VISUALIZATION AND INTERACTION METHODS FOR PORTABLE ANTIQUITIES OF SINDH

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Abstract

Protection and survival of cultural heritage depends on their preservation and availability to the public. Great nations do not let their cultural heritage be destroyed. Pakistan is bestowed with enormous wealth of cultural heritage. Sindh is one of four provinces of Pakistan; rich with cultural heritage from centuries that needs preservation and exposure to the world. A big collection of portable antiquities had been destroyed due to environmental changes and lack of resources for their preservation. Although, there are few archaeological sites such as Moenjo-Daro, Makli, Bhanbhor, Kot Diji and Rani Kot, for physical preservation of heritage objects, there is a desperate need to digitize and visualize this wealthy heritage to preserve its image for our future generations. A systematic digitization, visualization and interaction procedure will not only preserve this heritage in a digital form but it will also expose this rich culture to the world. This paper discusses cutting edge technologies and presents initial experimental results from our research. The aim of this research is to find optimal visualization and interaction techniques for portable antiquities of this region.

Keywords: Digital Heritage, Portable Antiquity, Visualization and Interaction Methods, Digital Heritage of Pakistan.

Introduction

Digital heritage contains computer-based virtual materials of enduring value that should be kept for future generations. Our cultural heritage has a great value so as its digitization process when compared with other sectors, communities and regions, in such a way that it requires active preservation approaches if continuity of digital heritage is to be maintained. The digital heritage is becoming more important and widespread over time with introduction of new technologies, interaction methods, requirements of access and need for preservation of cultural heritage.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) realizes the importance of a nation's cultural heritage and explains it as

> "Our legacy from the past, what we live with today, and what we pass on to future generations. A heritage is something that is, or should be, passed from generation to generation

because it is valued" [1].

With rapid growth in technology, increasing number of individuals, organizations and communities are using digital technologies to document and express what they value and what they want to pass on to future generations. New forms of expression and communication have emerged that did not exist previously. In the last decade, there has also been development in the area of digital heritage, new digital heritage libraries have been developed and various methods for visualization and interaction with digital objects have emerged. There are many ongoing and complete digital heritage projects in developed countries but there has been little or no development in this field in developing countries such as Pakistan. We have a cultural heritage of a great importance and it also requires preservation and exposure to other parts of the world. A few appropriate archival, visualization and interaction methods can be developed for our cultural heritage that will not only preserve it in digital format but it will also allow other heritage communities in every part of the world to study our heritage.

Background

In the last decade alone, there has been a significant work in the area of digital heritage. With the introduction of photogrammetric and realistic computer graphics techniques, the digital heritage archival, preservation, visualization, interaction and 3D reconstruction have been made easier than ever before.

Besides this work there are many other ongoing and successfully completed 3D heritage projects developed to enhance the digital heritage contents such as; creation, archival, exposition, presentation and interaction services for digital heritage collections. An example is BRICK - Building Resources for Integrated Cultural Knowledge Services [2] and DISPLAYS - Digital Library Services for Playing with Antiquity and Shared Heritage [3] provide infrastructures based on Grid/P2P through advanced archival, exposition and visualization and interactive services for the heritage community. The EPOCH Multimodal Interface [4] was implemented as part of a virtual museum interactive system developed for the rendering of 3d model and interacting with them on stereoscopic display.

Another 3D reconstruction project – Digital Repatriation of Medieval and Renaissance Galleries was completed at the Victoria and Albert museum, London. Although the church's Chapel and Altars were located in Florence, Italy but the idea was build a virtual environment of church with heritage objects to bring the feeling of original medieval era. The purpose of this digital repatriation project was to enhance tourism and bring enjoyment of the cultural heritage to tourists by using different techniques such as 3D reconstruction of The Chapel, Altar and Church. An interactive touch screen was provided to visitors of the museum to view different portions of the church, objects, and the people involved in the church. The project also has an online virtual museum for digital tourist [5].

Historical Importance of Sindh

Pakistan is bestowed with a large number of historical places and ancient sites; these historic assets represent the nation's history in terms living, working and cultural ethics. The Sindh province has rich cultural heritage crossing over centuries, going back to the BC era. The Indus Valley Civilization (IVC) also known as Bronze Valley Civilization is one of the three early and widespread old civilizations in the world, as early as 3300-1300 BCE [6]. During its florescence, Indus civilization was the most expansive, fabulous and spreading between India, Afghanistan and Pakistan. These culturally rich historic objects, monuments and sites are spread across Sindh. They represent various ages of our history and explain the richness of cultural ambiance of the Sindh province. This is our heritage and it

needs to be safeguarded, like family wealth to be passed on to future generations to maintain our distinctive identity. However most of the historic towns in Sindh are in the process of losing the valuable heritage [7], there are still many culturally rich archaeological sites, which require our immediate attention.

