Art Sensorium Project: A System Architecture of Unified Art Collections for Virtual Art Experiences

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This paper introduces Art Sensorium Project that is founded in Asia AI Institute of Musashino University. A main target of the project is to design and implement a system architecture of unified art collections for virtual art experiences. To provide art experiences, a projection-based VR system, called Data Sensorium, is used to stage art materials in a form of real-sized virtual reality. Furthermore, a system architecture of a multidatabase system for heterogeneous art collection archives is presented, so a set of integrated art data is applied to Data Sensorium for newly generated art experiences.

Keywords:
museum systems, multidatabase systems, multimedia databases, immersive image, projection-based VR

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1 Introduction

A term virtual museum has been widely discussed for a long time. A definition of virtual museums is as follows: "a collection of digitally recorded images, sound files, text documents and other data of historical, scientific, or cultural interest that are accessed through electronic media[1]." It could include various digital archives, databases, applications, digital gadgets and so on, so applying digital technologies to the area of art seems matching to the definition. To design and to implement virtual museums, there are many technologies expected to apply. In [2], seven technologies are mentioned useful to implement virtual museums as follows: 1) High Resolution Images, 2) Web3D, 3) Virtual Reality, 4) Augmented Reality, 5) Mixed Reality, 6) Haptics, 7) Handheld Devices.

In recent years, many museums have worked to construct digital archives of their art collections such as Louvre Museum[3]. In addition, some museums have published their digital data archives as open data[4,5]. These open data are provided through Web API, so many kinds of digital innovation are expected to come in the area of art. As a commercial activity, Google Arts & Culture[6] is an widely-used example that presents master pieces of art museums in forms of mobile applications or virtual reality on screen.

Governmental activities are also very active recently and globally. United Kingdom has launched a national project to establish a national collection with digital technologies, and it also targets to establish innovation using data of cultural heritages[7]. In Japan, some public services have been established such as Cultural Heritage Online[8] that integrates information of cultural heritages across many museums in Japan, and Art Platform Japan[9] that provides information of contemporary Japanese artworks.

The services like [6,8] provide accessibility to masterpieces of museums by integration, but a system framework to stage any artwork by integrating various digital archives is not proposed.

Museums, in general, provide art exhibitions designed with knowledge, experiences and inspirations of curators to provide art experiences for visitors. The actual museums provide exhibitions in common to all visitors since exhibitions are real and

static. However, a virtual museum in a virtual reality environment could provide a personal exhibition with dynamic curation according to visitor's favour.

The primary purpose of the art experience in this research is to stimulate the user's intellectual curiosity, appeal to his/her emotions, and provoke an emotional response through the provision of various art data. Furthermore, the art experience includes cross-cultural exchange, such as the visualization of different subjectivities through an environment that brings people into contact with art from all over the world, and the inspiration for the creation of new art.

In this paper, we would like to introduce *Art Sensorium Project* that dynamically integrates multiple art collection archives to stage art experiences in Data Sensorium.

2 Data Sensorium

Data Sensorium is a conceptual framework of systems providing physical experience of content stored in database[10], and Data Sensorium consists of spatial immersive display in a form of room-like display, various sensors that detect behaviour of users, and mechanical subsystems that provide haptics.

A prototype system of the Data Sensorium was implemented with four 120-inch screens and corresponding projectors, and Torus Treadmill[11] as shown in Fig.1.The Torus Treadmill is a locomotion interface that creates sense of walking.

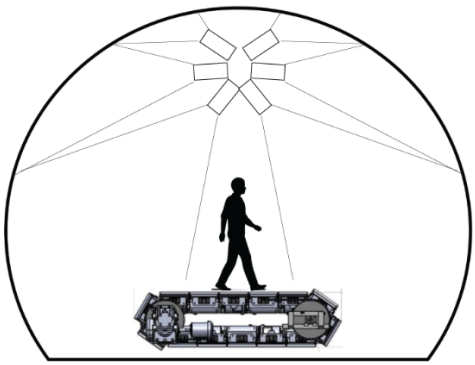

Figure 1: Data Sensorium

Source: own.

Art Sensorium Project

Art Sensorium Project started to stage art experiences in Data Sensorium. Fig.2 shows early sketches of the project to study expected applications of Data Sensorium in the area of art as follows:

A: Data Sensorium as Database User Interface

Visitors are expected to interactively search art collections to explore artworks such as searching artworks according to an artist, a museum, a motif, etc in Data Sensorium.

