nF, V_{max} = 30kV, L = 15nH$. The power supply charges the capacitors and the machine obtains energy ranging from 100 to 360J based on the charging voltage across the capacitors. To initiate the discharge, a trigger unit is employed, generating a 2.5kV, 1μs impulse that is transmitted to the pseudo spark switch through the pulse shaping circuit, consisting of 2 coaxial lines and a spark gap [3]. The spark gap is utilized to achieve a reduced rising time and doubling the impulse. Eventually, the energy is transferred to the vacuum chamber via the 16 coaxial lines.

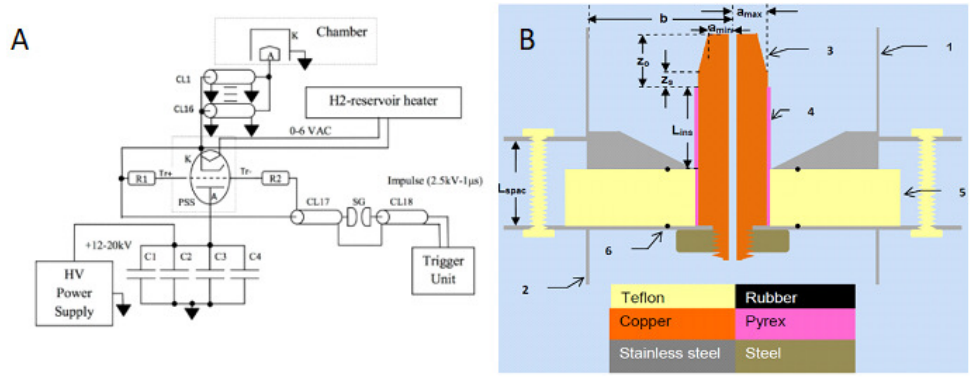

Figure 1. A. Electric circuit of the old version of the machine. B. A full sectional side view of the vacuum chamber. 1. Part of the chamber tube (cathode), 2. Part of the chamber tube (anode), 3. Main electrode of the anode (hollow cylinder), 4. Insulator sleeve, 5. Electrical insulation spacer, 6. O-ring for maintaining the vacuum.

The vacuum chamber comprises 2 coaxial cylinders: the anode and the cathode. Figure 1 B showcases the design of the vacuum chamber, highlighting its main components and the materials used in construction. Noteworthy parameters include the free path above the insulator sleeve until the anode becomes tapered (z_s), the free path above the insulator sleeve until the top of the anode (z_0), the radius of the anode (a) and the radius of the cathode (b). For this specific machine version, these parameters possess the following values: $z_s = 2.8mm, z_o = 9.5mm, a = 5.7mm, b = 23.8mm$.

3 The upgraded version of the machine

To enhance control over plasma behaviour and optimize machine performance, several modifications were implemented. The first change involved replacing the 16 coaxial lines with planar transmission lines made of copper. This substitution was necessary to achieve better matching between the capacitors and the vacuum chamber. The planar transmission lines facilitate energy transfer to the vacuum chamber with reduced resistance and inductance, enabling high current values. The subsequent and most significant change entailed replacing the original 4 capacitors with 6 new ones, The characteristics of these new capacitors are as follows: $C = 0.56\mu F, L = 15nH, V_{max} = 30 - 60kV$. These capacitors allow the transfer of higher energy to the vacuum chamber, ranging from 500 to 700J depending on their charging voltage. The pseudo spark switch and the pulse shaping circuit remained unchanged. Fig. 2 displays an image of the upgraded version of the plasma focus machine, featuring the capacitors, the vacuum chamber, the pressure gauge, the planar transmission lines and the latter part of a two frame shadowgraphy. Also the upper part of the anode can be seen in the right part.

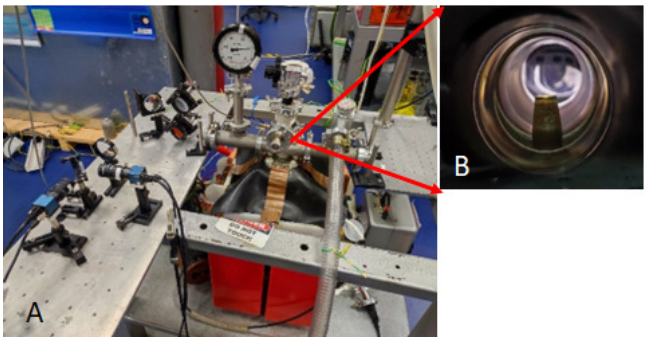

Figure 2. A. Photo of the upgraded version of the plasma focus machine. B. The new anode that was used for the upgraded version.

The final modification during the machine upgrade pertained to the characteristics of the anode. A tapered anode with similar properties was employed, albeit with slight adjustments to achieve improved pinching conditions. The updated anode characteristics are as follows: $z_s = 13.4mm, z_o = 23.4mm, a = 4.75mm, b = 23.8mm$.

4 The two frame shadowgraphy

In order to gain a better understanding of plasma behaviour and accurately measure plasma speeds, a two frame shadowgraphy technique way employed, as depicted in Fig. 3. Two frame shadowgraphy was chosen due to its ability to capture plasma screenshots with an adjustable time difference. The setup involved the use of a beam splitter to separate the laser beam into 2 separated beams. These beams pass through the vacuum chamber and reach 2 CCD cameras. The time difference between the 2 beams for this specific experiment was determined to be 9ns through measurements conducted using a photodiode. By utilizing two frame shadowgraphy, it was possible to capture sequential images of the plasma with precise timing, enabling analysis of plasma movement and velocity.

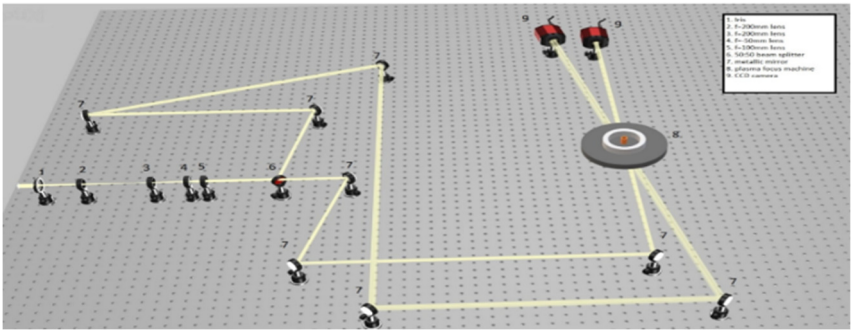

Figure 3. Schematic representation of the shadowgraphy setup

5 Results

The experiments were conducted multiple times to observe and record the plasma dynamics throughout the entire phenomenon. Fig. 4 presents the three phases of a Mather type plasma focus machine: axial, radial and breakdown. In Fig. 4a, the end of the axial phase is depicted, showing the sheath reaching the top of the anode. The subsequent figure illustrates the radial phase, where the plasma is compressed by magnetic fields. Figures c and d display moments a few nanoseconds before and after pinching, while the last two figures showcase the breakdown of pinching and the formation of bubble-like plasma observed at the conclusion of the phenomenon. The time indicated in each picture refers to the moment of pinching. Notably, Fig. 4 demonstrates the highly symmetric nature of the plasma sheath, which is crucial for successful pinching. Due to the higher velocity of the electron beam compared to their thermal speed, "beam plasma" instabilities arise. The electric field accelerates ions in the opposite direction with a higher velocity than the plasma sheath, resulting in the formation of bubble-like plasma, typically occurring after a strong pinching event. The images captured during the experiments were utilized to calculate the axial speed of the plasma, the radial speed of the shock front and the axial elongation speed of the plasma in the radial phase. For speed calculations, two images with a time difference of 9ns were used.

The operating pressure of the upgraded machine ranged from 8 to 13mbar, contrasting with the old version, which operated from 0.5 to 4mbar.

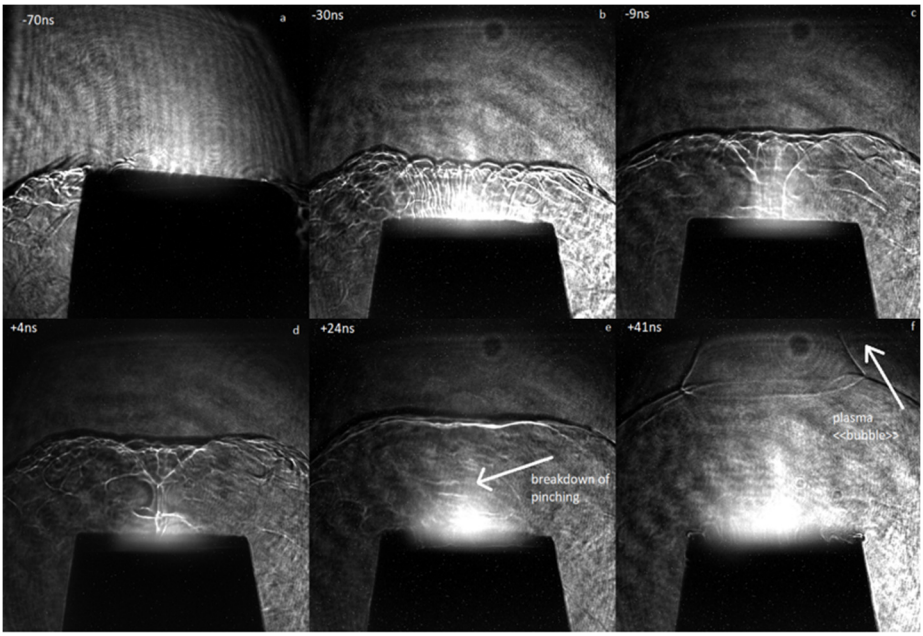

Figure 4. Dynamics of the plasma.

The speeds of two characteristic pressure values are presented in the table below.

Pressure(mbar)	Axial speed at the end of axial phase(cm/μs)	Axial elongation speed in radial phase(cm/μs)	Radial speed (cm/μs)
8	10.49 ± 1.17	8.95 ± 0.74	13.47 ± 0.86
13	2.88 ± 0.42	9.91 ± 1.10	8.58 ± 1.23

Although the values show a slight increase compared to the old version, where a maximum radial speed of 12cm/μs was measured, it should be noted that the upgraded version operates at higher pressures, indicating significant performance improvements. These experimentally calculated speeds align well with Lee's simulation model [4].

6 Conclusions

The upgrade of the Mather type plasma focus machine has resulted in significant improvements in its technical characteristics and overall performance. Through the implementation of enhanced energy supply and diagnostic tools, a higher level of control over plasma behaviour has been achieved, leading to increased precision and more accurate measurements. The measured speed of the plasma generated by the upgraded machine indicates comparable or slightly fasterplasma expansion compared to measurements that took place before the upgrade of the old version, but in a higher-pressure regime, primarily due to changes made to the anode. In conclusion, the upgrade of the plasma focus machine represents a substantial advancement, enabling enhanced performance, improved plasma dynamics and increased speeds. These achievements lay a solid foundation for further research, innovation and the exploration of practical applications in the fascinating realm of plasma physics.

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A Design Thinking Based Proposal for Self-guided Adaptative Visits to Cultural Facilities

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Abstract. *Nowadays, with all the advances in technology, access to information should be universal. But this is far from being true, especially if we focus on the access to cultural information. People with complex communication needs, low education levels, migrants, or not familiar with the culture of reference find problems accessing this kind of information to the point of not considering cultural resources a leisure alternative. In the Erasmus+ KA204 Allure project, one of its intellectual outputs was to find a solution to this problem. Through a Design Thinking process carried out by people working in cultural entities in a real museum with visitors, we found three solutions to improve accessibility to cultural events. In this paper we will explain all this process and detail the solution selected, an app for self-guided tours to museums with the ability to be adapted to the communication needs or cognitive or education level of the visitor.*

Keywords. Cultural events, accessibility, design thinking, app development, self-guided tour

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1 Introduction

It is a reality that many adult audiences do not use cultural resources due to different accessibility issues. Some of them suffer physical or psychological barriers which exclude them from participating. Others do not find cultural events appealing as they are not designed having them as a target audience.

The Allure project, in which this research is framed, works in pursuing universal cultural access for all, so all adults can learn within cultural activities by having accessible information and resources available.

One of the intended intellectual outputs of this project was to present a solution to improve non-formal and informal education for adults in cultural activities. This solution was not closed fully at the proposal of the project; instead a Design Thinking [1-3] process was scheduled to effectively come up with an appropriate solution.

The Allure project (2020-1-ES01-KA204-082720)[1], a KA204 - Strategic Partnerships for Adult Education action, is co-funded by the Erasmus+ Programme of the European Union. It includes the following partners:

Regional Ministry of Culture, Education Vocational Studies and University, Galicia (Spain) - Coordinator

- University of Vigo, Galicia (Spain)
- Workshops of Lublin, Małopolska (Poland)
- Business Association of Portugal (Portugal)
- Icelandic Textile Centre, Blönduós (Iceland)

Section 2 explains the design thinking process followed for this intellectual output. In Section 3 we show the solution that will be implemented, and finally Section 4 will briefly present the main conclusions.

2 Design Thinking Process

More than 25 years ago, Design Thinking emerged and, since then, it has developed as a worthy human-centered design methodology, with main applications in industrial design and marketing. Its main characteristic is that it allows the designer to come up with solutions adapted to people's demands in a structured way, creating more opportunities to offer the best user experience. Under these basic lines, the most common scheme presents Design Thinking as a five-step procedure consisting of the following stages: Empathy, Definition, Ideation, Prototyping, and Testing.

Within the frame of the Allure project, this process took place during 2 days in December 2022. The experience was conducted by 12 people divided in 3 groups, all of them delegates from the partner institutions of the project and with a wide experience in cultural events, supervised by two experts in the methodology. The challenge was to improve the experience of adults when visiting museums. It was done in Museu Serralves[2], a world-class Contemporary Art Museum, in Porto (Portugal).

[1] https://allureculture.eu/en

[2] https://www.serralves.pt/en/

During the empathy phase, the three teams went into the Museu Serralves to interact with actual visitors making interviews and taking notes of their reactions. In the definition phase, using different active techniques, the attendants moved from the data gathered to insights on the visitors (using participant boards and affinity maps), expressed as "Points of View" (PoV) for their projects. Each of the teams defined their PoV:

1. A person (no matter age) needs to enjoy positive experiences in museums to develop motivations to come back, because previous experiences were not enjoyable or did not exist at all.
2. A Brazilian trans-gender person, with certain political concerns, needs to feel included because of perceived lack of representation.
3. A non-regular or first-time guest needs to be guided by other visitors to get an emotional connection through the museum space because they get lost easily and it turns to be a bit confusing. The museum experience is constructed for more experienced users.

These PoVs seem to be reasonably inspiring for developing solutions: the involved people deserve good proposals for visiting museums. Next, in the ideation phase, keeping their PoV in mind, each of the teams performed a guided brainstorming process to generate valid ideas for the defined situations, then they organised these ideas and, finally, they selected one or more to be implemented.

Going into the prototyping phase, the teams created a prototype on their selected ideas, something tangible and manipulable, to be presented to actual users to check the validity of the proposal. The prototypes could be described as:

1. A smartphone application that helps the visitors navigate their way within the museum and to find specific artistic works, providing a description of them in real time.
2. Another smartphone application linked to a short initial survey that selects the visitor profile and then provides visiting routes tailored for this profile, with specific points of interest, artworks explanations and itineraries. Thus, people from different groups should feel more included in the museum experience: it is the case of trans-gender people, but it could be elderly, migrants, colour-blind people, children, and so on.
3. A stop spot, consisting on a bench to rest with technological support (a tactile screen with information regarding the actual room, its art pieces, the location within the museum, the proposed routes for visiting, and so on). On the back side, children will find activities related to the exhibition (paints, games, etc.) to improve their experiences when visiting the museum. Besides, users can ask for explanations from other expert visitors: art lovers, people without strong knowledge of arts, looking for comments adapted to their interests or understandings, etc.

Figure 1 presents the different prototypes proposed during this phase.

The final testing phase would be ideally done coming back to the museum and looking for feedback from other visitors once they receive and manipulate the different prototypes. Due to time restrictions, this part was made amongst participants themselves.

(a) Prototype 1

(b) Prototype 2

(c) Prototype 3

Figure 1. Prototypes proposed during the design thinking phase.

3 Solution Selected

The solution selected is a mixture of the first and second prototypes. It consist of two components:

1. A desktop application to be used by museums where cultural managers can insert all the information, with the ability to create different routes with different levels of detail in the information given for different groups of people depending on their communication needs, education levels, etc. This application and the information that it contains will be available in different languages.
2. A smartphone application, also available in different languages, where the visitors can download the information and different itineraries available for the museum they are currently visiting. The users will select the itinerary they want to follow according to their needs and preferences.

In Figure 2 we present how the application would look using images captured from a real museum, the Centro Galego de Arte Contemporánea[3] in Santiago de Compostela (Spain).

(a) Main screen (b) Itinerary selection (c) Route screen (d) Display screen

Figure 2. Allure Museum Mock ups.

[3] https://cgac.xunta.gal/en

Figure 2a displays the main screen, which contains basic information about the functionality of the application and the access to the different screens of personalization. In order to download the itineraries, the users may choose between scanning a code available at the entrance of the museum or the automatic detection using devices' location service. Figure 2b shows a sample of how the selection of itineraries would look like. The quantity and representation of the itineraries may vary depending on the museums or exhibitions.

Figures 2c and Figure 2d make up the basic app functionality. The route screens guide users through the different spaces of the museum, combining a visual representation with a descriptive text defined by the museum. The display screens show the different pieces of artwork along with the description considered appropriate for the itinerary selected by the museum. Descriptive texts can be played with a text-to-speech tool. The final route screen will guide the user back to the initial spot of the itinerary.

4 Conclusions

We have designed a solution to improve the experience of visiting a museum for adult people, including those with complex communication needs, low education levels, migrants, or not familiar with the reference culture. The solution was selected after a Design Thinking process in a real museum, the Museu Serralves, with real visitors, which demonstrates the need for this type of solution.

As future lines, we plan to finish the proposed solution and test it in a museum with real users. This will give us more ideas to improve before launching a version to the market.

Acknowledgements

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Designing Virtual Reality Scenarios for Reducing Stress Among University Students

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Abstract. *Stress in assessment situations is a problem among university students that could be improved through virtual reality tools. In the framework of the project Erasmus+ VRxanny, five virtual reality scenarios were proposed to be designed in order to help students cope with stress. A preliminary study (an online survey and a Design Thinking process) was carried out, aimed at finding out the preferences of university students for relaxation. The results showed that students mainly prefer natural settings in which music has a special relevance, identifying two student profiles (active and passive). These findings have been used to guide the design of the five scenarios in two stages: the first, to develop basic stress management skills in an action game and a forest environment; in the second, aimed at developing specific skills, specific scenarios to the university context are proposed. The evidence-based proposals will allow the design of more efficient virtual reality scenarios.*

Keywords. Design thinking, stress, student, university, virtual reality

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1 Introduction

Performance during university education requires students to make significant efforts to adapt to a new role, norms, responsibilities, and academic demands. Students face different stressful situations along all academic activities, especially in assessment events. High levels of stress in these situations can have negative consequences on their emotional well-being, health and performance [1-3]. Therefore, it is necessary to provide students with tools to help them cope with assessment events [4].

In this context, the use of technologies such as Virtual Reality (VR) could be a potentially valuable alternative. As an emerging research topic, VR is a promising field of work. Being nowadays in demand in the educational field, effective results have been proved in minimizing stress or anxiety among university students [5-6].

The project Erasmus+ VRxanny ("Virtual reality for anxiety and mental stress reduction in university students") aims to develop VR tools to help students reduce stress when they face an exam or an oral dissertation [7]. Although the main outcome of the project will be the design of the VR application, a careful psychological and contextual analysis to ground the technical design is critical for both the success of such application and the full project.

The main objective of this paper is to present the empirically-grounded characteristics for the design of useful VR scenarios aiming at helping university students to cope with assessment processes. The data come from an online survey and a Design Thinking (DT) experience carried at a Summer School in which European university students have taken part, as explained in section 2. Based on the information, different VR scenarios have been proposed after a two-phase process, according to the targets described in section 3. Finally, section 4 explains the main conclusions.

2 Framework for designing the VR scenarios

The characteristics of the VR scenarios should meet both the university students' needs and concerns gathered from an online survey done in winter 2022, and the proposals provided by them in after a DT international experience in summer 2022 in Vigo (Galicia, Spain).

The survey, aimed at finding out the university students' preferences for relaxing, had 182 respondents from different countries (mainly Poland, Spain and Estonia), being the gender distribution almost balanced. When focusing on the VR environment design, 73.6% of students declared that they prefer a realistic more than a cartoon-style one. With regard to the situations that help to feel relaxed, the variety of responses is wide: 20.9% said music; 15.9%, nature; but there are up to twelve more options with at least 3.3 % of the responses each of them. Colours got more consensuses: 40.1% consider that blue help them to feel relaxed, while green is preferred by 34.6%. On the topic of sounds, natural ones stand out, chosen by 45% of students. Finally, 47.8% of students prefer nature (forest and beach) as most relaxing environments, while 40.7 % lean towards home.

The DT experience involved three teams, four students in each, from different universities and countries). During a hands-on workshop they were trained in DT methodology, and then committed to design a proposal for reducing stress when facing exams. At the end of the activity, the proposals collected (Table 1) provided insight for designing VR scenarios.

Table 1. Summary of university students' proposals in the DT experience

Team	Proposal	Description	Details
1	To create an app with a menu to choose between passive and active VR activities.	The user just stays relaxed at passive environments (forest, coast...). The team does not define active environments due to technical issues	Colour ranges or type of graphics have not been considered. No activities or detailed environments have been described.
2	To create a virtual reality application, set on a desert island, where different games and stories can take place (leaving a jungle, going to space...).	The games force the user to activate her/himself to meet the challenge, but she/he is also forced to slow down or stop (i.e. to get air, get supplies, rest...) to induce other ways to relax.	Environment: nature (sea, beach, jungle) and space. Activity: games for activation, relaxation techniques and psychological training. Nature-evoking colours: blue, green, etc.
3	To create a well-equipped room for people with reduced mobility in the university, with comfortable seats (armchair, sofa...) to relax.	The user must select a natural environment (beach, mountain...) in which to situate her/himself and enter. There will also be a treadmill, so the user can move. Relaxation exercises are also proposed.	Environment: the user can choose it by selecting relaxing sounds and/or colours in the way she/he prefers (classical music, pop...). These features can be saved in an application linked to a personal account.

3 The training programme

The next step is to design a training programme to use VR scenarios, for which the psychologists and psycho-pedagogues of the project play a great role. Jointly with other members of the research team, and considering the characteristics of the situations, tasks and stimulus of emotional positive and relaxing states identified by the university students mentioned above, these professionals outlined a programme divided into two phases. The first phase, to be developed two or three weeks in advance to the assessment events, consists on the use of VR scenarios for training basic psychological skills for stress control. Then, closer to the exams and/or oral presentations (the previous week), the second phase aims at training specific psychological skills for coping stress response in situations of assessment. On the day of evaluation, students will not be exposed to training situations, as previous training should be enough to provide students with psychological tools to control stress.

3.1 Phase 1. Training in basic psychological skills for stress control

This first phase is intended to help students in controlling their stress levels in general situations, and in testing the kind of stimulus and/or situations that help them. Its specific goal is to develop basic skills (strategies for coping with bad mood or emotions to set more

positivism in general), to control stress, and to empower and gain control on emotional states, so that these skills can be transferred to specific scenarios. The mission is to forge psychological tools that allow the users to control stress situations and to focalize on a specific task so that they can use them in future stressful situations.

Two different student profiles have been identified:

- Those preferring passive situations, mainly selected by women studying Social Sciences and/or Humanities.
- Those requiring active proposals, whose profile responds mainly to men studying Engineering and Technology.

Accordingly, two VR scenarios emerged: an active (i.e. action games) and a passive one (a forest environment) to start, and a semi-passive scenario (e.g. a laugh-therapy activity) to finish in both cases. Within this framework, the type of musical background (chosen by experts) will be crucial and different in each scenario. The scientific literature suggests that combining palliative and direct coping strategies is likely to be more effective in alleviating distress in stressful conditions than either form of coping alone [8].

3.2 Phase 2. Training in specific psychological skills for coping stress response in situations of academic assessment

The second phase focuses on preparing students for actual situations of sitting exams or giving oral presentations. The objective is to develop specific skills (i.e. coping strategies for academic achievement) for the control of stress in assessment situations.

All tasks of Phase 2 are to be performed in environments as close as possible to real situations students need to face, preferable realistic environments, as students stated in the surveys. The VR tools and scenarios will be real settings (i.e. a university classroom), with visual and auditory contextualizing elements. Three scenarios are proposed: one is the entrance of the scene where the activity will take place, and the remaining two are focused on exams and on oral presentations respectively, and they take place in realistic environments. As discussed by the research team, the colours blue and green may be frequently present in these scenarios. After a common sequence such as the users entering the classroom where they will be having an exam, greeting their mates and preparing themselves for the exam, and listening to the lecturer's instructions, two different situations arise: one is a classical written exam, and the other is an oral dissertation.

4 Conclusions

Designing VR tools could be valuable in educational settings due to their novelty, interactivity and the success in other fields of research. In the framework of the Erasmus+ VRxanny project, VR scenarios may help students cope with stress in assessment situations.

This paper presents the results of a preliminary study that has revealed the preferences for relaxation of an international sample of university students. The survey showed that students mainly prefer nature (sounds and environments) and music to relax. The International Summer School facilitated valuable information, such as dividing the scenarios into two

phases: the first one for developing general basic skills, and the second one for being familiar with realistic places and circumstances for the control of stress in assessment situations.

The findings have allowed the development of proposals supported by empirical data that should be taken into account by technology designers in order to generate more efficient VR scenarios, adapted to the real needs of university students. The creation of the VR tools is the next steps to make within the aforementioned project.

After the implementation of the VR tools, the users are expected to generate psychological resources to control the stress by themselves, which could be activated or applied in real stressful situations they may face.

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Exploring Ethnicity-Based Factors of Bullying Involvement: A Social-Ecological Systems Approach

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Abstract. *In recent years, educational institutions in Europe have been experiencing a significant increase in classroom ethnic diversity. This prompted social scientists to shift their focus to understanding how students' ethnic identity shapes classroom social dynamic, namely bullying involvement. This article provides a brief overview of state-of-the-art research on ethnicity-based factors of bullying involvement. It describes the potential pitfalls of researching individual ethnicity characteristics, such as ethnic identity and ethnic status, in isolation of other individual and contextual factors. A comprehensive but seldom used social-ecological approach to studying bullying involvement is further explored. At the end, the benefits and limitations of aforementioned approach are highlighted, and a call-to-action is made for more empirical research applying this framework.*

Keywords. Classroom ethnic diversity, bullying, victimisation, social-ecological systems approach, multiculturality

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1 Introduction

In recent years, a combination of various environmental, socio-political, and economic factors has led to mass migrations of groups with different cultural, historical and ethnic backgrounds to the EU member states [1]. In 2019, non-European migrants accounted for 23.7 million of the EU's 447.2 million population, which roughly translates to one migrant per 19 people [2], [3].

The growing ethnic diversity of the population in Europe poses a challenge for many public institutions, especially those in the education sector [4]. Indeed, a significant proportion of migrants are children who attend educational institutions in their country of settlement as part of their integration into a foreign cultural environment [2].

Consequently, educational institutions are experiencing a significant increase in classroom ethnic diversity [5]. In recent years, a number of studies have attempted to address these changes and their potential to alter the classroom social dynamic [6].

2 Individual ethnicity-based factors of bullying involvement

One of the leading research trends on the topic of ethnic diversity in education is to study how ethnic diversity relates to bullying involvement (i.e., bullying perpetration and victimisation)[6]. Bullying can be described as violent and repetitive behaviour that is performed with an intention to harm another individual and occurs in a relationship characterized by an imbalance of power [7].

Many authors argue that this topic is particularly important in understanding ethnically based bullying (i. e. violent behaviour aimed at harming another because of their ethnic identity or origin) [8], as well as power imbalances in social dynamics that emerge in such classroom contexts as a projection of the inequality of the minority ethnic group at the societal level [6].

Bullying in ethnically diverse school contexts has been extensively researched in the USA and Canada, but mainly at the individual level - that is, in relation to ethnicity or ethnic status of the student [9], [10]. Students' ethnicity is operationalized in different ways depending on the area the study was conducted in. In Europe, studies define ethnic identity in terms of students' immigrant background, while studies in North America and Canada focus primarily on race [11].

As the present article focuses primarily on studies conducted in Europe ethnicity will be refered to as an individual's self-defined or ascribed membership of a particular ethnic group [8], while ethnic status refers to an ethnic group's standing in a given population, namely that of ethnic majority or minority [12].

Studies examining individual ethnic differences in the prevalence of bullying involvement, however, have yielded largely inconsistent results. Some findings suggest that ethnic minority status is a risk factor for victimisation [13], [14], [15] some that it is a protective factor that buffers against it [10], [16], [17], while others report no differences in victimisation between

ethnic majority and minorities [18], [19]. Ethnic differences in prevalence of bullying perpetration seem to show similarly inconsistent results. Some studies report a higher prevalence among ethnic minority students [15], [20] while others find a higher prevalence of bullying perpetration among ethnic majority youth [17], [21].

Such inconsistencies were further underlined by results of two prominent meta-analyses that in a sample of almost 700 000 children and adolescents, found that, ethnic majority and minority students do not differ significantly in their reporting of victimisation [22], nor in their reporting of bullying perpetration [23].

Recent studies suggest that bullying is a complex social phenomenon, highly dependent on the broader social context and the presence of other students, whose response and behaviour can have a significant impact on the bullying dynamic [24]. In a similar vein the relationship between a student's ethnic identity and their involvement in peer violence is strongly influenced by contextual factors at the classroom, school and even societal level [9], [23]. Studies suggest ethnic minorities might be disproportionately affected by contextual risk factors related to bullying perpetration and victimisation, which may in turn moderate the effects of individual risk and protective factors related to bullying involvement. Therefore, researching individual ethnicity-based factors as predictors of bullying involvement in isolation from other individual, classroom, school or societal-level variables proves to be insufficient [6].

Facing difficulty while focusing exclusively on ethnicity-based factors on the individual level, researchers started implementing ethnicity-based contextual factors, namely school/classroom ethnic diversity, to explain inconsistencies in the results mentioned above [11]. Classroom/school ethnic diversity co-determines potential power imbalances between particular ethnic groups [9], an important prerequisite of bullying involvement [7], and could thus explain how students' ethnicity affects the role they play in bullying in a given context. Some studies operationalize classroom/school ethnic diversity as the proportion of immigrant students in a given classroom or school [25], while others define it as a composite index taking into account the number of different ethnic groups as well as their representation in a classroom or school [26]. The latter operationalization is more comprehensive although seldomly implemented [11]. One such index, that has been successfully applied in previous studies [27], is Simpsons' diversity index [26] displayed below.

$$SID = 1 - \sum_{i=1}^{g} p_i^2$$

The abbreviation SID represents the classroom/school ethnic diversity as calculated by Simpsons' diversity index, p represents the proportion of students in the classroom/school that belong to ethnic group i, while g refers to the number of all ethnic groups within the classroom/school [26].

Simpsons' diversity index calculates the likelihood that any two randomly selected students from a classroom or school will be members of different ethnic groups. It ranges from 0 to 1, with higher scores denoting greater probability of students being from different ethnic groups, thus indicating greater classroom/school ethnic diversity [11]. While some studies suggest classroom/school ethnic diversity explains bullying involvement depending on the students' ethnic status, most indicate the relationship to be complex and dependent on other factors [11], [27], [28].

In response to this, research incorporating a multitude of relevant factors relating to the student's classroom, school and wider cultural as well as social environment, have become more numerous and prominent in the field [8].

3 Social-Ecological Systems Approach to Bullying Involvement Research

Research findings suggest that bullying is a multifaceted social phenomenon that can only be comprehensively understood through a socio-ecological perspective, addressing both individual and contextual factors that interact to shape social dynamics within the classroom and students' involvement in bullying [8].

In order to study the complex interplay of individual and contextual factors and bullying involvement, researchers are increasingly turning to an ecosystemic approach. The ecosystemic or social-ecological approach highlights the interaction between distal (i.e., societal-level factors that have an indirect impact on individuals) and proximal factors (i.e., interpersonal and individual-level factors that have a direct impact on individuals), which shape child's development as well as the functioning of the whole community [29], [30].

According to this theory, child's environment comprises several dynamically changing and interconnected subsystems. Proximal subsystems include factors that directly affect the child. These include [29]:

- The microsystem, which represents the social environment with which the child is in direct contact (e.g., parents, siblings, teachers and the classroom community). The relationship between the child and the environment is bidirectional and interdependent, which means that the child significantly shapes the environment, just as the environment significantly influences the child.
- The mesosystem includes the relationships or interactions between the child's microsystems, such as the interactions between the child's parents and teachers. The quality of the relationships between a child's microsystems has an important influence on the child's development.

Distal subsystems include social and community influences that indirectly shape the child's development. These include [29]:

- The exosystem, which encompasses the wider community in which the child is situated but does not directly influence them. It includes, for example, the child's neighbourhood, the working environment of the child's parents and the mass media.
- The macrosystem, which includes the social and cultural context in which the child is situated, such as the (cultural) ideologies, values and prevailing behavioural patterns of the social group (i.e., ethnic/national group, social class) to which the child belongs.
- The chronosystem that includes all environmental changes during the course of an individual's life that affect their development, including significant (normative or non-normative) historical events and milestones (e.g., transition from primary to secondary school).

In a social-ecological framework, student's involvement in bullying is both a result of individual's (cultural) characteristics, skills and beliefs, as well as their involvement in the different subsystems that influence them directly or indirectly. Ecosystemic approach has been successfully applied in systematic literature reviews to explain the bullying phenomenon and the different roles that individual students play in the context of their ethnic identity and cultural background [6].

Certain ethnic minority students for example might on the macrosystemic level be disproportionately affected by marginalisation and poverty, which might in turn affect their exosystem by predisposing them to living in adverse environments, such as violent neighbourhoods. Living in low-income neighbourhoods with high crime rate might influence their microsystem, contributing to non-supportive family or school environment, which has been linked to classroom bullying involvement [6].

Even though systematic synthesis of the studies suggest ecosystemic approach to researching the relationship between bullying, individual's ethnicity and cultural environment is crucial, there is still a considerable lack of studies empirically testing the model [6]. A potential reason for lack of research might be due to the complexity of the model, which makes it difficult to empirically test. Incorporating ecosystemic framework in a study requires multilevel research, as it encopasses variables at the individual, classroom/school and societal level. This proves to be a challenging task, as it involves operationalizing abstract macrosystemic variables and using advanced statistical methods, such as multilevel structural equation modelling or hierarchical linear modelling [31].

Although incorporating such a complex framework can be challenging, it has already been successfully applied in bullying research [32]–[34] and has proven to be crucial for the development of comprehensive and systematic solutions to bullying.

4 Conclusion

Recent research findings suggest that bullying involvement should be conceptualized as a systemic phenomenon shaped by a wide range of individual and contextual factors. In this article we have shown how social-ecological theory provides a useful framework for studying the complex interplay between individual's ethnicity, cultural characteristics of their immediate and distant environment and bullying involvement.

An ecosystemic approach proves to be challenging yet crucial when examining bullying involvement from the perspective of a student's ethnic identity, as the effect of the latter is largely dependent on the wider cultural environment and society [25]. Furthermore, applying ecosystemic approach to bullying research also provides us with an opportunity to design comprehensive and effective anti-bullying programs and interventions, as addressing contextual-level factors has proven to be key to interventions' effectiveness [6].

Empirical studies have yet to take full opportunity of the proposed model, as of now, there is a considerable lack of studies carried out in Europe [6].

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Inclusive Cultural Heritage Tourism

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Abstract. *Tourism is an important contributor to the global economy, providing employment and generating revenue. However, the industry faces many challenges, including the need for greater inclusivity and accessibility for all. Inclusive Tourism offers a new market niche that has both economic and social value and has the potential to compensate for any declines in tourism growth rates. This niche offers opportunities to extend the touristic experience of a region, activate cultural heritage, support the creation of new technological businesses, and stimulate the digitalization of touristic offers. Developing innovative solutions, such as the Inclusive Cultural Heritage Tourism online platform and the automatic bidirectional translator for touristic activities, can improve access to information and communication in everyone's first language. Advancing Inclusive Tourism can open doors to a significant share of the global tourism market and position promoters at a unique advantage in the international touristic environment.*

Keywords. Inclusive tourism, sign language, machine translation, holographic user interface, online platform

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1 Introduction

In order to ensure inclusion and accessibility for deaf citizens when accessing information, visiting cultural sites, or using services, new assistive solutions are needed to overcome communication barriers. For deaf tourists, language barriers pose a significant challenge and hinder their ability to fully participate in international tourism activities. As tourism is now widely recognized as a social good, it is essential that everyone has equal access to it through innovative and inclusive solutions.

The Inclusive Cultural Heritage Tourism (ICHT) project is aimed at expanding the benefits and opportunities of tourism to all members of society, especially those who are often excluded from tourism. The project focuses on developing digital and assistive tools and content to meet the criteria of sustainable development. It aims to improve accessibility and inclusion, offering a better quality of life to those who face difficulties accessing tourist destinations and services [1].

The ICHT project involves two key deliverables: an online platform and an automatic bidirectional translator for touristic activities (ATT). The aim is to enable communication in everyone's first language, and to improve the engagement of deaf tourists in all touristic activities. Five pilot installations will be adapted to incorporate these deliverables, and the project also advocates for a broader access to information in everyone's first language, as well as training of touristic operators in sign language basics to better welcome and assist deaf tourists [2].

In addition to its social relevance, the ICHT project promotes economic interests and expectations of development and innovation in the National Touristic Strategic Plan, by prioritizing "innovative strategies to develop new products with high added value by addressing niche markets" and "upgrading the quality of the visitor experience." By enhancing accessibility and inclusion, destinations become more attractive, fostering economic growth and international recognition [3].

Overall, the ICHT project aims to provide new assistive solutions for deaf citizens, promote the touristic offer, value cultural heritage, and boost economic growth through technology. By prioritizing inclusion and accessibility, it offers a unique opportunity to improve the socio-economic development of our societies.

2 ICHT platform for inclusive tourism

The ICHT platform integrates an online application with a holography user interface that is installed on-site at various tourist attractions. These elements are linked through a game that includes both deaf and non-deaf tourists and touristic operators, creating an all-inclusive and collaborative touristic experience that can be enjoyed before, during, and after the visit. The aim is to support deaf tourists and introduce the cultural heritage and touristic attractions to a wider audience.

2.1 Online platform

An internet-based platform has been developed to facilitate collaborative efforts amongst those who are interested in cultural heritage tourism. This platform has been integrated with on-site ICHT installations, providing a joint experience for both on-site and remote visitors. The platform offers information and support throughout the entirety of the touristic experience, from planning to sharing post-visit experiences with others. The user may choose to utilize their game account on the platform. The online platform is divided into six primary sections: Home, Courses, News&Events, Game, Practical Community, and Contacts.

Home. The primary page of the platform is the Home page, which the user initially encounters upon opening the platform. The Home page is divided into six distinct sections. The first section contains a video showcasing some of Porto's most stunning lo-cations to visit. The subsequent section provides a brief introduction and contextualization of the platform's objectives, along with meteorological information for the Porto district at the time of platform consultation. A third section provides links to pages that reference the locations where the ICHT system is installed, followed by a section featuring 12 suggested tourist destinations in Porto, and a section addressing potential user questions with their respective answers. Lastly, there is a section containing information on how to contact GILT.

Courses. The platform will feature two sign language MOOCs. One will focus on LGP, while the other will cover IS. These courses are designed for tourists and touristic operators interested in learning the fundamentals of each respective sign language. The primary objective of these courses is to provide national non-deaf human resources in the touristic sector and deaf tourists from foreign countries with a foundational under-standing of Portuguese sign language and international sign language, respectively. This will help to facilitate communication between deaf and non-deaf individuals during touristic activities. These courses will be accessible via the Courses page on the online platform.

News & Events. This page showcases the most recent news and upcoming events related to various topics, including the ICHT project, tourism, deaf individuals, and related subjects.

Game. The ICHT game will be integrated into the platform, allowing tourists to begin playing from the moment they express interest in a particular destination. Tourists can play the game for as long as they desire, accruing points and rewards for interacting with other users through the collaborative platform. The online platform will also serve as a central hub for promoting all ICHT destinations. The Game page on the online platform will be responsible for facilitating the interaction between the game and the platform. This page will display links for users to download the game, as well as pages containing information about locations where the game can be played.

GameMap. There will be five GameMap pages created for the following locations: S. Pedro do Sul Thermae, Porto Coliseum, Maia Zoo, Porto Commercial Atheneum, and Clérigos Tower. These locations will serve as pilot installations for the ICHT system. Each GameMap page will display the following information about the respective destination: a brief description of the touristic location, scheduling information, written and LGP-based question and answer sections, a gallery of destination photos, and a map highlighting the location of the destination.

