Faculty of Cognitive Sciences and Human Development

AUGMENTED REALITY FOR MUSEUM ARTIFACTS VISUALIZATION

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ABSTRACT

AUGMENTED REALITY FOR MUSEUM ARTIFACTS VISUALIZATION

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Recently, advances in computer graphics and interactive techniques have expended the visual quality and field of Augmented Reality (AR) applications. Research regarding to indoor exhibition systems associated with the use of AR technologies is getting more general. This project describes an AR based system for overlaying computer generated information on the real world where museum artifacts are digitized in this project and superimposed in real scene. Furthermore, this project also presents the information of the artifacts in virtual form. 3D models are created and rendered in an AR environment providing an opportunity for museum visitors to visualize virtual artifacts in the context of other contextual information.
ABSTRAK

AUGMENTED REALITY FOR MUSEUM ARTIFACTS VISUALIZATION

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Baru-baru ini, kemajuan dalam bidang grafik komputer dan teknik interaksi telah meningkatkan kualiti visual dan meluaskan aplikasi teknologi ‘Augmented Reality’ dalam bidang yang berlainan. Kajian tentang penggunaan teknologi AR dalam sistem pameran artifak muzium dalam bilik menjadi semakin umum. Projek ini membentangkan satu sistem yang mengaplikasikan teknologi AR dalam pameran artifak muzium dengan memodelkan artifak dalam bentuk model tiga dimensi supaya artifak maya ini dapat disimulasikan dalam persekitaran dunia sebenar. Selain itu, projek ini juga mempersembahkan infomasi artifak dalam konteks maya. Model 3D yang dihasilkan dan berfungsi dalam persekitaran maya membolehkan pelawat muzium dapat melihat artifak maya dalam konteks yang lain daripada artifak biasa.
CHAPTER 1
INTRODUCTION

1.0 Overview

This chapter comprises of the introduction for this project. It discusses about the background, problem statement, objectives, contributions and the scope of this project.

1.1 Background

An artifact is any object made or modified by a human being which contain the information about the culture of its creator and users, and later discovered by archaeologist. According to Digital Artifacts (2008), the artifact may change over time in terms of what it represents, how it appears and how and why it is used as the culture changes over time. Examples of artifacts include monument, pottery vessels, metal objects such as buttons or guns, and personal adornment items such as jewellery and clothing. Other examples include bone that show signs of human modification, fire cracked rocks from a hearth or plant material used for food. Artifacts can come from any archaeological context or source such as:

- Buried along with a body (grave goods).
- From any feature such as a midden or other domestic setting
Besides cultural artifacts, there are also other forms of artifacts. Digital artifact is another type of artifacts which are visibly defected in a digital photo or video picture that was specifically caused by the digital encoding (Digital Artifacts, 2008). Recently virtual artifacts pop out as a new alternative for artifact. Virtual artifact is an object which is not physically exists in real environment but present in digital environment, for example the Internet, virtual reality (VR), cyberspace and augmented reality (AR). The term "virtual artifact" has been used in a variety of ways in scientific and public discourse (Virtual Artifact, 2008). Previously it was referred to objects such as images, models, prototypes, computer animation or virtual books that exist in digital environments. Nowadays virtual artifact extends their role to different field such as museum artifacts exhibition where real world artifacts are modeled or reconstruct in a digital environment.

Museum is a place where the collections of cultural heritage is protected and exhibited. It also provides better understanding of history. According to the International Council of Museums, a museum is defined as a non-profit making and permanent institution that is open to the public. It also acquires, protects, research, communicate and exhibit cultural heritage for purposes such as research, education and enjoyment (Museum, 2008).

Some recent surveys in Europe show that about 35% of museums have already started developments using AR and VR technologies to present the objects (Tsapatori, 2003). Rapid development of technology results in facing the new paradigm of museum. The challenges of museum such as extended types and quantity of materials require rethinking conventional concept of museum. Even though new technologies are changing the museum environment gradually, it still
 keeps its role and purpose as its functions are exhibition, communication research and conservation.