B: Reproduction Environment of Past Exhibitions

As mentioned above, art exhibitions are intellectual product of curators to stage actual artworks in a specific space, however the exhibition disappears when the exhibition finishes. Virtual reality, especially Data Sensorium, could be a candidate technology to restore any exhibition in the past.

C: Virtual Museum with Dynamic Curation

Functionalities of dynamic curation are essential to automatically generate art exhibitions, and also very challenging. Knowledge base approaches such as [12,13] or machine learning approaches are currently under discussion to realize the dynamic curation.

D: Environment for Remote Participation in the Exhibition

Data Sensorium could be used as a remote controller for a robot with an omnidirectional camera, and such combination could make it possible to remotely attend an actual art exhibition in Data Sensorium.

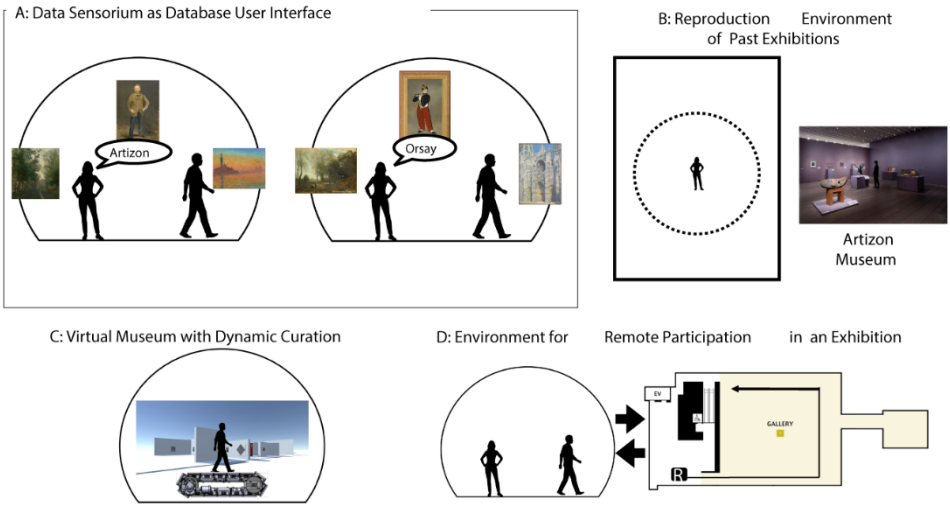

Figure 2: Early Sketches of Art Sensorium Project

Source: own.

A current collaboration scheme is shown in Fig.3. So far, a data set of Artizon Museum[14] is connected using Artizon Cloud[15], as well as the open-data of The Metropolitan Museum of Art[4] and Paris Musées[5]. Prototype systems of Data Sensorium in Musashino University as well as Thammasat University are already implemented, and Empowerment Studio of Tsukuba University is also discussed for the connection.

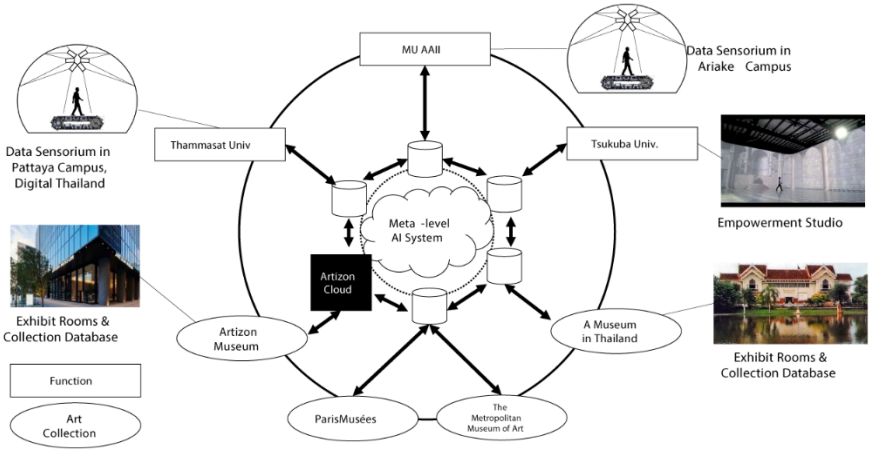

Figure 3: A Collaboration Scheme of Art Sensorium Project

Source: own.

4 A System Architecture for Art Sensorium Project

A system architecture of Art Sensorium is composed by two essential parts. Firstly, art data of each museum are integrated in a multidatabase system as Fig.4. Secondly, Data Sensorium Applications receive the integrated data to stage virtual exhibitions.