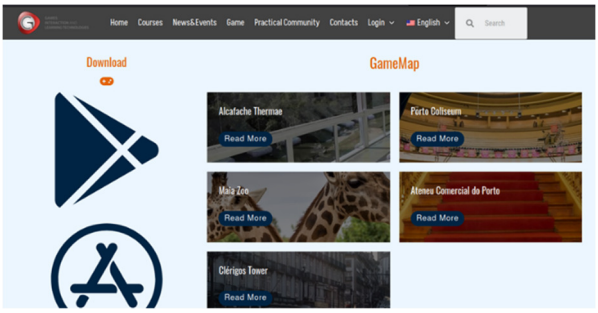

Figure 1. Game page

Practical Community. The Practical Community page on the platform allows users to access all the social networks associated with the ICHT project. Users can share their experiences, ask questions, and engage with other users through these social networks.

Contacts. The Contacts page on the platform was designed to provide users with a straightforward and easy way to contact the project developers via email.

2.2 Hologram

The holographic vision of the avatar doing the translation is obtained using the Dreamoc XL3 which is a 270° 3-Sided Holographic Display. To give a 3D aspect to the avatar, the video format needed to be this: 3 avatar images, one facing the viewer, in the middle between the 1st and 2nd quadrants, and two in profile, one in the 3rd quadrant and one in the 4th quadrant. The one facing the viewer must have a 180° angle and the profile ones must have an angle of 90° and 270° respectively. The background of the video must be dark.

This phenomenon is called Pepper's Ghost Illusion which is a special effect technique used in theatre, television and magic shows to create the illusion of a ghostly apparition or a transparent, holographic projection. The technique involves a reflection of an object or a person onto a glass or a transparent sheet positioned between the viewer and the object. The reflection is usually achieved by using a hidden, angled plate of glass or a sheet of Mylar film. The effect creates the illusion that the object is floating or appearing out of nowhere [4].

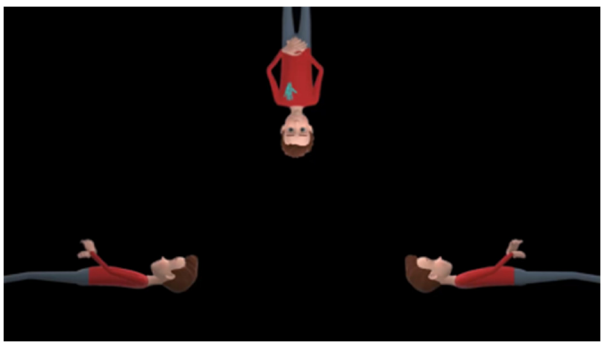

Figure 2. Holographic position

3 Conclusions

The ICHT project is a remarkable initiative that can bring about significant changes in the way the deaf and non-deaf communities communicate and interact in touristic activities. By providing sign language MOOCs and an automatic bidirectional translator, the project aims to empower both deaf tourists and touristic operators to communicate effectively and enjoy a more inclusive and fulfilling touristic experience.

Moreover, the development of the ICHT online platform, which integrates the sign language solutions with touristic information and assistance, can enhance the accessibility of tourism for the deaf community. By offering a collaborative experience among live and remote visitors, the platform can also promote cultural exchange and awareness.

Overall, the ICHT project demonstrates a promising approach to overcoming communication barriers and promoting inclusion and accessibility in touristic activities. It can serve as a model for other destinations seeking to improve their accessibility for deaf tourists and enhance their cultural heritage tourism.

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Motivational Aspects of Galician Shellfish Women Regarding their Participation in Associations

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Abstract. *The associationism of shellfish women in the Ría de Pontevedra can be influenced by different factors related to the gender perspective, due to the fact that it is a highly feminised group. These factors include the shellfish gatherers' personal expectations, institutional support and the working environment. A focus group was used as a means of collecting preliminary qualitative data and content analysis was used to organise the results. The main findings reveal the importance of associationism as an essential element to promote the active participation of this collective by providing them with the power of interlocution to dialogue and negotiate with institutions, other actors and other associations. Likewise, the results suggest that institutional support and the working environment are important and necessary for the promotion of associationism, for the participation of shellfish gatherers in decision-making and the definition of policies related to their activity.*

Keywords. Associationism, barriers, motivation, Galicia, participation, shellfish women

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1 Introduction

The shellfish gatherers of Galicia are known for their traditional work of collecting shellfish and other seafood from the beaches and coasts of a region in northwestern Spain. These women have played a key role in the local economy, and their work has been recognised for its contribution to the culture and identity of Galicia. They have been involved in several struggles and protests in defence of their rights and their environment, becoming a symbol of resistance and struggle for social and environmental justice in Galicia.

The fishing sector is highly masculinised, and there are still differences between men and women in terms of the distribution of work according to gender, the degree of responsibility they assume and the level of participation in decision-making. The gender perspective is essential in the situation of shellfish gatherers in Galicia, as this is an activity that has historically been carried out by women and, therefore, undervalued in many areas. Moreover, it is a sector that has various mechanisms that perpetuate discrimination against women [1].

2 Background and Motivation

Since the beginning of the professionalization of the shellfish sector in the 1960s, shellfish gatherers in Galicia have organised themselves into associative movements to fight for their labour and environmental rights, as well as for the preservation of their way of life and traditions. Associations are a group of people who voluntarily relate to each other in order to carry out a collective activity, in a stable, democratically organised and non-profit-making way, and independent, at least formally, of the State, political parties and companies [2]. The aim is to transform reality through participation, and associationism is understood as a form of social participation that helps to highlight opportunities for the improvement of women shellfish gatherers in governance and to promote gender equality.

Since the mid-1990s, the foot fishing sector has undergone a major transformation from a purely extractive, individual activity to an organised one with complementary jobs such as seed transfer, cleaning of sandbanks on shellfish beds, cultivation activities to improve production, protection activities, control, monitoring and surveillance of shellfish beds. Although the physical tasks associated with fishing are still dominated by men, the roles played by women in the European fisheries and aquaculture sectors are changing, with women now playing an important role in the diversification and survival of the sector thanks, in part, to the associations that have played a key role [3]. Many regional, national, European and international fisheries policies have explicitly committed to improving women's participation in the sector, including their representation in governance and enhancing their role in decision-making [4]. An example at the national level is the Plan for Gender Equality in the Fisheries and Aquaculture Sector 2021-2027 [5], which aims to promote gender equality in the sector. At regional level, the Xunta de Galicia has implemented policies to support women shellfish gatherers in Galicia, encourage their association, protect their rights and environment, and promote the United Nations Sustainable Development Goals (SDGs) [6] in the context of shell fishing. The relationship between SDG 5: Gender equality and SDG 14: Life under water, a goal directly related to fishing, has been pointed out in several studies [7], [8], [9].

The impact that associations are having on the recognition of women shellfish gatherers on foot makes it essential to investigate the initial motivational aspects of women of the sea in relation to participation in sector-specific and feminist associations, as well as the barriers they have to overcome. This justifies the need and relevance of carrying out this research, which also aims to contribute to broadening scientific knowledge in this field, filling some of the gaps in the scarce existing literature and serving as a basis for the future design of interventions and support that favour the presence of facilitating factors and reduce barrier factors.

3 Materials and methods

The methodology used was qualitative, based on the focus group technique, with an exploratory design on the reasons and difficulties of shellfish women to participate in associations in the Ría de Pontevedra in Galicia.

The objectives of the focus group were to obtain preliminary information on a topic that is little studied and to identify possible thematic areas to be investigated in depth, on the experiences and perceptions of shellfish gatherers with regard to their participation in associations in the sector in Galicia. It is intended to understand the reasons that drive or limit their involvement, as well as the benefits and challenges they face in the process.

Nine women shellfish gatherers were convened and eight participated, using purposive sampling, all with experience in the activity and in the associative movement in Galicia and in some cases in Spain. A diverse representation was sought in terms of years of professional seniority.

The focus group was held in October 2019 at the Cofradía de Raxó, a regional guild. The discussion was led following the prepared guide of semi-structured questions, encouraging the participation of all the shellfish gatherers present and ensuring that topics of interest were addressed. Questions focused on previous experiences in associations, reasons for participation, barriers and challenges, empowerment and proposals for improvement.

Two researchers, one acting as facilitator and the other as observer, collected information. Field notes were taken to ensure the accuracy of the information, and then the data was transcribed and analysed using the content analysis method to identify emerging categories and themes. Microsoft Office Excel 2007 was used to graphically represent the content.

The ethical principles that are in force in the Declaration of Helsinki were respected, including anonymity and the right to self-determination. The focus group was conducted for academic purposes and was kept confidential.

4 Results

The sample selected for the study has an average age of 49.2 years, with an age distribution ranging from 33 to 61 years. It should be noted that all participants belong to an association, as this was an inclusion criterion for the study. In terms of their work experience in shellfishing, the average length of service is 20.7 years, with 4 people with experience of less than 20 years and 4 with experience of between 26 and 32 years. The profile of the participants is shown in table 1.

Table 1. Profile of the participants:

Participants	Professional category	Sex	Age (years)	Professional seniority	Membership of an association	Seniority in The sector
P1	Shellfish gatherer	F	43	7	Yes	7
P2	Shellfish gatherer	F	54	26	Yes	26
P3	Shellfish gatherer	F	59	27	Yes	27
P4	Shellfish gatherer	F	56	30	Yes	30
P5	Shellfish gatherer	F	62	32	Yes	32
P6	Shellfish gatherer	F	33	16	Yes	16
P7	Shellfish gatherer	F	46	20	Yes	20
P8	Shellfish gatherer	F	42	8	Yes	8

F= female.

The main findings of the focus group are presented below:

Motivational aspects perceived by the shellfish gatherers to associate:

Economic benefits: they perceive that belonging to an association or cooperative can allow them to obtain better prices for their products, access new markets and obtain support for the marketing of their products.

Solidarity and mutual support: they expect to find the sense of community and solidarity that is expected from an association and may be one of the most important motivational factors for the shellfish gatherers. The possibility of sharing experiences and knowledge, as well as supporting each other in difficult times, can be an important source of motivation.

Participation in decision-making: they understand that the associations provide a space for them to actively participate in decision-making that affects their activity. This can be an important motivational factor for those who wish to be more involved in the management and development of their work.

Access to resources and training: Membership in an association provides access to resources and training that can enhance the quality of life and professional development of women shellfishers. This can range from access to equipment and tools, to training on technical, financial and legal issues.

Representation and advocacy: Associations can represent and advocate for the interests of women shellfishers to authorities and other organisations. This can be an important motivating factor for those who wish to have a stronger voice in the defence of their rights and in decision-making that affects their activity.

The most common barriers:

In terms of barriers, there are a number of difficulties that can prevent or limit the participation of women shellfishers in associations:

Lack of information: Many shellfish gatherers may not have sufficient information about the partnership or cooperative options available to them, which can hinder their ability to make informed decisions.

Financial costs: The cost of association can be a limiting factor for some shellfish gatherers, especially those with limited resources.

Mistrust: Some women shellfish gatherers may have mistrust or concerns about the effectiveness of associations or cooperatives, or the proper use of funds invested in them.

Lack of time: Shellfishers may find it difficult to devote time to participation in associations or cooperatives, especially if they have other work or family responsibilities.

Cultural barriers: Women shellfishers may face cultural barriers that prevent them from participating in associations or cooperatives, such as gender stereotypes or cultural norms that favour individuality.

Lack of leadership: Lack of leadership or effective management in associations or cooperatives can diminish the confidence and motivation of women shellfishers to join.

5 Discussion and conclusions

The focus group reveal that women shellfish collectors in Galicia face a number of challenges that affect to their work, health, and quality of life, including discrimination and labor exploitation by working double shifts, the paid work and unpaid work in the domestic sphere [3]. Other challenges that they usually face are water pollution due to industrial activity that has seriously affected shellfishing areas, poaching, climate change that has affected marine life on the Galician coast, unfair competition due to imported shellfish often at lower prices, the ability of shellfish gatherers to obtain fair prices for their work [4], [5]. Finally, the lack of socio-labor recognition, since sometimes their work is not fully recognized by the authorities as a professional activity, which makes it difficult to protect their rights and guarantee fair working conditions [8], [9].

The gender perspective is fundamental in the situation of women shellfish collectors, since they face discrimination in access to resources and opportunities [5], [9], as well as the low value of their work and their contribution to the economy and the society. Gender prejudices still rooted in a patriarchal society, the feminization of the profession and glass ceilings are other impediments for women to access positions of power and representation.
They often have to reconcile their work with household chores and family care, which implies a double working day and an overload of responsibilities, precarious salaries and working conditions that affect their well-being and that of their families, lack of access to training and professional development, and little participation in decision-making and leadership [1], [8].

It is important to bear in mind that motivational aspects may vary depending on the context and characteristics of each group of women shellfish workers. Therefore, it is advisable to carry out a detailed analysis of the factors that motivate or demotivate the participation in association in each particular case, in order to design appropriate strategies and actions to encourage the participation and commitment of the shellfish gatherers in the association.

Recognition of barriers is essential in order to overcome them, as association can offer a number of important benefits for shellfish gatherers, such as improved working conditions, defence of rights and representation in decision-making. To overcome these barriers, a series of strategies can be implemented such as training, education and awareness about the benefits of the association, the offer of training programs and advice to improve the management and leadership of the association, as well as strategies that contribute both to the design of programs and public policies aimed at promoting the participation of women in shellfishing and associationism, as well as to the design and strengthening of existing organizations.

As a limitation of this study, although the results of a focus group can provide valuable information on the motivations and difficulties of a particular group of people, they cannot be generalised to the population of shellfish gatherers as a whole without further research to validate these results and to go deeper into more specific aspects of this research.

Today, associationism has enabled shellfish gatherers to plan their work and control their exploitation with the support of the autonomous government through the biological, ecological, economic and social objectives of the management plans included in the General Plan for Shellfish Exploitation. Co-management, as a socio-political strategy of governance, is important as it allows the inclusion of women of the sea in these processes; however, improving the capacity of associations to deal with tasks related to co-management is a challenge to be overcome in the coming years.

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Progress in Fine Arts Creativity of 13 Year Olds through Contemporary Fine Art

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Abstract *Through the appropriate interpretation of contemporary works of art, pupils can develop their own critical thinking, adopt an attitude towards socially critical content and develop their artistic creativity.*
The basic aim of the dissertation, which we describe in the abstract and throughout the article, is the progress in pupils' creativity in relation to the implementation of contemporary fine art in the art classroom.
Primarily, we were interested in art teachers' attitudes towards contemporary art practises and how they are monitored. We also created a 15-week work programme and conducted a pedagogical experiment. Before and after the experiment, we administered an art test LV2 to check the progress in artistic creativity of eighth graders and compared the results in the control and experimental groups.
The results show that pupils make progress in artistic creativity when they use contemporary artworks in the classroom, and at the same time develop the creative thinking and reflect on artistic solutions.

Keywords. Primary school, art teaching, art didactics, creativity, contemporary fine arts

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1 Introduction

By learning about and encountering contemporary fine art, pupils develop and shape both concrete and abstract thinking [18]. We agree [8] that contemporary art encourages certain ways of experiencing, exploring and narrating the world. Consequently, artworks based on examples of contemporary fine art enable pupils to understand the environment and the times in which we live in [1], [3], [4]. The inclusion of contemporary fine art in art lessons as a stimulus for individuals to adopt a critical attitude towards the content discussed and as a stimulus for artistic and ideological creativity [5] should not forget the development of pupils' psychomotor skills and creativity [6]. In fact, artistic and creative skills have a direct impact on the development of an individual's overall creative potential [6], [7], [8], which can be influenced by teachers with an appropriate approach and properly designed artistic tasks [9], [10]. Artistic creativity is an area that develops with the support of a long-term pedagogical process, a stimulating environment and a creative teacher who teaches through active artistic activity [6], [11]. It is the creative product that helps us monitor the development of pupils' artistic abilities [12], [6], [7]. To measure artistic ability, researchers use a variety of proven tests that have high reliability, objectivity, sensitivity, validity, standardisation, ease of use and cost-effectiveness [6]. Various artistic tests can be used to assess artistic-creative development, artistic-appropriate skill development, fine form development and visual-thematic development [6]. Considering these facts, the contents of contemporary fine arts can be an encouraging learning environment for lifelong learning as well as for the development of artistic skills, which are usually measured through artistic practise. Thus, by interweaving the contents of the respective curriculum [13] and incorporating contemporary fine arts into the arts curriculum, we can promote progress in the overall artistic-creative development of individuals [6], strengthen lifelong learning [14] and develop some key skills for the future of young people [15].

2 Objectives and Course of the Research

2.1 Objectives

The basic objective of the study is to *experimentally measure the artistic-creative and visual-creative development of eighth graders at the time of the implementation of the programme to incorporate contemporary artistic practises in the classroom.* In the research, we also pursued the objectives that we gradually achieved according to the planned course of the research:

a) Determine art teachers' attitudes towards modern art practises and the extent to which they incorporate modern art into their teaching. The aim of this part of the research is to raise awareness of the importance and pedagogical value of contemporary art practises for inclusion in the primary fine arts curriculum.
b) Design a suitable method to implement contemporary art practises in third educational period art lessons, based on a set of appropriate didactic choices (*Program implementacije sodobnih umetniških praks v osnovni šoli* - hereafter referred to as the PISUPOŠ Programme).
c) Carry out a pedagogical experiment and evaluate it qualitatively.
d) Analyse the progress of artistic abilities of eighth graders using the LV2 test.

With these goals, we pursue the results that are crucial for achieving the basic objective.

2.2 Course of the Research

The research was conducted in phases, which were divided into three parts according to the linear relationship. The following table shows the progress of the research.

Table 1. Exploration progress display

<table>
<tr><td></td><td>Part 1</td><td colspan="4">Part 2</td><td colspan="2">Part 3</td></tr>
<tr><td>Phase 1</td><td>Phase 2</td><td>Phase 3</td><td>Phase 4</td><td>Phase 5</td><td>Phase 6</td><td>Phase 7</td><td>Phase 8</td></tr>
<tr><td rowspan="4">Overview of the state of the literature</td><td rowspan="4">Arts teachers' opinions analysis</td><td colspan="4">Pedagogical experiment</td><td colspan="2">Analysis of pupils' progress</td></tr>
<tr><td rowspan="3">Creating an effective pedagogical programme</td><td>Questionnaire for pupils</td><td rowspan="3">PISUPOŠ implementation</td><td>Questionnaire for pupils</td><td rowspan="3">LV2 test analysis</td><td rowspan="3">Conclusion on the success of the pedagogical experiment</td></tr>
<tr><td rowspan="2">Test LV2 - Initial</td><td>Test LV2 - final</td></tr>
<tr><td>Interview with teachers</td></tr>
</table>

2.2.1 Arts teachers' opinions analysis

First, we analysed the opinions and attitudes of teachers teaching fine arts in Slovenian primary schools with regard to knowledge of contemporary art practises, the introduction of contemporary fine arts content into the classroom, and pupils' perceived attitudes towards the content in question. The results of the analysis were the starting point for planning the continuation of the research. Good planning of the further phases of the research was important for an efficient course and for achieving the underlying goal. At the same time, the results of the first research series provide important information about the state of art teaching practise and the engagement of art teachers from the perspective of contemporary art practise.

2.2.2 Pedagogical experiment

Based on a literature review of previous findings, an analysis of teachers' opinions and tendencies on contemporary art didactics and a set of didactic decisions, we have designed a work programme for the implementation of contemporary art practises in art teaching in the third phase of education (PISUPOŠ). The set of didactic decisions includes didactic-organisational features, content features, features of didactic communication and activities, and the position and relationships between pupils and teachers. The PISUPOŠ programme contains suggestions for selecting a contemporary work of art, for linking a work of art or an artist with methods and forms of work, and for developing appropriate methods and didactic steps.

The programme was created in accordance with the art curriculum [13] and implemented in a 15-week pedagogical experiment with 13-year-old pupils to promote and verify its effectiveness in developing pupils' artistic skills (artistic-creative and artistic-formal development). The content of contemporary fine arts was linked to the interpretation of artistic concepts from the curriculum as well as to the explanation of the content reasons for their creation. As an effective tool for a

comprehensive understanding of the respective topic, we linked some artistic tasks across subjects. At the same time, we recorded the results according to the principles of formative monitoring and thus monitored the pupils' progress. Cross-curricular integration and formative monitoring are the guidelines of modern general didactics. The purpose of the pedagogical experiment in which we tested the effectiveness of the designed programme is to confirm the meaningfulness of including contemporary fine arts through specially designed artistic tasks. The purpose of the pedagogical experiment itself, which is the second area of research, is to encourage pupils to think critically and to progress artistically and creatively.

2.2.3 Analysis of the progress of pupils' artistic abilities

The analysis of the progress of *13-year-old pupils' artistic skills in the third research* set aims to determine whether the inclusion of contemporary fine arts content has a positive impact on pupils' artistic and creative development. The development and progress of pupils' artistic skills was measured using the revised LV2 test, also known as the four-character test [6]. The artistic tasks of the LV2 test are designed to provide information about the child's general artistic development while allowing partial monitoring of various factors of artistic development (redefinition, originality, elaboration, sensitivity to artistic problems, flexibility, fluency, visual-thematic development, design development, artistic taste, design experience and art technique, individuality, general artistic level). The test was administered before and after the educational experiment in both the experimental group and the control group. By comparing the groups and contrasting the results in the initial and final phases, the aim was to investigate the progress of the pupil's artistic skills, with the experimental group making greater progress.

3 Discussion and Conclusion

The evaluation of the questionnaire for the teachers showed that the teachers, regardless of age and professional experience, are equally committed to current developments in the field of fine arts and contemporary fine arts. The teachers believe that visiting exhibitions is necessary for individual's professional development. At the same time, visiting exhibitions stimulates and motivates their work in the classroom and their own creative practise, on the basis of which they often design content for implementation in the pedagogical process. Most teachers show a positive attitude towards contemporary fine arts. By accepting the content of contemporary artworks, even those with negative messages, they give contemporary art the opportunity to engage with them and adopt a more objective attitude towards it. The teacher's critical attitude towards certain content is crucial in deciding what content to present to the pupils. The analysis of the results from the point of view of the inclusion of contemporary fine arts in art lessons has shown that teachers recognise the value of contemporary fine arts in terms of both content and approach; however they want specific guidelines and content support in relation to contemporary fine arts within the curriculum. Besides the time component and the spatial possibilities, this is exactly the reason why teachers do not bring the content of contemporary art practises into the classroom to a greater extent. A qualitative analysis of the pedagogical experiment, which was the most extensive part of the research over time, showed that the pupils accepted the artwork well and gradually developed a positive attitude towards contemporary fine art, which they did not know

at the beginning of the experiment. They internalised the notion of an idea/concept and felt that they were creating what they wanted. At the beginning of the experiment, pupils who were not very talented in fine arts stood out with their ideas because they did not struggle with the visual image, they worked in a more relaxed way and followed the idea of the artwork. Some pupils who were considered talented had more problems because they were confronted with something new and were not very confident, which was a big obstacle for them at the beginning. Some pupils with special needs also responded well to the tasks and found good artistic solutions with a lot of imagination. Contemporary art can thus be a challenge and a new way for pupils to have find freedom in representing artistic motifs in order to stimulate creative thinking and ingenuity more intensively and quickly. The pupils realised that there were no limits to their ideas. They began to understand that something that is supposed to be "beautiful" does not necessarily have artistic quality. The analysis of the LV2 test conducted before and after the educational experiment showed the progress of the pupils in the experimental group, both in the total score of the artistic-creative level factors and in the score of the visual-creative development factors. Thus, the pupils in the experimental group who worked according to the 15-week PISUPOŠ programme achieved better results than the control group who worked according to the established teacher programme. We conclude that the implementation of contemporary artistic practises in the classroom can successfully influence pupils' overall artistic creativity as well as the development of imagination and the promotion of critical thinking, which is reflected in the expression of attitudes towards certain content. The research findings point to positive guidelines for the inclusion of contemporary fine arts in the primary school curriculum.

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Protected Areas in War Zones – Global Analysis Towards the Nature for Peace Concept

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Abstract. *Around 17% of the worldwide land ecosystems are currently under conservation [1]. Protected areas have the following three functions: protection, research and education. Through the Nature for Peace concept, the plan is to assign a further function for protected areas. Protected areas have the potential to become focal points for recuperation of those affected by an armed conflict (wounded, affected, vulnerable, uprooted persons or groups). Protected areas offer the necessary environment to carry out this rehabilitation function. To disseminate the Nature for Peace concept, the intent is to build a cluster to share materials and connect stakeholders. For establishing this cluster, a worldwide needs analysis is required. With the tool of ArcGIS the armed conflicts of the last few years were linked with protected areas in order to obtain a selection of areas where the Nature for Peace concept can be applied.*

Keywords. UNESCO, peace, conflicts, nature, rehabilitation, mental health

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1 Introduction

Armed conflicts have a significant negative impact on protected areas and local residents. The mental and emotional pressure and burdens brought on by armed conflicts are a major challenge for the local population. Protected areas are important retreat and regeneration spaces, particularly in times of conflict and post-conflict.

The vision of the Nature for Peace concept is, that protected areas shall become focal points for the recuperation of those affected by conflict [2]. Through the application of the concept, protected areas can offer rehabilitation by connecting victims of armed conflicts through interaction with nature (health generation, identity, awareness raising). The Nature for Peace concept was established in 2022 by Emily Chrystie, Marta Korchemlyuk, and Elisabeth Wiegele during the Management of Conservation Areas Course at the UNESCO Chair for Sustainable Management of Conservation Areas.

The Nature for Peace concept should establish itself as a method that can be applied in post-conflict areas worldwide. Therefore, establishing a cluster for sharing knowledge and resources between stakeholders and post-conflict protected areas is very significant. To support the Nature for Peace idea, an overview of the current situation is important. For this purpose, an accurate analysis is required to investigate the demand of the Nature for Peace concept. By evaluating the armed conflicts of the last seven years, it is feasible to identify protected areas for which the Nature for Peace concept is applicable. With this information, a cluster for disseminating the Nature for Peace concept can be built [3].

2 Methodology

The main objective of this research is to find out which protected areas have been affected by armed wars. Once these countries and protected areas have been identified, the research question can be answered. To address the research question (What is the global need of the nature for peace concept?) a large amount of data with information about conflicts is required. To find out for which protected areas the Nature for Peace concept is applicable, it is necessary to gather the armed conflicts and protected areas with an existing management.

The data collection process is divided into more phases. At the beginning, the concepts of conflict and peace were defined. The different phases of war and peace were identified. Afterward, the conflict countries for the analysis were gathered and the protected areas were collected. A combination of several approaches was chosen to compile the countries for this study. On the one hand, data from the largest conflict research institute was used (Uppsala University has established a Conflict Data Program database [4]). On the other hand, a war database was compiled manually on the basis of internet and news research. During the process of data collection, conflict data from the World Bank were included [5].

It is important for the application of the Nature for Peace concept that the protected areas have a functioning management, which is able to carry out the Nature for Peace concept. Since the UNESCO Geoparks, UNESCO Biosphere Reserves, UNESCO World Heritage Sites, Peace Parks and Transboundary Areas should have such a management structure, these categories were selected. The data of the UNESCO sites were obtained directly from the UNESCO database [6] [7] [8]. The data for the Transboundary Areas and Peace Parks were manually prepared.

3 Results

The data were determined by the Uppsala University - Conflict Data Program database [4] and conflict data from the World Bank [5] were included. In addition, and as a cross-check, a war database was compiled manually on the basis of internet and news research. These three databases were merged according to different criteria. Conflicts from the last 7 years were included, as timeliness is very important for the Nature for Peace concept. All countries with a total of more than 1000 casualties were taken into consideration. If countries were below this limit, they were still considered if they still had an active conflict in 2021 and 2022. Many of the worldwide conflicts are still *ongoing* because there are still no peace agreements or solutions that both parties agree to. However, many of these ongoing conflicts are inactive conflicts in which no action is taking place. Since the Nature for Peace concept is mainly focused on active conflicts, as it can be a rapid response measure, active conflicts are particularly relevant for this analysis. The current wars and border conflicts of the last two years have been included due to their relevance, even if they have less than 1000 casualties. The result is, that in the following 32 countries, the protected areas were analysed:

Afghanistan, Armenia, Azerbaijan, Burkina Faso, Cameroon, Chad, Colombia, Congo, Egypt, Ethiopia, India, Indonesia, Iran, Iraq, Israel, Kenya, Libya, Mali, Mozambique, Myanmar, Niger, Nigeria, Pakistan, Philippines, Somalia, South Sudan, Sudan, Syria, Thailand, Turkey, Ukraine, Yemen.

Once the data was collected and processed, the criteria were used to identify specific conflicts, countries and protected areas. The data of the conflicts were merged with the protected areas using the ArcGIS program. After analysing the data, a list and a map of protected areas affected by conflict in the last seven years were drawn up. These protected areas can be future Nature for Peace Parks or *Landscapes of Hope*.

The results show that 95 UNESCO Biosphere Reserves, 39 UNESCO Natural World Heritage Sites, 9 UNESCO Global Geoparks, 41 Transboundary Parks can apply the Nature for Peace concept.

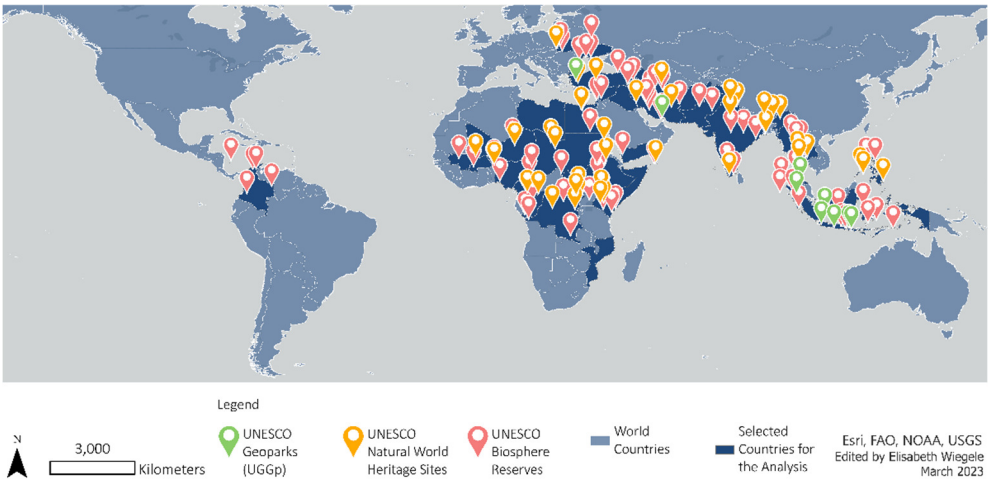

Figure 1. Protected areas that could apply the Nature for Peace concept.

4 Outlook

By evaluating the armed conflicts of the last seven years, protected areas for which the Nature for Peace concept is applicable were identified. With this information it is manageable to build a cluster. Within this, information about the Nature for Peace concept can be shared, manuals and workshop materials can be distributed and an exchange between stakeholders can take place. A cluster of this kind is the most effective way to disseminate the Nature for Peace concept and help many conflict-affected communities.

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Study of the Impact of the Quality of Communication on the Success of Projects Carried out at Higher Educational Institutions

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Abstract. *The research project is being prepared during the study in Doctoral School of Social Science at Maria Curie-Sklodowska University in Lublin from 2020 to 2024. The main scientific goal of the study is to model the impact of the quality of communication on the success of projects carried out at universities. The strength with which the quality of communication influences the success of projects at universities and the relationships between its determinants will be examined. The set research goals will be achieved through a review of Polish and foreign literature on the subject, analysis of existing data and structural equation modelling. For this purpose, a preliminary dependency model was developed, showing the impact of the quality of communication on the project success. The determinants that significantly affect this quality will also be analysed and defined. The research and its results will enable a deeper understanding of the role of communication and its quality attributes in the effective achievement of individual project results.*

Keywords. Project, project management, communication quality, communication in the project, higher education institution, universities

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1 Introduction

Nowadays, almost all universities in Poland implement projects and, for this purpose, obtain external funds. There are more funding opportunities and the conditions for project implementation have significantly influenced the way in which universities are managed. However, this issue is not sufficiently developed on the basis of the theory of management sciences. The specificity of project implementation at universities differs significantly from those organizations that have been described in the scientific literature so far. Published papers relating to universities focus on the specificity of project implementation in one institution or concern only research projects. They do not explore the importance of communication in this process. Effective project management at universities is an important issue, as it translates into the quality of their functioning and maintaining a competitive advantage.

Project management issues have been described extensively and in detail in both Polish and foreign scientific literature, but they still do not lose much of their topicality. Universities are organizations in which projects and efficient management of these projects are an important element of their functioning. This is important in terms of changes in the functioning of universities introduced by the law, as well as in the ongoing process of their internationalization. They carry out the didactic process as well as research and development activities. Their ability to adapt to changing market conditions and introduce changes is one of the key success factors. These changes usually take place in the project formula. According to data from the POLON system (April 30, 2021), there are 372 universities in Poland, of which approx. 60% are non-public. Due to the limited budget of the university, the undertaken projects are implemented mainly thanks to the acquisition of external funds under the available programs from the National Science Center, National Center for Research and Development, NAWA or the Ministry of Science and Higher Education. Thanks to this, it is possible to undertake activities in the field of research, research and development, international projects, implementation of IT and investment systems, improvement of the quality of education, student and employee mobility, implementation of practical elements within the course of studies, launching new specializations, establishing cooperation with representatives of the business, research commercialization. The implementation of this type of activities without external financing could be significantly limited or simply impossible. The effectiveness of obtaining external funds for research is also one of the criteria assessed in the annual ranking of universities "Perspektywy".

The concept of communication quality has been well researched in areas like psychology or communication and media studies sciences, but not in the area of project management. Many authors point out to communication as a key factor in the success of a project. However, communication is quite a broad concept and the most important thing is to identify its qualitative aspects and relate them to a specific situation or industry.

Most of the studies in this area concern the study of the quality of communication in IT projects and refer to a different approach to project success (there is no one generally accepted definition). However, universities and projects implemented in them have not been the area of research on this phenomenon so far. Therefore, there is a research gap, and due to the growing number of projects implemented at universities and significant funds that are ob-

tained by universities - this issue is important. The consequence of ineffective project implementation may be the return of received funds (in whole or in part). The effectiveness of obtaining external saucers for financing research projects is also one of the criteria for evaluating universities.

2 Scientific purpose

The research project is being prepared during the study in Doctoral School of Social Science at Maria Curie-Sklodowska University in Lublin from 2020 to 2024. The main scientific goal of the project is to model the impact of the quality of communication on the success of projects carried out at universities.

The following research questions were asked in the study:

1. Can we identify the factors influencing the quality of project communication at universities?
2. With what strength do the identified factors influence the quality of project communication?
3. Can we observe the relationship between the factors?
4. How does the quality of project communication influence its success?

A research model was developed on the basis of the literature review on the factors influencing the success of the projects. In this model, the relationship between the quality of communication in the project and its success will be assessed, as well as the impact of other variables on the quality of communication. The following theoretical constructs and definition of them were adopted:

- the competences of the members of the project team (by A. Rakowska, 2018) are their knowledge, skills, experience, personal qualities and attitudes,
- access to project knowledge (after P. Wyrozębski, 2014) is access to project knowledge by members of the project team in terms of information required in the implementation of assigned tasks, mainly related to reporting and project documentation,
- information and communication technologies (after K. Warzecha, 2018) is a set of systems, devices, communication media, tools and services that process, collect and transmit information in electronic form,
- the quality of communication (after B. Aubert, V. Hooper, A. Schnepel, 2013) is the degree to which the information provided by communication had appropriate content (was complete, reliable, accurate and purposeful) and had the appropriate form (was delivered in a timely manner, with an appropriate level of openness and formalities, adaptation to the recipient and was bidirectional),
- the success of the project (after E. Andersen, D. Birchall, SA Jessen, HA Money, 2006) is the degree to which the results were achieved for the project (project implementation within the planned time, budget and planned quality parameters), organization (preparing for the future) and satisfaction of members of the project team and its clients.

The model will also include moderating variables regarding the type of project (research, implementation, education). The main methodological goal of the work will be to prepare and

verify the model of the structural condition describing the analysed phenomenon. A measurement model will also be prepared.

3 Research methodology

The research goals will be achieved through the review of Polish and foreign literature on the subject, analysis of existing data (including regulations, guidelines) and structural equation modelling. A model has been prepared to assess the relationship between the quality of communication in the project and its success. The following theoretical constructs were adopted in the developed dependency model: quality of communication in the project team, quality of team communication with stakeholders, project success, team members' competences, access to project knowledge, information and communication technologies. The impact of the factors on the quality of communication will also be analysed.

Quantitative methods were used. Based on the definitions of theoretical constructs developed due to the review of Polish and foreign literature on the subject, questions for the questionnaire (measurement) were prepared - three or four statements for each construct. A Likert scale was used to monitor the responses. The survey was carried out using the proprietary questionnaire and the CAWI method. The selection was deliberated - participants of projects implemented at universities were recruited for the study (maximum 3 people from each university, depending on the type of project: research, implementation, education). The research was carried out in the period from November 2022 to January 2023. In total, 67 universities from Poland took part in the study. 160 of 175 received questionnaires were finally qualified for the study.

The research results are now being quantified in order to verify the research hypotheses set out in the project. The structural equation modelling (SEM-PLS) will be used to investigate the relationship between the variables. A measurement and structural model will be prepared. Convergent and differential validity tests will be used to analyse the model. Data analysis will allow to test the theoretical model taking into account various cause-effect relationships among the variables. The conclusions will also be formulated. The research results will be disseminated in the form of scientific articles in recognized journals dealing with topics related to management, including project management and management at universities. They will also be presented at scientific conferences.

4 The importance of the project's results

The problem of the quality of communication in projects has not received much attention in the conducted research in the field of management and quality sciences. Most of the studies in this area concern the study of the quality of communication in IT projects and refer to a different approach to project success (there is no one generally accepted definition). However, universities and projects implemented at them have not been the area of research on this phenomenon so far. Therefore, there is a research gap, and due to the growing number of projects implemented at universities and significant funds that are obtained by universities - this issue is important.

The results of the research work include defining the quality of communication adequately to the specificity of project implementation at universities, as well as examining the determinants that significantly affect this quality. In addition, the strength with which the quality of communication influences the success of projects at universities and the relationships between specific theoretical constructs will be examined. The results of the research will contribute to the organization and development of knowledge in the discipline of management and quality sciences. This will enable a deeper understanding of the role of communication and its quality attributes in the effective achievement of individual project results.

The research proposed in this project and the developed model are original and innovative and have not been tested so far, also at the international level. Also, previous studies have not used structural equation modelling to analyse this phenomenon in the same approach. The results of the research carried out due to the original approach and the area not studied so far have a chance to be disseminated in high-quality international scientific journals dealing with the issues of management, including project management and management in higher education.

The analysis of the obtained results will also help to better understand the mechanisms of achieving success in projects implemented at universities, as well as verify the hypotheses as to how communication is used to achieve the project's success and which of these methods is the best. On this basis, management staff will be able to improve the process of project implementation at universities and the results achieved in them not only for organizations and sponsors, but also for project clients and members of project teams.

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The Great Patriotic War in the Propaganda of "Komsomolskaya Pravda" and "Argumenty i Fakty" in the Years 2014-2022

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Abstract. *This work presents my doctoral project, which is currently in progress. Using the example of two Russian weekly newspapers - "Komsomolskaya Pravda" and "Arguments and Facts" - the project will provide a detailed description of the materials related to the Great Patriotic War, how they are used, to what extent, and in what ways they are used in Russian propaganda to promote and justify imperial patriotism of Russian society and the imperial policy of the Russian state.*

Keywords. Propaganda, Russia, ideology, war, media

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1 Introduction

In the 1990s, the new Russian state that emerged after the collapse of the USSR faced a radical modernization of its political system. The democratization of the system had to lead to the transformation of Russia into a modern state, which meant, among other things, weakening the central power and warming up relations between Moscow and the West. The shift towards a liberal system became an alternative way of exercising power, moving away from Russia's traditional imperialist policy of expanding its territory by annexing new areas that did not belong to it.

However, as a result of Yeltsin's liberalisation, it became apparent that the Russian state and its citizens were not ready for such political modernization. Vladimir Putin's ascension to power marked a new stage in Russia's history: real political compe

tition was eliminated, the media space was subordinated to executive power, and the powers of local authorities were restricted. President Putin aimed to restore Russia's strong position on the international stage and continue its imperialist tradition. To achieve these goals, it was necessary to find a source that would serve as the foundation for a new Russian ideology. The Great Patriotic war became that source.

The term „Great Patriotic War" has been historically used in the USSR's historiography, and it continues to be employed by the Russian Federation to describe the German-Soviet war of 1941-1945 as part of World War II. Although the term "Great Patriotic War" may not be universally recognized or understood in all academic contexts, but it would be appropriate to use the term in my project. By doing so, I aim to emphasize the specific historical and cultural context of propaganda.

2 Background

Research on the topic of the Great Patriotic war has so far focused mainly on analyzing the Great Patriotic war as a factor shaping the collective consciousness of Russian citizens [1][2]. The topic of the Great Patriotic war has also appeared in research on the image of the Great Patriotic war in Russian history textbooks in the context of the historical policy of the Russian Federation [3]. In addition, in scientific studies, the subject of the Great Patriotic war has been examined in order to explore and describe the impact of the militarization of the Russian state and the mythologization of the Great Patriotic War on Russian politics and geopolitics, as well as foreign policy [4]. Despite the growing research activity in this area, the topic of the Great Patriotic war in Russian propaganda, including weekly newspapers, is still an original and interesting research area, as previous research results have mainly focused on analyzing the Great Patriotic war as a direction of historical policy. Therefore, research on this topic in the field of media and social communication is still fragmented, and many research questions remain open.

