Development of a Prototype for a Smart Bracelet that Detects Falls for Multiple Sclerosis Patients using SCRUM Framework

Student: Katerina Kalcher

Telecommunication & Automation Systems, Master level, Department of Electronic Engineering, School of Engineering, Hellenic Mediterranean University, Romanou 3, 73100 Chania, Greece
katiakalch@gmail.com

Mentors: Konstantinos Petridis, Emmanuel Lourakis

Department of Electronic Engineering, School of Engineering,
Hellenic Mediterranean University, Romanou 3, 73100 Chania, Greece
{cpetridischania, lourakismanolis}@gmail.com

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

University of Maribor Press

DOI https://doi.org/10.18690/um.4.2023.17
ISBN 978-961-286-783-6

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.

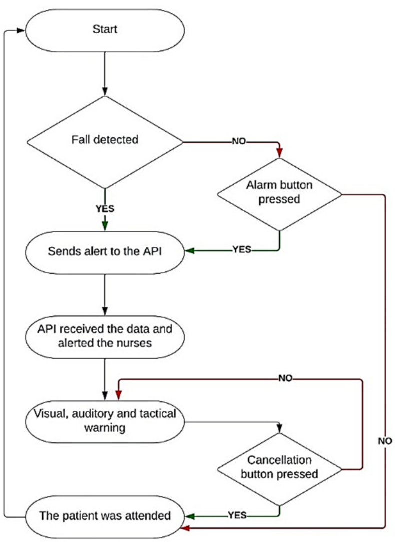
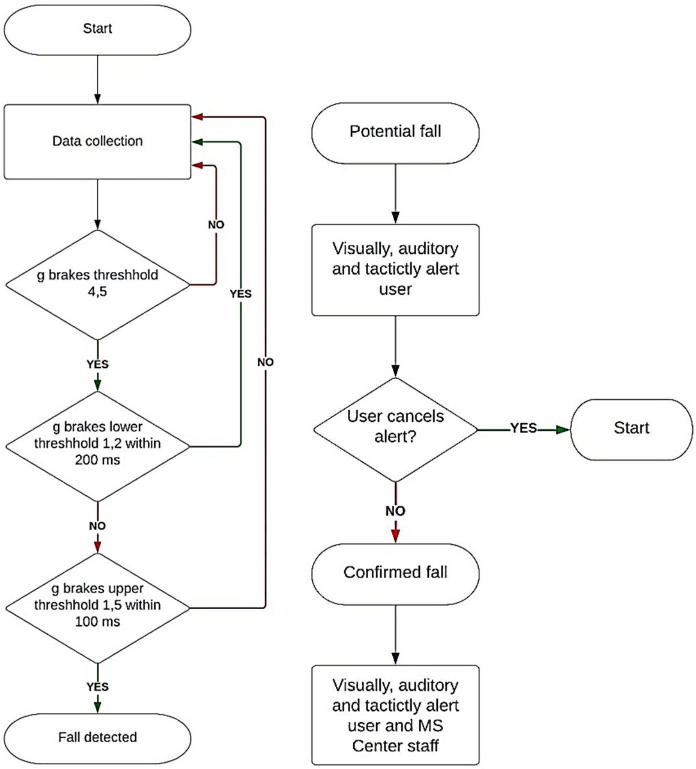


Figure 1. Bracelet Operation Flowchart

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.

References

[1] Ghasemi, N., Razavi, S., & Nikzad, E. (2017). Multiple Sclerosis: Pathogenesis, Symptoms, Diagnoses and Cell-Based Therapy. *Cell journal, 19*(1), 1-10. doi:10.22074/cellj.2016.4867

[2] Karakas, H., Seebacher, B., & Kahraman, T. (2021). Technology-based rehabilitation in people with multiple sclerosis: A narrative review. *Journal of Multiple Sclerosis Research, 1*(3), 54-58. doi:10.4274/jmsr.galenos.2021.2021-10-3

[3] Coote, S., Sosnoff, J. J., & Gunn, H. (2014). Fall incidence as the primary outcome in multiple sclerosis falls-prevention trials. *International Journal of MS Care, 16*(4), 178-184. doi:10.7224/1537-2073.2014-059

[4] Schwaber, K., & Sutherland, J. (2020, November). *The scrum guide - the definitive guide to scrum: The rules of the game*. Retrieved February 8, 2023, from Scrum Guides: https://scrumguides.org/docs/scrumguide/v2020/2020-Scrum-Guide-US.pdf