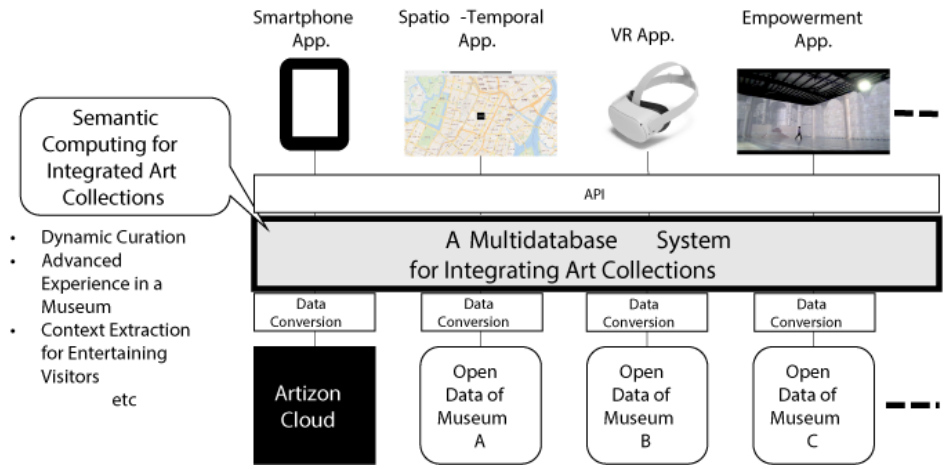

Figure 4: A System Structure of Art Sensorium Project
Source: own.

4.1 A Multidatabase System for Art Sensorium Project

An system architecture of the multidatabase system is shown in Fig.5. There are many approaches to design and implement multidatabase systems[16,17,18,19]. However, the meta-level system approach[20,21,22,23], seems applicable for the Art Sensorium Project by following reasons:

1. Flexibility to solve heterogeneity of local database structures and their access methods is a top priority, and the simple architecture to implement the multidatabase system is very important.
2. Solving heterogeneity in data formats and languages comes as a second issue, and flexibility is again very important to solve the problem for heterogeneity among various museums.

3. Semantic computing to realize the dynamic curation will be a critical issues to come, and the meta-level system approaches are observed as a good solution [12, 13,24].

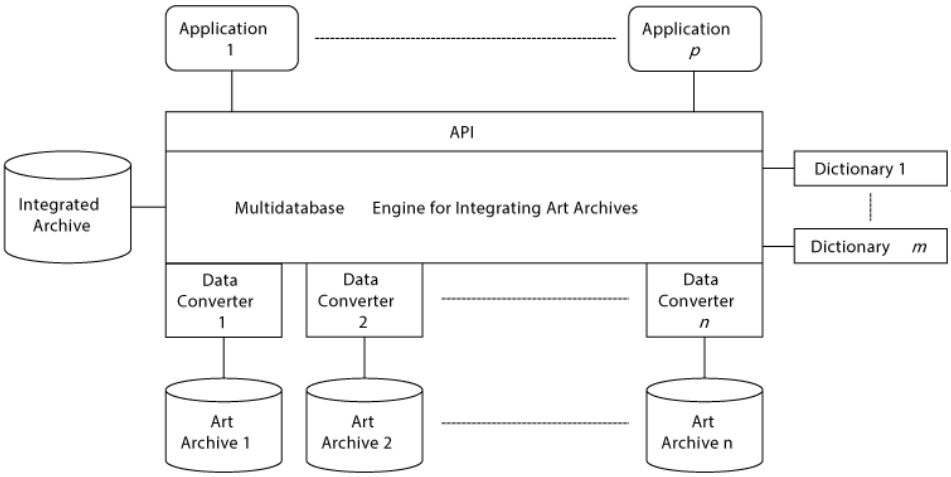

Figure 5: A Multidatabase System Architecture of Art Sensorium Project
Source: own.

To match such requirements, local data archives are connected to the multidatabase engine through corresponding data converters. Heterogeneity in data format, such as artist names, are converted using dictionaries, and the data are stored in the integrated archive as shown in Fig.5. An implementation method of the multidatabase system is described in [25].

4.2 Data Sensorium Applications

To design and implement Data Sensorium Applications, two key aspects are involved as follows:

1. Designs and implementations of gallery floors
2. Curation functions to stage artworks in 1

As Data Sensorium Applications, two prototype applications have been implemented. Dynamic generation of the gallery floor is quite challenging, so these prototype systems use static gallery floors. However, artwork data are delivered

through the multidatabase engine, so artworks are dynamically staged in Data Sensorium. All these applications are implemented with Unity[26].