The purpose of this research project is to conduct an analysis of the propaganda content of "Komsomolskaya Pravda" and "Argumenty i Fakty".

3 The Materials and Methods

The research focuses on the content, extent, and methods of utilizing Great Patriotic War-related content in Russian propaganda, specifically analyzing two weekly newspapers, "Komsomolskaya Pravda" and "Argumenty i Fakty".

Main research objective: To conduct a content analysis of the propaganda content in "Komsomolskaya Pravda" and "Argumenty i Fakty", enabling the discussion of identified research problems and verification of research hypotheses.

Main research hypothesis: The propaganda content related to the Great Patriotic War published in "Komsomolskaya Pravda" and "Argumenty i Fakty" promotes and justifies Russian patriotism, authoritarianism, and imperialism.

Main research questions:

- How did the cult of the Great Patriotic War originate, and what are its main characteristics?
- Under what conditions and to what objectives do Russian media carry out propaganda?
- What Great Patriotic War-related content is used in the propaganda of "Komsomolskaya Pravda" and "Argumenty i Fakty", to what extent, and in what manner, for the promotion and justification of patriotism within Russian society?
- What Great Patriotic War-related content is used in the propaganda of "Komsomolskaya Pravda" and "Argumenty i Fakty", to what extent, and in what manner, for the promotion and justification of authoritarian rule in Russia?
- What Great Patriotic War-related content is used in the propaganda of "Komsomolskaya Pravda" and "Argumenty i Fakty", to what extent, and in what manner, for the promotion and justification of Russia's imperial foreign policy towards neighboring countries and the West?

The main research method will be qualitative analysis of propaganda discourse. To achieve the research objective, the analysis of semantic field has been chosen as the method for interpreting the discourse. This will allow for a detailed qualitative analysis of how and to what extent the propaganda content related to the Great Patriotic War, published in "Komsomolskaya Pravda" and "Argumenty i Fakty", promotes and justifies imperial patriotism within Russian society, as well as the imperial policy of the Russian state.

4 Discussion and Conclusion

Alnalyzing scholarly works on the content, forms and goals of propaganda of the Russian Federation, it can be concluded that so far the connection between the Great Patriotic War and the promotion and justification of the formation of patriotism in Russian society and imperial foreign policy in Russian society in the main Russian mass media has not been sufficiently substantiated and explained. Fragmentarily, to a greater or lesser extent, certain aspects of the selected research topic have been addressed in many scientific studies. Therefore, undertaking the research problem specified in the title of this paper is justified not only by the importance of the issue, but also by the paucity of existing studies. This will

allow a thorough qualitative analysis of how and to what extent the propaganda content on the Great Patriotic war featured in “Komsomolskaya Pravda” and “Argumenty i Fakty” promotes and justifies the imperial patriotism of Russian society and the imperial policy of the Russian state.

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Adverse Reactions Mediated by Strontium-89, Samarium-153, Rhenium-186 and Rhenium-188: A Systematic Review of Literature

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Abstract. *One of the therapies used for the palliative treatment of pain associated with bone metastases is radiopharmaceutical therapy. Radiopharmaceuticals can cause adverse reactions, and, therefore, the aim is to systematize the results and conclusions of studies on the use of the radiopharmaceuticals ^{89}Sr, ^{153}Sm, ^{186}Re and ^{188}Re in the palliative treatment of pain associated with bone metastases. A systematic literature review was conducted according to PRISMA statement, using the databases MEDLINE and EBSCO. After the selection process, 20 articles were included. The studies showed that the 4 radiopharmaceuticals analysed presented very similar results regarding pain relief after treatment, decrease in analgesic consumption, side effects at the time of administration, hematologic toxicity and disease progression after treatment. Concluding, the use of radiopharmaceuticals for pain palliation seems to be safe and an alternative to existing treatments.*

Keywords. Pharmacovigilance, adverse reactions, radiopharmaceuticals, bone metastases, pain palliation

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1 Introduction

The World Health Organisation (WHO) defines pharmacovigilance as "the science and activities relating to the detection, assessment, understanding and prevention of adverse effects or any other medicine/vaccine related problem" [1]. Pharmacovigilance must constantly adapt to rapid developments in new technologies and new therapies, and their regulation. This field includes radiopharmaceuticals (RF), that can be used for diagnostic or treatment purposes, with the scope of nuclear medicine [2].

Bone metastases are one of the most frequent complications of advanced cancers and can significantly affect the quality of life of patients [3], [4]. One of the therapies used for the palliative treatment of pain associated with bone metastases is radiopharmaceutical therapy.

Like any other drugs, RF can cause adverse reactions (AR), and, therefore, the objective of the present study is review the results and conclusions of studies on the use of RF in the palliative treatment of pain associated with bone metastases, namely, Strontium-89 (^{89}Sr), Samarium-153 (^{153}Sm), Rhenium-186 (^{186}Re) and Rhenium-188 (^{188}Re), and provide up to date information on AR associated with this drugs.

2 Methods

A systematic literature review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement [7]. The research question was the "what is the characterization of the AR described associated with the RF ^{89}Sr, ^{153}Sm, ^{186}Re and ^{188}Re, in patients with pain associated with bone metastases, until the year 2022?".

A computerized literature search was performed using the databases MEDLINE (PubMed) and EBSCO (Academic Search Complete). Two researchers developed a search string for each database. Controlled trials, cohort studies, case-control studies and case series, in English, Spanish and Portuguese, were considered, between 1983 and 2022 (the date range comprises the appearance of the first studies in the literature until the moment when the search ended). The analysis and selection of the literature was performed using the Rayyan Software. The two researchers independently accessed all articles obtained and analysed its title and abstract for the inclusion or exclusion of each one. In case of doubt, the full article was read. Initially, 2583 articles were obtained from the two databases, of which 2563 were excluded. After analysing the title and abstract, 139 and 319 articles were obtained from reviewer 1 and 2, respectively. Review articles, articles that didn't contain complete data on the AR under study, articles where AR weren't well characterized or weren't written in English, Portuguese or Spanish were rejected. After resolving the articles selected as "maybe" and "conflict", 306 articles were selected to be included. Only 14 articles focused on the RF above mentioned. Six other articles were obtained by cross-referencing and manual search. The difficulty to find studies related to RF adverse events forced the acceptance of low-quality studies (with fewer than 10 reported cases), but those provided information not found in other literature. The AR described were classified according to the SOC-MedDRA hierarchy.

3 Results

From the 20 selected articles, an analysis was carried out which resulted in table 1 and graphic 1, with an overview of the evidence collected.

Table 1. Overview of included studies with their characteristics.

Study	Radiopharmaceutical	Patients
Collins *et al.* [8]; Ashamalla *et al.* [9]; Berger *et al.* [10]; Ribera *et al.* [11]	153Sm-EDTMP	101
Maxon *et al.* [12], Klerk *et al.* [13]	186Re-HEDP	22
Liepe *et al.* [14]; Palmedo *et al.* [15]; Li *et al.* [16]; Liepe *et al.* [17]; Zhang *et al.* [18]; Cheng *et al.* [6]; Beiki *et al.* [4]; Shinto *et al.* [3]	188Re-HEDP	287
Hesslewood *et al.* [19]; Baziotis *et al.* [20]; Kraeber-Boderé *et al.* [21]	89Sr	160
Dafermou *et al.* [22]	89Sr and 186Re-HEDP	510
Liepe *et al.* [23]	188Re-HEDP and 153Sm-EDTMP	46
Liepe *et al.* [5]	188Re-HEDP and 186Re-HEDP and 153Sm-EDTMP	79

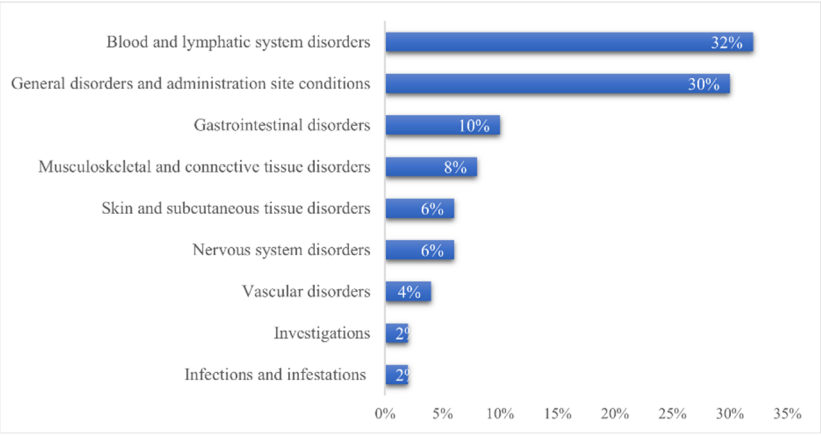

Figure 1. Overview of adverse reactions by SOC.

4 Discussion

In addition to some other cancers, such as myeloma or lung cancer, skeletal metastases can develop in around 50% of women with breast cancer, the most prevalent cancer in women, and in 80% of patients with prostate carcinoma, the second most frequent disease in men [24]. The pain phenomenon is directly caused by tumor invasion. After traditional surgical and/or non-radiologic therapy options have been explored, almost half of the patients will still experience significant

bone pain. A particularly significant therapeutic option is provided by metabolic radiotherapy [25].

All the studies recovered, show that these drugs can provide safe, symptomatic relief from painful osseous metastases and in most cases the hematological toxicity was reversible [3]–[6], [8], [9], [11]–[22]. There is also evidence of secondary outputs for health and quality of life. Collins *et al.* [8] , Baziotis *et al.* [20]; and Zhang *et al.* [18] showed a reduction in analgesic requirements and the works of Kraeber-Boderé *et al.* [21] observed an improvement in quality of life in terms of better sleep or increased activity after 65% of administered injections [8], [18], [20], [21].

The case report of Klerk *et al.* [13] describes an uncommon side effect which is transient cranial neuropathy after treatment with ^{186}Re-HEDP and the explanation for this side effect could be the direct radiation injury of cranial nerves surrounded by metastatic bone tissue [13].

The flare response is a reaction that some studies have observed in their patients, after the injection of the RF [3]–[6], [10], [12], [15]–[18], [20]–[23]. There are different explanations provided for this phenomenon. Dafermou *et al.* [22] suggested that the pain flare phenomenon is a positive predictive factor for the efficacy of the radionuclide therapy. In their trial, patients with pain flare showed slightly lower favourable response rate in comparison to those who did not experience this reaction. This difference may be due to the known psychological component of pain and to some individual variability in pain threshold [22]. Shinto *et al.* [3] explain that this probably related to transient inflammatory reactions that modify intratumoral pressures. In their study flare reactions occurred in more than half of patients and could be due to the patient's awareness of the probable short-term worsening of bone pain, higher administered dose, or greater fluctuations in the level of pain. Despite this fact, the authors showed that flare reactions can be managed by analgesic or steroid agents, are reversible and are not predictive of pain palliation [3].

In conclusion, pain is one of the most common and distressing symptoms described by patients with bone metastases. The analysed studies presented similar results regarding pain relief, decrease in analgesic consumption, AR at the time of administration, hematologic toxicity and disease progression after treatment. The use of RF for pain palliation seems to be a safe alternative to standard treatments, however more studies are needed to evaluate safety and toxicity.

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Biocomposites Based on Biopolymers and Waste Products for Food Packaging

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Abstract. *The employment of biopolymers in the food sector has grown widely in recent times since petrochemical plastic products caused a significant environmental impact. This work will be aimed at the development of innovative compostable ecosustainable systems, based on biopolymers and agri-food waste extracts and fillers, in order to find a new use for them in the Circular Economy and in the zero-waste standard context. The introduction of natural fillers into a biopolymeric material could lead to the realization of a packaging with good thermal, mechanical and antimicrobial properties, with the ability of preserving the food and extending its shelf-life.*

Keywords. Biopolymers, agri-food waste, circular economy, ecosustainability, food packaging

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1 Introduction

Multiple types of plastics are being used as materials for food applications. Traditional plastic is made of non-biodegradable petrochemical-derived polymers, which cause dramatic environmental impact [1]. For these reasons, the employment of biodegradable and/or compostable polymers has widely spread in recent times [2]. Biopolymers can be extracted from biomass, synthesized from bioderived monomers or produced by microorganisms. They are non-toxic eco-sustainable materials and they can reduce the environmental burden since they are derived from renewable and sustainable raw materials. The present PhD project involves the use of biopolymers in the food sector for food packaging applications and for the clarification of beverages in fluidized-bed reactors (FBR), as schematized in Fig. 1.

An ideal packaging material must have gas, vapor, aroma barrier abilities, antimicrobial function and good mechanical, optical and thermal properties. However, some biopolymers present drawbacks, such as low mechanical and gas barrier properties [3]. In order to overcome these limits, agricultural and food industry waste extracts and inorganic fillers (e.g., diatomite, calcium carbonate extracted from egg shell/clams, coffee ground extracts) can be added to the polymeric matrix [4]. The idea is to add them in different materials based on natural and synthetic biopolymers, such as polylactic acid (PLA), poly caprolactone (PCL), chitosan, zein, alginate.

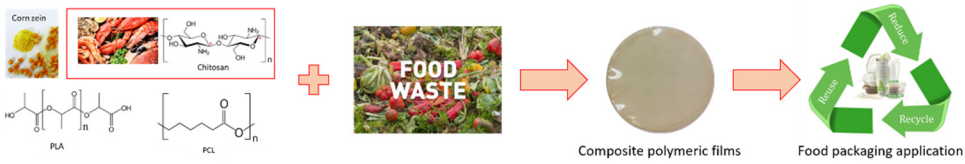


Figure 1. A visual schematization of the possible sources and compositions of the polymeric films with the potential to be applied in food packaging.

2 Materials and methods

Specific agri-food waste materials and inorganic components (e.g., shellfish, coffee grounds and eggshells extracts, diatomite) were selected to confer antioxidant and antimicrobial properties to the films. The filler particles (1-10 wt%) were dispersed in the polymer solvent by ultrasonication for 60 minutes. Biopolymers (e.g., PLA, zein, chitosan), in powder or pellet form, were added to the prepared suspensions to realize different film formulations. After magnetically stirring up to polymer dissolution, the solutions were cast on Petri dishes and maintained under fume hood until complete solvent evaporation. As a reference, neat polymeric films were also prepared, following the same procedure. The influence of the additives on the morphology, thermal and mechanical properties was investigated by Scanning Electron Microscopy (SEM), Differential Scanning Calorimetry (DSC) and uniaxial tensile tests.

3 Results and discussion

The good dispersion of the fillers into the biopolymeric matrix was demonstrated by the observation at SEM. It was evidenced from the acquired SEM micrographs that the filler presence caused a higher surface roughness of the film than the neat one, as in the case of zein films with and without diatomite (Figure 2).

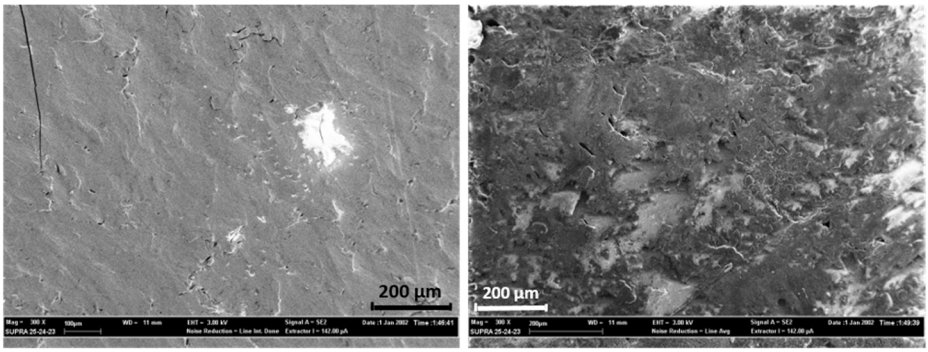
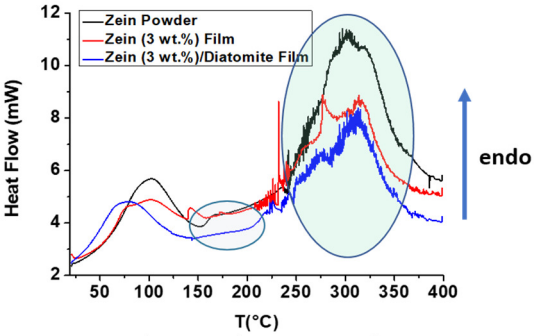


Figure 2. SEM micrographs of zein based films.

The thermal properties of the manufactured films were also influenced by the filler introduction. The smoothing of the curves in the area of the glass transition temperature (T_g) for the films seemingly implied an alteration of the protein amorphous structure, as evident from the comparison between the DSC thermograms related to neat and composite zein films in Figure 3.



Sample	T_g (°C)	$T_{degradation}$(°C)	$\Delta H_{degradation}$ (J/g)
Zein Powder	160.8	296.9	356.0
Zein film (3 wt.%)	-	276.9	331.4
Zein/Diatomite film	-	312.9	353.2

Figure 3. DSC thermograms and related temperatures and enthalpies for zein powder, neat zein film and composite zein/diatomite film.

The good dispersion of diatomite fillers within the polymeric matrix and the high filler/polymer wettability allowed to obtain and increment of the mechanical properties [5]. The influence of the diatomite fillers on the barrier properties of the produced films will be investigated in future, since it is expected that the presence of the dispersed fillers within the polymeric matrix creates a tortuous path to the gases, blocking their diffusion and avoiding their contact with the food inside the package [5].

4 Conclusions

Ecosustainable systems based on biopolymers and natural fillers were obtained. A good fillers dispersion, as well as their influence on the thermal and mechanical properties, was demonstrated. On the basis of the collected results, it is possible to conclude that different materials based on biopolymers can be considered as an innovative promising and performing alternative to the non-biodegradable petrochemical-derived polymers, commonly used in food applications.

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Development of Biomimetic Systems for the Treatment of Traumatic Brain Injuries

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Abstract. *Traumatic Brain Injuries are very common and have been treated with a variety of approaches over time. In this context, skull repair has been attempted with several materials, which need to show appropriate mechanical and biomimetic properties. Among the most interesting materials for cranial implants, polymers represent a valid alternative, because of their low cost, the many manufacturing options and their easy functionalisation.*
In this work, we focused on poly-lactic acid implants produces by Additive Manufacturing, namely through the Fused Deposition Modelling technique, and functionalised through a bio-ceramic coating to promote bone regeneration. We also developed a Drug Delivery System in order to prevent inflammation phenomena: in particular, we engineered poly-ε-caprolactone microparticles encapsulating a glucocorticoid (dexamethasone) for a regulated drug release. This Drug Delivery System has been implemented into the implants to confer optimal characteristics to the 3D-printed prosthetics.

Keywords. Biopolymers, glucocorticoids, microparticles, 3D-printing, drug delivery system, traumatic brain injuries

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1 Introduction

A Traumatic Brain Injury (TBI) is caused by a bump, blow, or jolt to the head, or a penetrating head injury that disrupts the normal function of the brain [1].

After the evaluation and resolution of medical issues such as swelling, haemorrhage and brain damage among others, cranial reconstruction is of the utmost relevance for reinstating a physical barrier and preventing or controlling alteration in the cerebrospinal fluid, the blood flow and the metabolic demands of the brain [2].

Cranial reconstruction has been performed by using several materials over time, among which bones from the same patient (autograft), bones from cadavers (allograft), bones from animals (xenograft) and inorganic materials such as metals (cranioplasty).

At the moment, the most used materials for cranioplasty are titanium and poly-methyl methacrylate (PMMA) [3]. Both of them present several advantages, among which the tailorable features, the good mechanical properties and the absence of significant negative reaction by the immune system after implantation.

Nonetheless, both of the materials listed above also present drawbacks (as do all the possible substrates for cranial reconstruction). Among those downsides are the cost and conductivity of titanium, together with its tendency to produce artefacts during imaging, and the high risk of fragmentation and degradation of PMMA [4]–[6].

For these reasons, efforts are continuously made in the biomedical field in order to improve the characteristics of cranial implants.

In particular, following the biomimetic approach (aimed at mimicking the composition and microstructure of the bone tissue to regenerate), it is important to formulate composite materials, based on organic and inorganic materials, and to appropriately engineer structures characterised by hierarchic porosity. As a matter of fact, the extracellular matrix of the bone tissue is composed of hydroxyapatite nanoparticles and collagen fibres, and presents a hierarchic organisation [7]. The combination of a selected biopolymer and calcium phosphate oxides or other ceramic materials would therefore allow to obtain comparable properties to those of the bone, as would the engineering and production of 3D structures through Additive Manufacturing (AM) techniques followed by proper functionalisation of the prototypes. This work aims at overcoming the limits of the traditional approaches, tackling the issue by functionalising 3D-printed biopolymeric structures with appropriate bioactive substances.

The chosen biopolymer for the AM of the structures in this work was poly-lactic acid (PLA), characterised by biocompatibility, biodegradability, ease of manipulation and printability by Fused Deposition Modelling (FDM) [8]. Despite that, it is not capable of mimicking the properties and functionalities of the bone, and can be characterised by the induction of inflammation and/or infections. Therefore, one of the aims of the project was to devise an effective strategy for the deposition of a bioactive ceramic coating (titania or hydroxyapatite) on PLA 3D-printed structures, in order to improve their performances and the potential applications in the bone regeneration field (Figure 1). Another objective was to provide anti-inflammatory properties to the produced structures, loading them with glucocorticoid drugs, due to their well known ability to avoid/reduce the inflammation occurrence.

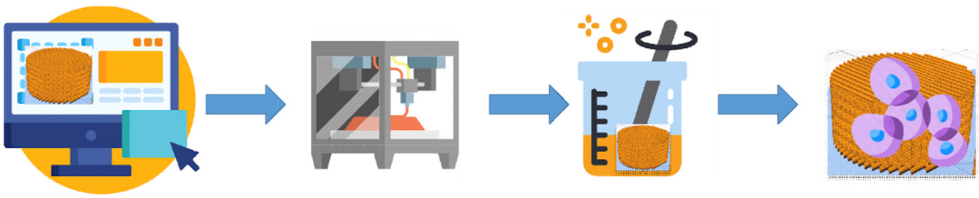

Figure 1. Functionalisation of 3D printed scaffolds: from the design to the biological characterisation.

2 Materials and methods

In order to optimise the 3D-printing of PLA structures, different FDM conditions in terms of extrusion and bed temperatures, and printing speeds, were tested, as well as different patterns and porosities. Moreover, an effective procedure for coating the 3D printed structures with hydroxyapatite (HAp) or titania was set up. To provide anti-inflammatory properties, selected glucocorticoids, e.g. dexamethasone, were immobilised on the scaffolds surface, both free and encapsulated within bio -polymeric microparticles, produced by emulsion.

The obtained structures were characterised by observation at the scanning electron microscopy (SEM);, as well as by uniaxial tensile tests and differential scanning calorimetry (DSC) measurements.

3 Results

The printing parameters of the PLA structures were optimised by trial and error. In particular, the chosen nozzle diameter was 0.2 mm in order to ensure good precision, and two different hierarchic patterns with fixed measures were selected, one with triangular and one with square pores. Other parameters, such as the nozzle and bed temperature, were assessed on the basis of the overall quality of the finished prototypes. The measures of the pores in the structure were chosen to best host cells.

The 3D-printed structures were also characterised from a thermal point of view by Differential Scanning Calorimetry (DSC) and compared to the properties of the PLA filament before printing. The collected data showed slight but sensible variations (1-3 °C) for the glass transition temperature, the cold crystallisation temperature and enthalpy and the melting point and enthalpy. These pieces of information are coherent with the usual thermal changes implied by 3D-printing of the used polymer.

As for the mechanical properties, we were able to identify the stress and strain at break and the Young's modulus, which were all coherent with the literature values known for the PLA [9].

The coating on the PLA structures was attempted with titanium oxide and HAp by following different synthetic processes and coating techniques. The final results consisted in a mass increase of around 10% for the HAp and a much lower one for the titania, combined with a better overall homogeneity of the HAp coating. The samples were morphologically tested through SEM (data not shown).

In order to provide anti-inflammatory properties, specific glucocorticoid drugs were immobilised on the 3D printed structure surface, both free and encapsulated within bio-polymeric microparticles. A partial degradation of the printed structure was observed after its dipping within the corticosteroid solution, due to the PLA solubility in the used solvent. Following the second approach, it was possible to demonstrate the embedding of some particles within the printed PLA porosities, but further adjustments and tests are to be conducted on the implemented system.

4 Conclusions

This work is promisingly addressing the issue of cranioplasty through affordable, versatile means while also overcoming some criticalities of the field. The functionalisation of a low cost polymer, tailored for the cranial implants of the patients through simple approaches, is showing interesting results both on the matter of the anti-inflammatory properties and of the osteo-integration and bone regeneration properties. In the future, the work plan includes biological tests such as MTT assays, drug release tests and cellular differentiation tests, and further improvements of the whole system to better tune it for the intended purposes.

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Exploring Parkinson's Disease Rehabilitation: Virtual Reality-based Action Observation Therapy in Focus

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Abstract. *Parkinson's disease (PD) is a chronic and progressive neurological disorder that affects motor and cognitive function. Although pharmacological and surgical treatments can help manage symptoms, non-pharmacological interventions such as rehabilitation have gained attention as a means to improve motor function and quality of life for PD patients. Virtual Reality (VR) based Action Observation Training (AOT) is an innovative rehabilitation approach that combines VR technology and the observation of movements to enhance motor learning and cognitive function. This paper provides a focused review of the literature on VR-AOT in PD rehabilitation. The article discusses the rationale and potential benefits of VR-AOT, including its ability to improve gait, balance, and upper limb function, as well as cognitive domains such as attention and executive function. Additionally, the challenges and limitations of VR-AOT are highlighted. The paper concludes by emphasizing the potential of VR-AOT as a promising and complementary therapy for PD rehabilitation, but also highlighting the need for continuing-research to establish its effectiveness and broader applicability.*

Keywords. Parkinson's disease, rehabilitation, virtual reality, action observation training, motor function, cognitive function

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1 Introduction

Parkinson's disease (PD) is a chronic and progressive neurological disorder characterised by the progressive loss of neurons in the brain [1]. This leads to a variety of motor and non-motor symptoms; the most common motor symptoms of PD [2] include tremors, rigidity, bradykinesia, and postural instability, while non-motor symptoms can include depression, anxiety, cognitive impairment, and sleep disorders [3]. Although the exact causes of PD are still unknown, it is believed that a combination of genetic and environmental factors may contribute to its development. PD affects approximately 1-2% of the population worldwide and is the second most common neurodegenerative disorder after Alzheimer's disease [4].

Over years, non-pharmacological interventions such as rehabilitation have gained attention as an important component of PD management. Rehabilitation interventions for PD can include physical therapy, occupational therapy, speech therapy, and cognitive rehabilitation [5]. Rehabilitation goals in PD include improving motor function, stabilizing mobility and balance, reducing falls, and enhancing quality of life. However, PD rehabilitation is often challenging due to the progressive nature of the disease, the presence of multiple symptoms, and the high degree of individual variability.

Virtual reality-assisted action observation training (VR-AOT) is a promising rehabilitation approach for PD that combines immersive virtual reality environments with action observation tasks. This approach is based on the concept of activation of mirror neurons system, which are specialized neurons in the brain that fire both when an individual performs a specific movement or action, as well as when that individual observes someone else performing the same movement or action [6]. By engaging mirror neuron systems, VR-AOT may help improve motor function and reduce symptoms in individuals with PD [7]. Furthermore, VR-AOT has the potential to provide a safe, engaging, and customisable rehabilitation experience that can be customised to individual needs and preferences.

Overall, the use of VR-AOT as a rehabilitation approach for PD is an exciting area of research that has the potential to improve outcomes for individuals with PD. In this short paper, we will review the current evidence on the effectiveness of VR-AOT for PD and discuss its potential benefits and limitations as a rehabilitation approach.

2 VR-AOT rehabilitation

2.1 VR-AOT framework

The framework of a VR-AOT system typically involves the following components:

- VR Environment: A simulated environment is created using computer graphics designed to provide an immersive experience for the user.
- Motion Tracking: The user's movements are tracked using motion sensors, such as inertial measurement units (IMU), Electromyography (EMG) sensors and Motion capture sensors.
- AOT: The user observes a virtual character performing a specific action, such as lifting weights or moving objects.

- Progress Tracking: The user's progress is tracked over time during the experiments to monitor improvements in performance using quantitative and qualitative assessments.

The purpose of a VR-AOT is to provide a safe and controlled environment for users to practice and improve their physical skills. By observing and mimicking the movements of virtual characters, patients can develop their own motor skills, and the system can provide feedback and adapt to their progress.

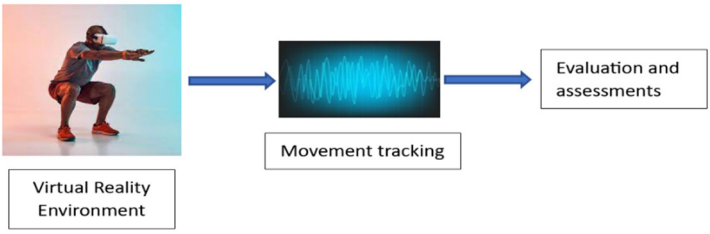

Figure 1. General framework of VR-AOT for rehabilitation experiments

2.2 Evaluation of PD rehabilitation intervention

Different assessments are used to measure improvements in PD rehabilitation[8][9]. These assessments analyse functional changes in all stages of the disease. Some commonly used evaluation measures for PD rehabilitation improvements are:

- Unified Parkinson's Disease Rating Scale (UPDRS): is a validated scale that provides an objective perspective and allows the classification of individuals with Parkinson's disease. It is used to assess various aspects of the disease, including motor symptoms, activities of daily living (ADL), and complications of therapy.
- Berg Balance Scale: is used to assess balance and stability in individuals with Parkinson's disease. It measures the ability to maintain balance during various tasks, such as sitting, standing, and transferring.
- Activities-Specific Balance Confidence (ABC) Scale is a patient-reported outcome measure that assesses an individual's confidence in maintaining balance while performing various activities.
- Six-Minute Walk Test (6MWT): measures the distance an individual can walk in six minutes. It assesses endurance and cardiovascular fitness.
- Jebsen-Taylor Hand Function Test (JTHFT): is a standardized and objective measure of fine and total motor hand function using simulated ADL.
- Functional Gait Assessment (FGA): This assessment is used to evaluate postural stability during walking and an individual's ability to perform multiple motor tasks while walking.
- 9-Hole Peg Test (9HPT) is a quantitative assessment used to measure finger dexterity.

These assessments help to monitor changes in function, balance, walking, and mobility in individuals with PD. It is common for combination of multiple assessments to be used in controlled clinical trials to provide a comprehensive evaluation of PD rehabilitation improvements.

2.3 VR-AOT related works

There are several studies exploring the use of VR-AOT in rehabilitation of PD. This paper searched PubMed, BMC, ScienceDirect, and Future Medicine databases for recent randomized controlled trials on VR interventions and their effects on motor and cognitive functions in Parkinson's disease patients. Various combinations of keywords like "PD and VR-AOT", "neurodegenerative disease and VR-AOT", "PD rehabilitation with VR" and "motor and cognitive functions" were used for this purpose. In the following table the selected related works are presented with details about the main findings and the experiment assessment in form of outcome measures (Table.1).

Table 1. Selected articles on the effectiveness of VR and AOT for PD rehabilitation

Papers	Intervention	Main findings	Outcome measures
Yang et al. [10]	Home based VR balance training and conventional home balance training for a duration of 6 weeks.	Training options were equally effective in improving balance, walking, and quality of life	• Berg Balance Scale • Dynamic Gait Index • PD Questionnaire • UPDRS
Faria et al. [11]	The intervention is VR based cognitive rehabilitation through simulated activities of daily living and it lasts for 1 month.	Significant improvements within VR group in global cognitive functioning, attention, memory, visuo-spatial abilities, executive functions, emotion and overall recovery.	• Addenbrooke Cognitive Examination (Primary Outcome) • Trail Making Test a And B • Picture Arrangement From Wais Iii • Stroke Impact Scale 3.0
Edu et al. [12]	Gait training with VR with 37 participants	Gait training with a VR program is as effective as treadmill training in improving walking distance and temporal gait variables in individuals with PD.	• Walking Distance • Gait Variables • 6 Minute Walk Test (6Mwt)
Emuk et al. [13]	AOT for upper extremity-function experiment with	• Action observation training improved upper extremity functions in all groups • Observing self-actions resulted in statistically significant positive changes in more variables compared with other methods ($p < 0.001$)	• Jebsen Taylor Hand Function Test Performance With Dominant and non-Dominant Hand • 9 Hole Peg Test Performance • Serial Reaction Time Task Performance • D2 Test Of Attention Performance
Errante et al. [14]	VR-AOT rehabilitation for upper limb function in patients with stroke for 6 months.	Effectiveness of AOT combined with VR technology compared to a control treatment of observation of naturalistic scenes without any action content followed by VR training.	• Upper Limb Function

Papers	Intervention	Main findings	Outcome measures
Gandolfi et al.[15]	21 sessions of balance and gait exercises lasting 50 minutes each, either in home VR telerehabilitation or in clinic sensory integration balance training (SIBT).	• VR telerehabilitation was found to be more effective than in-clinic SIBT in improving postural stability in PD patients. • Both groups showed improvements in all outcome measures over time, except for fall frequency.	• Berg Balance Scale • Dynamic Gait Index • Fall Frequency
Kashif et al. [16]	VR and MI training techniques in addition to routine physical therapy for 12 weeks.	The study is a two-armed parallel design, single-blinded, single-centred, randomized controlled trial that investigate the effects of VR with MI techniques in addition to routine physical therapy on motor function, balance, and ADLs in patients with PD.	• UPDRS (Part III) • Berg Balance Scale (BBS) • Activities Specific Balance Confidence Scale (ABC) • UPDRS (Part II)

Several systematic reviews have been published about the application of VR-AOT in different neurological diseases along with PD. On the whole, VR technologies is showing enhancement of the reorganization of the motor neuron ways and improve motor disability as well as assess and treat medical conditions [17], [18].

3 Conclusion

Rehabilitation through a new VR-AOT instrument is shown to be a valuable training tool in improving motor and non-motor symptoms including cognitive function in PD. Research on VR-AOT targeting lower-extremity functions such as gait rehabilitation is wildly explored compared to the rehabilitation of the upper-extremity function for PD. Therefore, more research is required to evaluate the efficacy of VR-AOT technology with a focus on the upper extremities before its implementation is promoted further. The effectiveness of VR-AOT interventions in different disease stages of PD should also be studied to determine the usefulness of VR-based interventions in the prevention of physical decline during the early stages of PD and during the progression of PD in the middle to late stages. Additionally, evidence-based recommendations should be provided on the frequency, duration, and content of VR-AOT interventions for PD rehabilitation that should be provided.

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Optimization of an HPLC-DAD Method for Quercetin Detection

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Abstract. *High-performance liquid chromatography (HPLC) is one of the most used liquid chromatographic techniques owing to its versatility that allows an optimal resolution. Quercetin (QUE), a polyphenol, has received increasing attention due to its antioxidant properties. Efforts have been made to overcome the traditional poor oral bioavailability of quercetin, requiring the development of analytical techniques for quercetin detection in different matrices. The main objective of this work was the optimization of a HPLC-Diode Array Detector (DAD) method for quercetin. An optimization process was conducted to guarantee the best conditions and results. Detection and quantification were executed with a reverse phase C-18 column. Different mobile phase (MP) compositions, flow rates, and wavelengths (with DAD) were studied. Better results were achieved with a MP composition of water:acetonitrile:methanol (55:40:5), with 1.5% acetic acid at a 1.3 mL/minute flow rate, with good results regarding chromatogram resolution, and quercetin quantification and detection.*

Keywords. High-performance liquid chromatography, HPLC, quercetin, optimization, tailing

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1 Introduction

Chromatography, a powerful analytical technique that allows the detection of compounds, can be applied for different pharmaceutical purposes [1]. This technique has the advantage that can be used to separate, purify, quantify and/or identify compounds in mixtures [1], [2].

Within the chromatographic techniques, the most widely used is HPLC, since this is a technique that allows qualitative and/or quantitative analysis [1], [2]. This technique consists of a MP containing the analyte of interest that is eluted at high pressure along a chromatographic column, where the stationary phase is contained [1], [2].

QUE is a phenolic compound with strong antioxidant properties and has received great attention in recent years from the scientific community. It has been suggested that QUE might become useful in the treatment of several diseases such as cardiovascular, skin, and neurodegenerative diseases, or cancer [3]. The low bioavailability of QUE might compromise its application at the industry level. Accordingly, several attempts have been made, to develop methodologies that improve the actual applicability of QUE [4].

The development of new methodologies to produce and/or administer QUE, implies the development of analytical techniques that allow the inspection of the newly developed enabling the detection of QUE, in different matrices.

The main objective of this work was the optimization of a HPLC-DAD for QUE detection.

2 Methodology

The present work was based on a method described in the literature by Zu *et al.* (2006) [5]. The analysis by HPLC were performed in a JASCO® equipment, coupled to a DAD detector (MD-4010) (which allows an analysis within a range of wavelengths for subsequent selection of the one with the best detection signal), with an autosampler (AS-4050), and a pump (PU-4180) [2]. A C-18 reversed phase column, (LiChroCART® 250-4; LiChrosorb®, RP-18, 250 mm x 4 mm, 5µm) was used as stationary phase. QUE standard solutions were prepared in water:acetonitrile:methanol (45:15:40) from a 0.49 mg/mL QUE solution in the same solvent, previously prepared with a QUE standard (≥ 95.0%; Sigma-Aldrich® Co., St. Louis, MO, United States of America). Different MP compositions were evaluated (Table 1), assessing different solvent rations and acid concentration, as well as different flow rates and wavelengths (254 nm and 368 nm). The analysis took place over a 10-minute period, with a 10 µL injection volume.

Table 1. Chromatographic condition evaluated for method optimization.

Condition		Analysis															
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**
C (%)	W	45	45	45	40	50	55	55	58	60	70	55	55	55	55	55	55
	A	15	15	15	15	35	40	40	40	40	30	35	24	25	40	40	40
	M	40	40	40	40	15	5	5	2	0	0	10	20	20	5	5	5
	Aa	0	0.5	1.0	1.0	1.0	1.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Flow Rate (mL/min)		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.3	1.3	1.5

C: composition; W: water; A: acetonitrile; M: methanol; Aa: acetic acid.

To assess the method's reliability, it was evaluated for linearity, sensitivity, precision, accuracy, selectivity, and stability criteria, as recommended by the International Conference on Harmonization (ICH) [6].

3 Results and Discussion

The analysis A, mentioned in the Table 1, corresponded to those described in the study of Zu *et al.* (2006) that served as a starting point [5]. An improvement in the retention time of QUE was achieved, which resulted in a decrease in the analysis time and in the solvents consumption. However, the tailing phenomenon was quite evident, motivating the evaluation of different chromatographic conditions.

The tailing may be related to an overloading of the column, or with a high concentration of the analyte, so different techniques can be applied for its correction or elimination. Changes in the MP aiming at improving the affinity of the analyte; or the acidification of the MP, are two previously described strategies [2], [7].

By testing the proposed conditions, different results, that presented both advantages and disadvantages at the analysis level, were observed. In some situations, a decrease in tailing was verified, but, on the other hand, there was a significant increase in the retention time. Also, depending on the composition of the MP, different signal intensities were verified, which also influenced the future quantification of the compound under analysis, and that could eventually lead to a decreased sensitivity. Changes in the proportion of each of the three solvents of the MP were tested, with an increase in the percentage of aqueous phase, as well as an increase concentration of acid in the final solvent mixture. The flow rate at which the analysis was performed was also changed to understand if a variation in flow rate at the time of QUE detection had any impact on the resolution of the chromatographic peak.

After all the optimization process, analysis O proved to be the one that best corrected the tailing observed in the chromatographic peak of QUE, as well as decreased the retention time, allowing a reduction in the analysis time, and a lower solvents consumption.

Hence, a 50:40:5 ration of water, acetonitrile, and methanol, acidified with 1.5% acetic acid, at a variable flow rate of 1.3 mL/minute, with a wavelength of 368 nm was selected, obtaining a retention time of approximately 3.6 minutes, and a good chromatographic resolution (Figure 1).

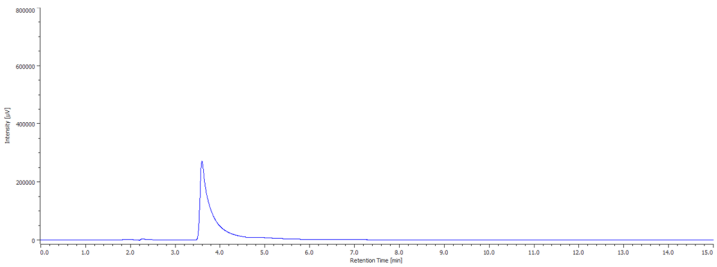

Figure 1. Chromatogram of quercetin (185 µg/mL) exhibiting the retention time at 3.6 minutes.