One of the benefits of the advance technology for museum is it provide a tremendous way to exhibits museum artifacts. Besides conventional display in the gallery, AR technology offer new possibilities where the artifacts are digitized to several forms so call virtual artifacts and augmented artifacts. VR is a user interface technology that allows users to interact with a computer simulated environment through human sensory channels in real time (Virtual Reality, 2007). The virtual world is interactive where the users interact with the system with real-time response in an effective way. Then, the users are immersed in this virtual environment.

VR technology has already reached the level of maturity which allowed it to be applied in real life application such as cultural heritage. The virtual museum and its artifacts is a generation of three-dimensional scene by computer and it requires high performance computer graphics system to provide a sufficient level of realism to the environment.

[Figure 1](a) Image of real artifacts (b) Image of virtual artifacts

AR is one of the variations of VR. It is a different application where the virtual objects superimposed upon in the real world environment and the users are interacting with this virtual object in real time (Vallino, 1998). AR on the other hand extends VR systems with the support for blending real and virtual elements into
seamless composite scenes. It offers a natural view of virtual objects in real scenes. AR enhances the physical reality by integrating virtual objects into the physical world which become an equal part of the natural environment (Augmented and Mixed Reality, 2000). As stated by Vallino (1998), one of the objectives of AR is to augment the real world while maintaining users’ sense and feel of existing in a real world.

In this project, real museum artifacts are converted to augmented artifacts. This project constitutes the concept of augmented museum with real museum where the exhibited artifacts are digitized to render in the AR environment.

1.2 Problem Statement

Museum usually holds a lot of collection of artifacts which they cannot exhibit them publicly especially those unique artifacts, since the security and the preserving of the artifacts is one of the important factors. They need to take into account the risk on the nature and fragility of the artifacts.

One of the disadvantages of the conventional exhibition is the interaction between the visitors and the artifacts are limited. The visitors cannot study the artifacts from different angles and in different context since the artifacts exhibited is static and protected in gallery or in the glass to prevent the visitors from touching and destroying it.

Museum is a place that provides an opportunity for the visitors to learn about the history and cultural heritage. In conventional museum, the information of the exhibited artifacts is presented using panels or leaflets. But the disadvantage of this method is it only provides small amount of information to the visitors since the information size is restricted by the physical area of the panel or paper. If the visitors want to know more about the artifacts they need to find the information by themselves through another media such as expert, books or internet. This is not a
convenient method for the visitors since they cannot get the information directly from the panels or leaflets.

Some museums might not have enough space and resources for them to exhibit the whole collection of artifacts to the public. Thus an effective solution is needed so that they can exhibit the whole collection to the public without requires wide space

1.3 Objective of study

The objective is divided into two categories which are the general objectives and specific objectives.

1.3.1 General Objective

The aim is to design and develop an augmented reality system for museum artifacts application.

1.3.2 Specific Objectives

The specific objectives of this project are:

- To design and develop an effective system for user and artifacts interaction using Augmented Reality technology
- To enhances the effectiveness of artifact exhibition

1.4 Contribution

This project develops a system for museum artifacts visualization using AR technology. This technology offers a great help where it provide solutions enabling visualization of 3D digital models of artifacts in both virtual and real environment.

AR technology is an emerging technology which enables the artifacts to be digitized and replace the original artifacts in exhibition for some purpose such as protection. This system will help to protect unique artifacts where the security and
nature and also fragility of the artifacts are considered. It provides some advantages to museum where the possibilities of the artifacts will be damage during exhibition are eliminated. On the other hand this system presents the virtual artifacts to visitors for study and exhibition purpose.