Selected Heritage Object: Our first selected portable heritage object was 'Statue of Buddha' which was found in Kahoo-jo-Daro, an ancient archeological site situated about half a mile away to the north of Mirpur Khas. The Mirpur Khas is known as gateway to the southeastern edge of the Sindh province. This ancient site is spread over 30 acres (120,000 m2). The excavation of the site has proved that the settlement belonged to the period of Buddha. The city was flourished in the first half of the sixth century AD. This object is currently stored in Sindhiology museum, University of Sindh, Jamshoro.

Visualization and Interaction

We understand 'visualization' as a communication process to represent data, information and knowledge in understandable and experience-able interface for its audience. It allows possibilities to display exact data, photorealistic visuals and easy to use user interfaces to observe visual form of data [8]. With rapid growth in the field of information technology, there are many visualization and interaction methods from simple hand drawings to CAD (Computer Aided Design), 3D representations, animations, augmented reality and even stereoscopic representations in virtual reality applications. Besides realistic looking objects, these technologies also offer easy to use and easy learn software interfaces, which can be learnt by a museum curator, researcher or a novice photographer.

In digital heritage domain, we normally find use of renders and pictures, which is not the normal trend in visualizing these days. Now more advanced techniques are used such as interactive real-time visualization, where environment and objects behave in accordance with user's selection or input [9]. At present 3D modeling is mainly used in entertainment, simulation and advertisement industries [10] with some use in digital heritage domain [11].

3D Modeling

A 3D representation of an object provides views from different angles in contrast to a 2D representation, which only produces a two-angle view. There are various tools and technologies available to produce a 3D model, selection of a right tool for a project is an important decision since some require a high level of technical expertise while others require little or no knowledge or experience of 3D modeling. Choosing the right application tools heavily depends on the available resources and skill set in a team.

3D authoring tools such as Autodesk Maya, Softimage and 3Ds Max along with open source Blender 3D are computer graphics software tools used to create 3D modeling, animations and rendering solutions for games, images, films and scientific simulations. These productive and high performance 3D authoring tools are for professional 3D modelers to deliver and help to enhance overall productivity for working with complex, high-resolution assets. These types of tools are expensive and require extensive knowledge, design skills and time to produce 3D models.

A project related to digital heritage usually comes with limited budget, time and knowledge. These projects often require quick solutions to produce hundreds of digitized objects in limited time with limited expertise to share with its audience. If all the digital heritage objects are to be developed in 3Ds max it may take several years, many resources and huge budget to complete such a project. We therefore propose using one of the photogrammetry services to quickly developed 3D models for Digital heritage objects.

Photogrammetry services:

Photogrammetry services are a great way to produce quick, easy and affordable 3D models with little efforts on photography setup. Images are taken from every angle of an object to constitute a 3d model. One of the well-known photogrammetry services is the 123D Catch photogrammetry service provided by Autodesk [12]. A photogrammetry service requires photographs from every angle, typically 15 to 35 photographs of an object to generate a 3D model. There are two options to access the 123D catch service, either download 123D app install it on their computer, iPad or mobile device or use an online application using Google Chrome browser to create 3D models. In the second option, images are uploaded and rendered into a cloud environment. Once ready these models are made available for download into different formats accessible in 3Ds max, Maya, AutoCAD and Blender. Other similar photogrammetry services include BOB Capture's 3DSom Pro, Acute 3D, Photomodeler, etc.

Interaction

Different methods can be used to interact with a digitized heritage object. For instance mouse based interactions techniques can be used for online visitors of a museum website using 2D or 3D environments such as: VRML, X3D, X3DOM, and various game engines or much more physically challenging interaction methods can be used for on-site visitors by using sensor based interactions approaches [4]. In terms of computing, 3D interaction is a form of interaction between human and machine. Users are allowed to interact in 3D virtual environment for object navigation, manipulation and application control. There are many techniques like mouse-based techniques, sensor-based techniques, stylus, joysticks, touch screens, knobs, and trackballs to interact with virtual objects. Early researchers used the gesture and speech-based put-that-there at MIT, and Schmandt's stereoscopic workstation with polhemus electromagnetic 6-DOF tracker [13].