The method, with the defined conditions, evaluated according to the guidelines defined by the ICH, shown to be linear over a concentration range of 0.14 – 245 µg/mL, with a correlation coefficient higher than 0.995 [6]. Regarding precision (intra and inter-day), this was determined using the coefficient of variation, with the results showing values lower than 15% for all tested concentrations (0.35 µg/mL, 0.57 µg/mL, 5 µg/mL, 125 µg/mL, and 185 µg/mL), as recommended by ICH [6]. For accuracy and stability, a 15% variation is defined by the regulatory authorities as tolerable. These was also verified in all concentrations evaluated for accuracy (0.35 µg/mL, 0.49 µg/mL, 0.57 µg/mL, 49 µg/mL, 125 µg/mL, and 196 µg/mL), and stability (0.57 µg/mL, 5 µg/mL, and 125 µg/mL at – 20C, 4C, and room temperature) [6]. With the selected chromatographic conditions, the method proved to be capable of discriminating QUE from other compounds of similar chemical structure, deeming its selectivity.

4 Conclusions

Given the need to develop new formulations that allow the use of QUE in the pharmaceutical industry, the optimization of analytical techniques for its detection in various matrices becomes imperative. In this work, a HPLC-DAD method for QUE detection was successfully optimized, achieving a good correlation of characteristics that allow a correct detection, identification, and quantification of the analyte, through the use of a MP consisting of water, acetonitrile, and methanol (50:40:5), with 1.5% acetic acid, at a flow rate of 1.3 mL/minute, obtaining good results when evaluated the parameters defined by ICH.

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Optimizing the Water-based Extraction of *Rubia tinctorum* L. Pigments

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Abstract. *Water is one of the greenest solvents, but it is often limited to the extraction of polar compounds. Microwave assisted extraction (MAE) was used to extend the range of polarity of extracted compounds from madder. The main pigments in madder are anthraquinones, generally extracted with hydroalcoholic solvents due to their medium polarity. However, water-MAE was as efficient as reference hydroalcoholic MAE and soxhlet.*

Keywords. Microwave-assisted extraction, water-based extraction, Rubia tinctorum, response-surface methodology, HRMS/MS, anthraquinones

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1 Introduction

In the current context of ecological crisis, the use of natural products and the development of green extraction methods to retrieve them are of great interest. Amongst these, plant pigments are gaining attention after having been replaced by cheaper synthetic pigments during the XIXth century [1].

Madder pigment (*Rubia tinctorum* L.) contains mostly anthraquinones in their free and glycosylated forms [2]. Anthraquinones are orange-reddish compounds resistant to washing, UV and temperature making them a good ingredient in cosmetics [1]. Because of their medium polarity, they are generally extracted by hydroalcoholic solvents [2].

Water is one of the greenest solvents. It is accessible, non-toxic, non-pollutant and easily disposable compared to organic solvents. However, its high polarity makes it selective towards very polar compounds and less effective for the extraction of other compounds of interest [3]. Some methods, like microwaves can help lower the polarity of water and improve the extraction of less polar molecules [3].

In this paper, water-based microwave-assisted extraction (MAE) was developed to extract pigments from madder. The extraction was optimized using an experimental design. The optimized extract was compared to reference hydroalcoholic extracts.

2 Development of the water-based microwave assisted extraction

2.1 Experimental design

Microwaves cause dipole rotation and ionic conduction both in the solvent and in the sample, which helps to generate heat faster and to increase solubility and diffusivity of compounds. Water is particularly able to absorb microwaves and to generate heat due to its high dielectric constant (78.3) and dielectric loss factor (1.87) [4].

Table 1. Coded and uncoded variables used in the experimental design

X_1 (cycles)	X_2 (power in W)	X_3 (ratio in mg/20 mL)	Coded variables
1	200	100	-1
3	600	550	0
5	1000	1000	1

To develop an efficient extraction method with no degradation of the extracts, some parameters must be optimized. We used response surface methodology (RSM) with a Box-Behnken experimental design conducted and analyzed on the Ellistat software. It allowed us to analyze together the influence of the number of cycles, power and plant to water ratio on the yield (table 1) in a limited number of assays. To prevent overheating, each cycle only lasted 30 seconds and the extracts were cooled down in icy water between each cycle.

The experimental design involved 17 extractions including 3 central points. The number of cycles, as well as its interactions with the other two factors were significant. Quadratic terms X_1X_1 and X_3X_3 were also significant. The maximum yield was obtained after 5 cycles at 1000 W and 550 mg/20 mL (extract 16).

All extracts displayed a yellowish to bright orange color that was not correlated to the yield (Fig.1). Indeed, extract 16 was not the most orange extract despite having the best yield. The best combination of yield and color was extract 13 (1 cycle, 1000 W, 100 mg/mL). Like extract 16, it was obtained with a high power that allowed a higher extraction temperature, which is generally correlated with higher yields [4]. However, the lower plant to water ratio increased the surface exchange and facilitated the extraction of more compounds of interest [5]. Only two extracts (8 and 16) had a higher yield than extract 13 but their colors were paler. Both were obtained at 1000 W but in 5 cycles, implying that a longer extraction only recovered non-colored compounds. These results were confirmed by UV-visible spectrophotometry.

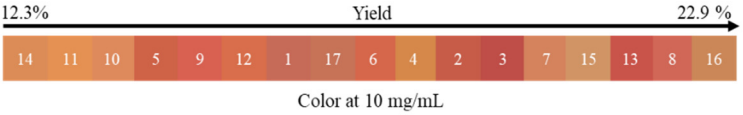

Figure 1. Representation of the color of all extracts on a yield scale.

2.2 Comparison to hydroalcoholic extracts

Extracts 13 and 16 were compared to reference hydroalcoholic (EtOH/water 50/50) extractions (Table 3). A microwave assisted extraction was used to assess the impact of the solvent. It was carried out using the parameters of extract 16. A Soxhlet was also performed as it is the most frequently used extraction method for madder pigments [2]. 2.5 g of madder were extracted for 4 h by 100 mL of EtOH/water (50/50) at boiling temperature. All MAE extracts were prepared in triplicates for the comparison, but only one Soxhlet extraction was done as it consumes more energy and water and did not perform well compared to MAE.

Table 2. Comparison of water-based and hydroalcoholic extracts

Extract	13 n = 3	16 n = 3	16 EtOH/W n = 3	Soxhlet n=1
Yield (%)	21.5 ± 0.5%	21.6 ± 1.1%	20.7 ± 0.4 %	14.1
Abs at 500 nm (ua)	0.35 ± 0.05	0.16 ± 0.01	0.31 ± 0.09	0.17
Total phenolics (mg gallic acid eq/g)	21 ± 4[a]	15 ± 1[b]	21 ± 2[a]	-
Anthraquinones (mg alizarin eq/g)	49.4 ± 9.3[a]	25.2 ± 1.7[b]	48.0 ± 11.5[a]	-

[a,b,c]: *significantly different results for each test using Tukey's range test ($p<0.05$)*

In terms of yield, all MAE extracts were comparable at approximately 21% (table 3). Soxhlet however, yielded lower at 14.1%. In fact, its yield was on the lower side compared to the range obtained in the experimental design (12.6 – 22.9%). The Soxhlet extract also had a lower absorbance at 500 nm, comparable to the one of extract 16. Extract 13 and the hydroalcoholic microwave extract had an absorbance about twice higher (table 3).

The composition of all microwave extracts was then compared. The total polyphenolic content was assessed using the Folin-Ciocalteu method in gallic acid equivalent. Anthraquinone content was also assessed by a colorimetric method in alizarin equivalent. Once again, extract 13 and the hydroalcoholic extract gave similar results that were superior to extract 16. The lower anthraquinone content in extract 16 explains its paler color. Extract 13 was further characterized by UHPLC-HRMS/MS leading to the putative identification of 11 anthraquinones and 7 flavonoids. The main pigments of the extract were pseudopurpurin, purpurin, lucidin and lucidin primveroside.

3 Conclusion

We developed the first water-based microwave extraction of madder pigments. The number of cycles was the most significant parameter, as well as its interactions with power and plant to water ratio. During the optimization we noticed that color and yield were not correlated, due to the parallel extraction of non-colored compounds like sugars. The best combination of yield and color was obtain after 1 cycle (30 s) at 1000 W and 100 mg/20 mL. The optimized extraction was as efficient as hydroalcoholic MAE and better than soxhlet in terms of yield, color and content. This method is eco-responsible thanks to the use of water, a green solvent, in low quantities and the economy of energy allowed by a 30 seconds extraction. It is also fast, accessible and easy to develop, contrary to other green extraction techniques. Thus, water-based MAE is a good alternative to other methods when extracting non-thermolabile compounds with medium polarity.

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PML/ RARA Variants and their Role in Arsenic Trioxide Resistance in APL: A Scoping Review

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Abstract. *Currently, the treatment of Acute Promyelocytic Leukemia (APL) is grounded on therapeutic regimens based on arsenic trioxide (ATO). However, mutations in the PML component of the PML/RARA oncoprotein are believed to be involved in the mechanism of resistance to this agent. We performed a scoping review to understand the role of variant PML/RARA fusion proteins in the mechanism of resistance in APL. Applying the defined criteria, we selected 10 studies, in which patients presented a picture of relapse and/or resistance after the administration of ATO, having been identified at least one PML mutation. We also reported that RARA is the most frequently mutated gene, although we also found mutations in genes related to other processes involved in cell differentiation. Briefly, this is a multifactorial mechanism and PML/RARA variants are important but not an obligatory condition for ATO resistance to occur.*

Keywords. Acute promyelocytic leukemia, arsenic trioxide, relapse, resistance, mutations

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1 Acute Promyelocytic Leukemia

Acute Promyelocytic Leukemia (APL) is a subtype of AML. The tumourigenesis is linked to the myeloid lineage precursor cells, occurring a clonal proliferation combined with a reduced ability of differentiation, leading to an accumulation of promyelocytes. Under the former FAB classification we categorized APL based on morphological and immunophenotypic features. The AML M3 variant is detected in 60 to 70% of the cases. Recently, it was adopted the World Health Organization Classification of Tumours of Haematopoietic and Lymphoid Tissues from 2016. This new system takes into account the clinical manifestations and, above all, the genetic aspects of each variant of the neoplasia. In despite of existing different possible translocations on the origin of APL, the reciprocal translocation between the retinoic acid receptor alpha gene (RARA) and the promyelocytic leukemia gene (PML) explains the pathogenesis in 95-98% of all cases. The t(15;17)(q24.1;q21.2);PML/RARA, identified in 1977 by Rowlley et al., is the biological hallmark of classic APL [1], [2].

The RARA protein belongs to a superfamily of nuclear receptors that act as nuclear transcription factors by binding to the oxidised form of vitamin A, i.e. retinoic acid, which is involved in cell differentiation. On the other hand, the PML protein contains a RING finger domain, which allows its organization in subnuclear macromolecular structures defined as nuclear bodies (PML NB). This gene is involved in several processes of tumour suppression and genomic stability, as well as in pathways related to apoptosis and senescence [2], [3]. In cells expressing PML/RARA, the classic model of pathogenesis states that this fusion prevents coactivator recruitment by exerting a dominant negative action on Retinoic Acid Response Elements (RARE) transcription, rendering them insensitive to the presence of physiological levels of retinoic acid [2], [4].

The blockade of myeloid lineage precursor cell differentiation leads to several clinical manifestations following pancytopenia. In particular secondary haemorrhages due to disseminated intravascular coagulation in combination with primary hyperfibrinolysis, characteristic of APL [5]. In order to attenuate the fatal outcome of this pathology it was applied the first therapeutic regimen consisting of anthracycline-based chemotherapy (QT). In the early 1990s the concept of differentiation therapy emerged, whereby Breitman et al. demonstrated that all-trans retinoic acid (ATRA) is able to induce myeloid leukemic cell differentiation *in vitro* [5]. The era of risk-adapted therapy has therefore been ushered in, based on evidence from a number of studies, such as GIMEMA AIDA0493 and PETHEMA LPA096. To overcome ATRA resistance, short and long-term toxicity, myelosuppression and consequent infections due to ATRA+QT, arsenic trioxide (ATO) was introduced in the late 1990s [2]. The GIMEMA-AMLSG-SAL APL0406 and UK NCRI AML17 studies confirmed the advantage of the combined ATRA+ATO regimen over ATRA+QT [2]. So, the most recent NCCN and European LeukemiaNet guidelines includes the targeted therapy of ATRA+ATO as the gold standard in APL treatment, aiming clinical remission [5], [6].

ATRA interacts with specific RARA domains triggering a PML/RARA conformational change, promoting the transcription of genes essential for differentiation. Furthermore, it contributes to protein degradation via proteases. ATO, in turn, establishes disulfide bonds with the rearranged PML through oxidation of cysteine residues (C212/213) at the B2 domain. This process promotes the covalent conjugation of SUMO modifiers to the PML lysine residues affecting the cellular localization of PML proteins, thereby promoting the rearrangement of PML NB. The substitution of zinc (RING finger) by arsenic induces conformational changes in PML that promotes polymer formation and interaction with the ubiquitin-conjugating enzyme 9 (UBC9),

forming high molecular weight chains. These chains recruit to the interior of PML NB a specific SUMO-dependent ubiquitin E3 ligase, RNF4 (Really interesting new gene (RING) Finger protein 4). Thus, PML/RARA is degraded via proteosome [7], [8].

In summary, ATO is now approved by the FDA (2000) and EMA (2002) for the treatment of APL [2]. However, approximately 5 to 10% of patients present relapse and probable resistance to ATRA and ATO. Some mutations in the rearranged PML of PML/RARA have been detected, which are believed to be involved in the resistance mechanism. Therefore, the following question is raised: What role do variant PML/RARA fusion proteins play in the mechanism of resistance to ATO in APL? [4].

2 Methodology

This review follows PRISMA-Scr guidelines. We looked at studies related to the human model published in the last decade, in which patients were diagnosed with APL and also had molecular relapse or resistance to ATO reported. It was imperative that these individuals would have been subjected to therapeutic regimes based on ATO or targeted therapy (ATRA+ATO). In addition, the molecular study of the rearranged PML gene would have been carried out throughout the follow-up, preferably with a comparative study between the molecular profile at diagnosis and at relapse.

We used PubMed (Medline) and Web of Science platforms with the following query: ("acute promyelocytic leukemia" OR "acute promyelocytic leukaemia" OR APL OR AML M3) AND ("arsenic trioxide") AND (relapse OR resistance OR mutation OR disease progression). Based on that strategy, 51 potential studies were identified. After a meticulous analysis, we included 10 studies that complied with all the stipulated criteria. We used the OCEBM LoE (Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence) to assess the level of evidence for each study.

3 Results

In the 10 studies included, a total population of 1070 cases diagnosed with APL was gathered. Approximately 345 of them relapsed. Thus, a PML-MT subpopulation was defined, consisting of cases with detected and identified mutations in the rearranged PML gene (representing about 13% of the relapses). The average age of the total population shows that the pathology falls within the young adult/adult age categories, ranging between 26 and 45 years, which is consistent with the statistical data in the literature [1].

In the PML-MT subpopulation (n=45) a total of 27 mutations were identified in the PML gene, 16 when not considering the repetitions: A216V, L218P, C213S, S214L, del(p.Asp219Glu), ins(p.Ser220Met), L218H, L211P, C213R, L217F, D219H, S221G, D241G, A216T, E224G and L218F. Note that only in 3 studies were detected mutations simultaneously in the PML-WT gene (not rearranged PML gene). On top of that, their identification was only available in 2 of the studies (A216T and A216V) [9]–[11]. The A216V mutation was reported most frequently, being identified in 60% of the studies [12]–[14].

In 80% of the analysed studies (n=8), genetic alterations other than PML mutations were also identified. According to the sources, RARA is the gene with the highest mutation rate, being mutated in 87.5% (n=7) of the 8 cases mentioned. RARA mutations were exclusively identified

in 4 of them. In other 3 studies, besides mutated RARA, other genetic alterations were identified. In the remaining study, besides the mutated PML only alterations in EMG genes were also reported (n=1) [15].

Only one study didn't provide information on the outcome of the patients [10]. In 20% of the studies no resistances were associated to the therapeutic regime applied. On the other hand, in the remaining 70% the following resistances were reported: probably acquired during treatment (10%, n=1); specifically to ATRA (10%, n=1); and to the administered therapy (50%, n=5). Regarding to the referred 50%, resistance specifically to ATO was identified in 3 studies. In one of those 3 studies, with a PML-MT subpopulation of 14 cases, 9 showed resistance to this agent. In the total n=14, 3 patients relapsed and another 6 died after two relapses, corresponding precisely to the 9 cases resistant to ATO. The remaining individuals in that same study achieved clinical remission (n=5), one of them after haematopoietic stem cell allotransplantation [14]. In the remaining 2 studies, resistance led to disease progression and death was reported in one of them [11], [13].

For the remaining sources of evidence where resistance was reported (40%, n=4), the outcomes were varied: in one of them, death of the individual was reported; in another, relapse after 3 months; and in a third study, only 2 individuals with resistance were identified. In the one clinical case where ATRA resistance was specifically reported, the individual also died [9], [12], [15], [16]. In the sources of evidence where no resistance was associated to therapy administration (20%, n=2), only one death was reported in one of the studies [17].

RARA and PML mutations have been reported and associated with changes in the mechanisms of action of ATO and ATRA on the oncogenic protein. Several examples of these mutations have been detected and identified in the PML-MT subpopulation. ATRA resistance is associated with mutations in the ligand binding domain (LBD) of RARA gene [12]. On the other hand, mutations in the PML gene are associated with resistance to ATO. As an example, evidence points out that mutations in codon 218 of the PML gene, described in 30% of the evidence sources considered, contribute to aberrant PML NB formation [13]. While A216V, identified in 60% of the sources, prevents the irreversible binding of ATO to cysteine residues. A216V was the first mutation identified in PML and is considered to be the most frequent [14]. Note that on 20% of the studies analysed, although mutations were detected in the rearranged PML gene, resistance to ATO wasn't reported [17].

Other genes frequently mutated in AML were analysed in some of the studies. It can be noted that most of them are genes whose functions are related to cell proliferation and differentiation. It was also found genes essential for the control of remodelling and methylation of chromatin, highlighting the importance of these processes in the physiological mechanism of retinoic acid. Mutations in TP53 were also reported, notice that this gene plays a crucial role as a tumour suppressor. Alterations in these genes negatively influence the response to treatment [2], [4], [10]–[12], [15].

In the studies comparing samples from the early stages of the disease with samples from advanced stages, it has been observed that the number of concomitant mutations per patient is higher in individuals with multiple relapses, indicating an accumulation of genetic alterations throughout the progression of the disease [2], [4]. Some of the sources of evidence used in this review described cases of evolution and selection of ATO-resistant subclones, verifying that the distinct subclones may decrease or vary with time and therapeutic intervention. Data from these studies suggest that subclones with a greater capacity to adapt and acquire new mutations may be selected over the course of treatment, giving them advantages in terms of self-renewal and

proliferation. Subclones with mutated PML may be present even before the start of treatment with ATO. They are sometimes present in such small numbers that they cannot be detected by conventional sequencing methods and become detectable only after clonal proliferation. More sensitive methods would add value to this type of analysis, such as NGS, which was used in one of the included studies [3], [4], [9], [11], [14].

4 Conclusion: PML/RARA variants and their role in resistance

The PML/RARA oncoprotein plays a central role in APL diagnosis and treatment, not only as a target for therapeutic agents but also as a biomarker for monitoring minimal residual disease, helping to define molecular relapse events [2]. Mutations in the B2 domain of PML gene are linked to ATO resistance, however, it was verified that some individuals expressing them did not present resistance to therapy. On the other hand, the development of resistance was observed in individuals who did not express them. The evidence suggests that there is no obligatory direct relation between mutated PML and resistance to ATO. Currently, there are different hypotheses that aim to explain the reduced or absent response to this therapeutic agent. Additional mutated genes and alterations in the tumoral microenvironment are also believed to be involved in the resistance mechanisms, which still remains unclear [3], [4], [17], [18].

In the future, it could be of great value a molecular study of a broader panel of genes at diagnosis [2]. In a nutshell, ATO resistance is now considered to be multifactorial, involving several mechanisms and events. So, mutations in PML/RARA play an important role but not as relevant as it was believed when they were initially detected [3], [4].

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Shellfish Catchers' Health in Relation to Their Biological Cycles

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Abstract. *Shellfish catchers' health can be damaged due to several factors in relation to their biological cycles. The menstruation, pregnancy and menopause are natural processes in women, but experienced in some work ambiances, such as the sea, can cause health alterations. It is conducted a descriptive, observational and transversal design, using quantitative methodology through an auto managed survey, being the sample size twenty-five women between 28 and 62 years old. The aim of this paper is to understand the impact of the biological cycle in shellfish catchers´ health and to identify possible risks at their working site. The importance of this issue requires a suitable understanding about their specific needs with the purpose of improving their health and wellness, promoting gender equality and contributing to the implementation of ad hoc health programs and policies for this professional collective.*

Keywords. Shellfish catchers, reproductive health, menstruation, pregnancy, menopause and working conditions

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1 Introduction

The World Health Organization defines health as: "The complete state of physical, mental and social wellness, and not only the lack of illnesses or complaints". This concept was not exempt from plenty critics, because it was considered utopian. However, it was a landmark, and it keeps being, due to the fact that for the first time, the person is considered a bio- psycho-social being. [1]

There is a current vision more focused on health in a context of personal and social development in which lifestyles play a basic role, although it is not the only factor. The choice of a healthy lifestyle not only depends on the Will ("to want"), but also on knowledge ("to know"), and the access to itself ("power"). This implies the need to carry out some actions in order to modify the environment and making it healthier. [2] Here lies the need of knowing the environment where the shellfish catchers' activities are taken place on, and being able to understand those social, cultural, working, economic and political aspects that might affect their health conditions. This environment also has an impact on working conditions, which have effects on biological cycles. [3]

Regarding the socio-economic context, they are qualified workers enrolled in the Social Security System as "self-employed", and they are gaining an increasing level of education. Even though they belong to a highly-feminized sector that is affected by gender inequalities, they are obtaining more social recognition.

The purposes of this paper consist of understanding the impact of biological cycles on shellfish catchers´ health and to identify the possible risks and specific challenges they face regarding the different stages of biological cycles.

As it is observed in the literature, Rodríguez Romero (2011) carried out an observational investigation, in which he highlights the prevalence of musculoskeletal injuries and its consequences in the quality of life of this collective, that he considers is lower for them than for the rest of the reference Spanish population. [4]. Other investigations, carried through an institutional level, such as the CANO group, point as an aggravating circumstance pregnancy and breastfeeding, and they describe the risks they have in these phases of the vital cycle. [5]

As for justification, it is important to highlight that this investigation about sea women´s health in relation to their biological cycles may help to contribute the lack of knowledge in scientific literature, and provide useful data for future investigations centred on improving the health and wellness of this collective, the promotion of gender equity, the equality in the maritime background, and, even the contribution to the implementation of specific programs and policies for the sea women.

2 Material and methods

The design is descriptive and quantitative, conducted through a survey targeted to a group of shellfish catchers from "Ría de Arousa".

It is transversal, because it was carried out in a certain time and place, and also observational, due to the lack of control in variables.

The survey consists of four sections: sociodemographic data, menstruation, pregnancy and reproductive health, and menopause. Preliminary results are shown in this paper, choosing a question for section.

A convenience sample has been proceeded with a non-randomized design, since the chosen participants are those who attended the Conference: "Avanzar Compartindo", taking place on 22/09/2021 in Vilagarcía de Arousa (Pontevedra – Spain).

The sample is made up of a total of twenty-five women. The selection criteria for the sample are based on women who belong to the shellfish catcher´s sector in a professional way, and those who do not belong to it are excluded.

It has been used for the literature review different databases, such as: Scopus, Scielo, Elsiever and the Google Scholar meta-search engine.

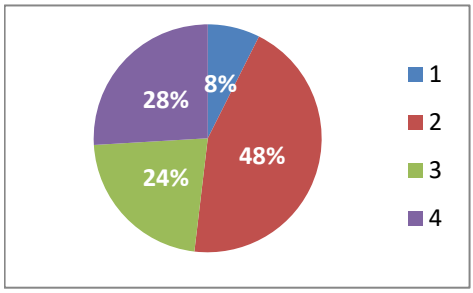
Microsoft Office Excel 2013 was the tool used as data and graphic processor and Zotero has been used as a bibliographic manager.

The ethical principles that are into force regarding Helsinki Declaration are taken into account: anonymity and right to self-determination. The form has got an academic purpose and it is confidential.

3 Results

The average age in the sample is 47.51, the distribution of age varies from 28 to 62, and the average period of time in this working activity is 14.92 years.

Regarding menstruation, it is important to observe the affectation caused to their health conditions and wellness, the obtained answers to the question: How do you feel when you have your period? Are shown in Fig. 1:



1 For me those are completely normal days
2 I feel really uncomfortable due to pain or annoyance, and exhaustion. My health has been altered, so it is frequent that I take medication.
3 I feel really uncomfortable because my period is plentiful, and I am afraid it may cause stains.
4 I experience change in mood, and also tend to be grumpy and sad.

Figure 1. Menstruation

It is observed that 48% of the interviewed women have some kind of disruption, such as pain, exhaustion, etc., 24% present discomfort, but only 8% do not appreciate any differences with other days in the cycle.

In the pregnancy survey, women are asked if they have presented any kind of complication after delivering or after having a caesarean section, like urine incontinence. Results shown in Fig. 2 and in Fig. 3 expose the level of knowledge they have about Kegel exercises or pelvic floor rehabilitation as a prevention to urine incontinence.

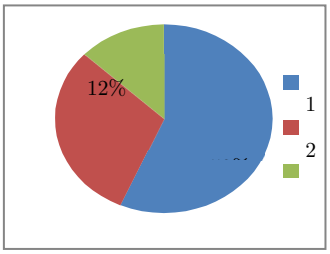
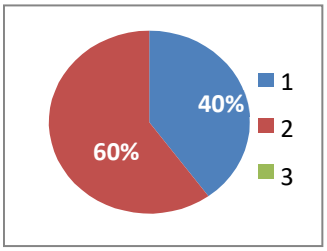


Figure 2. Pregnancy



1. YES
2. NO
3. DK/DA

Figure 3 Reproductive Health

Both graphics are exposed together, since it is very remarkable to observe how 52% of women have some kind of pelvic floor disruption, but 60% of them do not know anything about the rehabilitation exercises commented before.

About menopause, they are asked about the possibility of having some symptom in relation to this biological process. The results can be observed in Fig. 4. Where it is displayed that stifling sensations constitute the most identified sign with a 56%, followed by urinary incontinence with 36% and vaginal atrophy with 28% of the interviewed women.

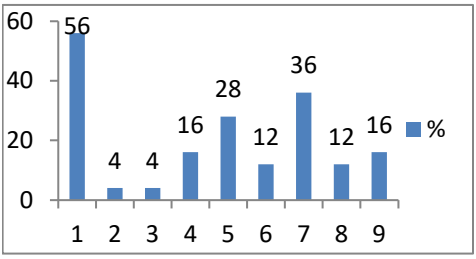


Figure 4. Menopause

1. Suffocating feeling
2. Anxiety
3. Depression
4. Health disruption
5. Vaginal atrophy
6. Sexual dysfunction
7. Urine incontinence
8. Osteoporosis
9. Memory alteration

4 Discussion and Conclusions

Women sea workers have the right to obtain safe and healthy working conditions that also include the care during their biological cycles, as it was demonstrated that these "only-women" natural phenomena, affect their health and wellness because of the following facts:

- Menstruation is a normal biological process that affect many women in reproductive age. However, working conditions in the sea may complicate their correct management, which can cause discomfort, pain, lack of hygiene, shortage in their access to adequate health products, and increase of infection risk. [6]
- Pregnant sea workers face extra risks for their health and wellness during the pregnancy, such as: exposition to dangerous substances, edemas, varicose veins, forced positions and difficulties to manage physical demands and handling loads, risk of abortion, preterm birth, and new-born with low weight. [7] [5]
- Sometimes, these workers lack of enough information and education about sexual and reproductive health that might lead to not using the adequate health resources. [8]
- Menopause is a natural stage in women´s lives that indicates the end of the reproductive capacity, and it is associated to hormonal and physical changes in the body. Regarding

the shellfish catchers, menopause may have several implications for their health and wellness:

- The stifling sensations, changes in the mood, sleep disturbances, and vaginal atrophy can affect their ability to carry out their job in an efficient and safe way, especially on those working environments with bad climate conditions or demanding physical activities.
- Menopause is associated with a decrease in estrogen levels, which might have a negative impact on bone-related health. Sea workers, especially those overtaking hard physical conditions, are more likely to have bone-related health issues. [9]
- During menopause, women are more likely to develop cardiovascular diseases. Sea workers, that usually encounter demanding and overwhelming working conditions (poaching, closed gathering season, and climate), are exposed to additional risk factors like work-related stress, bad food hygiene. [10]

As main limitations to the investigation presented in this paper, it is underlined the selection bias, as the interviewed women were already interested in this issue when attending the commented Conference. The sample was not probabilistic, and of convenience for being the most easily reachable candidates. This means that the sample is not highly representative, as it does not catch all the heterogeneity associated to these phenomena.

The purposes of this paper referring to the understanding of the impact in the health that the biological cycle has on the shellfish catchers, and the identification of the possible risks they face, have been accomplished. The graphics prove how these women suffer from the malaises present in the different stages of the women´s life cycle, which are expanded because of the hard conditions associated to their working site. Pre-menstrual symptoms, cramps, cycle irregularities and good control over menstrual hygiene affect their wellness and quality of life. Pregnancy constitutes a special vulnerability period that must be protected, and the menopause is a stage in life that can have an impact in the life of shellfish catchers, due to changes in osseous, cardiovascular and mental health, among others.

As final conclusions, it can be deduced:

- It is fundamental to take suitable measures to protect the health and wellness of women sea workers in relation to their biological cycles.
- It is important that the sea workers in different stages of life have a suitable access to health resources for a correct use and monitoring of symptoms.
- Health education about women biological cycles is basic: information about anatomy and physiology of menstrual cycle, the importance of an appropriate hygiene, control over common symptoms, as well as the promotion of a positive and non-stigmatized attitude toward menstruation and women´s health in general.
- The existence of suitable programs and policies regarding the health of women sea workers in relation to their biological cycles is very important. This can include the implementation of gender equality policies in the fishing sector.

Each one of the conclusions is liable to specific investigation areas. Women´s biological phenomena, and its repercussion in health, and other aspects of life, are issues that have little scientific background, and, above all, women sea workers.

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Water Quality Monitoring of Shallow Lakes Through Google Earth Engine

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Abstract. *This work focuses on the monitoring of water quality parameters in Trasimeno lake, a shallow water body located in central Italy, in the period 2015-2022. To this aim ad hoc Google Earth Engine (GEE) based routines are implemented to analyse data from Sentinel 2 multispectral images. The spatial distribution of turbidity and chlorophyll-a concentration can be derived through the spectral band ratio method: a semi-empirical approach expressed by the mathematical ratio between the reflectance of two or more spectral bands. Two normalized indices are considered: NDTI - Normalized Difference Turbidity Index and NDCI Normalized Difference Chlorophyll-a Index. The results show an increasing trend both for turbidity and Chlorophyll-a concentration over time, highlighting a light worsening in Trasimeno lake quality status.*

Keywords. Sentinel 2, NDTI, NDCI, turbidity, chlorophyll

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1 Introduction

Recent scenarios and current conditions of climate change express particular concern for the continued increase in drought, which necessarily leads to water shortages and water pollution. Trasimeno lake is a shallow body, with no tributaries or emissaries, lying on a poorly permeable bed. Due to its characteristics, the water level varies greatly, as a result of local rainfall an inverse correlation between lake water level and water quality is observed: when water level decreases, parameters such as chlorophyll concentration and turbidity increase [1]. The Chlorophyll-a (Chl-a), belonging to the phytoplankton class of Optically Active Constituents (OACs), is closely associated with algae and their constituents present in the water column; like other chlorophyll pigments; it absorbs solar energy at wavelengths in the Blue and Red regions while reflects light at wavelengths in the Green region.

The turbidity and the suspended sediments belong to the class of non-algal particles which influence the reflectance of incident solar radiation; varying the response in Visible and NIR waves. [2]

These two water quality parameters are extracted and analysed by means of remote sensed data, Sentinel 2, managed in GEE environment.

The Sentinel-2 satellite is a Copernicus mission including a constellation of two polar-orbiting satellites placed in the same sun-synchronous orbit at a mean altitude of 786 km, phased at 180° to each other: Sentinel-2A launched on 23 June 2015, Sentinel-2B launched on 7 March 2017. Both Sentinel-2 platforms are equipped with a multi-spectral sensor that acquires 13 spectral bands with 12-bit radiometric resolution

GEE is a platform for browsing and processing a huge amount of satellite imagery and geospatial datasets, it has very high computational power. Users can access and analyze data using JavaScript API in Earth Engine Code Editor, an Interactive Development Environment (IDE) where it is possible to implement your own script and view real-time processing results.

2 Materials and methods

The turbidity and chl-a concentration analysis on Lake Trasimeno is carried out through two normalized indices NDTI - Normalized Difference Turbidity Index and NDCI - Normalized Difference Chl-a Index:

$$\mathrm{NDTI}=\frac{\rho_{red}-\rho_{green}}{\rho_{red}+\rho_{green}} \quad (1)$$

$$\mathrm{NDCI}=\frac{\rho_{redEdge1}-\rho_{red}}{\rho_{redredEdge1}+\rho_{red}} \quad (2)$$

where the Red and Green reflectance correspond to B4 and B3 bands respectively; while RedEdge1 reflectance corresponds to B5. The spatial resolution of these three bands is 10m for B3 and B4, 20m for B5; then in the computation of NDCI the B4 band is resampled, upscaling in our case from 10 to 20 m. Both indices are normalized and are related to water quality parameters as follows: NDTI ranges from -1 to 1 and represent clear and very turbid water, respectively [1];

NDCI values close to -1 indicate an optically transparent water body, while for values between -0,3 and 0,5 there is a moderate to high algal biomass, and finally for values close to 1 the algal bloom conditions are extremely intense. [3]

The script implemented in the GEE for water quality analysis provides the following step:

1. Selection of the Sentinel-2 MSI image collection;
2. Application of filters to define study area and time period, in our case Lake Trasimeno and a period between 10-20 July of each year from 2015 to 2022;
3. Application of dedicated cloud cover filter to search for the image with the lowest cloud cover (less than 5%) in the specified time period;
4. Implementation of spectral band ratio method to calculate the normalized indices NDTI and NDCI for each year;
5. Export of the result in GeoTiff format.

3 Turbidity and Chlorophyll-a results

The turbidity spatial distribution and chl-a concentration of Lake Trasimeno are computed by considering sentinel-2 data acquired in mid-July of each year between 2015 and 2022; the script automatically selects the least cloudy images of the reference period
for all images, NDTI and NDCI indices are computed in GEE and mean values for turbidity and chl-a concentration are extracted (Tab. 1).

Table 1. Average NDTI and NDCI values with reference to the least cloudy images from Sentinel-2 between July 10 and 20, 2015 to 2022.

Image date	NDTI (average value)	NDCI (average value)
11 July 2015	-0.33	-0,12
18 July 2016	-0.32	-0,06
13 July 2017	-0.30	-0,11
10 July 2018	-0.31	-0,09
20 July 2019	-0.32	-0,10
12 July 2020	-0.18	-0,06
12 July 2021	-0.17	-0,04
14 July 2022	-0.14	-0,02

The results show an increasing trend of turbidity over time, from a value of −0.331 (in 2015) to a value of −0.144 (in 2022). The average NDTI value increases slightly from 2015 to 2017, decreases in 2018 and increases again from 2019 to 2022.

Similarly, the NDCI results outline an increasing trend of chl-a concentration, starting from a value of −0.12 (in 2015) to −0.02 (in 2022).

4 Conclusion

The work examines the potentials of Sentinel 2 imagery managed in GEE in mapping Chl-a concentrations, turbidity, and detecting in this way possible algal blooms. Moreover, time-series analysis showed that both parameters increased especially in drought period, suggesting the need for political strategies to reach a good quality status.

As already mentioned in the introduction, there is an inverse correlation between the water level of the Lake and the concentration of Chl-a and Turbidity; therefore, any strategy to mitigate the water level decrease can also be considered advantageous for preserving the quality of the Lake, such as careful water replenishment from the reservoirs of the adjacent basins (Casanova and Montedoglio) [1].

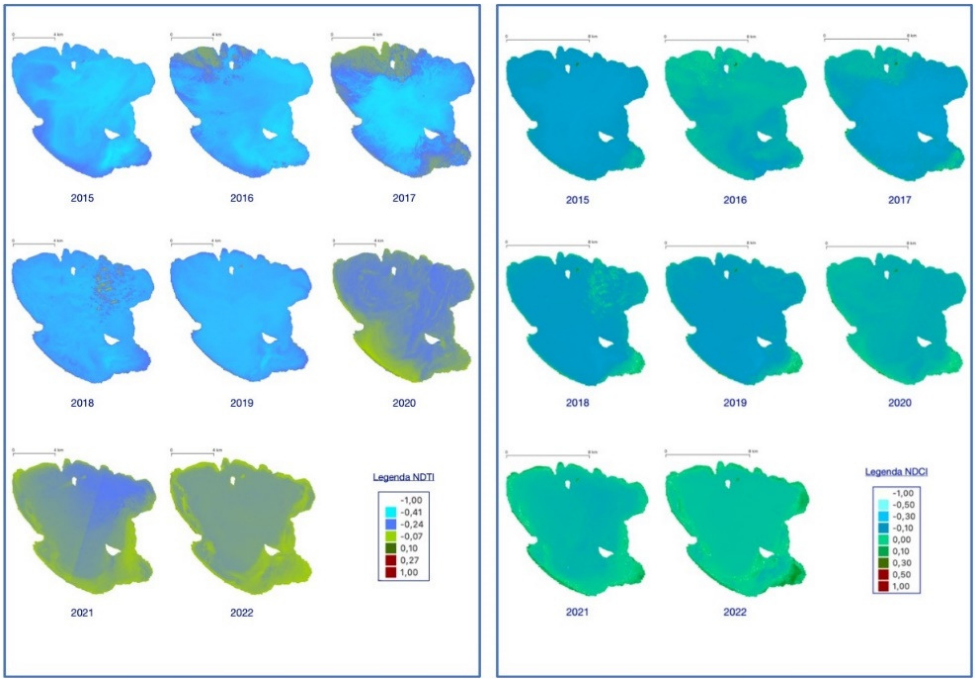

Figure 1. NDTI (left) and NDCI (right) of lake Trasimeno in the middle days of July, from 2015 to 2022.

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Developing a Near-IR Eye Tracker to Analyze Eye Movements Related to Suicide Risk Assessment

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Abstract. *This project's aim is to develop and evaluate an eye-tracking system to record different eye parameters. The use case for the developed eye-tracking glasses is to detect pattern between people with and without suicidal risk. The eye-tracking glasses use near-infrared to track the pupil and record the eye parameters. The system will be evaluated through a study. The question to be investigated is whether people with suicide risk show different eye parameters during a psychological interview than people without suicide risk. Additionally, during the study participant's heart rate will be measured. The research will involve recruiting a sample of individuals with a history of suicidal ideation and/or attempts as well as a control group of individuals with no history of suicidal behavior. This project is carried out by the regional hospital KABEG and the Carinthian University of Applied Sciences and the results project will have implications for the development of new tools for assessing suicidal risk. If there is a significant difference between the eye patterns of the two groups, the findings of this research will contribute to the development of more effective interventions for preventing suicide.*

Keywords. Eye-tracking-system, near IR, suicide risk assessment, heart rate, oxygen saturation

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1 Introduction

Technology in mental health has seen significant growth in recent years. One such technology is the near-infrared camera, which can measure the precise pupil position, its relative size, and other parameters such as blinks or saccades. These parameters have been studied as potential indicators of various mental states, including suicidal ideation [1].

Suicide is a serious concern, and early detection and intervention are crucial to preventing this act. While traditional methods of detecting suicidal ideation, such as self-reporting, professional questionnaires, and psychological tests are today's standards to assess one's suicidal risk, they have limitations, including the need for highly skilled and trained psychotherapists and the establishment of a very safe and well-thought-out environment. This is taking a big toll on both the doctors and the group at risk.

Despite the great effort in the past to systematically try to assess one's mental state, e.g., through mimic or vital parameters such as heart rate [2], the idea of trying to identify suicidal risk by both analyzing eye movement alongside the heart rate remains insufficiently investigated.

Building a near-infrared eye camera for detecting parameters related to suicidal ideation requires a multidisciplinary approach involving knowledge of optics, image processing, and mental health.

In this project, the goal is to build a near-infrared eye camera and develop algorithms to analyze the data collected from it. The hope is that this technology could possibly be used in clinical settings to help identify individuals at risk of suicide and provide appropriate interventions.

2 Methods

For building the IR-Eye tracker, the following components were used:

- 4 x 100 Ohm Resistors
- Normal glasses frame (plastic)
- Microcontroller (ESP32 Cam)
- rotary potentiometer to regulate the IR LEDs brightness.
- 4 x Infrared LEDs
- IR Camera (OV5640)
- USB Socket
- USB-Type A to USB-Type A Cable
- WLAN Router (802.11b/g/n)

The ESP32 microcontroller can transfer data through various communication interfaces such as UART, SPI, I2C, Ethernet, and Wi-Fi.

Since the initial thought was to make this eye tracker completely wireless, the chosen data transfer method was Wi-Fi. The video stream can be easily accessed by calling the IP address of the connected microcontroller.

After assembling the components together, the next challenge is to develop the corresponding software.