Using this technology, it enable museum to exhibit whole collection of artifacts in limited space. Typically in conventional artifacts exhibition, the artifacts are protected in gallery which requires wide spaces and this caused only part of the artifacts to be exhibited. Thus by digitizing the artifacts, there is no necessary to put the virtual artifacts in gallery since it is a virtual model. Consequently, available space can be used to display the other artifacts to the public.

Apart from that, it also allows visitors to interact with the model in variety of ways. The visitors can interact with the content in a more intuitive and exciting manner. They can interact with the artifacts in real time such as look at the artifacts from all angles, compare the artifacts and study them in different contexts without the existing of hindrance as in conventional exhibition method. Furthermore, this system also involves spatial, temporal and contextual conceptualization and provide kinesthetic, explorative and knowledge-challenging stimulus. Users are given the freedom to the page and move the marker to create more interaction scenarios.

Besides that, this project offer more efficient way to present the information of the cultural heritage. More information can be shown using AR technology where the information is presented virtually in real environment. Since the two-way interaction between the artifacts and visitors is increased, it helps to increase the understanding of visitors on the artifacts presented.

Nowadays, museums are keen on presenting their collections in a more appealing and exciting manner to attract visitors. This method can help a museum to attract more visitors. Visitors will interested to visit the museum because of the
curiosity on the technology used and also the facilities provided that help them to interact and obtain the knowledge about the cultural heritage more easily and conveniently.

1.5 Project scope

Since there are few limitations in using conventional method to exhibit the artifacts, AR could solve the problem by bringing the virtual artifacts and enable users to interact with it in real environment. The scope of this project is to digitize the museum artifacts as real as original artifacts and display it in real scene using augmented reality technology. This system can help to enhance the visitor’s enthusiasm of learning and research about the cultural heritage.

1.6 Values of the study

The potential of using AR is to augment the user perception of the world around and enhancing their interaction (Augmented Reality, n.d.). Since AR provides safe environment, it can be used by anyone. This system proposes a new dimension in museum field. It allows user to have a more interactive environment and also provides an effective way to learn and understand more about the cultural heritage. Furthermore, it also offers a new way to exhibits the artifacts.

1.7 Significance of the study

The significant of the study is to expose AR technology and its application to the world. This system introduces an AR application that can be used in museum field to open people mind and obtain more understanding about AR technology.
1.8 Structure of the thesis

This paper consists of five chapters each explaining and discussing the feature occupied in the process of development of this system. This paper starts with chapter one which established the research topic and background information of this project. The overview of the literature is discussed in chapter two whereas chapter three will present the research methodology of this project. The system design is discussed in this chapter. Chapter four consists of the development of this project. Lastly discussion, conclusion and future work of this study is discussed in chapter five.

1.9 Conclusion

This chapter introduced the overview of this project. Apart from that, the background, problem statement, objectives, contribution and scope, values and significance and also the structure of this project are discussed. The following chapter will discuss about the literature review of this project.
CHAPTER 2
LITERATURE REVIEW

2.0 Overview

This part reviews about virtual reality (VR) and augmented reality (AR) research in museum application. Besides that 3D modeling tools and relevant software also discussed in this chapter.

2.1 Virtual Reality application in museum

VR is a computer generated system that allows user to immerse in interactive 3D environment (Ng, n.d., p.8). Many museum applications based on VRML has been developed for the web. This technology has been use to reconstruct the archaeological artifacts and historical sites. The examples of this technology in museum application are 3D Murale and The Rideau Street Chapel.

2.1.1 3D Murale

3D Murale is referring to 3D Measurement & Virtual Reconstruction of Ancient Lost Worlds of Europe. This project developed and using 3D multimedia tools to record, reconstruct, encode and visualized archeological ruins in Virtual Reality. It is aimed at developing a system capable of recording archaeology excavation phases using Virtual Reality techniques. Visualization of the
reconstructed site is important both for the scientists to test and document their hypotheses in virtual reality as well as for the broad public to get an idea of how the ancient city could have looked like (3D Murale, 2003).