4.2.1 Reproduction Environment of Past Exhibitions

For a reproduction environment of a past exhibition, a floor layout of an exhibition "Inaugural Exhibition Emerging Artscape: The State of Out Collection", that was held 18/Jan./2020-31/Mar./2020 at Artizon Museum[14], was virtually reproduced as show in Fig.6.

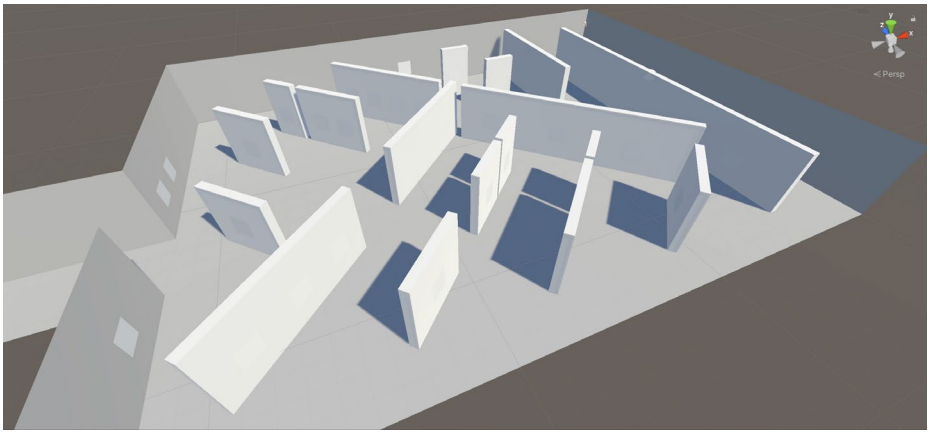

Figure 6: An Example Floor of a Data Sensorium Application
Source: own.

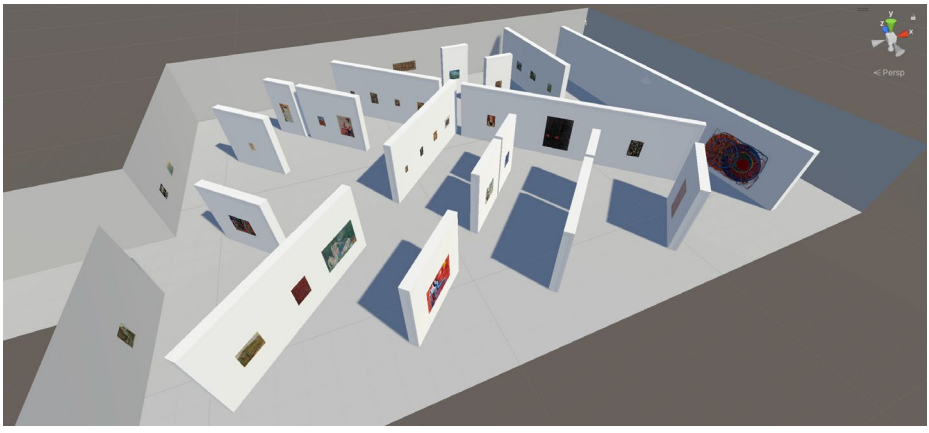

Figure 7: Representing a Past Exhibition in the Data Sensorium
Source: own.

A list of artworks corresponding to each wall is stored in the multidatabase system, and URLs of artwork images are transmitted to each wall as shown in Fig.7.

4.2.2 A Virtual Museum with Dynamic Curation

As a prototype application of a virtual museum with dynamic curation, 10*m* x 10*m* a cube shaped gallery was constructed in Unity, and 2 planes on a wall are assigned to stage each artwork as shown in Fig.8.

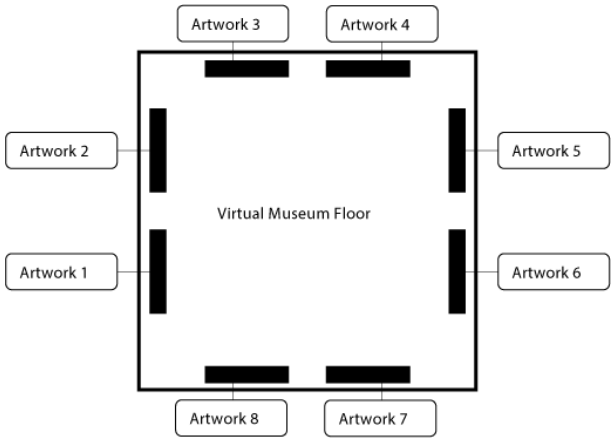

Figure 8: A Virtual Exhibition Room
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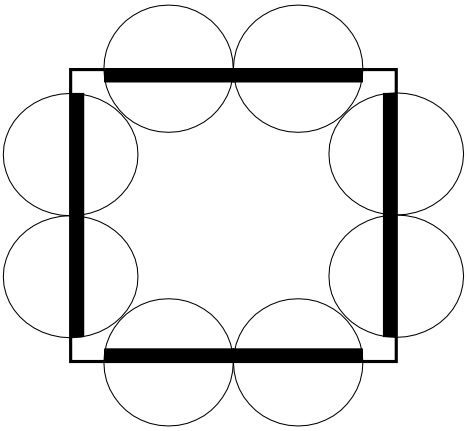