For this project, the chosen programming language is python for the whole process, from creating the API to the image processing. This poses some challenges, but it also makes the development consistent. The first step was to decide if the graphical user interface (GUI) library would allow interaction with the eye tracker. A popular library "PyQt5" was used to construct the whole GUI. PyQt offers a rich set of widgets, a flexible workflow, a customizable design, and a multithreaded-safe approach, of which its importance will be explained in short. Furthermore, it offers its own plotting library "pyqtgraph", which utilizes the GPU power to allow for much faster and smoother line real-time rendering [3].

The software is required to be multithreaded since there are four main processes that ought to be running in parallel. First, the camera thread, which receives the stream data directly from the ESP32 Cam system. Secondly, the GUI interaction is a separate process that, in no case should affect the video stream. Then the image processing module, which is important for pre-processing and image pre-filtering. Finally, the saving process, which allows the data to be saved/recorded in the background.

The software design is illustrated in Figure 1.

Figure 1. Software design concept for the Eye tracker system

The next step is to develop an algorithm that detects the eye parameters. This is not an easy task since there are many relevant parameters that aren't directly detectable and always contain some error (e.g., the pupil size when the person is looked at from the sides).

The importance of using IR images can be seen by looking at Figure 2, the pupil is much easier to separate and detect. Also, the noise effects are drastically reduced using IR.

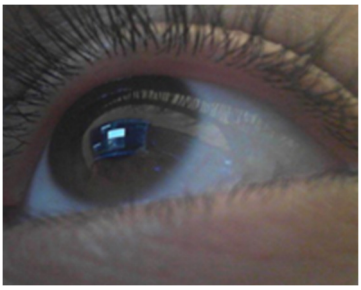

Figure 2. a) without Infrared b) with Infrared

Since the images are captured with an IR sensor, the intensity of the pupil is clearly visible and different from the other parts, meaning that it should be possible to detect it by using simple image processing techniques (erosion, binary filtering, ellipse fitting, etc.). For now, the "simple blob detection" algorithm was used, which basically detects blobs (big objects) in an image that share common properties such as color, connectivity, and distance. Some additional tuning parameters, such as the circularity, convexity and inertia of the desirable object can be manually tuned.

Essentially, the following parameters were used:

- Minimum Area: 500
- Maximum Area: 5000
- Threshold: 0-120
- Circularity: 25
- Convexity: off
- Inertia: off

3 Results

The design for the eye tracker took many iterations, in Figure 3, the final concept can be seen and its realization.

Figure 3. a) 3D Visualization of the eye tracker concept b) Real implementation of the eye tracker concept

The software derives video from one or both eyes. Currently, the glasses consist of one camera. With the video of the eye the eye parameter can be constructed. The heart rate is measured by a conventional pulse oximeter. Furthermore, the voice of the participants will be recorded to divide

the segments into the corresponding number of questions. Also, the metadata of the participants will be noted, such as their sex, age, suicide risk, diseases, and types of taken medication of the participants.

4 Discussion

The further steps in this project are to develop a website or another platform to analyze the recorded eye parameters and other measured vital parameters such as heart rate and oxygen saturation. This website should represent if there is a significant different pattern between people with suicide risk and people without. The project is currently in the middle of implementation phase and should be completed in June 2024 at the earliest.

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Evaluation of the Effectiveness of a Previous Paint Layer to Slow Down Deterioration of Urban art Murals

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Abstract. *The art created in public spaces is part of the cultural richness of modern society being nowadays contemporary muralism one of the most common painted manifestations of urban art. Unfortunately, these urban creations suffer serious deterioration in a very short space of time due, in some cases, to the lack of prior conditioning of the surface. In this study, the effectiveness of a previous paint layer in slowing down de deterioration of urban art paints was evaluated in two situations: a real mural (monitoring changes during 1 year) and in laboratory – by means of a UV aging test. The presence of the previous layer can modify the colour appearance of the paints, but its application had not meant a better durability after exposure.*

Keywords. Urban art, spray paint, alkyd paint, previous paint layer, painting conservation, contemporary muralism

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1 Introduction

Nowadays, contemporary murals are one of the artistic expressions commonly found in public spaces [1]. The artistic value of these artworks could be compromised due to the deterioration processes affecting the paints and derived from the action of the environment factors [2]. Many of the deterioration forms that affect the materials used in urban art (loss of pictorial layer, scaling, etc.) are due to the fact that the substrate has not been properly prepared before applying the paints [2,3]. One possible solution could be to apply a previous layer of paint to the substrate to prepare it to receive the final paint coating.

To create the artworks, artists commonly use modern commercial paints, applied in different formats, the most common being aerosol and brush. Most of these pictorial materials are composed of an organic base of one or several polymers or resins of different natures (acrylic, alkyd, vinyl, styrene, phenolic, polyurethane polyester, epoxy, etc.), pigments of organic and inorganic nature, which confer colour, solvents, fillers and additives. Artists apply these paints to a wide range of substrates (concrete, brick, stone, glass, metal, wood, plastic, etc.) with or without a previous paint layer.

The aim of this study is to evaluate the effect of the application of a previous paint layer in the context of urban art and to study the impact on colour fading. For this, a real mural -in which a previous paint layer was applied- was selected and monitoring 1 year. For comparative purposes, laboratory mock-ups of the same paints with and without the presence of the previous paint layer were made and subjected to an UV ageing test. After the exposures, physical changes were studied in order to evaluate the paint durability by means of stereomicroscopy and spectrophotometry.

2 Materials and Methods

2.1 Contemporary urban art mural and paints

The mural selected is *A Guarda Escrita Nas Estrelas* (Fig. 1A), which was painted in August 2018 by the artists Nuvi and Éxfico on the harbour wall in the port of A Guarda (NW Spain). The structure is made by reinforced concrete.

The wall was first spray gun-painted with a styrene-acryl blue paint from Montó Pinturas (Montokril Liso S 5540r90b), which corresponded to the previous paint layer (PL). The rest of the mural was painted using Montana Colors MTN 94 alkyd spray paints in orange-OR (RV 2004), pink-PI (RV 151), green-GR (RV 6018) and yellow-YE (RV 1021).

In order to evaluate physical changes produced by the mural exposure, colour monitoring in the CIELab space was carried out for 1 year [4], using a Minolta CM-700d spectrophotometer. The measurements (10 random shots per area) were made in specular component excluded (SCE mode), with a spot diameter of 3 mm, illuminant D65 and observer angle of 10°. Colour parameters were recorded: lightness L*, a* (colour position between red -positive values- and green -negative values-), b* (colour position between yellow -positive values- and blue -negative values-) and chroma C*. The changes in colour were evaluated by calculating the ΔL^*, Δa^*, Δb^* and ΔC^*_{ab} colour differences and the total colour difference (ΔE^*_{ab}).

2.2 UV ageing test

Mock-ups of the same paints used in the mural were prepared. For this, concrete specimens of 7 x 7 x 2 cm were used. Two types of mock-ups were made: with and without the previous blue paint layer (Fig. 1B and 1C). The spray paints were applied following manufacturer's recommendation and held for 30 days in laboratory conditions (15 ± 5 °C; 60 ± 10% RH).

The painted mock-ups were exposed to UV radiation, using OSRAM Ultra Vitalux 300 W UV lamps (16.3 W of UV-A and 1.3 W of UV-B radiation power), positioned at a vertical distance of 50 cm from the surfaces of the mock-ups, ensuring equal irradiation. The mock-ups were exposed to 210 cycles of 22 h of irradiation (and 2 h of darkening), resulting a total of 4620 h of irradiation. The colour monitoring was performed following the same procedure described above but registering 6 random shots per area. The mock-ups were visualized by a stereomicroscope before and after the ageing test using a Nikon SMZ800.

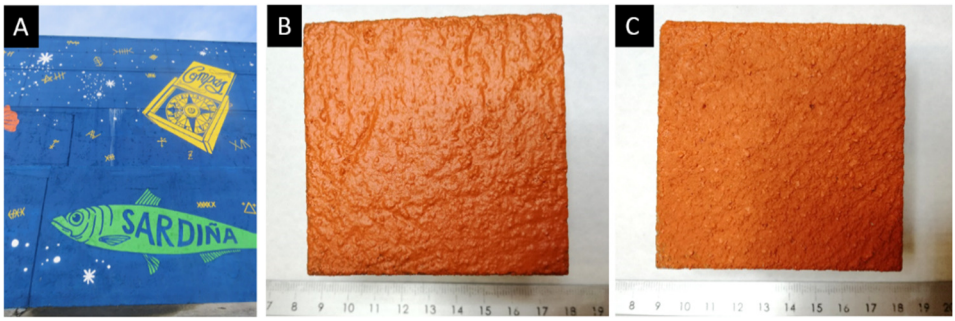

Figure 1. A: detail of *A Guarda Escrita Nas Estrelas mural*, where the previous blue paint layer and the features painted with green, yellow and orange paints are observed. B and C: mock-ups before the UV exposure with (B) and without the previous blue layer (C).

3 Results and Discussion

3.1 Impact of the previous layer on the original colour of the paints

In order to evaluate the impact of the application of the previous layer of blue paint on the original colour of the paints, the ΔE^*_{ab} values were calculated after the application of the paints to the blue paint, taking the surface of the mock-ups without the previous layer as reference (Fig. 2A).

Considering a ΔE^*_{ab} value of 3 CIELab units as the threshold after which the colour change is perceptible to the human eye [5], the application of the previous layer produced a visible change in orange (5.20 ± 0.45 CIELab units) and green (3.59 ± 0.44 CIELab units) paints. In both paints, the application of the previous layer produced an increase in the lightness, whereas, in the orange paint, a statistically significant increase in C* was detected. Therefore, the green paint became paler and the orange paint lighter (compare Fig. 1B and C).

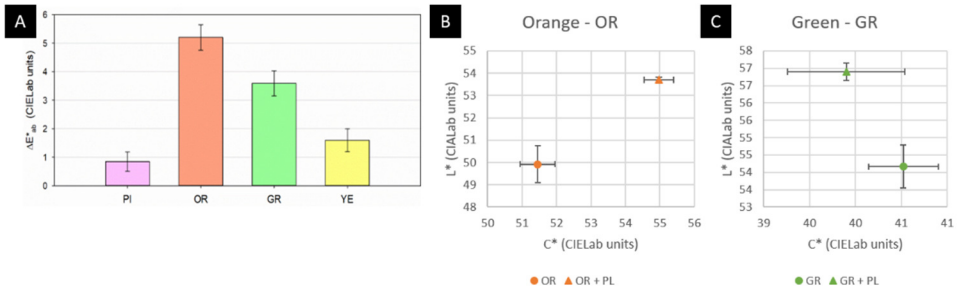

Figure 2. A: Plots of colour parameters in painted surfaces. A: mean values and error bars of ΔE^*_{ab} caused by the application of the previous blue layer on the paints in the mock-ups. B and C: mean values and error bars for L* and C* parameters in the paints without and with the previous layer: orange-OR (B) and green (C).

3.2 Evaluation of the paint durability after the mural exposure and UV aging test

The values of ΔE^*_{ab} of the paints exposed to real environment and UV test are graphically represented in Fig. 3A. The values of the colour parameters are included in Table 1.

Regarding the mock-ups, those in which the paint was applied over a previous paint layer suffered a higher colour change after exposure than mock-ups in which the paint was applied directly to the concrete, although the differences were statistically significant only in the pink-PI paint (Fig. 3A). Comparison of the surfaces of the pink-PI mock-ups with and without the previous paint layer and before and after the UV test are shown in Fig. 3B and C.

In the mural, ΔE^*_{ab} suffered by the paintings after the exposure was, in all the cases, higher than the ΔE^*_{ab} suffered for the mock-ups made with the same paints applied over the previous paint layer (Fig. 3A). The paints suffering the highest colour change were orange-OR and pink-PI. The greater colour deterioration in real outdoor conditions can be attributed to the fact that more factors of deterioration besides solar radiation converge in the mural, which contribute to a greater degradation of the colour [2].

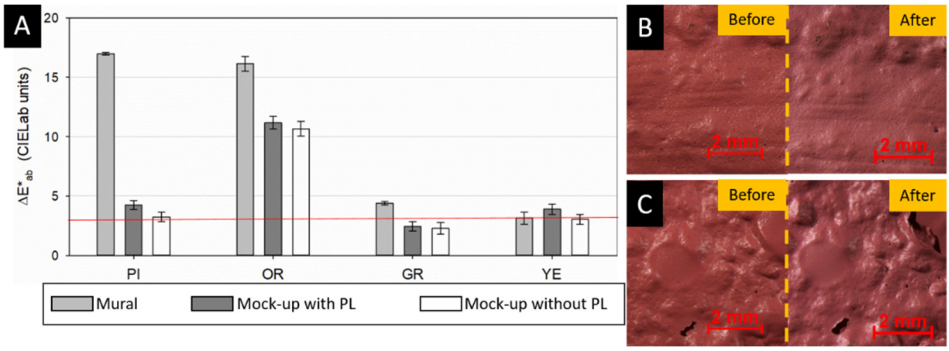

Figure 3. A: mean values and error bars of ΔE^*_{ab} after the mural exposition and the mock-ups after the UV test (with and without previous layer PL). B and C: stereomicrographs of mock-ups surfaces of pink paint with (B) and without (C) the previous layer, before and after the UV test.

The colour deterioration of the paints is mainly due to a change in two colour parameters (Table 1): in general, C* decreased and L* increased (except for GR, where L* decreased). Therefore, the colour of the paints OR, PI and YE became paler after exposures and darker in the case of GR.

Table 1. L*, a*, b* and C* colour variations and the total colour difference (ΔE^*_{ab}) in paints of the mural after 1 year of outdoor exposition and in the mock-ups with previous blue paint layer (MK-PL) and in the mock-ups without previous blue paint layer (MK) after the UV test.

Paint	Condition	ΔL^*	Δa^*	Δb^*	ΔC^*_{ab}	ΔE^*_{ab}
	Mural	8.06 ± 0.05	-13.95 ± 0.10	5.38 ± 0.05	-9.51 ± 0.08	16.98 ± 0.12
PI	MK-PL	0.53 ± 0.33	-3.92 ± 0.18	-1.53 ± 0.08	-4.17 ± 0.18	4.24 ± 0.39
	MK	-0.13 ± 0.36	-2.79 ± 0.08	-1.62 ± 0.05	-3.08 ± 0.08	3.23 ± 0.37
	Mural	6.98 ± 0.18	-14.52 ± 0.48	-1.00 ± 0.35	-9.53 ± 0.56	16.14 ± 0.62
OR	MK-PL	1.76 ± 0.32	-7.41 ± 0.34	-8.15 ± 0.28	-10.99 ± 0.39	11.16 ± 0.53
	MK	1.87 ± 0.41	-6.14 ± 0.30	-7.81 ± 0.29	-9.79 ± 0.40	10.11 ± 0.59
	Mural	0.02 ± 0.07	0.61 ± 0.08	-4.36 ± 0.11	-3.44 ± 0.13	4.40 ± 0.15
GR	MK-PL	-0.41 ± 0.18	0.52 ± 0.18	-2.36 ± 0.29	-2.03 ± 0.33	2.45 ± 0.39
	MK	-1.03 ± 0.45	0.78 ± 0.18	-1.82 ± 0.25	-1.88 ± 0.24	2.23 ± 0.55
	Mural	1.81 ± 0.29	-2.56 ± 0.28	0.00 ± 0.32	-0.29 ± 0.34	3.14 ± 0.51
YE	MK-PL	0.53 ± 0.23	-3.70 ± 0.27	-1.05 ± 0.22	-1.64 ± 0.26	3.89 ± 0.42
	MK	0.58 ± 0.30	-2.73 ± 0.07	0.14 ± 0.36	-0.38 ± 0.36	2.79 ± 0.47

4 Conclusions

The presence of previous layers of paints visually modifies the original colour of the paints applied on it. In this study, this modification was unpredictable, affecting two of the four paints. Artists should consider this fact if the final appearance of the paints is important to them.

The application of a previous paint layer did not increase the final durability of the paints to UV radiation test, so if the objective is to slow down fading of the paintings due to photo-degradation, the application of the previous layer would not be necessary. In the case of exposure to the real environment, as occurs in the mural, it would have been necessary to compare the durability of the paint in areas where the previous paint layer was not applied, in order to be able to conclude about its effectiveness in slowing down deterioration.

Acknowledgements

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Methodology for the Correct Reproduction of Megalithic Paintings: Substrates and Binders

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Abstract. *Rock art researchers describe the existence of a preparation layer of kaolin (with or without organic binder) on the rock, on which megalithic painting was carried out, using a mixture of pigment and binder. The natural pigments used were mainly hematite, ochre and carbon black. As binders, animal fats, blood, resins, etc. were reported. The uncertainty regarding the composition of these paintings means that there is not a clear procedure for their reproduction in the laboratory as mock-ups. This study shows a methodology based on the assessment of a group of parameters that allow assessing the suitability of a binder (in this case, butter or casein) both in the preparation layer and in the pictorial layer. Covering capacity, drying velocity, binding capacity, grip on the substrate and biological growth were evaluated. It was completed with colour spectrophotometry and scanning electron microscopy. The mixture of butter with pigment applied on a kaolin-based substrate was identified as the most suitable.*

Keywords. Rock art, pigment, ochre, binder, butter, casein, conservation

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1 Introduction

Megalithic paintings are understood to be those expressions created by humans, approximately between the V millennium B.P. and the end of II millennium B.P. They were found on dolmens, shelters, stelae, etc. The main pigments were hematite, goethite, clays and black carbon from the combustion of organic materials such as wood [1-2]. The ochre pigment appeared at least collected in some dolmens studied in Galicia, NW Spain [3]. In the characterized megalithic paintings, blood, urine, egg, vegetable resins, animal fat or casein are usually reported as binders for the pigments [4-6], the latter two being the most common. The use of organic binders has even been reported in the kaolin preparation layer under the paintings of one of the most important dolmens in NW Spain, the Dombate dolmen [4]. Despite the existing hypotheses about the composition of these paints, mainly about the organic binder, no clear and systematic methodology has been found for the laboratory recreation of paint mock-ups. Mock-ups can be exposed to different tests; with them, it will be possible to know their behaviour when are exposed to a polluting gas or to determine the most effective cleaning techniques for this heritage without threatening the integrity of a real work.

This study presents a work methodology to verify the adequacy of the use of organic binder (butter or casein, from animal milk) both in the kaolin preparation layer and in the pictorial layer. Pigment was mixed with butter or casein, either mixed directly or previously dispersed in water.

2 Material and Methods

2.1 Materials

The following materials were purchased: commercial skimmed milk to obtain the casein, commercial clarified butter, kaolin from a quarry in Vimianzo (A Coruña, Spain) with an aggregate size of 50 µm and Ochre Yellow SA pigment with reference PY43.77492 provided by Kremer Pigmente GmbH & Co. .KG. The skimmed milk was mixed with glacial acetic acid to obtain the casein. This was diluted in water (1:3, casein:water by weight) at 30°C. The butter, of industrial origin, was simply heated in a glass to 50ºC. The kaolin was kneaded with deionized water in a 5:2 ratio (kaolin:water by weight). Three types of paste were made (Table 1, check substrate section): kaolin, kaolin mixed with 5% butter (by weight) and kaolin with 5% diluted casein (by weight) and a few drops of NH_3 (2% by weight regarding the diluted casein and added by a Pasteur pipette).

Each paste was applied in Petri dishes (55 mm in diameter) following the methodology described in [4]. Two layers were applied in each dish. Special care was taken in their compaction. To avoid cracks, drying was done by partially covering them. The samples were left for 7 days under laboratory conditions (15±5ºC and 60±10% RH) to identify which of the paste compositions were more suitable as substrates for the application of the paints.

Once suitable substrates were selected, the paint was applied with a brush. As indicated in Table 1 (check paint conditions), 3 types of paint were made: 1) pigment with butter, 2) water dispersed pigments with butter, 3) pigment with diluted casein (1:3, casein:water by weight) with addition of NH3 (Table 1). The application was made with the wet substrate; similar conditions

to those that can be found in dolmens and shelters. The samples were evaluated 7 days under laboratory conditions.

Table 1. Substrate and paint compositions.

SUSBTRATE		
Kaolin	***Kaolin+butter***	***Kaolin+diluted casein+ NH_3***
Kaolin: 300 g H_2O: 120 g	Kaolin: 300 g H_2O: 120 g Butter: 21 g	Kaolin: 300 g H_2O: 120 g 21 g casein:water (1:3 wt.) + 1.68 g NH_3
PAINT CONDITIONS		
Ochre +butter	***Ochre+water+butter***	***Ochre+diluted casein+NH_3***
Pigment: 1 g Melted butter: 2 mL (50ºC)	Pigment: 1 g Water: 1 mL Melted butter: 2 mL (50ºC)	Pigment: 1 g 4.28 g casein:water (1:3 wt.)+ 0.15 g NH_3

2.2 Methods

2.2.1 Characterization of the pigment

The mineralogical composition of the Ochre Yellow SA pigment was determined using X-ray diffraction (XRD) by means of a SIEMENS D5000.

2.2.2 Characterization of the substrate and the painting

After 7 days of drying, under naked eye, the substrates were evaluated considering the appearance of fractures and biological growth. The substrates without fractures and biological colonization were used to apply the paints.

During the paint application, the covering capacity and drying velocity were considered.

Once paint mock-ups were dried, a stereomicroscope (SMZ 1000, Nikon) was used to study their superficial appearance, to determine binding capacity, grip on the substrate and biological growth.

Then, the colour of the surface was characterized using CIELAB and CIELCH colour spaces [7] using a Minolta CM-700d spectrophotometer. In the CIELAB space, L* (lightness), a* and b* (colour coordinates) were measured. L* is the lightness, a* indicates the colour position between red and green and b* indicates the colour between yellow and blue. The chroma or saturation (C*ab) was also measured. Five measurements were made at random points on each sample to provide statistically consistent results, with each measurement being the average of three. The measurements were made in the Specular Component Excluded (SCE) mode, for a spot diameter of 3 mm, using D65 as the illuminant and an observer angle of $10\circ$.

The microtexture and elemental composition of the paint mock-ups were studied by scanning electron microscopy with energy-dispersive x-ray spectroscopy (SEM-EDS) using a FEI QUANTA 200 in both Secondary Electron (SE) and Back Scattered Electron (BSE) modes.

3 Results and Discussion

3.1 Selection of the substrate conditions

Cracks were not generated in any of the substrates. The same could happen in shelters, caves or dolmens where the high RH% remains constant. In the substrate where casein was added, rapid biological colonization was detected. The substrates executed just with kaolin and kaolin with butter were evaluated as adequate.

3.2 Pigment characterization

Ochre Yellow SA pigment was composed of goethite (FeOOH) and calcite ($CaCO_3$).

3.3 Painting mock-ups characterization

During the application of the paint on the substrate, it was detected that the paint with the best covering capacity was the mixture of water dispersed pigments with butter regardless of the substrate (just kaolin or kaolin with butter). The paint mock-ups drying faster were those made with diluted casein regardless of the substrate.
After drying, the highest binding capacity was identified in the painting with pigment and butter on kaolin-based substrate. The addition of water to the pigment before mixing with the butter decreased the binding capacity markedly on both substrates. Moreover, the application of pigment with butter on kaolin with butter-based substrate also reduced the binding capacity. The casein mock-ups, despite paint layer lifted, had a good binding capacity. The painting with pigment (without water) mixed with butter showed a high grip on the substrate in both substrates. Adding water to the pigment before mixing with butter slightly decreased adhesion. Biological colonization was not detected after 7 days of drying.

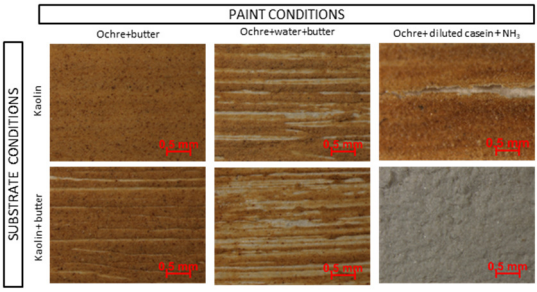

Figure 1. Micrographs of the paint mock-ups

Based on this qualitative evaluation, an evaluation methodology (Table 1) is proposed in which these parameters are evaluated on a scale from 1 (low) to 5 (excellent) with the objective of determining which procedure for the elaboration of megalithic art mock-ups is the most appropriate. Considering the highest score, the condition with the best evaluation was the application of pigment mixed with butter on a kaolin-based substate (without binder).

Spectrophotometry allowed us to determine that the mock-up with the water dispersed pigment with butter on a kaolin and butter-based substrate showed the greatest L* and its C^*_{ab} was closer to that of the original pigment (Fig. 2). Samples with casein, regardless of the substrate, showed lower L* and higher C^*_{ab} than those of the original pigment. Mock-ups with pigment mixed with butter regardless of the substrate showed similar L* and C^*_{ab}; these samples showed similar L* and higher C^*_{ab} than the original pigment. The condition identified as the most adequate to obtain megalithic paintings following our methodology (i.e., pigment with butter on a kaolin-based substrate) showed a similar L* to that of the pigment but a slight increase in C^*_{ab}.

Table 2. Methodology to determine the adequacy of the procedure for simulating megalithic paintings. Evaluation from 1 (low) to the 5 (excellent)

SUSBTRATE	PIGMENT CONDITIONS	Covering capacity	Drying velocity	Binding capacity	Grip on the substrate	Growth of micro-organisms	TOTAL
KAOLIN	Butter	3	3	5	5	5	21
	Water+butter	4	3	2	4	5	18
	Casein + NH_3	3	4	4	2	5	19
KAOLIN+ BUTTER	Butter	3	3	3	5	5	19
	Water+butter	4	3	2	4	5	18
	Casein + NH_3	2	4	4	1	5	17

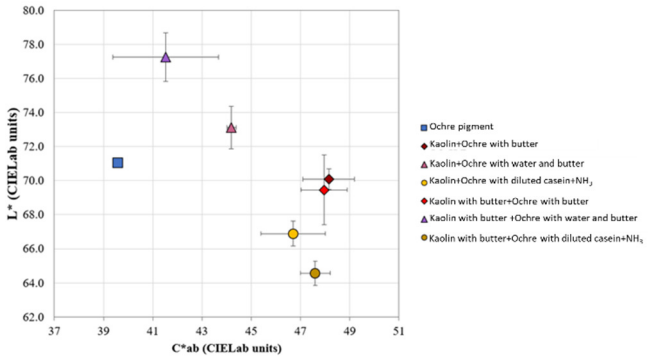

Figure 2. Mean values and error bars for L* and C^*_{ab} parameters registered in the different mock-ups.

Using SEM, it was detected that mock-ups with pigment and butter showed a greater agglutination than the samples with diluted casein (Fig. 3a and b respectively). In the casein-mock-ups (Fig. 3b) longitudinal cracks were observed crossing the pictorial layer.

4 Conclusion

A methodology based on the quantitative evaluation of the covering capacity, drying velocity, binding capacity, grip on substrate and biological growth in megalithic paint mock-ups allowed us to identify the suitability of the procedure to recreate them. In this case study, the best condition was achieved with the pigment mixed with butter on a substrate just with kaolin. However, it is necessary to consider the effect caused by the binder on the resulting colour, since both butter and casein change the original colour of the pigment.

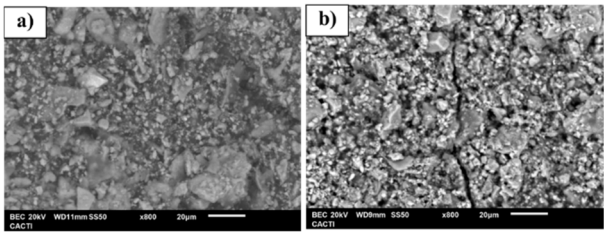

Figure 3. SEM micrographs of some of the mock-ups. a) ochre with butter on a kaolin-based substrate. b) ochre with diluted casein+NH_3 on a kaolin with butter-based substrate.

Acknowledgements

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Preliminary Study of the Durability of Nano-silica-based Chromatic Reintegration and Fresco Mock-ups with Lapis Lazuli Exposed to Different Natural Environments

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Abstract. *Wall paintings are susceptible to deterioration when exposed to environmental factors (humidity, solar radiation, polluting gases, etc.) that can lead to alteration forms such as the loss of the pictorial layer. Then, chromatic reintegration treatments are usually carried out. Currently, the most recommended technique it is the application of a mixture of the pigment with a mineral binder. In this study, an aqueous colloidal dispersion of nano-sized silica has been used as a binder since it withstands harsh environmental conditions. The commercial pigment lapis lazuli was selected to paint following the fresco technique and it was also mixed with nano-silica to be applied on a lime mortar base as a reintegration. Mock-ups were studied after 6 months of natural exposure in Vigo (NW Spain) and Granada (S Spain). Their characterization was done by means of colour spectrophotometry, X-ray diffraction, Fourier-transform infrared spectroscopy and scanning electron microscopy with energy dispersive X-ray spectroscopy.*

Keywords. Fresco, wall painting, chromatic reintegration, nano-silica, natural exposure

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1 Introduction

The main alteration agents that can affect wall painting, especially when they are outdoor-exposed, are generally moisture and soluble salts [1-4], causing detachment of the painted surface (i.e., lacunae) [3-4]. In this context, chromatic reintegrations aim to fill those paint losses. In the case of outdoor exposed wall paintings, the use of a mineral binder such as silicate mineral dispersions, might be a suitable alternative for its water-repellent properties [4-5], which would ensure withstanding strong weather conditions [4]. Aqueous colloidal dispersion of nano-sized silica should be considered due to its apparent inalterability and high resistance to atmospheric deterioration agents [4-7]. This study aims to determine the physical compatibility of a nano-sized silica-based reintegration with a fresco painting made with a commercial lapis lazuli ($3Na_2O \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot 2Na_2S$) and exposed to different natural environments. The reason for the use of lapis lazuli is the common use of this blue pigment in artistic paintings since the 12th century [8] until the end of the 18th century [2].

2 Materials and Methods

2.1 Materials

A set of three paintings mock-ups (ca. 10 cm×15 cm×2 cm) were prepared conformed by two lime mortar layers reproducing the structure of historical wall paintings according to Old Master recipes [8]. Using a calcitic lime in the form of a paste, slaked under water over more than 20 years, coarse (1-2 mm) and fine silica (0,4-0,8 mm) aggregates and marble powder (<0,7 mm), the first layer was carried out with a 1:3 ratio by volume (lime:aggregate), made with coarse and fine silica aggregates, whilst the last painting layer with a 1:2 ratio by volume with fine silica and marble powder as aggregates. In half of the mock-ups, lapis lazuli (LA hereinafter) was applied following the *fresco* (F) technique. Then, mock-ups were left carbonating for one month under laboratory conditions and the other half was painted with a chromatic reintegration (SB) made of an aqueous colloidal dispersion of nano-sized silica commercially known as Nano Estel. This was diluted with demineralised water in a 1:1 ratio and then mixed with the pigment and applied on the dried surface. One of the mock-ups was left at laboratory conditions (18±5ºC at 60±10% RH) as reference. The other two were outdoor exposed for 6 months under 2 different natural environments. On the one hand in Vigo (V), a coastal city in NW Spain, with high humidity, moderate temperatures, marine influence, and low pollution levels. On the other hand, in the inland city of Granada (G) in S Spain, a dry environment, with extreme temperatures depending on the season and highly polluted.

2.2 Methods

A stereomicroscope (SMZ 1000, Nikon) was used to examine the pigments as well as the textural, structural and chromatic features of the paint mock-ups.

The colour of the paint mock-ups was characterized using CIELAB colour space, measuring L* (lightness), a* and b* (colour coordinates), C^*_{ab} (chroma) and h_{ab} (hue) by means of a Minolta

CM-700d spectrophotometer. $C^* = (a^2+b^2)^{1/2}$ and h_{ab}=arctan(b*/a*), where a* indicates the colour position between red (positive values) and green (negative values) and b* between yellow (positive values) and blue (negative values). A total of five measurements were made for each mock-up, one every 40 days.

The mineralogical composition of the raw pigment and the mock-ups was determined using X-ray diffraction (XRD, XPert PRO PANalytical B.V.). Analyses were performed using Cu-Kα radiation, Ni filter, 45 kV voltage, and 40 mA intensity. The exploration range was 3° to 60° 2θ and the goniometer speed was 0.05° 2θ s1.

The chemical composition was obtained by Fourier-transform infrared spectroscopy (FTIR) in diamond crystal attenuated total reflection (ATR) mode, using a Thermo Nicolet 6700 in the infrared spectral region between 400 cm-1 and 4000 cm-1.

The microtexture and elemental composition of the paint mock-ups was studied with scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX), using a FEI Quanta 200 with backscattered electron (BSE) and secondary electron (SE) detectors. Both the surface of samples and their cross sections were studied under SEM after previous carbon coating.

3 Results and Discussion

Stereomicroscopic observations revealed evident differences in colour between fresco mock-up (LA-F, Fig, 1A) and its counterpart chromatic reintegration (LA-SB, Fig 1D) the latter showing more intense colour. After 6 months exposure, in all the fresco mock-ups (LA-F-V, Fig. 1B and LA-F-G, Fig. 1C) whitish surfaces were detected, whilst brown depositions were observed only in the mock-ups exposed in Granada (LA-F-G, Fig. 1C). No clear differences were detected in the reintegration mock-ups exposed to both outdoor environments (LA-SB-V, Fig. 1E and LA-SB-G, Fig. 1F), compared to the reference ones (LA-SB, Fig. 1D)

Regarding the chromatic study by means of spectrophotometry, when the colour variation (ΔE^*_{ab}) is higher than 3.5 CIELAB units, the human eye can perceive the differences in colour [9]. Fresco mock-ups exposed to Vigo's environment encountered major variations (>3,5 CIELAB units) over 6 months than the samples from Granada, especially the fresco mock-up (LA-F-V).

The mineralogical study of the raw pigment by XRD analysis identified different mineral phases of the sodalite group: lazurite (Na3Ca(Al3Si3O12)S) and sodalite (Na8Al6Si6O24Cl2). Moreover, calcite (CaCO3), diopside (CaMgSi2O6), pyrite (FeS2), albite ((Na,Ca)(Si,Al)4O8), muscovite (KAl2Si3AlO10(OH)2) and wollastonite (CaSiO3) were also found. The same mineralogical composition was obtained after outdoor exposure, apart from a slight increase in the calcite peaks, due to the lime mortar substrate of the mock-ups.

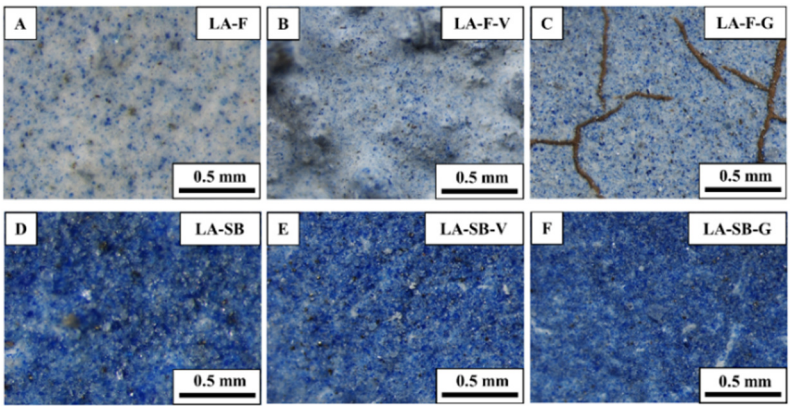

Figure 1. Stereomicrographs of lapis lazuli mock-ups following the fresco technique (A-C) and the nano-sized silica-based reintegration with lapis lazuli (D-F).

FTIR spectra taken on the surface of the exposed samples differ from those obtained on the reference mock-ups (LA-F and LA-SB) only in the wider intensity of the bands at 725, 874 and 1409 cm-1 that correspond to the -CO3 (carbonate) functional group. This can be easily related with the higher amount of calcite obtained also by XRD, especially in the mocks up exposed in Vigo (LA-F-V and LA-SB-V) .LA-SB-V also shows an increase in the bands corresponding to the Si–O stretching (at 425, 663 and 965 cm-1 presumably due to accumulation of silica from the substrate.

The study of the SB mocks up under SEM showed a completely cracked surface before (Fig.3A) and after exposure (Fig.3B). Different particles on the surface of all mock-ups that appear to be neoformations rich in Ca, according to EDS analysis (Fig.3B). On the one hand, in Vigo exposed mock-ups other neoformed phases composed of Na and Cl were also identified (Fig.3B). It could be related to halite (NaCl), a common salt found on heritage materials exposed to marine aerosol [10-12]. On the other hand, the brown deposits observed by stereomicroscopy (Fig.1C) in the fresco mock-ups exposed in Granada were composed of Si, Al, Na, Ca, Mg, P, S, and Fe (Fig. 3C). These elements correspond to those found in airborne particles of Granada according to previous studies [13]. Additionally, in LA-SB-G there was also occasional particles rich in P and calcium Ca (Fig.3D) that can be related to apatite ($Ca_5(PO_4)_3F$), a common impurity found in lapis lazuli pigments [14], probably not eliminated during the purification process of the pigment.

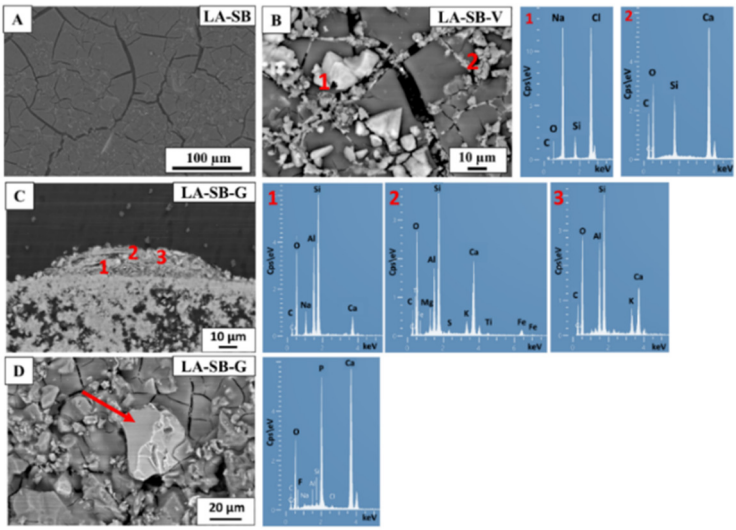

Figure 3. SEM micrograph and EDS spectra in mock-ups from A) reference LA-SB; B) LA-SB-V; C) LA-F-G; and D) LA-SB-G.

4 Conclusions

Comparatively to the fresco mock-ups, their chromatic reintegrations show cracked surfaces and chromatic variations. This might indicate a low compatibility between both techniques. Moreover, paints exposed in Vigo showed more intense alterations and colour changes, especially in fresco mock-ups. Both the frescoes and the chromatic reintegrations show the formation of carbonate deposits on the surface. In addition, in Vigo, sodium chloride salts can also be seen because of the marine aerosol. These formations can induce the slight whitening of the surface. In Granada, brown depositions have been encountered, probably from airborne particles. Nano-silica used as binder for chromatic reintegrations was not as resistant to environmental factors as expected, especially in marine environments.

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Use of Hackathons in Engineering Curriculum: Best Practices

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Abstract. *Hackathons are increasingly more integrated into the higher education system as a form of a pedagogical approach, as their benefits are becoming more recognised. This work builds on a previously presented framework for introducing hackathons in engineering curriculum with an additional presentation of related works, gathered with a preliminary literature review of two digital databases. Seven best practices are presented from the reviewed literature and from our experience with the organisation of hackathons in one master's level academic course at the University of Maribor over four academic years. The best practices we recognised are introducing additional stakeholders, a short timeline with enforced downtime, a hackathon as an exam, preparing communication channels in advance, adjusting the level to participants, offering additional prizes for the best projects, and preparing students by teaching Design thinking concepts before the event and Intellectual property protection afterwards.*

Keywords. Hackathon, academic curriculum, active learning, engineering curriculum

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1 Introduction and motivation

Incorporating hackathons into the engineering curriculum represents a dynamic approach to fostering active learning and practical skill development. Hackathons are highly engaging, continuous events centred around a key theme where participants in small groups create working software prototypes in a set amount of time, usually within 1-3 days [1]. In education, they are viewed as helpful tool to extend the core content without unnecessarily inflating the curriculum [2]. Previous studies on hackathons have recorded many advantages to introducing hackathons into the curriculum: (i) helping to solve industry-based challenges, (ii) fostering cooperation and cooperative learning, (iii) developing industry-specific skills, and (iv) engaging in informal and practical learning [2][3]. Lessons learned in a decade of organising code camps and hackathons for engineering students were reported in [2] along with a proposed taxonomy for hackathons and guidelines for using them in the graduate curriculums. A positive view of this pedagogic approach from educators (on a sample of 162 teachers) was reported by Mehta et al. [3]. The main stakeholders recognised in educational hackathons are **students**, **higher education institutions**, **industry representatives**, **society and citizens** [4]. University's Business Incubators and Knowledge and Technology Transfer Offices were also recognised as important stakeholders in our previous work [5].

This work builds on our previously published framework for introducing hackathons as a form of pedagogical approach to engineering curriculum [5]. This paper presents further insight into our approach. The main contributions of this work are i) a preliminary systematic literature review of related work with ii) analysis and overview of existing best practices in the field, and iii) an additional presentation of best practices from the organisation of yearly hackathons in four consecutive years as a part of the observed Master level course.