This project used 3D multimedia tools to measure, reconstruct and visualize archaeological ruins in virtual reality using a test case which is the ancient city of Sagalassos in Turkey. Media and textual information about archaeological content is stored in a database. This content is structured by metadata information. Metadata information will make this content available by remote Internet access through the use of search engines for archaeological researchers and members of the public. Furthermore, the project offers the reconstruction of excavated remains of pottery, sculptures and buildings as well as their visualization in a way as they possibly looked like throughout ages (3D Murale, 2003).

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buildings as well as their visualization in a way as they possibly looked like throughout ages (3D Murale, 2003).

In this system, the users are able to freely navigate the ancient city. Collision detection is added in this system to avoid users passing through objects. To add the educational value, various kind of interactive multimedia such as textual information, images, movie, sound and recorded objects is integrated into the virtual environment. Guided tours is also provided to guide users navigate through the system. User can select to use signpost or an avatar virtual guide instead.

![Figure 2.1 Guide tours through signpost (left) and virtual guide (right).](image)

(3D Murale, 2003)

### 2.1.2 The Rideau Street Chapel

The Rideau Street Chapel or chapel of the *Convent of Our Lady of the Sacred Heart* in Ottawa was demolished by a developer in 1972. Luckily, its architecturally unique interior was taken apart and later reconstruct inside the National Gallery of Canada where it is currently preserved. Reconstructing a historical site as it once was or as it evolved over time is one of the most important goals of virtual heritage (El-Hakim, MacDonald, Lapointe, Gonz & Jemtrud, 2006).

This project objective is to digitize and model the existing interior and reconstruct the destroyed exterior from old images and drawings to create a complete virtual reconstruction of the chapel as it once was. The steps applied for modeling
and visualization of a heritage site through time is CAD modeling from existing engineering drawings, laser scanning with two different scanners, Photogrammetry, and modeling from old photos (Figure 2.2 and Figure 2.3). The existing engineering drawings, which were based on surveying and Photogrammetry, created the overall model of the interior of the chapel. The outside of the chapel was modeled from photographs taken before 1972. All models were integrated together and presented with the tools.

![Figure 2.2. Rideau Chapel: old images (up), virtual model (down)](image)

After that, all 3D models and other data are assembled by linking components to each other, correcting scale, filling gaps, and creating smooth transitions. An interactive presentation and high quality pre-rendered animations is created with all models and data and light modeling is done with different light types at various daytimes and seasons to increase the realism of the model.

![Figure 2.3 Current chapel interior: (a) overall view, (b) part of wire-frame model, (c) scanned data](image)

(El-Hakim, MacDonald, Lapointe, Gonzo & Jemtrud, 2006)
2.2 Augmented Reality

AR can be defined as referring to cases in which a real environment is “augmented” by means of virtual objects (Milgram & Kishino, 1994). AR has a wide variety of uses, as it can clearly demonstrate spatial concepts, temporal concepts and contextual relationships between both real and virtual objects (Aldridge, Bilinghurst, Garrie & Woods, 2004).

Figure 2.4 shows Milgram’s Reality Virtuality Continuum which describes the relationship between augmented reality and virtual reality (Milgram & Kishino, 1994). AR lies near the real world end spectrum with the perception in the real world augmented by computer-generated data. AR is a system which most objects in the environment are synthetic with some real world images mapped on it.

![Milgram Reality Virtuality Continuum](image)

Figure 2.4 Milgram Reality Virtuality Continuum.

Thus AR technology creates partially virtual and real environments which enable it to be applied to different application such as medical, entertainment, education, robotics or architectures. The goal of AR systems is to combine the interactive real world with an interactive computer-generated world in such a way that they appear as one environment (Vallino, 1998).

2.2.1 Augmented Reality Application in Other Fields

AR is getting common in human’s life. Research show that augmented reality provides solutions in many domains, its application areas ranging from education to military training. This section discussed some of the applications for AR.