Figure 9: Invisible Spheres to Detect a Visitor
Source: own

Since the prototype system of Data Sensorium consists of the spatial immersive display and Torus Treadmill, but it does not have any other sensor. Therefore, invisible spheres have been set according to each plane for an artwork to detect if an user is close to the artwork as shown in Fig.9.

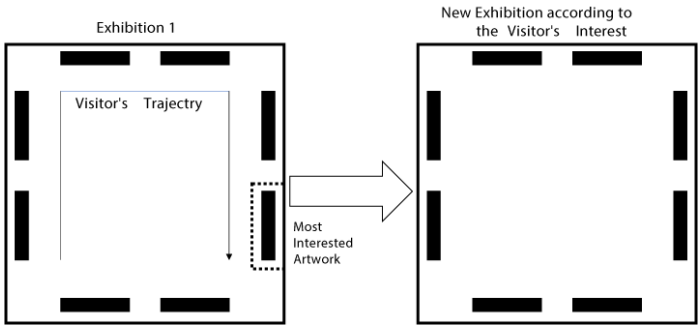

Figure 10: A Transition of Virtual Exhibition Rooms
Source: own.

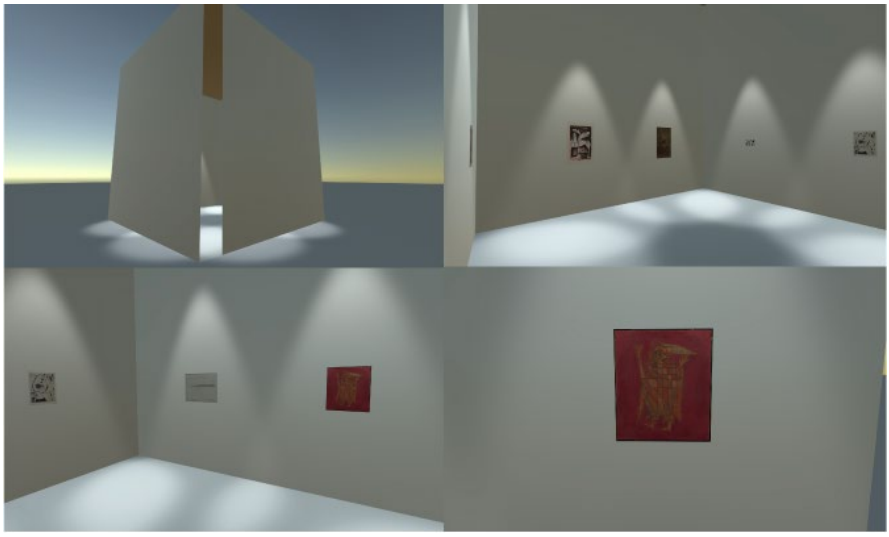

Figure 11: An Example of a Virtual Exhibition
Source: own.

Once an user enters the virtual gallery, 8 artworks are randomly selected and staged from a set of artworks that are staged in actual Artizon Museum at the same time. Then, the user takes a look on each artwork, and the most interested artwork is

extracted by using times spent in each invisible spheres. Furthermore, 8 newly selected artworks are selected relating to the previously selected the most interested artwork when the user reloads the gallery as shown in Fig.10.

Some example screenshots of the gallery is shown in Fig.11, and more details for the implementation method for creating the gallery is presented in [27].

5 Conclusion

In this paper, *Art Sensorium Project* was introduced. The main target of the project is to design and implement the system architecture of unified art collections for virtual art experiences. The system architecture of the multidatabase system that integrates various digital art archives was proposed, as well as Data Sensorium applications were mentioned.

For the future issues, there could be many strategies for the dynamic curation. The knowledge of curators should be treated as knowledge bases for generating an exhibition, or physical/logical perspective of artworks could be computed to generate an exhibition in a form of machine learning. Sensing techniques for one's emotion or interest is also an issue. Above all, a system architecture that provides capabilities to implement such variety of strategies for dynamic curation is strongly needed as a collaboration framework.

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