Implementation

This research started with the study of various visualization and interaction methods, which are currently being used by various heritage museums such as British museum, Alska museum, Victoria and Albert museum, etc. Our second step was to find a few sample portable toy objects, digitize, visualize and interact with them in a virtual environment to test our findings. We then obtained permission to digitize some of the real portable heritage objects from one of the several museums of the Sindh province. During these experiments, we did not use any professional photography setup; instead we simply took photographs from a mobile camera to test this concept. In this paper we present our initial results from digitization, visualization and interaction. In future experiments we plan to use more sophisticated setup including a good quality digital camera and a white background. Also, at present we are interacting with our digitized objects in 123D catch application, in future we plan to build a browser interaction environment that can published on a web for a wider community to access.

Workflow Design

A methodical, manual and easy to understand workflow has been designed with five basic steps to easily digitized portable heritage objects. These five basic steps of the workflow are:

1) Set up a photography environment
2) Take 34 photos from every angle
3) Process photos using 123D catch services to generate 3D model
4) Test and rectify the model if necessary
5) Interact with the digitized object in a virtual environment

Figure 1 below shows these five steps in pictorial format with one of our first toy object being used in the workflow design.
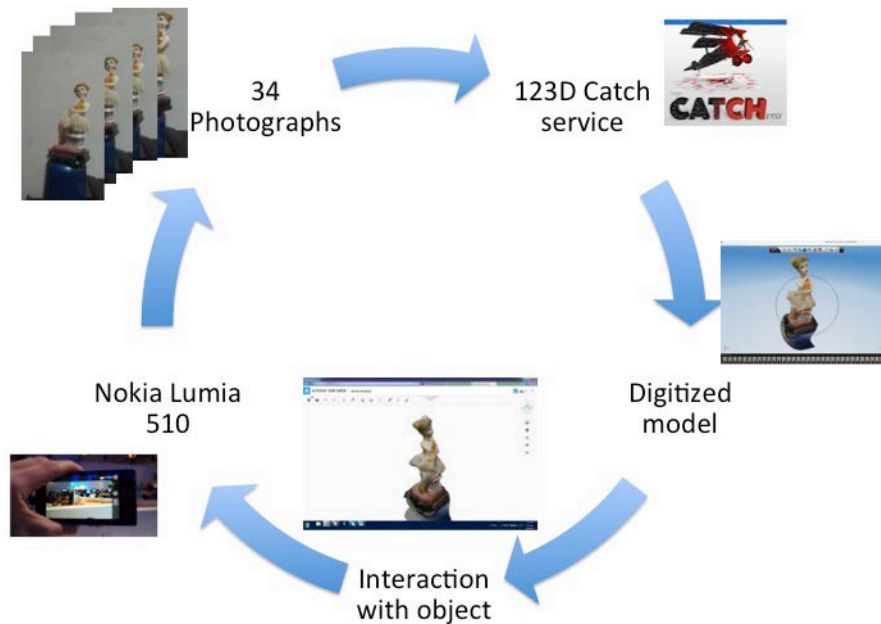

Figure 1: Workflow design for digitization and interaction

3D Content Creation

A photogrammetry service requires 15 to 35 photographs of a physical object. Initially we chose a few dummy objects including a toy doll pictured in the original workflow design. The success in initial results from toy objects gave us the credibility to obtain permission to use real heritage objects and travel to heritage museums.

Since the researchers didn't have a proper photography setup i.e. no sophisticated digital camera and a white backdrop, the objects in these experiments were placed against a white wall for photographs. A five mega-pixel camera from Nokia Lumia 510 mobile was used to photograph during these initial experiments. Every photography session involved a photographer and an additional helper to rotate the heritage object slightly after every photograph. The mobile camera was focused at upper half of the object for first 22 pictures, and the object was rotated slightly after each picture. After the first set of 22 pictures, the mobile was then fixed to focus at lower half of the object and then another set of 22 photographs were taken while rotating the object slightly after every photograph. The figure below shows two pictures of our first real heritage object the 'Statue of Buddha' with cameras pointing (in white color) at different sides of the Buddha statue. The figure 2 (a) and (b) below are 123D catch generated pictures to demonstrates the camera positions during our photography session. Figure 2a shows camera positions at the lower half and figure 2b shows camera positions for the upper half of the object.
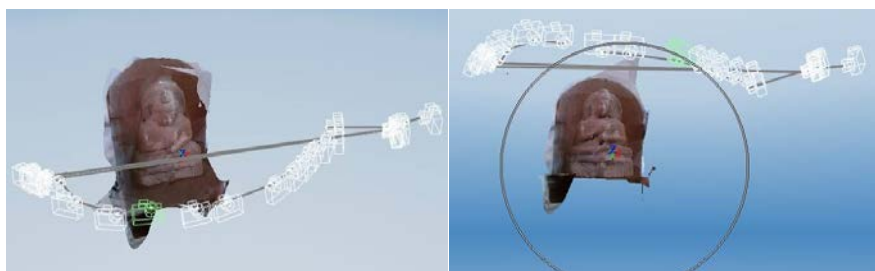
Figure 2: (a, b) Statue of Buddha with camera positions