2 Background and method

We conducted a preliminary systematic literature review (SLR) to observe hackathons that have already been included in the engineering curriculums and answer the research questions:

- RQ1: How many students were included in the hackathon?
- RQ2: At what higher education study level were they introduced?
- RQ3: How was hackathon included in a course?
- RQ4: How long were hackathons?
- RQ5: What stakeholders were included?

The SLR was conducted in two digital databases, IEEE Xplore and ACM Digital Library, on 28. 8. 2023. The following query was used to search through titles, abstracts and paper metadata:

"hackathon" AND "curriculum" AND "engineering"

The search was limited to journal and conference publications in English. Only studies focused on higher education students (exclusion criteria or EC1) and with a presented case of hackathon implementation (EC2) were retained. Six papers were obtained from IEEE Xplore and one from ACM. After EC1 was implemented, five papers were retained (4 from IEEE Xplore and 1 one from ACM).

3 Results

The results of preliminary SLR are presented in Table 1. Hackathons were included in engineering curriculums in various countries; one of them was conducted as an international event. The number of participating students varied greatly, from 18 up to 260 per event. They were introduced at the bachelor and master level of education. Most of the observed papers documented hackathons related to software engineering (SE), Data Science or SE management. They were introduced as a part of the curriculum and graded as such, for example, as a part of the final project (in [6]) or were introduced as a volunteering part of the course and graded with bonus points (in [7]). Two examples of volunteer hackathons (i.e. outside of mandatory curriculum) in the form of engineering days' events (in [8]) and summer school (in [9]) were also introduced. The latter measured somewhat lower attendance. The length of hackathons was, in most cases, limited to a few days, with the exception of an eight-hour hackathon [7] and a weekly event [6].

Table 1. Overview of hackathon papers gathered with SLR.

Ref.	Country	Student nr.	Study level	Curriculum fit	Duration	Stakeholders
[8]	Israel	18 per event, together 700	bachelor	Annually, 40 workshops between semesters	3 days	Students, teachers
[10]	Canada	48-260 per event, multiple events	bachelor	engineering design days, various courses	2-4 days	Faculty, teachers, students
[6]	Brazil	Two events, 22 and 34 students	bachelor	Hackathon as a final project	weekend hackathon	Students, teachers, mentors
[9]	Online, international	39 international students	bachelor, master	Erasmus+ Summer school	1 week	Students, industry, academic board
[7]	Russia	34 students	master	Volunteer part of course	8 hours	Students, industry (as customer), researchers

3.1 Best practices

Extracted best practices combined with our experience presented in [5] are summarised in the following points, completing the lessons learned that were already recognised in the literature [2].

3.1.1 Introducing additional stakeholders

Introducing industry stakeholders allows students to get in touch with possible future employers, while participating in the project-oriented workflow, which is more related to the industry workflow. Introducing mentors from the industry and academia allows students to improve their solutions, while introducing other university offices (i.e., Incubators, Technologiy Transfer Offices)

allows the presentation of entrepreneurial initiatives available to students. Nevertheless, the mentioned stakeholder have also their own benefits, like ideating support for their challenges, insight into perspective employees, etc.

3.1.2 Short timeline with enforced downtime

Execution of the hackathon within a few days allows students to retain their focus on the course at hand and avoid scheduling issues with other study and work obligations of students. Event dates should also consider other events close to major assessments in the term, such as final exams, as those reduce student attendance and attention [10]. Hackathon culture often involves overnight work. However, in our experience [5] and in [6], enforcing the downtime to keep the students rested and avoid health concerns and sleep deprivation proved effective. Some students might continue their work outside the official schedule, though they are not forced to do so by the design. Compliance with the educational law and university schedule policies should also be taken in advisement.

3.1.3 Hackathon as an exam

Using hackathon as a final project in a course to keep students' motivation is shown in [6] and in our experience [5]. This allows for the demonstration of knowledge and skills of each student [2], while also pushing students towards participation. The organization of hackathons outside the mandatory curriculum has a lower participation rate [7]. Fair and balanced grading within a group is a recognized challenge.

3.1.4 Preparing students by teaching Design thinking and Intellectual property protection

To successfully integrate hackathons into the curriculum, students need to understand design thinking and the basics of business planning. After the event, students should be presented with the options to develop their projects further. This includes familiarizing them with topics of innovation, intellectual property, and technology readiness level. The university's business accelerator hub and local business hubs should also be presented after the event, if they are available to students [5].

3.1.5 Preparing communication channels in advance

The development of effective communication skills is one of the competencies required from engineering graduates [2]. To support effective communication in hackathons, we found it best to prepare communication channels in advance, specifically channels for communication between groups and mentors from the industry. In the case of our hackathons, MS Teams groups and shared calendars of meetings with mentors were created [5], while [9] prepared Zoom, cloud file share and miro boards as base collaboration tools for groups in online hackathons.

3.1.6 Adjusting the level to participants

Hackathons can be used at different levels of education and should be adjusted to the skillset of participant. Porras [2] recommends focusing on skills and competencies for first-year bachelor students and building skills for understanding new technologies in higher levels of studies. In our experience, the adjusted level should also impact stakeholders; companies are more interested in collaborations with students who have already developed basic skills and are capable of independent problem-solving. Therefore, they might not be a suitable partner for a hackathon targeted at freshmen students.

3.1.7 Additional prizes for best projects

Our experience with hackathons showed that students are more motivated to prepare and present better solutions if an additional reward is presented. This can be organised with the collaboration of industry partners or other sponsors, as described in [5][10].

4 Discussion

Hackathons are becoming a widely accepted pedagogical approach in higher education curriculums as a method of teaching creative thinking, decision-making skills, problem-solving, solution development, teamwork, use and expansion of skill and innovation. Most of the literature focused on introducing hackathons into the SE curriculum, while other engineering disciplines were less represented, though they could similarly benefit from them. A wider adoption is still in the process, and therefore, sharing best practices and lessons learned can positively impact the adoption rate, quality of organized events and their integration into engineering curriculums. This work builds on our previously published paper [5] where a framework for introducing hackathons in curriculums was presented, presenting recognized best practices from the literature and our lessons learned.

5 Conclusion

With the annual organisation of hackathons in the observed Master level course, broader literature review of alternative implementations and wider promotion of this pedagogical approach, we aim to gather further success stories and lessons learned to enable a swift and easy inclusion of hackathons in engineering curriculums. The knowledge and expertise accumulated through the organisation of hackathons hold the potential for implementation within the wider ATHENA university network. By sharing our experiences, insights, and best practices, we aspire to foster further use of this pedagogical approach. Implementing hackathons within the ATHENA testbed combined with lessons learned from related approaches (e.g., Praxis and BIP) can foster international and multidisciplinary environment cooperation models suitable for obtaining micro-credentials for students and cross-border industry involvement.

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SiOHCA: A Case Report on Strategies for Fostering Student Innovation

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Abstract. *This report describes the effective partnership among students, academic mentors, and industry mentors in creating the SiOHCA registry for out-of-hospital cardiac arrest cases in Slovenia. SiOHCA project aimed to enhance clinical outcomes of OHCA patients by providing pertinent data to researchers and EMS personnel. The case report analyzes organizational strategies that led to significant advancements in a short time. The project demonstrated that motivated and empowered students can drive significant improvements, sometimes faster than larger enterprises. The project utilized remote work, digital communication tools, the University of Maribor's network and mentorship from both academic and industry partners.*

Keywords. OHCA, student project, work organization, student research, registry

1 Introduction

SiOHCA is the Slovenian out-of-hospital cardiac arrest (OHCA) registry project that showcases the results that can be achieved through successful partnership among students, academic mentors, and industry mentors. The SiOHCA project endeavors to provide researchers and EMS personnel with more pertinent OHCA data, thereby enabling them to enhance the clinical outcomes of OHCA patients.

Retrospective data is the only available source for studying OHCA [1]. Cardiac arrest registries are widely used in developed countries to monitor OHCA statistics and improve survival rates. [1]–[3].

Studies conducted by international researchers have illustrated the feasibility of round-the-clock data gathering throughout the entire nation [1], which facilitates optimal optimization of Emergency Medical Services (EMS). Our aim is to impart the expertise and experience from abroad to Slovenia.

The funding received enabled the establishment of a proficient and multidisciplinary team comprising of students and mentors, who provided the students with the autonomy to engage in innovative practices that were beyond the conventional norms. This article presents an analysis of the organizational strategies implemented in our work environment, which have led to significant improvements within a relatively brief timeframe. This serves as a compelling illustration of how students, when suitably motivated and empowered, can produce significant and prompt transformations, outpacing even big enterprises.

2 Methods

The SiOHCA student project was established on March 1, 2022, under the guidance of Professor Matej Strnad and in collaboration with the Emergency Medical Dispatch Service of Slovenia, with mentorship from Miha Brezovnik. The project was started due to insufficient data on OHCA in Slovenia [4]. Initial funding was obtained through the University of Maribor's "Študentski izzivi

(ŠI:UM)" grant. Our industrial partner at that time, Computel d.o.o., is a leading provider of EMS software in Slovenia with vast experience in the industry.

We obtained financing on December 1, 2022, through the public tender "Projektno delo za pridobitev praktičnih izkušenj in znanj študentov v delovnem okolju 2022/2023" [5]. We expanded the team by hiring a developer and a law student. During this funding round, we initiated the development of SiOHCA software version 2.0 and organized the data obtained from the EuReCa THREE study for which our software was used. Matjaž Gornik, CEO of Better d.o.o., and Jovan Pevićevič, International Markets Director at Better d.o.o., functioned as industrial mentors and contributed to the strategic planning of software and operative development. Their international software development experience in healthcare industry was highly valuable to the team.

We chose remote work over a physical workspace to enhance efficiency. Students used Discord, Zoom, Trello, and YouTrack for communication and task management. Email facilitated collaboration with mentors, who offered prompt feedback. Timely replies within 24 hours were crucial for progress. The mentors offered feedback-based guidance, allowing students to learn from their mistakes and successes.

The University of Maribor's (UM) network was crucial for our work. The software is hosted on Electrical Engineering and Computer Science's (FERI) servers with a backup on Academic and Research Network of Slovenia's (Arnes) servers. We acquired complimentary domain and email hosting services from Arnes, facilitated by UM's network. We leased a FERI professional studio and photography equipment for PR needs. One of the primary advantages was the ability to establish connections with professionals and advisors within the UM network, which accelerated our progress.

Attending EMS2022 Scotland and various conferences in Slovenia facilitated knowledge exchange and promoted the project to Slovenian EMS personnel. The Faculty of Medicine in Maribor provided us financial support to attend conferences and promotional gifts for our partners.

3 Results

Upon recognizing the absence of freely available software for the establishment of OHCA registries, we opted to release our code as open source. The source code for SiOHCA version 1.0 is readily available on our GitHub repository [6], encouraging the establishment of OHCA registries for other countries, particularly in developing regions where financial constraints may be an obstacle. The inaugural release of SiOHCA version 1.0 was formally introduced on September 1, 2022, with the intention of enabling its implementation for the EuReCa THREE study. [7].

The data collection process for the EuReCa THREE international OHCA study in Slovenia was digitized through the utilization of the SiOHCA software. The study conducted over a period of three months demonstrated the successful use of the registry in a clinical setting [8].

Our work resulted in important contributions to the scientific community.

Table 1. Publications

Title	Date
V Sloveniji potrebujemo register predbolnišničnih srčnih zastojev = The need for an OHCA registry in Slovenia [4]	16/06/2022
Siohca : nova iniciativa in preliminarni podatki = Siohca : new initiative and preliminary data [8]	30/09/2022
SiOHCA: Informacijsko-komunikacijska rešitev za vzpostavitev registra predbolnišničnih srčnih zastojev [9]	12/10/2022
Stanje digitalizacije NMP v Sloveniiji [10]	08/11/2022
How can out-of-hospital cardiac arrest (OHCA) data collection in Slovenia be improved?	In press (Medicina, MDPI)

4 Discussion

Our aim was to show the need and possibility of creating a registry for OHCA, as well as a successful collaboration between University of Maribor and the industry. The team was structured to prioritize agility and remote collaboration, resulting in swift progress and the timely presentation of the minimal viable product (SiOHCA version 1.0) on September 1, 2022, for use in the EuReCa THREE study [7]. Our mentors have emphasized that the cultivation of self-motivation in students and the provision of autonomy in problem-solving are crucial for achieving the results mentioned above. Promoting a safe space for mistakes and fostering creativity resulted in innovation and efficiency among students. The project resulted in a future-ready workforce, with medical students gaining IT skills and developers getting familiar with medical projects.

The SiOHCA registry was created due to inadequate OHCA data in Slovenia and was inspired by the EuReCa TWO study [11]. SiOHCA initiative demonstrated the potential of academic-industry partnerships in promoting healthcare projects by collaborating with students, academic mentors, and industry mentors.

Despite the accomplishments of SiOHCA, there is room for further improvement. Successful implementation and sustainability of SiOHCA depends on financial support, mainly through grants. Maintaining the registry's longevity may face challenges related to finances, logistics, and organization. Maintaining the registry necessitates reliable funding and support for ongoing data collection, software updates, and system upkeep.

5 Conclusion

The SiOHCA registry was developed through a partnership between scholars, educational mentors, and corporate mentors. The methods implemented in our work culture showcased an innovative strategy for achieving change in healthcare IT, a process that is considered by many to be challenging and slow, frequently hindered by burdensome paperwork. The presented structure for student projects has demonstrated its efficacy. We suggest that a greater number of students should partake in such experiences, as it would yield young professionals possessing invaluable expertise that could potentially drive innovation both domestically in Slovenia and internationally. It is our recommendation to investigate a framework that facilitates the implementation of such projects on a larger scale.

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Appendix A

ATHENA Colloquial Talks

The ATHENA Colloquial Talks Initiative: A Report and Future Developments

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Abstract. *In this manuscript, we report the motivation, the content, the challenges and the future plans of one of the outstanding ATHENA Alliance research activities: the ATHENA Colloquial Talks. Thanks to the latter, state-of-the-art scientific work, mainly in engineering and in teaching science, was presented in the last three academic periods from 2020 to 2023. The talks were delivered by world leading experts, many of them scientists with an h-index higher that 100, followed also by talented young researchers working in some of the most prestigious institutions. The event attracted more than 100 scientists as speakers and more than 1800 different individuals as attendees. Besides the expertise-showcase ATHENA Colloquial Talks is an additional incentive to alliance members in achieving the mission of ATHENA European university.*

Keywords. Invited Talks, Research, Networking, Observatory, Higher Education

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1 Introduction

Among scholars, the phrase “publish or perish” has become an ironclad rule of academic career development. Still, besides all alternative efforts for research quality assessment, without a sufficient number of publications in well-respected academic journals, tenure and promotion are just a pipe dream. But there is another, neglected and much less studied aspect of faculty work that can also shape the arc of a career in the professoriate. It is not teaching nor service. It is the invited talk. These talks can take many forms. There can be lectures, popular seminar series, colloquiums, workshops and keynotes. Some definitions of the various forms of invited talks follow:

Invited Lectures: At a speaking engagement in which an individual is specifically invited to present a lecture or talk on a particular topic or subject. It is typically organized by a host institution or an event organizer who recognizes the expertise, knowledge, or unique perspective of the speaker and wishes to provide an opportunity for them to share their insights with a specific audience.

Keynote Talks: A significant presentation or speech given at the beginning or during an event, such as at a conference, seminar, or industry gathering. The purpose of a keynote talk is to set the tone for the event, inspire and engage the audience, and provide a central theme or message that aligns with the event's objectives.

Colloquiums: A formal presentation or lecture given by an expert or a speaker on a specific topic in an academic or professional setting. It is typically a part of a larger academic program or event, such as a conference, seminar series, or departmental gathering.

Workshops: Workshop talks can cover a wide range of topics depending on the context and audience.

One of the main reasons universities organize invited talks is to provide their students and faculty members with opportunities to engage with prominent experts and professionals in their respective fields. By inviting distinguished speakers, universities aim to expose their communities to cutting-edge research, innovative ideas, and diverse perspectives. Invited talks also serve as a platform for networking and collaboration. They allow students, researchers, and faculty members to connect with experts who may share similar research interests or offer valuable insights. These interactions can lead to potential research collaborations, joint projects, or even future job opportunities.

Furthermore, invited talks contribute to the overall academic and intellectual environment of the university. They enhance the learning experience by offering students a chance to go beyond their regular curriculum and explore real-world applications of the subjects they study. Invited talks often inspire students, ignite their curiosity, and motivate them to pursue further studies or careers in the respective fields.

Additionally, universities organize invited talks to showcase their academic community and research accomplishments. By bringing in renowned speakers, universities can demonstrate their commitment to academic excellence and attract attention from the broader academic community, potential students, and funding agencies.

The invited talks can contribute to the professional development of faculty members. They provide an opportunity for the faculty to share their research findings, present their work to a wider audience, and receive feedback from experts in the field. It's a way for faculty members to establish themselves as experts, build their reputation, and expand their professional networks.

Lastly, the invited talks can be considered as a part of the at home internationalization actions the host university takes to boost the collaboration beyond the borders and encourage people to mobilize in other universities and labs.

Crucial factors such as the rising impact of academic travelling on the environment, the importance of the work-life balance, and the increasing reliability of internet connections open the avenue of new ways to organize seminars and conferences: the teleconference solution. Moreover, the technology e.g., Zoom and other platforms, provided greater accessibility to excellent speakers from all over the world without the need for mobility, which entails the use of additional funds and time. Therefore, the cost was close to zero - and no need arose to pay for airline flights, hotels and conference rooms.

The ATHENA European University Alliance shares the above-mentioned incentives to build and support its scientific ecosystem and through its Observatory of Higher Education initiative to organize the ATHENA Colloquial Talks (also used just as ATHENA Talks): a series of online colloquial talks throughout which experts within and beyond the Alliance presented their pioneer work. Moreover, the organization of online and free of any tuition fees events served the main priorities of the ATHENA: digitalization, accessibility and inclusivity.

2 Background and Motivation

The ATHENA European University Alliance invites (mainly online) since 2020 experts from universities, research centres and industry to talk about their work. The talks are completely delocalized with the speakers and attendees scattered all over the world. However, all the types of invited talks have been organized (Invited and Keynote Talks, Workshops and Colloquiums) the focus of this article will be the ATHENA Colloquial Talks. Despite this delocalization, the ATHENA talks kept some of the traditional features: the existence of a moderator, and the execution of Q&A session. The main criteria for selecting our speakers are the following:

- Expertise (KPIs: h-index, received citations).
- Availability to provide a synchronous presentation.
- Presentation Skills.
- Member (a preference is given) of the ATHENA Alliance.

The organizational committee of the ATHENA Talks invites, decides, plans and announces on a yearly base the academic program.

The paper is constructed as follows:

- Presentation of the main features of the given talks: title, thematic topic area, abstract, speaker (affiliation, h-index, received citations), attendance, link in YouTube channel.
- ATHENA Talks statistics: total views, average h-index of the presenters.
- Challenges and Future Plans.

The moderator who was handling the Q&A session and the management of participants was the organizer of the event. The ATHENA Talks used a standard registration form, from which an email list was made and a Zoom link and password were emailed to all registered participants 24 hours ahead of time. The recorded sessions were publicly available to everyone have access to the event's website.

3 Presentation of the ATHENA Talks

The topics have spanned from solar cells to problem-based learning teaching approach. More than 80 such talks have been hosted and the program is mainly addressed to researchers, academic teachers and postgraduate students.

Links to the complete seminar program and the speakers per academic year can be found at the https://athenauni.eu/athena-talks and at the following hyperlinks (DOI standard links):

- 2020 – 2021: https://iro.hmu.gr/sci-cafe-colloquial-talks/
- 2020 – 2021: https://iro.hmu.gr/the-athena-colloquial-talks-in-teaching-science-april-2021-june-2021/
- 2021 – 2022: https://iro.hmu.gr/sci-cafe-colloquial-talks-2021-2022/
- 2022 – 2023: https://sites.google.com/view/athenaunicolloquialtalks/home
- 2022 – 2023: (in mathematics teaching science): https://sites.google.com/view/athenaunimathemath/home-page

The lectures can be watched again in the ATHENA Talks YouTube Channel:

- Talks in Science: https://youtube.com/playlist?list=PL3OWQw2onmC_fjutflKRDT0OVw_1z0XFW
- Talks in Teaching Pedagogies: https://youtube.com/playlist?list=PL3OWQw2onmC_ZVHku-zWDn3GykwMUP86g
- Talks in Teaching Mathematics: https://youtube.com/playlist?list=PL3OWQw2onmC8g0JDdxGno10itZWtD5p21

A brief presentation of the selected ATHENA Talks follows in chronological order.

3.1 Academic Period 2020 – 2021

Managing projects with Theory of Constraint Principles

Topic Management

Abstract In IT, according to the survey made by The Standish Group and published in the 2015 CHAOS report, only very few projects perform well to the project management triple constraints of cost, time, and scope. Only 29% of software projects were completed on-time and on-budget, while 19% of projects were canceled before they ever got completed and 52% of projects increased their cost, scope, or have scope creep. Clearly, the failure rate of IT projects is high and as a response to that organizations tend to implement modern project management practices and attitudes, with limited or inconsistent success in terms of better project or business performance. The lecture shows examples of project portfolio using different management approaches, starting with traditional approaches and continuing with step-by-step approaches using modern project management methodologies, providing significant benefit to the organization. Achieving such improvements requires changes in how project work is managed, planned, scheduled, and queued. Particularly, it is shown how Theory of Constraints tools and applications enables at least doubling the number of projects that organization can complete in the same period, and able to deliver over 90 percent of them within defined scope, budget, and time – all within existing employees and without changes in technology and no changes to how they are performing IT-related tasks like design, implementation, and testing.

Date 23/09/2020

Speaker Tomaž Aljaž

Affiliation Academic Staff in FINI Novo Mesto university, Slovenia.

Video https://youtu.be/L7FUHTu9FjQ

The ATHENA European University

Topic	Internationalization of Higher Education.
Abstract	In this presentation, the ATHENA European University will be presented along with the tasks that have been assigned to HMU. On top of this, a review of the actions of the IRO in the last six months will be reviewed. In the end, the targets of the office the following three months will be presented.
Date	02/10/2020
Speaker	Konstantinos Petridis
Affiliation	Associated Professor, Department of Electronics, HMU, Greece.
Video	https://youtu.be/L7FUHTu9FjQ

Environmental quality-Environmental protection: A global approach

Topic	Environmental Sciences
Abstract	The presentation is referred to as the basic terms that a scientist who deals with the protection of the environment has to be familiar with. It is referred also to as the methods for monitoring the water and wastewater quality and to the water and wastewater treatment. These methods are the ones that the presenter is expert in.
Date	09/10/2023
Speaker	Melina Kotti
Affiliation	Associated Professor, Department of Electronic Engineering, HMU, Greece.
Video	https://youtu.be/eYmrZ7lEE9M

Geophysical survey at Wabar Meteo-Crater: Recent findings

Topic Geosciences

Abstract The study of impact craters on Earth has picked up high worldwide consideration, which can be done by studying the ground surface using remote sensing (satellite), geological outcrops, drilling holes and apply small-scale laboratory experiments trying to build the dynamic models of crater formation and by collecting geophysical data.
In this work, the near- crater sediments at the young Wabar crater field in Saudi Arabia has been investigated using the magnetic, EM, seismic, and GPR methods. The main targets of this research were exploring the possibility of any remnant major pieces of the meteorite, investigate the meteoroid direction, and map the deformation structure associate with the meteorite impact. During the expeditions, many small pieces of the meteoroid were found and collected for further geochemical analysis.

Date 16/10/2020

Speaker Pantelis Soupios

Affiliation Professor in King Fahd University of Petroleum & Minerals, Saudia Arabia.

Video https://youtu.be/kvgvKPY6JCE

Artificial Intelligence/An Overview

Topic Engineering

Abstract This talk will go through an introduction to the area of artificial intelligence, from the early signs of its appearance (B. C.) to its latest developments. Definitions, concepts, and philosophical concerns regarding the importance and the goals of AI will be discussed. After a brief historical overview, AI examples will be shown, together with some of AI's earlier and recent applications to everyday life. The aim of the talk is to give a general idea of AI's concept, inform about the different disciplines and research areas involved in AI's development and provide food for thought concerning the challenges and risks of AI.

Date 23/10/2020

Speaker Maria Zakynthinaki

Affiliation Assistant Professor

Video https://youtu.be/u4kkwRBaLCg

Polaritonics for improving the performance in light-emitting devices

Topic Engineering / Photonics

Abstract In our everyday life, we experience the interaction of light with the materials around us. For example, the colors we see in a flower is a result of light interacting with the flower's surfaces and molecules. Some of the very well-known light-matter interactions are light absorption, emission, reflection, and scattering. In some special cases, light interacts with matter so strongly that they merge into one and indistinguishable hybrid form. Microcavity polaritons are one of these special cases of bosonic particles that come into life under strong light-matter interactions. In the lab conditions, we create polaritons artificially in optical microcavities (2 mirrors facing each other separated by only a few hundreds of nanometres) sandwiching a thin film of a semiconductor. Because polaritons decay generates photons, we can use spectroscopy to study them.

To date, most of the polaritonic samples are used for fundamental studies in physics, because polaritons hybrid light-matter nature makes them exceptionally light (8 orders of magnitude lighter than the rubidium atoms) bust still have matter properties. Besides, polaritons can propagate through defects without scattering (under special conditions), can show ultrafast nonlinear response to light inputs (all-optical transistors), and the quantomechanical states of polaritons can simultaneously emit and absorb light. In this talk, I will discuss how the special properties of polaritons can improve devices such as lasers light-emitting diodes (LEDs), waveguides, and all-optical switches.

Date 30/10/2023

Speaker Konstantinos Daskalakis

Affiliation Assistant Professor, Turku University, Finland

Video https://youtu.be/Pj_quxO_ttA

Fullerene Like Structures

Topic Engineering/Materials Science

Abstract The discovery of C60, the third variety of carbon, in addition to the more familiar diamond and graphite forms, has generated enormous interest in many areas of science. Furthermore, it turns out that C60 is only the first of an entire class of closed-cage polyhedral molecules consisting of only carbon atoms – the fullerenes (C20, C24, C26, … C60, …C70, … C1000000-carbon nanotubes). This talk presents the main mathematical principles for engineering fullerene-like structures (based on symmetry considerations and Euler relation between the numbers of faces, vertices, and edges in polyhedra). I will discuss how Nature, using fullerene-like structures, minimizes energy, and matter resources in molecules and nanoclusters, viruses, and living organisms. Examples of achievement of such goals in architecture are also presented. Discussion of scientific terms and concepts will be held in the context of the history of their discoveries. The history of discoveries of fullerenes and carbon nanomaterials made at the end of the XX century will be punctuated by excursions into the depths of time – until the Renaissance and even Antiquity.

Date 06/11/2020

Speaker Eugene Katz

Affiliation Professor, Ben Gurion University, Israel

Video https://youtu.be/4f3hEPtV5iU

Demonstration of current-induced Electro-Thermo-Mechanical instability anisotropic growth in metallic wire targets

Topic Plasma Physics

Abstract Results on the first demonstration of an Electro-Thermo-Mechanical (ETM) instability growth induced anisotropy in high current heated metallic wire targets will be presented. The anisotropy is the result of the associated difference between the longitudinal and azimuthal growth rates of the ETM instability. The nonlinear magnetic diffusion and shock wave propagation in the conductor is considered in the study. The demonstration of the anisotropy is an observation of fundamental importance since it sheds light on the unexplained elliptical instability structures observed in magnetized liner experiments.

Date 13/11/2020

Speaker Michael Tatarakis

Affiliation Professor, Department of Electronics, HMU, Greece

Video https://youtu.be/Dv8vQVlSByM

Fundamentals, challenges, and current state of the art in marine energy conversion and integration

Topic Engineering / Energy

Abstract Electricity generation is one of the major contributors to Greenhouse Gas (GHG) emissions. Meeting the Paris Agreement targets for the reduction of GHG, in order to reduce the effects of anthropogenic climate change, will require the diversification of the energy resources we use so that we can minimize our dependence on fossil fuels. There is an abundance of resources available in the marine environment, including offshore wind, wave, and tidal energy. Early research initiated during the oil crisis in the '70s has been revisited during the past decade, with new technology development and rapid expansion of offshore wind installed capacities worldwide, but also with a renewed interest in wave and tidal energy conversion systems. This has resulted in a substantial body of research in the resource, conversion, and integration of marine energy, as well as many converter designs, currently at various stages of development, ranging from conceptual design to commercial units. The University of Edinburgh is considered the birthplace of marine energy since the '70s and is still one of the world's leading research institutions in this field. In this presentation we will go through the fundamentals of marine energy conversion, we will discuss the major challenges for its development, and we will present the current state of the art as well as ongoing research at the Institute for Energy Systems of the University of Edinburgh.

Date 20/11/2020

Speaker Aristides Kiprakis

Affiliation Professor, University of Edinburgh, UK

Video https://youtu.be/d1dFo6r3tVY

Novel X-ray sources with high coherence: new horizons in biomedical imaging

Topic Physics / Optoelectronics

Abstract The index of refraction of materials in the x-ray regime is given by the equation n=1-δ+iβ, where δ is a parameter related to the ionization that slightly reduces below one the real part of the index of refraction, while parameter β counts for the absorption. Even if inherently the x-ray diffraction limit is less than 1 nm, such a spatial resolution is not even approached due to the incoherent properties of most of the available x-ray sources. The imaging using the x-ray absorption in matter, i.e. the parameter β, limiting the imaging resolution at least five orders of magnitude higher than the Abbe diffraction limit. Consequently, the need for coherent x-ray sources is of increased demand. X-ray FEL facilities currently provide such coherent sources of directional and high brilliance x-ray radiation. However, they require high budget investments for construction, maintenance and man-power operation and for this reason are a few worldwide. During the last two decades the rapid evolution of ultrafast and high-power laser technology enabled a) the generation of coherent soft X-rays with a non-linear process named High Harmonic Generation (HHG) of the fundamental laser pulse and b) the acceleration of electrons inside gas targets in table-top experiments using the Laser Wakefield Acceleration (LWFA) resulting in the generation of a directional and semi-coherent x-ray betatron-type radiation. This hard X-ray radiation fulfils the requirements for a semi- coherent x-ray source appropriate for imaging applications in the micro-scale. Laser installations that support the generation of x-ray betatron-type radiation are much less costly compared to XFELs and thus offered for development by many laboratories worldwide.

Date 04/12/2020

Speaker Nektarios Papadogiannis.

Affiliation Professor, Department of Acoustics, HMU, Greece

Video https://youtu.be/rstNe3irkLA

A non-extensive statistical physics view in Earth Physics: Geodynamic properties in terms of Complexity theory

Topic Physics / Geosciences

Abstract Boltzmann-Gibbs (BG) statistical physics is one of the cornerstones of contemporary physics. It establishes a remarkably useful bridge between the mechanical microscopic laws and macroscopic description using classical thermodynamics. If long-range interactions, non-markovian microscopic memory, multifractal boundary conditions, and multifractal structures are present then another type of statistical mechanics, then BG, seems appropriate to describe nature (Tsallis, 2001).

To overcome at least some of these anomalies that seem to violate BG statistical mechanics, non-extensive statistical physics (NESP) was proposed by Tsallis (Tsallis, 1988) that recovers the extensive BG as a particular case. The associated generalized entropic form controlled by the entropic index q which represents a measure of non-additivity of a system. Sq recovers SBG in the limit q→1. For a variable X with a probability distribution p(X), like that of seismic moment, inter-event times or distances between the successive earthquakes or the length of faults in a given region, using terms of NESP, we obtain the physical probability which expressed by a q-exponential function as defined in Tsallis, (2009). Another type of distributions that are deeply connected to statistical physics is that of the squared variable X2. In BG statistical physics, the distribution of X2 corresponds to the well-known Gaussian distribution. If we optimize Sq for X22, we obtain a generalization of the normal Gaussian that is known as q-Gaussian distribution (Tsallis, 2009). In the limit q→1, the normal Gaussian distribution recovered. For q>1, the q-Gaussian distribution has power-law tails with a slope -2/(q-1), thus enhancing the probability of the extreme values.

Date 11/12/2020

Speaker Filippos Vallianatos.

Affiliation Professor, Kapodistrian University of Athens, Greece

Video https://youtu.be/TKBgfCHl_RE

Challenges and Perspectives of Energy in the Built Environment: From Smart Buildings to Smart Cities

Topic Engineering

Abstract In an increasingly urbanized world, governments and international corporations strive to increase the productivity of cities, recognized as economic growth hubs, as well as ensuring a better quality of life and living conditions for citizens. Although a significant effort is performed by international organizations, researchers, and others to transform the challenges of cities into opportunities, the visions of our urban future are trending towards bleak. Social services and health facilities are significantly affected in negative ways owed to the increase in urban populations (70 percent by 2050) as verified by the recent Covid-19 pandemic The talk starts with the emerging challenges for urban regions and cities and focusing on the importance of data collection and smart energy management for buildings, districts, and communities. Zero energy communities and the energy technologies to achieve zero energy targets are analyzed. The role of smart grids as a key mechanism for smart communities is discussed. Finally, the integration of nature-based solutions in smart cities and the benefits for the urban context and citizens' health and wellbeing is presented.

Date 18/12/2020

Speaker Denia Kolokotsa

Affiliation Professor, Technical University of Crete, Greece

Video https://youtu.be/EYA0cNeKyL4

Biomarker Discovery, Machine Learning, and Agro-Health: building bridges between experts

Topic Biomedicine.

Abstract Biomarkers are the cornerstone of precision medicine: identified as a measurable indicator of some biological state or condition, they promise to offer solutions for accurate diagnosis, prognosis, and therapeutic monitoring. Among other biological entities, DNA methylation patterns differing dramatically between tissues and changing dynamically over time, are suggested to carry clinically valuable information. We have been studying methylation in liquid biopsy material, ie cell-free DNA liberated in the circulation, in different pathological conditions such as cancer and diabetes. Recently, following the global scientific trend, we move gradually from hypothesis-driven to (big) data-driven approaches, as modern -omics technologies lead the accumulation of large precious multi-parametric biological datasets. We employ ad-hoc auto Machine Learning tools for data extrapolation, delivering low-feature validated models/classifiers. Translational development will lead to emerging cost-effective multiplex bench assays expected to retain high diagnostic performance in a real-world setting, readily available for commercialization. Our approach can have unprecedented added value in different medical conditions, such as the Covid-19 pandemic, and/or other biological problems

Date 22/01/2021

Speaker Ekaterini Chatzaki

Affiliation Professor, Democritus University, Greece

Video https://youtu.be/oi6QWpd2CcQ

A brief introduction into the physics of ultra-cold atomic systems

Topic Physics

Abstract In the last 25-30 years, the field of cold atomic gases has shown remarkable achievements, ranging in a very wide range of sub-fields of physics. These include condensed-matter physics, atomic physics, quantum optics, nonlinear physics, nuclear physics, etc. These systems are gaseous and are very dilute, which is a great advantage, as compared with other systems, e.g., liquid Helium, superconductors, nuclei, etc. In addition, we can manipulate them, as they are easily tunable. Given the numerous activities on cold atoms, in this talk, I will give a very brief introduction and I will focus mostly on some basic principles. I will then discuss some of their remarkable properties, focusing mostly on their superfluid properties.

Date 29/01/2021

Speaker George Kavoulakis

Affiliation Professor, Department of Mechanical Engineering, HMU, Greece

Video https://youtu.be/b_rJ7O7Mu6o

Printed Nanoelectronics: there is a plenty room down there

Topic Engineering / Electronics

Abstract In silicon microelectronics, the ability to downscale critical dimensions of its building block, the field-effect transistor, has proven extremely successful over the past sixty years in increasing the computational power of modern microprocessors. These extraordinary developments have been achieved through a virtuous circle of scientific and engineering breakthroughs which have led to the proliferation of information & communication technologies with an extraordinary impact on our daily life and society. However, adopting silicon's approach of scaling to emerging technologies such as printed and large-area electronics, has proven challenging both in terms of technology and cost. In this talk, I will focus on the progress being made downscaling emerging forms of large-area electronics through new materials and fabrication paradigms and their application in the ever expanding ecosystem of The Internet of Everything.

Date 05/02/2021

Speaker Thomas Anthopoulos

Affiliation Professor, KAUST, Saudia Arabia

Video https://youtu.be/NXwr7IJyfms

An Introduction to Bioelectronics

Topic Engineering / Bioelectronics

Abstract Organic bioelectronics defines a generic platform with unprecedented biological recording and is maturing toward applications ranging from life sciences to the clinic. Conjugated polymers that support mixed (electronic and ionic) conduction are key to advancing a host of technological developments for next-generation bioelectronics devices. When interfacing an electrolyte, the electrical properties of the conjugated polymer film are modulated dramatically due to ions penetrating into the bulk of the film. The latter is the main principle of operation of organic electrochemical transistors (OECTs), which operate in biological media and translate low magnitude ionic fluctuations into measurable electrical signals. This talk will go through the principles of electronic and ionic conduction in conducting polymers, such as PEDOT:PSS and other, p-type and n-type semiconducting polymers. Polymer structure-property relations and their link with OECT performance will be demonstrated. The talk will also go through novel biological applications of organic bioelectronics devices such as metabolite biosensors, cell membranes-on-a chip, and 3D bioelectronic devices for tissue engineering.

Date 12/02/2021

Speaker Achilleas Savva

Affiliation Post-Doctoral, University of Cambridge, UK

Video https://youtu.be/VADaaCvZx3A

Carbon-Based Electrodes for Solution-Processed Solar Cells

Topic Engineering / Optoelectronics

Abstract Solution-processed metal halide perovskite solar cells (PSCs) are considered the most promising photovoltaic (PV) technology to replace Silicon due to their high certified power conversion efficiencies (PCEs), low manufacturing cost, and potential for high throughput device fabrication. Recently, the research efforts of the PSC's scientific community have been focused on tackling the remaining drawbacks towards commercialization, which includes: 1) the use of expensive metallic electrodes and hole transport layers (HTLs), that increase the overall device cost and hinder their high throughput fabrication and 2) the low device operational stability. Thus, the aforementioned bottlenecks should be tackled in order for the full potential of PSCs to be reached. The most promising approach to overcome these drawbacks of PSCs is with the adoption of a fully printable device fabrication route, which is enabled by the replacement of the thermally evaporated electrodes using low-cost printable carbon-based conductive films. Using this fully printable device configuration, efficient, very stable and ultra-low-cost PSCs can be prepared at very high throughput. In this talk, I will focus on the recent advancements, fundamental challenges, and prospects of this promising PV technology and finally, I will present my recent results in this research direction.

Date 19/02/2021

Speaker George Kakavelakis

Affiliation Assistant Professor, Department of Electronic Engineering, HMU

Video https://youtu.be/p7n3XuWM3t8

Light-matter interactions in atomically thin semiconductors

Topic Physics / Material Science

Abstract The Nobel Prize in Physics 2010 was awarded jointly to Andre Geim and Konstantin Novoselov "for groundbreaking experiments regarding the two-dimensional material graphene". Thenceforth two-dimensional (2D) materials have attracted tremendous research interest due to their unique optical, electronic, and mechanical properties. The way these materials interact with light depends strongly on the number of atomic layers. More than 5000 compounds are predicted to appear layered and they can be easily assembled to form heterostructures and combine the unique properties of the constituent layers. Potential applications in future photonics, optoelectronics and quantum technology are based on our understanding of the light-matter interaction on an atomic monolayer scale. I will discuss what we can learn from optical spectroscopy of these atomically thin semiconductors and their heterostructures for future applications but also for fundamental physics. A description of the physical origin of the main absorption and emission features in the optical spectra will be introduced.

Date 26/02/2021

Speaker Ioannis Paradisanos

Affiliation Postdoctoral Fellow, CNRS, France

Video https://youtu.be/_GeqL3ETbiI

Atomic Physics with Accelerators: Projectile Electron Spectroscopy

Topic Atomic Physics

Abstract The APAPES initiative (Atomic Physics with Accelerators: Projectile Electron Spectroscopy) established in Greece the discipline of Atomic Physics with Accelerators, a field with important contributions to fusion, hot plasmas, astrophysics, accelerator technology, and basic atomic physics of ion-atom collision dynamics, structure, and technology. This has been accomplished by combining the existing interdisciplinary atomic collisions expertise from Greek Universities, the strong support of distinguished foreign researchers, and the high technical ion-beam know-how of the "Demokritos" tandem Van der Graaff accelerator group into a cohesive initiative. The on-going ion-atom collisions research activities of the APAPES team in "Demokritos", the related collaborative activities at GSI heavy nuclei accelerator, and future perspectives will be presented.

Date 05/03/2021

Speaker Emmanouil Benis

Affiliation Associate Professor, University of Ioannina, Greece

Video https://youtu.be/xdS3Ya7IMBg

Multiphoton Lithography: Principles, Materials, and Applications

Topic Physics / Laser Physics

Abstract Multiphoton Lithography is a technique that allows the fabrication of three-dimensional structures with sub-100 nm resolution. It is based on multi-photon absorption; when the beam of an ultra-fast laser is tightly focused on the volume of a transparent, photosensitive material, polymerization can be initiated by non-linear absorption within the focal volume. By moving the laser focus three-dimensionally through the material, 3D structures can be fabricated. The technique has been implemented with a variety of materials and several components and devices have been fabricated such as micro-optics, biomedical devices, and scaffolds for cell growth. The unique capability of Multiphoton Lithography lies in that it allows the fabrication of computer-designed, fully functional 3D devices. Here, I summarize the principles of microfabrication and present recent research in materials processing and functionalization of 3D structures. Finally, I discuss the future applications and prospects for the technology.

Date 12/03/2021

Speaker Maria Farsari

Affiliation Director of Research, IESL-FORTH, Greece

Video https://youtu.be/YNZbFweHkRw

Nanoparticle Based Photonic Devices

Topic Engineering / Materials Science

Abstract In this talk, I will describe the fabrication and the optical characterization of multilayer photonic structures. The multilayer structures have been fabricated starting from colloidal dispersions of metal oxide nanoparticles and by employing the spin-coating technique. We have mostly used nanoparticles of silicon dioxide, titanium dioxide, and indium tin oxide. We have obtained in this way porous multilayer structures. I will then show the exploitation of such multilayer structures in different device architectures. By placing the photonic structures between two electrodes, we could observe electric field-driven tuning. By adding a thin layer of silver on top of the photonic structures we could obtain colorimetric sensors for bacterial contaminants.

Date 12/03/2021

Speaker Francesco Sotognella

Affiliation Associate Professor, POLIMI, Italy

Video https://youtu.be/7COY4iq5h80

Laser Direct Printing for Flexible Electronic Applications

Topic Laser Physics

Abstract Current technological trends require the precise deposition of highly resolved features, in a direct writing approach that preserve their structural and electronic properties upon transfer while increasing the number of components that can be integrated into a single device. Over the past decade, printed electronics technology has evolved and is now used in applications such as flexible screens, intelligent labels, and packaging. Among the printing techniques, Laser-induced forward transfer (LIFT) technique is capable of printing electrical circuits quite inexpensively and quickly. At the same time, this technique is environmentally friendly and has no restrictions in terms of viscosity. In this work, we highlight the newest trends of LIFT manufacturing for the development of a variety of components with electronic, optoelectronic, and sensing functionality such as RFID antennas, RF transmission lines, organic thin-film transistors, metallic interconnects, circuits defects repairing, and biochemical sensors.

At the same time, the increasingly demanding requirements have highlighted the need for more thorough, all-embracing research regarding the rheological characteristics of the printable fluids, their jetting dynamics, and their electrical, post-sintering properties, that will define the process' reliability, aiming towards its industrialization.

Date 19/03/2021

Speaker Ioanna Zergioti

Affiliation Professor, National Technical University, Greece.

Video https://youtu.be/swhqCI2bhkA

Organic electronics for Neural Interfaces

Topic Materials Science / Electronics

Abstract Our capacity to understand and modify neural activity will lead to tremendous advancements for humanity during the next decades. These advancements will pave the way for high-quality brain-machine interfaces, wearable electronics and therapeutic devices. However, current technology and materials impede this development with bulky, non-biocompatible electrical components that require rigid encapsulation in body, and interfaces that lack the appropriate mechanical and electrical properties to safely and efficiently contact tissue for extended periods of time. There is a critical need for reliable, safe, soft, implantable devices that can acquire and process neural and electrophysiological data, as well as deliver responsive stimulation. Organic materials and electronics hold great promise as the optimal interfaces with biological tissue owing to their biocompatibility, efficient ionic conductivity, and mechanical properties that resemble biotic materials. Let me show you a beginning of a journey where dissolved scientific boundaries among different fields and an interdisciplinary way of thinking can create biomedical devices and therapeutic systems that will benefit human health.

Date 26/03/2021

Speaker George Spyropoulos

Affiliation Assistant Professor, Ghent University, Belgium

Video https://youtu.be/9KnrszlxrHM

Studies and Research Collaboration with China

Topic Education / Internationalization of Higher Education

Abstract In this talk, tips regarding the collaboration with the Chinese Higher Institutions will be revealed. Moreover, the priorities of the Chinese Institutions will be presented and key information will be provided

Date 09/04/2021

Speaker Pelagia Karpathiotaki

Affiliation Associate Professor, University of International Business & Economics, China

Video https://youtu.be/xCzRRvDBNao

Essentials of Problem Based Learning for Teachers.

Topic	Education Science
Abstract	In this talk, the main principles of the Problem-Based Learning (PBL) pedagogical approach will be presented. Then, we will discuss how PBL can be applied with project-based learning and how other instructional design issues, such as facilitation and assessment, are affected by PBL. Part of this presentation is based on the results of the ITEM Erasmus+ project (https://item.hmu.gr/) and the Strategic Partnership project CRETE module in PBL for teachers
Date	14/04/2021
Speaker	Evangelia Trianafyllou
Affiliation	Assistant Professor, Aalborg University, Denmark
Video	https://youtu.be/9uDI0yuOBMA

Approaching effective and rational energy transition in Crete

Topic	Engineering / Renewable Energy Sources
Abstract	Since 2019, Crete has been included in the 20 pioneering islands of the European Commission regarding energy transition, within the frame of the "Clean Energy for E.U. Islands" initiative. This means that Crete has the role and the responsibility, among the other pilot and pioneering European islands, to pave the way towards effective and rational energy transition for the islands in Europe. Energy transition has to be based on specific pylons, such as capacity building for the local community, energy-saving, transition to e-mobility, electricity and thermal energy production from renewables, and integration of decentralized projects within smart grids. Given the abundant wind, solar, and biomass potential available on the island, the energy transition can lead to 100% energy independence in Crete, through technically secure and economically effective projects. With the extensive involvement of the local citizens in the overall process, the energy transition can also constitute the basis for economic and social development for the Cretan society.
Date	16/04/2021
Speaker	Dimitris Katsaprakakis
Affiliation	Professor, Department of Mechanical Engineering, HMU, Greece.
Video	Not available

Bio-Optic Interfaces

Topic	Engineering
Abstract	The overarching goal of my research is to induce light sensitivity in living cells, in order to control cell functioning. We develop specific devices that behave as light actuators. In the years we studied planar interfaces, nanoparticles, and intramembrane molecular switches that are able to transduce light absorption into a biological signal. Fundamental questions regard the coupling mechanism at the abiotic/biotic interface, while the application is in the treatment of neurodegenerative diseases. Direct neuronal stimulation is a promising tool for addressing disorders such Alzheimer's and Parkinson's, but also in prostheses for the rescue of fundamental functions such as vision. An artificial retina prosthesis is one of the most advanced applications so far demonstrated in animal models. Controlling muscular cell contraction is another development under study that may lead to artificial organs as well as cyborgs.
Date	21/04/2021
Speaker	Guglielmo Lanzani
Affiliation	Professor, POLIMI, Italy
Video	Not available

Demystifying micro-credentials: between opportunities, threats, and everyday life

Topic	Education Science
Abstract	Micro-credentials are high on the policy agenda of the European Commission. Today we see competing definitions of what micro-credentials are and are not. Is it the latest Covid-19 induced fashion or something that has been around for decades? How to assure their quality? What challenges are associated with their recognition? Asking questions is important, even if we may not know all the answers yet.
Date	21/04/2021
Speaker	Aurelija Valelkiene
Affiliation	Administration Staff, Vilnius Tech, Lithuania
Video	https://youtu.be/e254D882IrE

Lab-in-a-fiber photonic devices: technologies and prospects

Topic	Physics / Optoelectronics
Abstract	The field of Optical Fibre Devices is conceptually re-directed towards the investigation of smart materials and versatile guiding platforms for attaining novel functionalities while targeting numerous applications in a "disruptive" approach. Different optical designs, processing, and material science technologies fuse together for constituting the "Lab-in-a-Fiber" concept, where benchtop operations are now scaled down and implemented into the robust optical fiber geometry. The photonic devices which will be presented, refer to configurations realized in standard, tapered and microstructured optical fibers, whereas their development blends diverse photonic, processing, and material technologies, demonstrating operational characteristics beyond the current state-of-the-art.
Date	23/04/2021
Speaker	Stavros Pissadakis
Affiliation	Research Coordinator, IESL, Greece
Video	https://youtu.be/z4BYduMFVPI

Digital Tools for Active Online Learning and Engagement

Topic	Education Science
Abstract	In this talk, I will present some digital tools and tasks that focus on student collaboration and production. I will demonstrate how to make online lessons truly interactive and share some good practices for engaging students online in a meaningful way. In addition, I will discuss how virtual collaboration can be integrated into our teaching program and demonstrate how to encourage student active participation.
Date	28/04/2021
Speaker	Elena Mizrahi
Affiliation	Teaching staff, Western Galilee College, Israel
Video	https://youtu.be/HrYGuDsmPmE

Micro-credentials in Higher Education

Topic Education Science

Abstract The Irish National Framework of Qualifications (NFQ), established in 2003, facilitates the offering of small awards/micro-credentials. Irish Higher Education Institutions (HEI) – public and private – have offered programs leading to small awards for a long time and continue to do so. The NFQ sets out award-type descriptors for a range of different kinds of small qualifications – minor, special purpose, and supplemental – in addition to the traditional major awards e.g. degrees. Quality Assurance is a key feature underpinning the NFQ and central to the development of all programs and awards. HEIs have primary responsibility for QA. HEIs are autonomous and have their own awarding powers. They develop their own QA policies and procedures, in line with QQI's Core Statutory Guidelines and the European Standards and Guidelines (ESG). QQI has a legislative responsibility to externally review HEIs every seven years.

Date 05/05/2021

Speaker Barbara Kelly

Affiliation Director of Qualifications with Quality and Qualifications Ireland (QQI)

Video https://youtu.be/13OeSCfp7GA

The Flipped Classroom Approach

Topic Education Science

Abstract In this talk, I will introduce the flipped classroom instructional approach and its pedagogical underpinnings. Then, I will present the principles of Game-Based Learning (GBL) and how GBL and the flipped classroom can be combined for engaging students both in online and offline learning environments. Part of this presentation is based on the results of the FLIP2G Erasmus+ Knowledge Alliance (https://flip2g-project.eu/).

Date 12/05/2021

Speaker Evangelia Triantafillou

Affiliation Assistant Professor, Aalborg University, Denmark

Video https://youtu.be/HRVGYHnjC3Y

Ultrafast laser engineering of biomimetic surfaces: from lab to fab From Lab to Fab

Topic Engineering / Materials Science

Abstract Nature has provided a plethora of functional surfaces exhibiting unique, complex hierarchical morphologies with dimensions of features ranging from the macroscale to the nanoscale. Such morphologies are behind the superior properties exhibited by the natural surfaces, including extreme wetting, antireflection, floatation, adhesion, friction, and mechanical strength [Mat. Sci Eng. R, Reports, 141, 100562, (2020)]. Femtosecond (fs) laser surface structuring has been employed to produce numerous biomimetic structures for a range of applications, including microfluidics, tribology, tissue engineering, and advanced optics. In this paper, we provide an overview of our recent research activities towards fs laser fabrication of biomimetic self-organized surface structures of variable shape and periodicity on different types of materials, including metals, semiconductors, and dielectrics. Such structures were produced upon line and large-area processing with femtosecond laser beams of tailored shape and polarization. The primary research objective is to perform a systematic investigation of the laser conditions that lead to structures with specific application-based properties such as, drag reduction, omnidirectional diffraction, and anti-reflection. The capability of fabrication of a plethora of complex structures, realized upon variation of the laser beam polarization, brings about a new concept in biomimetic structuring and it can be considered as an emerging laser-based fabrication approach. The structure formation mechanism is explained through a detailed investigation of the fundamental processes that characterize laser-matter interaction.

Date 14/05/2021

Speaker Emmanuel Stratakis

Affiliation Research Director, IESL, Greece

Video https://youtu.be/0Ld9Mq5rCh0

Writing More and Better: the Tel Aviv University Academic Writing Initiatives

Topic Education Science

Abstract As Sir Mark Walport stated: "Science isn't finished until it's communicated". Thus, apprenticing our students to become effective writers as well as excellent scientists is of the essence. Tel Aviv University deploys several strategies toward this aim. In 2010, our division (The Division of Languages) started a multifaceted program offering academic/scientific writing courses for Ph.D. students in selected faculties which has expanded to almost all faculties to date, as well as discipline-based writing courses for masters and undergraduate students. To reach an even larger audience, we recently designed and developed a new online academic writing reference course for all graduate and post-graduate populations, in conjunction with our Center for Language Excellence (CLE) which provides individualized support to help students with all their writing and communication needs. Taking advantage of the university's move toward internationalization which, among other changes, requires undergraduate students to take 1-2 content courses in English, our division provides support for students as well as the faculty who need to give their content courses in English for the first time. By implementing this integrative holistic approach, we hope that the strategies and tools we provide will help students and faculty gain international recognition in professional journals and conferences, and become more effective science communicators.

Date 19/05/2021

Speaker Monica Broido

Affiliation Head of the Writing Programs in the Division of Languages at Tel Aviv University, Israel

Video https://youtu.be/hiHdkrWdWBY

The European Student Card Initiative

Topic	Education Science
Abstract	The European Student Card establishes a common European identity for higher education students. Students can get their student status verified easily across Europe with their European Student Card.
Date	26/05/2021
Speaker	Joao Bacelar
Affiliation	Director of the European University Foundation
Video	https://youtu.be/8U9beH9_kGc

Metamaterials: metallic nanogaps for single-molecule sensing

Topic	Materials Science
Abstract	Not available
Date	04/06/2021
Speaker	Angelos Xomalis
Affiliation	Postdoctoral Fellow in Swiss Federal Labs for Materials Science, Switzerland
Video	https://youtu.be/HyWHsIOe6Lk

The Assessment Dilemma

Topic	Education Science
Abstract	In this session, Dr. Bengu will share some tips about how to design our courses holistically and make the assessment for learning as part of our course design. She will also talk about alternative assessment techniques and present a list of tools that can be used for assessment.
Date	09/06/2021
Speaker	Elif Bengu
Affiliation	Assistant Professor, Abdullah Gul University, Turkey
Video	https://youtu.be/6cNsYHpOOC8

Laser Annealing as a platform for optimising materials properties

Topic Laser Physics

Abstract Advanced materials are becoming increasingly important as substitutes for traditional materials and as active elements in new and unique applications. They have had a considerable impact on the development of a wide range of strategic technologies. Structural ceramics, biomaterials, composites, optical materials and advanced semiconductors fall under this particular category. Even though these materials can be fabricated by conventional schemes, material processing with lasers is an expanding field which is drawing considerable attention. In particular laser processing has been employed in many applications to modify materials' properties. As lasers offer several advantages such as spatial and material selectivity, flexibility and automation, the scope for materials' laser processing is further increased.

Date 11/06/2021

Speaker Nikolaos Kalfagiannis

Affiliation Associate Professor, University of Ioannina, Greece

Video https://youtu.be/Y8TzjjaZLUU

The OPEN Science Initiative

Topic Education Science

Abstract Not available

Date 16/06/2021

Speaker Ivo Grigorov (DTU, Denmark) & Iris Buunk (LIBER, Netherlands)

Affiliation Research Coordinator, DTU, Denmark

Video https://youtu.be/R-6QnNaAgFE

Optoelectronics using Quantum Dots

Topic	Physics / Optoelectronics
Abstract	The discovery of quantum confinement effects in nanometer-sized crystals embedded in glasses marked the birth of the field of colloidal quantum dots (CQDs). Four decades after the discovery, breakthroughs in synthetic approaches allow the fabrication of highly robust, air-stable CQDs with a narrow size distribution, multinary composition, and elaborate shapes and multi-shell structures. The synthetic progress has been combined with an extensive body of theoretical and experimental breakthroughs on the chemistry and physics of CQDs that pave the way towards a CQD optoelectronics technology. The talk will discuss important milestones on the roadmap towards CQD consumer products, focusing on photophysics and the optoelectronic properties of various classes of semiconductor CQDs.
Date	18/06/2021
Speaker	Grigorios Itskos
Affiliation	Professor, University of Cyprus, Cyprus
Video	https://youtu.be/5sOj2JWhYiQ

How to Teach Mathematics on the 21st Century

Topic	Education Science
Abstract	Not available
Date	23/06/2021
Speaker	Nissim Harrel
Affiliation	Senior Lecturer in HIT, Israel
Video	https://youtu.be/7U1_iEnKTKc

Green Electronics

Topic Electronics

Abstract The growing demand of new and sustainable consumer printed electronics led to the increased interest in devices integrating natural materials. Here we present the wok resulting from recent research concerning the application of cellulosic materials and suberin (a cork component) in flexible electronic devices. First topic to be addressed are printable inks based on carbon fibers and zinc oxide nanoparticles mixed with cellulose derivatives that were optimized to create printed active layers at temperatures lower than 150 °C. This allowed the development of fully screen-printed sensors and electrolyte gated transistors on paper substrates. Second topic is related to the development of electrolytic membranes to be used as dielectric in transistors exploring the high capacitance that can be obtained by the formations of electric-double layers. The optimization of the cellulose dissolution method in alkaline hydroxides allowed for selfhealable ion-conducting membranes. Addition of suberin introduce anti-microbial characteristics to these membranes. Finally, we will show how cellulose nanocrystals can self-assemble in chiral nematic structures that mimic structures existing in nature. These can be then used as dielectric in field-effect transistors making possible the detection of circular polarized light in such devices

Date 25/06/2021

Speaker Luis Pereira

Affiliation Professor, NOVA, Portugal

Video https://youtu.be/ViiaEnrP78o

Project-Based Learning

Topic Education Science

Abstract Project-Based Learning (PBL) is a unique learning method in which students develop skills and knowledge by working on authentic, challenging, and engaging projects. The definition of PBL varies to some degree among educators. Buck Institute of Education developed Gold Standards to help educators implement effective PBL practices. Gold Standard PBL consists of the following elements; forming a challenging open-ended problem or question, having sustained inquiry and authenticity, students having an input/ownership, attainment of thoughtful reflection, analyzing and revising, and having a public product. Gold Standard PBL has been proven to link the gap between theory and real-world problems.

At York College of Pennsylvania, I have implemented project-based learning in freshman-level engineering design and senior-level thermal system design classes. Collaboration with the local community and industry partners helped to provide a variety of interesting real-world applications. Examples of these projects include a little free library project with a local high school, the design of an interactive Ram pump museum display for the York Agricultural and Industrial Museum, and the cooling system design for injection molding machines. In PBL, students ideally work ineffective team environments, where every member of the team is valued equally. In this talk, we will discuss various tools and strategies that can help to improve team effectiveness and promote inclusion when implementing PBL.

Date 30/06/2021

Speaker Emine Celik Foust

Affiliation Associate Professor, YCP, USA

Video https://youtu.be/vRn8p6P7jnI

3.2 Academic Period 2021 – 2022

Introduction to tribology and green tribology

Topic	Mechanical Engineering
Abstract	Not available
Date	07/10/2021
Speaker	Raimundas Rukuiza
Affiliation	Professor, Vytautas Magnus University, Lithuania
Video	https://youtu.be/T1K3FWUckdM

Tunable Laser Sources for Ultrashort Laser Pulses Generation

Topic	Laser Physics
Abstract	Not available
Date	22/10/2021
Speaker	Masood Ghotbi
Affiliation	Assistant Professor, University of Kurdistan, Iran
Video	https://youtu.be/agYLfv6spyE

Atomic-scale computational modeling of materials: synergy of theory and experiment towards novel technological applications

Topic Atomic Physics

Abstract Materials modeling at the atomic scale is well established as an indispensable tool to explain available experimental data, but also opens new directions in research by proposing novel materials and phenomena. Perhaps the most popular method for the quantum-mechanical atomistic study of materials is the so-called Density Functional Theory (DFT) approach, which is an effective and robust way to deal with the challenging many-body problem of interacting electrons. This talk will first give a brief introduction to the basic concepts and technicalities of DFT and then highlight representative cases of joint experimental and DFT-based computational work on the design and optimization of state-of-the-art devices in diverse fields of technology. Examples include work on solar cells with outstanding photo-conversion efficiencies and on transistors with high carrier mobilities and operational stability. We will conclude with the recently achieved laser-induced transfer of two-dimensional materials, such as graphene, a new paradigm for printing even atomically-thin systems with high quality and well-defined patterns.

Date 19/11/2021

Speaker Leonidas Tsetseris

Affiliation Professor, National Technical University of Athens, Greece

Video https://youtu.be/UvLarmncnn8

Technology for Bioelectronic Medicine

Topic Bio-electronics

Abstract Bioelectronic medicine provides a new means of addressing disease via the electrical stimulation of tissues: Deep brain stimulation, for example, has shown exceptional promise in the treatment of neurological and neuropsychiatric disorders, while stimulation of peripheral nerves is being explored to treat autoimmune disorders. To bring these technologies to patients at scale, however, significant challenges remain to be addressed. Key among these is our ability to establish stable and efficient interfaces between electronics and the human body. I will show examples of how this can be achieved using new electronic materials and devices engineered to communicate with the body and evolve with it.

Date 26/11/2021

Speaker George Malliaras

Affiliation Professor, University of Cambridge, UK

Video https://youtu.be/SjntOQhOMrk

The Floriculture Research Group of the University of Chile

Topic Agriculture

Abstract Chile presents rich biodiversity of vascular plants with almost 5,000 native species, being about 50% of them endemic. Many of these species show an attractive ornamental value, therefore the Floriculture Research Group (GIFLOR) of the University of Chile has been focused on the propagation, characterization, and breeding of some of these species, particularly in genera such as *Alstroemeria* and *Pasithea* (geophytes); and *Junellia*, *Malesherbia*, *Salpiglossis* and *Schizanthus* (herbaceous perennials). In vitro and ex Vitro studies, using different explants and media, have been conducted to achieve an efficient method of propagation. Flower color and scent have been analyzed using different methodologies, including phenotyping (color chart, color meter, morphology), sensorial (trained and non-trained panel), chemical (HP-LC, GC-MS), and molecular (gene expression, molecular markers). Promissory species and genetic lines of *Alstroemeria* have been bred using interspecific hybridization by embryo rescue. At the moment, some of these hybrids are being evaluated to validate their performance as new varieties for the ornamental plant market.

Date 03/12/2021

Speaker Danilo Aros

Affiliation Associate Professor, University of Chile, Chile

Video https://youtu.be/lJpzwTGfPvU

Developments in Laser Inertial Fusion Energy

Topic Plasma Physics

Abstract Inertial Fusion Energy is a topic of scientific curiosity for understanding the involved science as well as for exploring the possibility for future energy production. An update of the current status of IFE will be presented. In addition, the research which takes place at the Institute of Plasma Physics and Lasers (IPPL) will also be presented.

Date 10/12/2021

Speaker Michael Tatarakis

Affiliation Professor, HMU, Greece

Video https://youtu.be/6BwiU1a61vg

Device Synthesis

Topic	Electronics
Abstract	In a nutshell, device synthesis is a method designed to complement material synthesis. It could be considered as "adapting the device structure to the material properties" or as "using the device structure to compensate for nonideal material properties". While placing all the elements together to define "Device Synthesis" is probably new, large parts of it have been practiced at least since the 1960s. For example, we tend to forget that the device structures used today are those that were found to best fit the properties of Si (and SiO2). In this talk, I will introduce the new methodology and demonstrate it primarily in the context of solar cells. If you have already watched the OMD YouTube channel, I am going to present a different perspective and the chem-Phys examples are different (i.e., you won't be bored).
Date	17/12/2021
Speaker	Nir Tessler
Affiliation	Professor, TECHNION, Israel
Video	https://youtu.be/Np63phyhZMg

Transparent Electronics

Topic	Electronics
Abstract	Not available
Date	21/01/2022
Speaker	Elvira Fortunato
Affiliation	Professor, NOVA & Minister of Education & Research, Portugal
Video	https://youtu.be/WagmfoObxbM

The Softer Side of Robots and their Wearable Applications

Topic Robotics

Abstract The inherent compliance in soft material robotic systems can enable capabilities and task versatility not found in traditional rigid-bodied robotic systems. The robots of the future will use soft design approaches to provide a more conformal, unobtrusive, and compliant means to interface and interact, externally and internally, with the human body, and will be able to monitor, assist, or augment the capabilities of individuals. For example, elastomeric and textile actuators powered by pressurized fluids can offer several desirable features including robust, lightweight structures, inexpensive development, proven fabrication methods, and simple as well as complex motion paths with simple inputs. Furthermore, these actuators can provide compliance, fast actuation speeds, and most importantly safe human interaction, making them ideal for wearable and medical applications.
This talk will focus on soft components (actuators and sensors) as well as integrated systems that are tested in realistic settings. The first part will cover the principle of operation of soft composite elastomeric and fabric-based actuators, as well as their design and fabrication. The second part of the talk will present a number of research projects on wearables that demonstrate the design, fabrication, and sensing principles required to realize such soft systems as well as their challenges.

Date 11/02/2022

Speaker Panagiotis Polygerinos

Affiliation Associate Professor, HMU, Greece

Video https://youtu.be/XD48ffuftNQ

Neural networks for direct and inverse problems in mechanics

Topic Mechanical Engineering

Abstract Machine learning methods, neural networks, and big data have attracted the interest of researchers in mechanics. The exploitation of experimentally or numerically generated data is one example where artificial neural networks can be trained in order to provide a reduced-order metamodel. A multi-layer feed-forward network, trained by the back-propagation method can be used in structural analysis problems for several inputs in order to predict the expected outputs. Depending on the input-output data, this approach can be used in order to study direct or inverse problems. A review of various applications will be given at the first part of the talk, including the early work for the study of crack and damage identification and recent results on spring-back prediction in metal stamp processing and on data-driven multiscale analysis of composite structures.

The talk will demonstrate that combined usage of computational mechanics and artificial intelligence tools is able to give solutions to hard classical tasks and provide novel approaches for the design of smart systems and reliable digital twins.

Date 18/02/2022

Speaker George E. Stavroulakis

Affiliation Professor, Technical University of Crete, Greece

Video https://youtu.be/C7hOIhFmNi4

Additive Manufacturing 2D and 3D printing technologies.

Topic	Mechanical Engineering
Abstract	Additive manufacturing (AM) is currently considered as one of the most promising manufacturing technologies. 2D printing has been widely used for low-cost printed electronic devices e.g. Thermoelectric Generators (TEGs,) Photovoltaic (OPVs, PePVs: third-gen PVs) harvesting devices, actuators, heaters, sensors, etc. Among 3D printing technologies, fused filament fabrication (FFF) has been the most prominent technology, while the utilisation of multi-functional polymer nanocomposite filaments has received a continuous scientific interest. Within this talk, a focus will be given to 2D and 3D printing technologies with a special emphasis on: *i)* the printing process principles, proper materials & formulations with tailored optoelectronic properties, and *ii)* to the resulting multi-functional devices/ objects with thermoelectric harvesting capabilities (TEG devices), heater functions, electrically conductive 3D objects, mechanical reinforcement and structural character. A hybrid approach combining 2D and 3D printing will be presented towards printed structures with response to multiple external fields against 4D printing applications.
Date	25/02/2022
Speaker	Lazaros Tzounis
Affiliation	Associate Professor, HMU, Greece
Video	https://youtu.be/7Jfdq40slHM

Nano-Biosensors for Health

Topic	Electronics
Abstract	Not available
Date	11/03/2022
Speaker	Arben Merkoci
Affiliation	ICREA Research Professor, ICN2, Spain
Video	https://youtu.be/6hTK4_q-0EA

The Versatility of Perovskite Materials for Optoelectronics

Topic Optoelectronics

Abstract Perovskite solar cells (PSCs) have created much excitement in the past years and attract spotlight attention. This talk will provide an overview of the reasons for this development highlighting the historic development as well as the specific material properties that make perovskites so attractive for the research community. The current challenges are exemplified using a high-performance model system for PSCs (multication Rb, Cs, methylammonium (MA), formamidinium (FA) perovskites). The triple cation (Cs, MA, FA) achieves high performance due to suppressed phase impurities. This results in more robust materials enabling breakthrough reproducibility.

Through multi-cation engineering, usually not-considered alkali metals, such as Rb, can be studied resulting in one of the highest voltages compared to the bandgap. Polymer-coated cells maintained 95% of their initial performance at elevated temperature for 500 hours under working conditions, a crucial step towards the industrialization of PSCs.

To explore the theme of multicomponent perovskites further, molecular cations were re-evaluated using a globularity factor. With this, we calculated that ethylammonium (EA) has been misclassified as too large. Using the multi-cation strategy, we studied an EA-containing compound that yielded a high open-circuit voltage of 1.59 V. Moreover, using EA, we demonstrate a continuous fine-tuning for perovskites in the "green gap" which is relevant for lasers and display technology. [6]

The last part elaborates on a roadmap on how to extend the multiplication to multicomponent engineering providing a series of new compounds that are highly relevant candidates for the coming years, also in areas beyond photovoltaics, for example for medical scintillation detectors.

Date 18/03/2022

Speaker Michael Saliba

Affiliation Professor, University of Stuttgart, Germany

Video https://youtu.be/kF9m4pE4aQ8

Replacing mechanical metrology tools, one photon at a time

Topic Mechanical Engineering

Abstract Metrology is a founding pillar and a driving force of scientific discovery and understanding. Albeit its key importance in all aspects of science and engineering, the field is still dominated by the use of mechanical, intrusive probes. To tackle the matter, our group is developing coherent Rayleigh-Brillouin scattering (CRBS) as an alternative, non-intrusive probe for neutral and plasma thermodynamic characterization. CRBS is a four-wave mixing diagnostic technique that relies on the creation of an optical lattice in a medium due to the interaction between polarizable particles and intense laser fields. Single shot CRBS[1] has been demonstrated to be the coherent analog of spontaneous Rayleigh-Brillouin scattering in measuring the temperature, pressure, bulk and shear viscosity, speed of sound and polarizability of a gas or gas mixture[2], as well as nanoparticles produced in an arc discharge[3]. In this talk, an overview on the theory and experimental aspects of single shot CRBS will be presented along with our recent work in measuring simultaneously the temperature, density and flow velocity[4] of neutral species radially across a glow discharge and a neutral flow. Finally, the feasibility and working progress towards the use of CRBS as a thermodynamic characterization technique for partially/fully ionized gases such as those encountered in fusion or low-temperature plasmas will be discussed.

Date 08/04/2022

Speaker Alexandros Gerakis

Affiliation Senior researcher, Luxembourg Institute of Science & Technology, Luxembourg

Video https://youtu.be/_X8zMFLjFC0

Hydrothermal carbonization of biomass for the production of added – value materials

Topic	Materials Science
Abstract	Not available
Date	06/05/2022
Speaker	Dimitrios Kalderis
Affiliation	Professor, HMU, Greece
Video	https://youtu.be/WcweS4eaKP4

Cell Opto stimulation by intra membrane molecular switches

Topic	Physics
Abstract	Not available
Date	13/05/2022
Speaker	Guiglielmo Lanzani
Affiliation	Professor, POLIMI, Italy
Video	https://youtu.be/qvQntcVraaU

Integrative lighting: Understanding the visual and non-visual effects of lighting on humans

Topic	Engineering
Abstract	Not available
Date	20/05/2022
Speaker	Giorgos Traintafyllidis
Affiliation	Associate Professor, Aalborg University, Denmark
Video	https://youtu.be/Atc7fsY6Jek

A frank assessment of ceramic conductors as alternative plasmonic materials

Topic Physics

Abstract Ceramic conductors, such as the nitrides of the group IVb, Vb and VIb metals (TiN, ZrN, HfN, VN, NbN, TaN, and MoN) and transparent conductive oxides (TCOs) like ITO, AZO and IGZO, have emerged as important alternative plasmonic materials due to the unique combination of substantial electric conductivity and plasmonic features in the midIR-NIR-Vis-UV ranges with their refractory character (mostly for nitrides) and chemical inertness, which provide the durability of nanostructures upon exposure to high-power laser beams, and due to their compatibility with CMOS (for nitrides) and solution (for TCOs) fabrication of various devices. However, this comes in the expense of inherent electronic losses that lead to reduced near-field enhancement compared to metals. Furthermore, their refractory character can turn from a blessing to a curse due to the excessive density of structural defects when grown at relatively low temperatures. The extended defects, i.e. the grain boundaries, scatter the conduction electrons resulting to further enhanced electronic losses. Unlike the conventional plasmonic metals, the conductive conductors may also incorporate point defects, which affect the plasmonic performance. In this seminar, the defect formation mechanisms in nitrides and TCOs will be reviewed, and their association with the bottom-up growth processes will be discussed in view of their plasmonic performance. In addition, we will consider and discuss the optical properties of conductive nitrides and TCOs in the form of films, colloidal nanoparticles, and self-assembled nanowires and nanoislands produced by various high-throughput physical processes such as glancing angle deposition, nanosphere lithography, and laser ablation in liquids.

Date 27/05/2022

Speaker Panos Patsalas

Affiliation Professor, AUTH, Greece

Video https://youtu.be/pA1JUnCL7Vw

3.3 Academic Period 2022 – 2023

The genesis of molecular photovoltaics and perovskite solar cells.

Topic	Optoelectronics
Abstract	Not available
Date	14/10/2022
Speaker	Michael Graetzel
Affiliation	Professor, EPFL, Switzerland
Video	https://youtu.be/az54MbUckrM

Agreements and disagreements between mathematics teacher educators. A collaborative work around a calculus lesson

Topic	Mathematics Education
Abstract	Mathematics teacher education in Uruguay is a concurrent preparation, which means the joint occurrence of general education and professional education in the same program. Mathematics teachers and mathematics teacher educators use to work solely, and they do not discuss their teaching practices among them. This talk will report a study about collaborative work of mathematics teacher educators around a lesson planning process. Mathematics teacher educators' team had to collectively plan, implement, and analyse a calculus lesson in the context of mathematics teacher education. I used classic Grounded Theory as the methodological approach, to inquiry into the process and obtain an explanation. I identified a process developed by the team, called looking for agreements. This process was resolved by the activation and eventual mobilization of the personal theories built-in practice of each mathematics teacher educator, the core category that emerged during the research. I will present the different degrees of agreement and disagreement caused by these divergent personal theories. I will also discuss the implications of this study for mathematics teacher education.
Date	20/10/2022
Speaker	Daniela Pages
Affiliation	Professor, Instituto Politechico Mexixo, Mexixo
Video	Not available

Ultrafast quantum nano-optics

Topic	Laser Physics
Abstract	Not available
Date	21/10/2022
Speaker	Mario Agio
Affiliation	Professor, University of Siegen, Germany
Video	https://youtu.be/ac-ggSwdXNE

Layered Materials Characterization and Applications

Topic	Materials Science
Abstract	'Graphene and layered materials (LMs) have great potential in photonics and optoelectronics, where the combination of their optical and electronic properties can be fully exploited, and the absence of a bandgap in graphene can be beneficial. The linear dispersion of the Dirac electrons in graphene enables ultra-wide-band tunability as well as gate-controllable third-harmonic enhancement over an ultra-broad bandwidth, paving the way for electrically tuneable broadband frequency converters for optical communications and signal processing. Saturable absorption is observed as a consequence of Pauli blocking and can be exploited for mode-locking of a variety of ultrafast and broadband lasers. Graphene integrated photonics is a platform for wafer scale manufacturing of modulators, detectors and switches for next generation datacom and telecom. Heterostructures based on LMs have properties different from those of their individual constituents and of their three dimensional counterparts. These can be exploited in novel light emitting devices, such as single photon emitters, and tuneable light emitting diodes. LMs have potential for quantum technologies, as scalable sources of single photon emitters (SPEs). Quantum emitters in LMs hold potential in terms of scalability, miniaturization, integration. Generation of quantum emission from the recombination of indirect excitons in heterostructures made of different LMs is a path with enormous potential.''
Date	04/11/2022
Speaker	Andrea Ferrari
Affiliation	Professor, University of Cambridge, UK
Video	https://youtu.be/OQxxGRNNlUo

Gamification: An Instructional Approach for Teaching Mathematics

Topic	Mathematics Education
Abstract	Gamification, integrating game elements into the learning process, seems to be one of the most popular teaching methods nowadays. It has a wide application area, from elementary school to higher education, including online classes. Its potential could be valued for improving learning outcomes, assessment, and solving educational administrative issues. This talk aims to take a closer look at existing research to understand the effect of gamification in education and to be aware of the game elements which can take place in gamification design. Supported with implication examples, the talk will include the design of gamified learning environments following player types. The talk will end by mentioning the tools and tips to gamify classrooms.
Date	03/11/2022
Speaker	Selay Arkün Kocadere
Affiliation	Associate Professor, Hacettepe University, Turkey
Video	https://youtu.be/4qUEPUNXqAI

The 2022 Nobel Prize in Physics: A very brief introduction to quantum mechanics and Bell's inequalities

Topic	Physics / Quantum Mechanics
Abstract	Not available
Date	09/11/2022
Speaker	George Kavoulakis
Affiliation	Professor, HMU, Greece
Video	https://youtu.be/1fYbGzuX8ro

Towards a framework to reconcile and support students' remote and face-to-face mathematical problem-solving activities

Topic Mathematics Education

Abstract The teachers and students' intense use of digital technologies and online developments not only marked the implementation of educational tasks during the pandemic confinement; but also opened novel paths for students to deal with mathematical problems. What ways of reasoning do students develop to reason and solve mathematical tasks? To what extent does the students' activation of digital tool affordances shape their ways to represent, explore, discuss, and solve mathematical problems? During the talk, I will address this type of questions and sketch elements of a framework to integrate and reconcile both students' remote and face-to-face problem-solving activities.

Date 10/11/2022

Speaker Luis Manuel Santos Trigo

Affiliation Professor, Cinvesrav-IPN, Mexico

Video https://youtu.be/FE6t7RL1dgY

Supramolecular Strategies in Hybrid Perovskite Photovoltaics

Topic Optoelectronics

Abstract Hybrid organic-inorganic perovskite materials have become one of the leading semiconductors for renewable solar-to-electric energy conversion in photovoltaics. However, they are unstable under operating conditions, which stimulates global research efforts to overcome this challenge towards practical applications. Supramolecular strategies have provided an invaluable tool for controlling hybrid perovskite materials by purposefully tailoring non-covalent interactions with organic components, such as through halogen bonding, π- interactions, and host-guest complexation, which has been assessed at the atomic level by solid-state NMR spectroscopy. These strategies were also applied to the development of low-dimensional perovskite architectures that further enhance stabilities as well as photovoltaic performances. As a result, perovskite solar cells have reached superior operational stabilities without compromising their performances, providing a versatile strategy for advancing hybrid photovoltaics.

Date 18/11/2022

Speaker Jovana V. Milić

Affiliation Assistant Professor, University of Freiburg, Germany

Video https://youtu.be/gCez_g1a4pY

A Paradigm Shift to Education 4.0: The STEAME School of the Future – Building the puzzle

Topic Mathematics Education

Abstract The project "STEAME Guidelines for Developing and Implementing STEAME Schools" was completed recently and now several projects are producing the building blocks completing the puzzle around it. This project became the kick-off of a paradigm shift to Education 4.0 as it provides what steps Education Systems around the world could follow in order to escape from Education 2.0 and change to Education 4.0 with learning based on inquiry and project based learning. Literature and research is showing for years now that this should be the way forward in order to help school students and HE students develop the needed competences and skills that appear to lack when they enter HE studies or enter the world of work. With today's development of digital learning, most of the learning needed by students can be easily accessible or retrieved at any time and place through digital and video learning. STEAME (Science - Technology – Engineering - Arts - Mathematics - Entrepreneurship) has been developed to support European teachers' knowledge and understanding of creating successful STEAME learning and creativity plans and programs. The results are based on a European survey and a validation though focus group of experts. It offers approaches to teaching, teaching materials, entrepreneurship aspects, organizational suggestions for STEAME-oriented teaching, propositions and analysis of STEAME-oriented curriculum. All the OERs of the project are available through the STEAME Observatory. As an observatory, it is designed to be adaptive and dynamic, able to support a dynamic and adaptive STEAME Curriculum in any school that needs to implement STEAME activities in the learning process. The presentation will also show proposed architectural designs of the STEAME School of the future and results from several projects contributing to the completion of the needed puzzle of future learning.

Date 01/12/2022

Speaker Gregory Makrides.