Although we took 44 photographs, it is advisable to use up to 35 photographs for 123D catch photogrammetry service. Hence we dropped about 10 photographs that were nearly duplicated during our photography session; leaving exactly 34 photographs for processing on the 123D catch service. In the next step we installed the Autodesk 123D catch application and loaded these 34 photographs into the application in a sequential order for processing into a 3D virtual object. The desktop application took about fifteen minutes to render the 3D object on an Intel Core i3 laptop with 4GB ram. Figure 3 below shows two snapshots of 123D catch application with our digitized 3D heritage object.

Figure 3: Front and Right view of 'Statue of Buddha'

This object is currently stored in our 123D account and after a few refinements and approval from the respective museum, the object along with its metadata contents will be published for exposition on a public facing website. During these experiments, we learned that the quality of 3D objects during this project was greatly affected by our poor photography setup. The factors such as poor lighting conditions, in appropriate background colors in photographs and a low-resolution of a mobile camera had a great impact on the quality 3D models. This can be improved in future work by using a good quality digital camera and white backdrop setup during photography.

Interaction

Creating a 3D model on its own is valueless unless it is made available to its audience like a physical object in a real museum. The audience should be allowed to interact and play with it, which will be even greater access than a museum can provide with physical objects. Once the objects are digitized, we then explore various interaction methods that are currently being used by other world-class heritage museums to identify a suitable interaction method. At this stage our primary focus is on improving quality of digitization and we are using the 123D catch application to visualize and interact locally on the same computer. In the future versions we will visualize and interact with all digitized objects on public interfacing web based 3D environments, subject to the permissions from respective museums.

Interacting with virtual objects in the 123D catch application is not difficult and it only requires importing the virtual object and learning the application toolsets for interaction. The figure 4 below shows a snapshot of 'Statue of Buddha' in the 123D catch application.
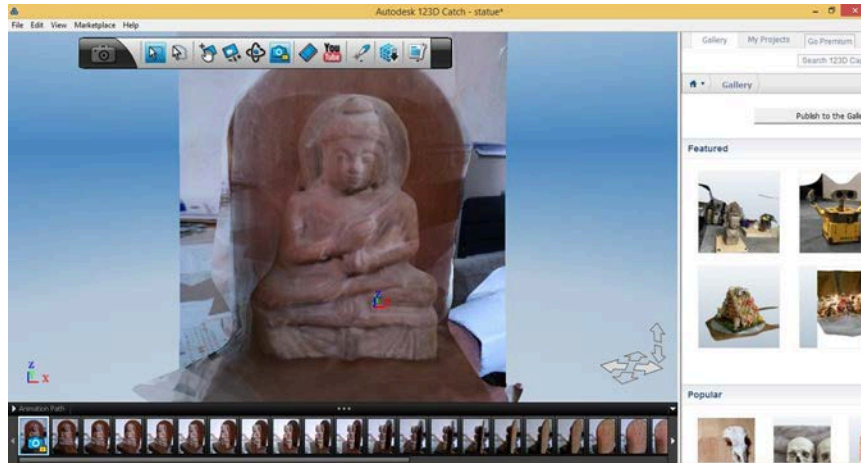
Figure 4: Statue of Buddha in Autodesk 123D Catch application

Figure 5: 123D catch application toolset

The 123D catch application provides following basic end-user operations for interaction with virtual objects:

A. Orbit – to rotate the current view in either side or direction by placing mouse on object after selecting the orbit option.

B. Pan – to move the camera from one place to another or side to side i.e. change the location of object on the screen.

C. Zoom – to enhance or reduce the size of heritage object in virtual environment.

Building a more sophisticated application in HTML5 or Game engines such as Unity3D can increase these interaction options. Future work of this research aims to identify and implement an improved interaction method that can be used by digital heritage community in online environments.

Conclusion

In this research work, we propose an optimal, cost effective and efficient visualization and interaction process for portable cultural heritage objects, which are found in museums and archaeological sites of Pakistan, in particular to Sindh province. During this research we acquired a sample portable heritage object from one of the museums to apply our knowledge and experience learned from other well-established digitization projects. Further we plan to enhance our scope with many archaeological sites and museums in Sindh province to test our research findings. The outcome of this research can be a framework that be used by museums, archaeological sites and research institutes to create their own visualization and interaction toolsets for portable heritage objects.

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