Affiliation Visiting Professor in the university of Cracow, Poland

Video https://youtu.be/4F4GMTAoRww

Semiconductor photoelectrodes and photocatalysis for solar-driven water splitting

Topic	Optoelectronics
Abstract	Not available
Date	02/12/2022
Speaker	Kevin Sivula
Affiliation	Professor, EPFL, Switzerland
Video	https://youtu.be/jnwf9q8owBQ

International Sign Everywhere: Towards Internationalization of Education and International Mobility of Deaf Students

Topic	Assistive Technologies.
Abstract	The inclusion of deaf students in education has been always a topic of debate and research for a long time. Deaf students experience numerous communication challenges, which is especially true for communication with those from other nationalities due to the lack of a common sign language. Further deaf students face serious difficulties to understand new technical concepts along their academic path. Fields such as engineering or geography, lack signs representing specific lexicons like nanotechnology or tropical rain belt. The University of Siegen along with EU partners and stakeholders aims to overcome these challenges through the outcomes of InSign and TechWhiz Erasmus+ projects. **InSign** promotes the internationalization of education and the international mobility of deaf students through the use of International Sign as an effective channel of communication between deaf and non-deaf and its implementation in higher education. **TechWhiz** aims to promote equity in education by providing access to explanations of technical and scientific concepts for deaf students in sign language. Deaf students are a specific cluster in European Higher Education where they have little support that might be largely extended by InSign and Techwhiz projects.
Date	08/12/2022
Speaker	Omar Gamal
Affiliation	PhD candidate, University of Siegen, Germany
Video	Not available

Perovskite Photovoltaics enabled by 2D materials take to the field

Topic Optoelectronics

Abstract During the past decade, there was intensive research on the development of perovskite solar cells (PSCs), which have emerged as an alternative efficient energy harvester for both IoT devices and solar farms. The power conversion efficiency (PCE) of PSCs has rapidly increased and is now approaching the state- of-the-art PCE of 26.1%1 obtained by crystalline-silicon PVs. However, this impressive PCE obtained on small-area cells and in laboratory conditions should be also valid to large-area PV panels in real outdoor conditions. Interface engineering, using solution processable 2D materials (e.g., graphene and transition metal dichalcogenides) is an effective approach to increase the readiness of this technology for manufacturing. The incorporation of the 2D materials improves the charge dynamics of the interfaces and most importantly protects the perovskite layer against diffusion of external agents, such as oxygen and moisture and the metal ion migration2. In this context, the Graphene Flagship partners University Rome Tor Vergata, BeDimensional S.p.A, Greatcell and Hellenic Mediterranean University demonstrated the validity of this technology through the entire value chain, from materials development, perovskite modules and panels fabrication and their integration in an autonomous solar farm, to outdoor field tests, and assessment of the real energy production output. The main validation of the proposed approach is the realization of an autonomous solar farm, consisting of 5m2 perovskite PV panels in the HMU campus at Crete3. A continuous monitoring of the solar farm was performed through in-house developed maximum power point trackers, coupled with a correlation of the environmental conditions, recorded by a weather station, with the outdoor performance of farm. The assembled solar farm delivered peak power exceeding 260W, proving the scalability of the proposed technology. The energy production of the solar farm was monitored for 12 months, demonstrating a remarkable 20% reduction (T80) of the PV performance over 8 months of operation. Moreover, the solar farm's electrical characteristics were monitored as a function of temperature and light intensity. The data analysis demonstrated that the perovskite panels enabled by 2D materials are promising for outdoor operation at elevated temperatures, such as in high-irradiance global locations.

Date 09/12/2022

Speaker Emmanuel Kymakis

Affiliation Professor, HMU, Greece

Video https://youtu.be/6m7P5kFeiBo

Design and implementation of advanced water treatment and desalination system and advanced studies on photocatalytic activity of hybrid nanomaterials for different environmental applications.

Topic Environmental Sciences

Abstract The quality of groundwater in Egypt is deteriorating rapidly due to salinization and industrial pollution. To help reverse this trend, novel batch reverse osmosis (RO) desalination for high recovery of freshwater from ground-water, and new photocatalysts to eliminate emerging contaminants from wastewater – thus allowing effective and safe recharge of aquifers, have been developed. Prof El Nazer research team members have also developed an innovative solution for the management of harmful brine from desalination plants, using it to cool agricultural greenhouses. With the overall aim of developing new technology for better protection and management of groundwater in Egypt, the specific objectives are to (a) develop novel photocatalytic materials and composites, with sensitivity to both UV and visible light, for the removal of emerging pollutants from wastewater and groundwater, (b) develop high efficiency, high-recovery desalination technology for groundwater, based on batch reverse osmosis (RO), giving resistance to fouling by organic and inorganic species, (c) Develop a solution for management of brine rejected from groundwater desalination plants by evaporative cooling of agricultural greenhouses, (d) demonstrate the above solutions in the study areas, and disseminate the knowledge generated, through the Egyptian ministries and industrial partners involved in the project. In addition, Prof. El Nazer guest, Prof. Yasser Mahmoud (Photochemistry Department, National Research Center, Egypt), will discuss the implementation of heterogeneous nano-photocatalysts in environmental applications that have been significantly investigated in the last decade as a result of the increasing demand for the use of green approaches and through the availability of visible light source. Herein, the presented results highlight the basic concepts of nano-photocatalysis and the applications of these catalysts in various photocatalytic processes.

Date 14/12/2022

Speaker Hossam El Nazer

Affiliation Professor, National research Center, Egypt

Video https://youtu.be/EXokH9E3DT0

Advanced electromagnetic wave control with chiral and parity-time symmetric metamaterials

Topic	Materials Science
Abstract	Not available
Date	16/12/2022
Speaker	Maria Kafesaki
Affiliation	Professor, University of Crete, Greece
Video	Not available

Creativity, Innovation and Sustainability in STEAM education

Topic	Mathematics Education
Abstract	The presentation is focusing on the role of creativity, innovation and sustainability in the STEAM learning process, based on projects and publications by our Research Group of Innovative Learning Environments (https://www.jyu.fi/it/ile). We will explore pedagogical potentials based on the integration of STEAM, i.e., Science, Technology, Engineering, Arts, and Mathematics. Discussing issues related to creativity, innovation, sustainability, and STEAM learning, we will address the role of informal methods in formal education, especially in the area of skills and competence development. The presentation includes several practical examples based on the Experience Workshop STEAM Network (www.experienceworkshop.org), such as using 3D-printers, robotics, Augmented Reality in the mathematics classroom. We will explore the potential of mathematics and art combinations, including projects focusing on children and youth engagement and motivation.
Date	12/01/2023
Speaker	Kristóf Fenyvesi
Affiliation	Researcher in Finish Institute for Educational Research, University of Jyväskylä, Finland
Video	https://youtu.be/gOUAs1ROCWM

Semiconductor Nanocrystal Optoelectronics for Lighting and Displays: Pushing the Limits, Breaking Records

Topic Optoelectronics

Abstract Lighting and displays are integral parts of human activities and economic development. Semiconductor nanocrystals, now offering a market volume exceeding 1 Billion Euros annually, have attracted great interest in quality lighting and displays in the last decade. Such colloidal semiconductors enable enriched color conversion essential to superior lighting and displays. These colloids span different types and heterostructures of semiconductors, starting in the form of colloidal quantum dots about three decades ago and extending to the latest subfamily of nanocrystals, the colloidal quantum wells, in the last decade. In this talk, we will present most recent examples of photonic structures and device architectures using the colloidal quantum wells for lighting and displays. Also, we will present a powerful, large-area self assembly technique for orienting these colloidal quantum wells either all face down or all edge up. We will demonstrate three dimensional constructs of their oriented self assemblies with monolayer precision. Among their extraordinary features important to applications in lighting and displays, we will show record high efficiency from their colloidal LEDs and record gain coefficients from their colloidal laser media using heterostructures and/or oriented assemblies of colloidal quantum wells. Given their current accelerating progress, these solution processed quantum wells hold great promise to challenge their epitaxial thin film counterparts in semiconductor optoelectronics in the near future.

Date 13/01/2023

Speaker Hilmi Volkan Demir

Affiliation Professor, Bilkent University, Turkey

Video https://youtu.be/CW5466sCpzk

The university mathematics lecture: To record, or not to record, that is the question

Topic	Mathematics Education
Abstract	While recordings of lectures proved invaluable for students' learning during the pandemic, as our university transitioned back to in-person teaching there was a call from some lecturers to remove the requirement to provide lecture recordings due to the perceived negative impact on attendance. Colleagues in other universities describe similar debates. In this talk, I will present findings from studies conducted with colleagues on the role of recordings in the teaching of undergraduate mathematics, from both before and after the lockdown due to the pandemic. As an education researcher and mathematics lecturer, I will discuss the implications for lecturers' practice.
Date	19/01/2023
Speaker	Maria Meehan
Affiliation	Lecturer, University College Dublin, Ireland
Video	https://youtu.be/TI9zHqOyULY

Beyond the ritualised vs exploratory mathematics dichotomy: teaching and learning in symbolically structured environments.

Topic	Mathematics Education
Abstract	In this session Alf will consider some recent debates around ritualised versus exploratory activity in mathematics – two approaches which are often set in opposition. The session will exemplify the idea (developed with colleague Nathalie Sinclair) of teaching and learning mathematics in a symbolically structured environment (SSE), which includes processes they label "ritualisation". In a SSE, students are actively engaged from the start, initially in a tightly controlled context, which then broadens out to allow space for conjecturing and proving.
Date	26/01/2023
Speaker	Alf Coles
Affiliation	Assistant Professor, University of Bristol, UK
Video	https://youtu.be/u-mREDC-eDU

Taking advantage of the magnetic functionality of nanostructures with induced movement

Topic Engineering / Materials Science

Abstract The incorporation of magnetic nanostructures into a nano/micromotor design is a very convenient strategy for magnetic actuation. Accordingly, herein, some advantages with which nanostructures become endorsed when including magnetic nanoparticles in the final assembly, will be detailed. One hand, we can consider the basic physical mechanism by which a magnetic field can be used to generate motion in fluidic environments, namely by inducing the so-called magnetophoretic motion by applying forces due to the magnetic field gradients, which require a spatially inhomogeneous field. Furthermore, this effect can be exploited jointly with self-propulsion of swimmers, such that, the movement becomes directed. On the other hand, we can also take into account the ability of magnetic nanoparticles to deliver heat, via the external stimulation using an alternating magnetic field. This heat delivered can have a tremendous impact in the induced movement, as it can be employed to catalyse the reactions involved in the concentration gradient generating the movement or to change the surrounding environment.

Date 27/01/2023

Speaker Verónica Salgueiriño

Affiliation Associate Professor, University of Vigo, Spain

Video https://youtu.be/a4jK1ZExNXQ

Ignition a dream that came true, a brief history of the ICF program at LLNL

Topic	Laser Fusion
Abstract	A historical discovery for science and technology was announced on Tuesday 13-12-2022 in the US. The announcement concerned the demonstration of the production of net laser fusion energy in the National Ignition Facility (NIF). As it was said by the US Minister of Energy, the achievement of the fusion "will remain in the books of History". Indeed, for about 70 years, scientists have been trying to unlock the secret of controlled thermal fusion. To produce pure energy in the way nature produces it in our sun and in all stars. Two methods are followed, one uses magnetic fields to limit the plasma and the other powerful laser. The achievement announced in the US concerns fusion using strong lasers. The talk will go over the science evolution until the historical event of ignition at NIF.
Date	10/02/2023
Speaker	Sebastien Le Pape
Affiliation	Professor, Ecole Polytechnique Paris, France
Video	https://youtu.be/cCVUItFJnhM

Teachers' Inquiry in Mathematics Education

Topic	Mathematics Education
Abstract	The talk will present the main ideas and results of the Erasmus+ project TIME (named as in the title). Some of the ideas are likely to be relevant to teachers of science and other disciplines, and indeed some of the cases considered in the project also concerned the boundaries between mathematics and other school subjects.
Date	23/02/2023
Speaker	Carl Winsløw
Affiliation	Professor, Copenhagen University, Denmark
Video	Not available

Using EduScrum in mathematics teaching

Topic	Mathematics Education
Abstract	Not available
Date	02/03/2023
Speaker	Carla Pinto
Affiliation	Coordinating professor, IPP, Portugal
Video	https://youtu.be/GW_fX3m20vo

Accelerating emerging PV technologies.

Topic	Optoelectronics
Abstract	The development of complex functional solar materials poses a multi-objective optimization problem in a large multi-dimensional parameter space. Solving it requires reproducible, user-independent laboratory work and intelligent preselection of experiments. However, experimental materials science is a field where manual routines are still predominant, although other domains like pharmacy or chemistry have introduced robotics and automation long before. Human interaction in the process of data acquisition is seen critical due to incomplete assessment of meta-data or hidden processing correlations which complex reproducibility. Materials Acceleration Platforms (MAPs) are regarded as an enabling technology for Data-Driven Material Science, leading to an increased number of concepts and a dynamic evolution of MAP lines. In this talk, I will present our approach to laboratory automation in materials science with a strong focus on fully functional solar devices. AMANDA (Autonomous Materials and Device Application Platform - www.amandaplatform.com) was developed as a generic platform for distributed materials research comprising a self-developed software backbone and several MAPs. However, one realizes that accelerating a whole technology requires more than accelerated materials research. It also takes devices and process development to truly accelerate a PV technology. These are concepts are summarized under Technology Acceleration Platforms (TAP). This talk will stepwise introduce the current concepts and technologies to accelerate solar technologies: from the material to the device and to the process. The outlook will discuss how these platforms can be made communicative to each other to transform them into autonomously acting TAP with the power to accelerate the learning curve for a whole solar cell technology.
Date	03/03/2023

Speaker Christoph Brabec
Affiliation Professor, FAU, Germany
Video https://youtu.be/iPZVHk7klFw

Mathematics learning as the art of transitioning across discourses

Topic Mathematics Education
Abstract Every conversation about learning and teaching makes epistemological assumptions regarding how these processes come about. Being preoccupied with often heated debates about "what works", the interlocutors rarely invest in reflecting and explicating what they mean with such impalpable objects as "learning", "understanding", "knowledge", and even "mathematics". In this talk, I will argue that considering mathematics and its learning through the lens of communication and discourse has the potential to cast a new explanatory light on classical conundrums that we encounter in mathematics classrooms. Specifically, I will argue that many students' difficulties occur at specific points where "the rules of a mathematical game" change significantly. These points may be not evident to mathematics teachers who effortlessly transition across mathematical discourses.
Date 09/03/2023
Speaker Igor Kontorovich
Affiliation Senior Lecturer, University of Auckland, New Zealand
Video https://youtu.be/FUWIv4BUHLU

Remote inspection of civil infrastructures based on Unmanned Aerial Systems and Artificial Intelligence.

Topic Robotics

Abstract Condition assessment of civil infrastructure is a key instrument for infrastructure managers to evaluate structural integrity and operability, as well as defining possible maintenance or rehabilitation strategies. In recent years, remote inspection techniques based on computer vision and Unmanned Aerial Systems (UAS), also known as drones, have been recognized as key components for improving inspection and monitoring strategies to achieve an automated condition assessment of civil infrastructures. These technologies proved to be competitive in identifying damage in inaccessible and extensive areas, allowing a considerable reduction of costs and execution times. This presentation is focused on the latest developments on the remote inspection of civil infrastructures using advanced image processing techniques based on Artificial Intelligence. Within this topic, Deep Learning algorithms, such as the Convolutional Neural Networks (CNNs), and its latest enhancements, like the Mask R-CNN algorithm, will be detailed. The application of these AI algorithms to the automatic damage identification on large scale infrastructures will be presented. The first case-study is focused on the detection of exposed steel rebars in a storage silo, while the second case-study is related to the detection of corrosion on roofing systems of industrial buildings.

Date 17/03/2023

Speakers Ricardo Santos & Dr. Diogo Ribeiro

Affiliation Professors in ISEP, IPP, Portugal

Video https://youtu.be/J-tHmppJdmA

Approaches to formative assessment

Topic Mathematics Education

Abstract Not available

Date 27/04/2023

Speaker Jason Cooper

Affiliation Scientist, WIS, Israel

Video https://youtu.be/slI3mxD5n78

HPC RIVR project to establish a National supercomputer center in Maribor, Slovenia

Topic Computer Science

Abstract This talk aims to share our experience in establishing a large national research infrastructure for supercomputing. This was made possible through the HPC RIVR investment project, jointly funded by the Republic of Slovenia, the European Union (from the European Regional Development Fund), and The European High-Performance Computing Joint Undertaking (EuroHPC JU). To meet the needs of the Slovenian and European scientific community, we built three hybrid HPC systems, with the flagship production supercomputer HPC VEGA rated at 6.9 PETAFLOPS (Rmax = 10.1 PETAFLOPS). This was the first EuroHPC JU supercomputer to be put into operation in Europe. The built HPC systems are accessible under the Open Access to Public Research Infrastructure rules and regulations. During the talk, we will focus on explaining our journey from the idea of building a National supercomputer center to ensuring the necessary political and national support, executing the investment project, and finally achieving full-scale operation of the HPC systems.

Date 07/04/2023

Speaker Zoran Ren

Affiliation Professor, University of Maribor, Slovenia

Video https://youtu.be/gPBbCvr8SB4

Quantum optics in cold atomic gases

Topic Physics / Quantum Mechanics

Abstract The groundbreaking demonstration of slow and even stopped light in cold atomic ensembles led to a plethora of quantum technology applications, spanning from ultrasensitive sensors and precise interferometers to single-photon switches and quantum memories. After a brief introduction to the field of quantum optics with cold atomic gases and its applications, I will present two recent experimental studies conducted by our group. More specifically, I will demonstrate how a non-Hermitian quantum interface between single atoms and light can surprisingly switch bosonic correlations to fermion-like ones, and how such a process can contribute to quantum storage and, potentially, quantum computation. I will also present a new way to simultaneously arbitrarily manipulate the temporal and spatial wavefunctions of entangled non-spreading photons generated from an atomic gas.

Date 28/04/2023

Speaker George Siviloglou

Affiliation Professor, SUSTech, China

Video https://youtu.be/AP_nzxpuoZ0

2D materials in tandem perovskite/Si technology

Topic Materials Science

Abstract Hybrid perovskite solar cells (PSCs) are one of the most promising technologies for new-generation photovoltaics due to outstanding semiconductor properties and low-cost solution processing methods for fabrication. Indeed, PSCs dominated the PV scientific research in the last decade, by developing efficient and stable devices, produced by employing scalable and low-cost printing techniques, easily embedded in roll2roll or sheet2sheet production lines. However, PSC technology still requires to demonstrate the transfer from lab to fab, pushing the scientific community to find brilliant solutions for drawing a feasible and reliable route toward its commercialization. Moreover, the impressive potentiality of perovskite technology has already been demonstrated to compete on equal footing with traditional inorganic PV or to work in synergy with established silicon technology in tandem cell configuration. As a matter of fact, the astonishing power conversion efficiency recently achieved by small area perovskite/silicon tandem solar cells (PCE>32%) demonstrated the technology potentialities to be appealing for the PV market. However, such technology should keep the promise to be easily manufactured by employing the existing silicon cell production line and by minimizing the Levelized Cost of Electricity (LCOE). Thus, the synergetic development of large-area perovskite devices fitting the standard silicon wafer dimensions and the optimization of perovskite/silicon tandem architectures can definitively open up new horizons for winning the commercialization challenges. In this work, we develop a mechanically stacked 2T perovskite/silicon tandem solar cell, with subcells independently fabricated, optimized, and subsequently coupled by contacting the back electrode of the mesoscopic perovskite top cell with the texturized and metalized front contact of the silicon bottom cell. The possibility to separately optimize the two sub-cells allows to carefully choose the most promising device structure for both top and bottom cells. Indeed, semitransparent perovskite top cell performance is boosted through the use of selected two-dimensional materials to tune the device interfaces. A textured amorphous/crystalline silicon heterojunction cell fabricated with a fully industrial in-line production process is here used as state of art bottom cell. The perovskite/c-Si tandem device demonstrates remarkable PCE of 28.7%. Moreover, we demonstrate the use of a bifacial silicon bottom cell, as a viable way for overcoming the current matching constrain imposed by the 2T configuration. Here, the current generation difference between perovskite and c-Si cells is compensated by exploiting the albedo radiation thanks to the bifaciality of the commercial c-Si cell

used in this article. Considering standard rear irradiation, final power generation density above 32 mW/cm2 can be achieved, paving the way for a tandem technology customable according to the final installation site.

Date 12/05/2023

Speaker Antonio Agresti

Affiliation Associated Professor, Tor Vegata, Italy

Video https://youtu.be/I9EOTDKDazw

4 Conclusions and Future Plans

The ATHENA Talks during this pilot phase of the Alliance went satisfyingly well and are considered one of its success stories. However, there is still room for improvement particularly towards the expansion of its topics in other scientific fields. All the 90 colloquial talks conducted via the Zoom platform with more than 1800 individuals participating (as have been registered in the google forms used for registration) as speakers or participants. The recorded sessions have been viewed more than 9000 times. The main tips learned on how to organize such events are: (a) the early planning with the speakers but also on the announcement of the talks into its stakeholders; (b) the grouping of the talks per topic; (c) the inclusion of speakers from all the ATHENA partners; and (d) the engagement of students. ATHENA Talks operated as key opportunities for developing new collaborations, especially for early career researchers to gain valuable feedback and interact with leading figures in their topic. Moreover:

- ATHENA Talks introduce key disruptive technologies, pedagogies and research innovators within the Alliance
- ATHENA Talks are a vehicle of the research take place within the Alliance
- ATHENA Talks operated as a dissemination activity of the Alliance within and beyond its consortium
- ATHENA Talks was one of the research activities of the Alliance

Despite the success of this pilot phase, we have experienced some challenges that are reported below.

- The need for more effective dissemination of the ATHENA Talks within the Alliance community and especially among the PhD students
- The frequency of the Talks: it seems two talks per week is too much
- The engagement of other disciplines beyond engineering and teaching pedagogies
- The rotation of the coordination of the ATHENA Talks within the consortium
- The presentation time (@10.00 CET) did not permit us to include speakers and participants in different time zones e.g., participants in the USA or in Australia
- The interactivity, the emotional engagement of the audience, and the lack of applause after each talk
- Safety issues e.g., strange intruders during the online meetings
- Audio and Video quality problems

A list of proposals follows on how to tackle the challenges, increase the ownership of the ATHENA Talks among the partners.

- The run of post – surveys after the talks to capture the challenges but also new ideas from the audience in various timeslots of a talk: before, during and after a talk
- The assignment of the branding of the talks to the branding ATHENA team
- The search of the most successful dissemination channels to announce the talks

- The call of abstracts within the ATHENA Alliance partners very early e.g. July in order to plan the talks that usually start on October of each academic year
- The organization of colloquial talks for PhD candidates in order to provide them the opportunity (a) to present their work; (b) to facilitate their professional development e.g., find a postdoc position as a next step of their career
- The expansion of the topics beyond the engineering and teaching pedagogy topics.
- The grouping per topic of the ATHENA Talks
- The assignment to all the partners of a topic of their excellence and organize per two months a series of at least three colloquial talks
- The organization of working hubs based on the colloquial talks selected topics e.g., the Photonics Hub as a result of a series of talks in this field
- The organization of BIPs in some of the presented topics in the proposed rounds of colloquial talks
- The better dissemination & branding of the talks through the creation of cluster of people interesting in the addressed topics
- The better dissemination after a talk happened, the pose of the ATHENA Talks in the ATHENA YouTube Channel
- The organization of conferences using the network build in these only talks. The integration of the Erasmus funding opportunities (e.g., short mobilities and invitation of experts) to invite experts in these face – face events
- The incorporation of virtual reality tool will be explored e.g., MaxWhere software
- The use of pre-prepared subtitles may make online talks even more accessible
- The organization of the ATHENA podcasts and the ATHENA virtual poster sessions as a by-product of the ATHENA Talks

Appendix B

Work Package reports

Work-package 1
Project Management and Coordination

WP Leader Nuno Escudeiro

Affiliation Polytechnic Institute of Porto

Structure of the WP

Tasks

- T1.1 Consortium and financial management
- T1.2 Communication within the partnership
- T1.3 Ad-hoc task forces
- T1.4 Risk management
- T1.5 Quality assurance

Deliverables

- D1.1 Project Management Framework
- D1.2 Risk assessment
- D1.3 Validation methodology
- D1.4 Reporting to EACEA

Results, achievements, and ATHENA integration	Unlike the remaining work packages, WP1 – Project Management and Coordination – is exclusively related to the Erasmus+ project lifetime, from October 2020 to September 2023, aiming to manage the partnership and the project as such and to warrant the project sustainability. During these three years, WP1 created and explored a management framework that assisted all partners in performing, monitoring, and assessing project development and the risks faced along the project lifetime. We have adapted to the Covid-19 pandemic that forced ATHENA to find ways to keep the project running in unexpected circumstances that no-one had experienced before. Several taskforces were created to develop specific features, such as the Competence Clusters, the ATHENA Research Book, the EduCTX blockchain solution for student's certificate management and verification, to name a few. The Quality Assurance Board has revised all deliverables ahead of their submission, in dialogue with the work package and taskforce leaders, and periodically reviewed internal and external risks. WP1 assured that by the end of the financing period, in October 2023, the remaining work packages have setup, and fully developed the bodies, the required structures, tools and mechanisms that will support the operation of the ATHENA European University Alliance. Currently ATHENA has its governance bodies in full operation, its educational and research joint strategies defined and most of the supporting tools and common infrastructure in place. In September 2023 ATHENA is empowered to continue developing as a European University Alliance and WP1 can be disregarded.
Date of report	4. 9. 2023

Work-package 2
Governance: Preparing the future of the Alliance

WP Leader Konstantinos Petridis

Affiliation Hellenic Mediterranean University

Structure of the WP

Tasks

- T2.1 Draft ATHENA statutes and operation rules
- T2.2 Draft ATHENA business strategic plan
- T2.3 Create and operate the Higher Education Market Observatory
- T2.4 Rectors' annual meetings

Deliverables

- D2.1 Statutes of the ATHENA European University
- D2.2 ATHENA European University Model
- D2.3 ATHENA business strategic plan
- D2.4 Performance model
- D2.5 Annual reports of the Higher Education Market Observatory

Results, achievements, and ATHENA integration

The ATHENA WP2 – The Governance is led by HMU and all the partners have participated during its operation. The ATHENA Alliance governance refers to the structure by which the Alliance is organized, managed, and administered. It involves: (a) the decision-making bodies (Executive, Educational and Research Board); (b) the supporting to the boards elements (ATHENA Rectors' Office and General Secretary); (c) the consulting bodies (steering committee; internationalization committee; the student board; the Observatory of Higher Education; and the Industry Interface Committee. Finally, the ATHENA Alliance governance contains the supporting services which includes the International Relations Office; the Branding Communication Office; the Infrastructure Team; and the Quality Assurance Team. During the running of the Alliance two more services added: the ATHENA Legal Office and the ATHENA Grant & Support Office. All the operational and decision making processes of these boards, committees and services are described in the ATHENA governance book. The main outcomes of this collaboration are:

- The operation of all these bodies; committees; and services.
- The composition of the regulatory framework (governance book) of their operation and decision making.
- The organization of seven executive face -to-face and 17 online meetings.
- The establishment of the 1st ESN network in an Alliance level.
- The expansion to nine partners and the incorporation of four associated members into the Alliance. The production of the respective documents (e.g., MoU template).
- The composition of the strategic and performance Alliance documents: the strategic plan and the university model (which contains the performance indicators).
- The composition of two reports regarding the modern policies, tendencies, and transformative technologies in the field of Higher Education (Education and Research).
- The organization of 103 ATHENA talks in science & pedagogies; the organization of a BIP in soft skills; the organization of two intensive programs (in Perovskite technologies and in Printed Electronics).

Date of report 20. 7. 2023

Work-package 3
Education: Creating an innovative and inclusive educational offer

WP Leader Nuno Escudeiro

Affiliation Polytechnic Institute of Porto

Structure of the WP

Tasks

- T3.1 Setup a cooperation model for joint Education
- T3.2 Setting up Competence Clusters and developing joint curricula
- T3.3 Implement an embedded mobility culture
- T3.4 Promoting inclusive education
- T3.5 Introducing Micro-credentials
- T3.6 Creating lifelong learning offers
- T3.7 Developing accreditation mechanisms
- T3.8 Fostering entrepreneurship and links with the local community

Deliverables

- D3.1 ATHENA model for Joint Education
- D3.2 Competence Clusters data base
- D3.3 Educational Directory
- D3.4 ATHENA mobility quick guide
- D3.5 Online course catalogue

Results, achievements, and ATHENA integration	ATHENA has setup a novel educational model designed to advance inclusive and sustainable education and place the university educational assets to the service of the local community and the society at large. The ATHENA Model for Joint Education stands on an embedded mobility foundation that traverses all sectors of our ecosystem and impacts all its internal and external stakeholders. The ATHENA concept of Embedded Mobility relates to a holistic set of attitudes, skills, and competences, underpinned by supporting procedures, tools and resources involving and empowering all our internal stakeholders (students, academics, researchers and administrative staff) in building an exciting and catchy international university campus that inspires local communities and delivers significant added value to the society. Competence Clusters – cohesive groups of equivalent courses assuring the same learning outcomes at a comparable workload – are an innovative approach to disclose ATHENA educational assets and a key driver setting the foundations that allow students to design their own personalized academic path while opening new markets for higher education. The operation of the ATHENA Educational Model depend on the achievements of several other work packages, such as WP8-Infrastructure – blockchain, Moodle Net and virtual classrooms – or WP6-Industry – FabLabs and BlendEd challenge base project courses. By stimulating the international contacts during studies through COIL courses and blended mobility approaches we have increased students' mobility to unprecedented levels, reaching 100% in the case of the Department of Informatics of the School of Engineering of the Polytechnic of Porto.
Date of report	4. 9. 2023

Work-package 4
Research: Stimulating research within the Alliance

WP Leader Tatjana Welzer Družovec

Affiliation University of Maribor

Structure of the WP

Tasks

T4.1. Cooperation model for R&D
T4.2. Joint R&D projects
T4.3. Activities for student R&D work and projects
T4.4. Raising awareness of ATHENAR&D research activities
T4.5. Link to industry

Deliverables

D4.1 ATHENA R&D model
D4.2 ATHENA R&D website page
D4.3 ATHENA R&D annual book
D4.4 D4.4 Shared resources directory

Results, achievements, and ATHENA integration

From the aspect of research and innovation, the ATHENA Cooperation Network is built of regional entry points facilitating capability identification and joint interests of alliance members. The entry points - agreed upon and mutually used with WP6 - are called ARICs (ATHENA Research and Innovation Coordinators). The cooperation model is complemented by the Shared Resources Directory (SRD), a powerful database of research areas, fields of expertise, joint projects, research equipment, and open research infrastructures available within the ATHENA alliance.
Two volumes of the ATHENA Research Book publication have been produced. Both volumes aggregate the research endeavours of the ATHENA alliance members, their research capacity, and the involvement of students in research and innovation. The book is an account on the ATHENA research landscape, serving wide audiences and initiating new means of research cooperation.
The ATHENA R&D website page is fully integrated into the official ATHENA website, where all background and hands-on information for various stakeholders are available, e.g., a list of open calls, funding opportunities for strengthening the joint activities of ATHENA partners and industry cooperation-related information (with WP6) and the mirroring of selected data from the records in Shared Resources Directory.
The WP4 team is supporting and facilitating the work of the ATHENA Research Board.
Several research-related events have been organised by alliance members and/or jointly with other European university alliances: ATHENA seminar series, ATHENA talks, Motivating women and girls in ICT, Women in Leadership, two PhD Forums, two ATHENA's World Intellectual Property Days. Noticeable contributions have been made with active participation at the EUNICE European university summer schools in the field of cybersecurity and the Cybersecurity of Learning Environments handbook was published. Similarly, participation in the EUTOPIA European university events and Circle U alliance also demonstrate Athena's openness to other European universities.

Date of report 28. 8. 2023

Work-package 5
Branding: Creation of an ATHENA brand and identity

WP Leaders Asta Radzevičienė, Eglė Girdzijauskaitė

Affiliation Vilnius Gediminas Technical University

Structure of the WP

Tasks

- T5.1 Market research
- T5.2 Development and implementation of Branding and Communication strategy
- T5.3 Development and implementation of the follow-up branding and communication action plan

Deliverables

- D5.1 Market research report
- D5.2 Branding and communication strategy paper
- D5.3 ATHENA brand book
- D5.4 Communication action plan
- D5.5 ATHENA website report
- D5.6 Follow-up branding and communication action plan

Results, achievements, and ATHENA integration

ATHENA Branding and Communication is crucial for the management and integration of joint efforts, to:

- Spread the ATHENA message, strengthen the ATHENA brand, disseminate and increase the visibility of the alliance initiatives.
- Raise awareness of the stakeholders and main target groups (internal and external) about the alliance, create connections within the eco-system, and facilitate engagement.
- Attract new individuals and organizations to join ATHENA activities, increase impact and growth, and build up ATHENA communities.

The fundamentals of the ATHENA Branding and Communication strategy are based on the Higher Education Market Research, which encompasses competitor communication analysis (positioning, needs addressed, channels) and value propositions of 41 European University alliances. ATHENA's Communication Strategy, Brand book, Branding rules, and communication kits (online templates, guidelines, galleries of visuals, etc.) are the main tools to develop ATHENA's brand identity and implement strategic and operational communication. ATHENA Branding and Communication strategy sets the objectives of the communication during and after the 2020-2023 lifecycle and has been implemented through communication action planning, which integrates long-term directions with annual plans, corresponding KPIs, and identification of the required human and technical resources. The strategy and Action plans, guidelines, tools, 6 digital communication channels (website athenauni.eu, Facebook, Instagram, Twitter, LinkedIn, YouTube), coordinated interplay between centralized and decentralized activities, clear task distribution between partners, regular performance monitoring and analysis, competences of the communication team and its upskilling and training are the main building blocks of the ATHENA communication model. This makes ATHENA Virtual communication office fully operational and serves as a backbone for the continuity and sustainability of ATHENA activities.

Date of report 30. 8. 2023

Work-package 6
Industry: Fostering strong links with the corporate partners

WP Leader Peter Haring Bolívar
Co-Leader Ilka Kureck

Affiliation University of Siegen

Structure of the WP

Tasks

- T6.1 Establishment of an effective Industry Interface
- T6.2 Develop a new University-Enterprise cooperation model/mindset
- T6.3 Establish innovative University-Enterprise cooperation practices
- T6.4 Promote transfer of R&D knowledge and results to society

Deliverables

- D6.1 Industry Interface Committee report
- D6.2 Labour market needs report

Results, achievements, and ATHENA integration

The objective of WP 6 is to foster collaboration with industry. WP 6 has established strong links with companies through international network meetings between companies and researchers, company visits, online events, and participation in industrial fairs. Communicating with industrial stakeholders serves two objectives of our European University: 1) promoting joint research with industry, 2) adapting our educational offers to current market needs. Recently, we published a course catalog for further education and training, providing both, technical trainings and management courses for managers and employees working in industrial companies. Moreover, we have run a needs survey among companies and start-ups in our regions. The results of this survey were evaluated in our Labour Market Needs Report to help improve and expand our offers in the future. Our joint ATHENA Career Service organizes cross-border activities, such as online job fairs for students interested in an industrial career. In addition, we provide the PRAXIS platform – our platform for internships. Another joint facility that has been established under WP 6, is the ATHENA Co-Creation Hub, a collaboration of our FabLabs, Makerspaces and Design Factories. The hub provides practice-oriented education for students, but also for interested citizens. Here, industry partners can connect with students and local communities by contributing to co-creation activities, such as practice-oriented workshops. All WP 6 activities are supported by local ARICS (ATHENA Research and Innovation Coordinators), and by the Industry Interface Committee, that was established to provide strategic advice regarding industry collaboration within ATHENA.

Date of report 13. 7. 2023

Work-package 7
Internationalisation: Transforming our institutions, networking and outreach

WP Leader Virginie Le Tallec

Affiliation University of Orléans

Structure of the WP

Tasks

- T7.1 Establish the ATHENA International Relations Office
- T7.2 Promote activities for internationalization
- T7.3 Generalise the use of the European Student Card
- T7.4 Setup the required conditions to promote a mobility culture
- T7.5 Teacher / researcher support in each institution

Deliverables

- D7.1 Operating model for the ATHENA International Relations Office
- D7.2 Staff training modules
- D7.3 Action plan for teacher/researcher support

Results, achievements, and ATHENA integration

Internationalisation is at the core of ATHENA activities and is therefore essential to build our European University on solid and deep cooperation between all partners. Work Package 7 is continuously developing the international activities of the ATHENA community, i.e. students, researchers, teachers, administrative staff as well as other stakeholders.

Through the establishment of the ATHENA International Relation Office (IRO), ATHENA facilitates the mobility of students, academic and administrative staff between all partner universities, for example by creating the ATHENA Mobility Fair to encourage and advertise ATHENA mobility opportunities for students.

The ATHENA IRO also works towards the implementation of virtual mobility through creating the necessary administrative framework. In addition, a support plan for teachers and researchers has been devised to help them in their efforts to internationalise their courses, develop new collaborations and set up new multilateral diplomas.

To further internationalisation in departments of our universities that are not yet exposed to a multicultural environment often enough, ATHENA now offers staff training opportunities for academic and non-academic staff in all member institutions. For example, a series of interactive talks on soft skills has been set up, called the ATHENA Soft Skills Academy.

In parallel, the ATHENA Internationalisation Committee has been created to tackle the strategic aspects of internationalisation.

ATHENA develops connections with the civil society as it is grounded in the local ecosystems of the member universities. One highly visible initiative that is led by the internationalisation work group is the Europe Day ATHENATHON, mobilising each year hundreds of students and staff.

Date of report 4. 9. 2023

Work-package 8
Infrastructure: Online tools and software for the Alliance

WP Leader Daniele Barettin

Affiliation Niccolò Cusano University

Structure of the WP

Tasks

- T8.1 Mobility assistance repository
- T8.2 Implementation of a common infrastructure supporting learning at a distance
- T8.3 Setting up a blockchain platform

Deliverables

- D8.1 Blockchain backbone report
- D8.2 E-learning platform materials
- D8.3 Multimedia lab manual
- D8.4 Virtual classroom manual

Results, achievements, and ATHENA integration	The WP has been dedicated to the implementation of the Athena multimedia classroom standard to define a single standard for synchronous, asynchronous, classical and laboratory teaching with different hardware and software instruments in order to minimize the differences between in-presence and online teaching. Any specification of each tool has been described in detail in the deliverables. In particular we have described the use of touch monitors and their configuration within the classroom, sets of ambient and personal microphones, environmental cameras both for students and teacher, monitors for instant use of interactive chats, and any other possible tool. The WP also worked on the construction of Athena multimedia classrooms. This implied an implementation of the platform for access to courses and learning materials, the implementation of several common standards, until our final choice of Moodle LMS (learning management system) as the standard platform of the project. A specification of guidelines for the deployment of the platform has been implemented, and it has been updated according to the subsequent phases of the Moodle LMS. Analysis and testing of a system for connecting universities have been carried out concerning data, materials and courses, together with an analysis of GDPR requirements and feasibility for different solutions, as MNet and SSO (eduGain). The possibilities of an implementation of different Moodle platforms for individual universities in the consortium were also considered. Finally, an analysis and an implementation of a secure certification system with blockchain technology for managing degrees, exams, grades and careers (EduCTX) has been performed.
Date of report	23. 8. 2023

Work-package 9
Sustainability and Dissemination

WP Leader Konstantinos Petridis

Affiliation Hellenic Mediterranean University

Structure of the WP

Tasks

- T9.1 Development and implementation of ATHENA Dissemination Plan
- T9.2 Development of the content for dissemination activities
- T9.3 Establish connections with national and regional governmental education entities
- T9.4 Annual conference
- T9.5 Development of the Sustainability Plan

Deliverables

- D2.6 ATHENA Dissemination Plan
- D2.7 ATHENA Sustainability Plan
- D2.8 ATHENA package of dissemination materials

Results, achievements, and ATHENA integration

Dissemination and sustainability are two important concepts that play a crucial role in the ATHENA University Alliance. The activities of this WP led by the HMU with the active participation of all the partners. The main objectives of this WP were: (a) the awareness/communication of the stakeholders (students, administrators, scholars, Erasmus National Agencies, the Commission, the Industry and other Alliances) within and beyond the Alliance of its outcomes and events; (b) to identify which processes & outcomes will sustain and how. The implemented activities are foreseen in the two main documents of this WP which are: (a) the dissemination plan; and the sustainability plan. The main achievements of this WP are the following:

- The dissemination plan.
- The sustainability plan (under construction) – to identify which and how to sustain processes, services the Alliance contains and offers.
- The ATHENA website and social media (Facebook, Twitter).
- The production of dissemination material (posters, leaflets, interviews, videos)
- The organization & implementation of two International Weeks in 2021 and in 2022 in Crete, Greece.
- The organization and implementation of scientific events (colloquial talks, online schools, round table discussions).
- The organization of the 1st ATHENA Technology Forom (September, 2023 in Sitia, Crete, Greece).
- The organization of athletic events (e.g. ATHENATHON).
- The organization of students hackathon.
- The ATHENA celebration events (e.g. in CUAS, in ATHENA student ESN inauguration event)
- The establishment of the ATHENA Grant & Support Office.

The impact of the ATHENA dissemination and the sustainability actions are reflected by the following numbers:

- The more than 9000 views of its academic activities.
- The more than 1000 followers in our social media.
- The participation of more than 2000 online participants in our dissemination activities.
- The attraction of about 1.500.000 Euros from other Erasmus grants as a result of the partners' collaboration002E

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ATHENA Research Book, Volume 2

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Abstract. *The ATHENA European University is an alliance of nine Higher Education Institutions with the mission of fostering excellence in research and innovation by facilitating international cooperation. The ATHENA acronym stands for Advanced Technologies in Higher Education Alliance. The partner institutions are from France, Germany, Greece, Italy, Lithuania, Portugal, and Slovenia: University of Orléans, University of Siegen, Hellenic Mediterranean University, Niccolò Cusano University, Vilnius Gediminas Technical University, Polytechnic Institute of Porto, and University of Maribor. In 2022, two institutions joined the alliance: Maria Curie-Skłodowska University from Poland and University of Vigo from Spain. Also in 2022, an institution from Austria joined the alliance as an associate member: Carinthia University of Applied Sciences. This research book presents a selection of the ATHENA university partners' research activities. It incorporates an overview of the research activities of each member, a selection of the most relevant bibliographic works of the members, peer-reviewed student papers, a descriptive list of the ATHENA Talks and reports from the individual work packages of the ATHENA project. The ATHENA Research Book provides a platform that promotes joint and interdisciplinary research projects of both advanced and early-career researchers.*

Keywords. European University, Erasmus+, research, interdisciplinarity, co-operation

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