Simplifying Architectural Heritage Visualization

AUGMENTEDparion

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Among other historical artifacts, architectural heritage is the most difficult to present in museums. There is a need for a high-tech visualization of cultural heritage since it is important to visualize, share and analyze data for stakeholders such as historians, archaeologists, architects and tourists. This study aims to represent architectural heritage in terms of photogrammetry and AR methods for the Parion Theater, Biga, Turkey, dates back to 1st-2nd century A.D. and has been under excavation since 2005. The study uses MULTIRAMA, a method previously developed by ARC Team (MIT) in 2013, which aims to represent the "unseen" to such users by visualising and documenting via an app. The method supports architectural heritage representation via the processes of, i) documentation, ii) data process and modeling, and iii) presentation. This holistic and low cost approach will focus on the problem of visualizing the digital architectural heritage, and led light to future projects of a historical visualization database throughout Turkey.

Keywords: Augmented Reality (AR), Cultural Heritage, Photogrammetry, Parion

INTRODUCTION

Documenting the inventories of archaeological cultural heritage is very important regarding the knowledge transfer of historical, national and cultural properties of nations over to the future generations (Benli and Ozer 2013). In this respect, architectural representation is adopting digital methods and digital data at a fast pace, such as in the case of cultural heritage visualization which is often referred to as Digital Heritage. Within the last 20 years, the paradigm shift to these new computer technologies makes it necessary to use various communication tools and media effectively. Among these technologies, Augmented Reality (AR) techniques are well known since they contribute a lot to the representation process. In this respect, use of AR tools and methods, besides various sectoral use, is important to study and research of their integration to historic visualization.

Certain artistic objects are difficult to present in a different context, especially, removing architecture from its original location to display in a different environment would lose a good part of its artistic essence since it is strongly tied to its context. Alternatively, use of traditional scale models, photographs, videos,
and drawings is a way of translating the original into useful representations commonly deployed by architects. But these methods fragment the building into isolated forms of different media, and an ordinary audience is often left clueless about the original architecture. For instance, relating a technical drawing and its scaled model to the cultural heritage is complicated for people who do not get the architectural language.

Architectural Cultural Heritage, appears as a complex field to represent since there is a risk of losing some of its physical characteristics while visualising or documenting. In 2006, a symposium was organized to find solutions to Computer-Based Visualization of Cultural Heritage, and later London Charter was published with its first draft of the principles and objectives of Digital Cultural Heritage by Hugh Denard. This charter aims to establish broad principles for the research and communication of cultural heritage based on computer-based visualization, intellectual integrity of such methods and outcomes (Beacham et al. 2006) [1].

Within the literature, early studies have started with virtual archaeology (Reilly 1990), the credibility of virtual representations (Ryan 1996), virtual restitutions (Lucet 1997) and a search for alternative representations for cultural heritage [3]. Later to the end of the twentieth century, a new tool called Digitarama has been developed by one of the co-authors, which is a method placing 3D printed model of Hagia Sophia, visualising the digital models and inner space with two digital screens attached to two arms (Nagakura 1997). It was followed by VR and AR studies as a training tool applications (Bound et al. 1999) and visual archaeology studies (Gillings 1999).

The technological approaches have grown rapidly in the year 2000, with an important book named Virtual Reality in Archaeology (Barcelo et al. 2000), valuable contributions were made to the field. It was followed with computer simulations (Pasztor et al. 2000), acoustical and illuminative archaeological reconstructions (Pope and Chalmers 2000) and immersive walk through experiences (Kadobayashi et al. 2000). Ray tracing techniques (De Nicola et al. 2000), virtual reality applications (Goodrick and Harding 2000; Frischer et al. 2000; Bonfigli et al. 2000) is also developed in the same year. In 2002, an article was published on the developing VR applications in archaeology which shed light to cultural heritage representations (Frischer et al. 2002). Additional to these, similar to our work, a work named "Augmenting Kashgar" was published (Aydin and Schnabel 2014-2015). Their work is a virtual representation, documenting a historical village via photogrammetry. Apart from that, our study is aiming to visualise an AR via an app which shows different representations of photogrammetric documentation.

Later, one of the co-author’s team in MIT developed several methods called Deskrama (Nagakura and Oishi 2006) and Ramalytique (Nagakura and Sung 2014) (Nagakura et al. 2015) [2]. These methods were concentrating on virtual representations of architecture and cultural heritage, and they were progressing in developing a new method called MULTIRAMA later in 2013.

MULTIRAMA (previously Ramalytique) was a method developed by ARC (Architecture Representation Computation) Group at MIT in 2013, with the collaboration of Takehiko Nagakura, Woong-ki Sung, Daniel Tsai and Howard Burns. It was an interactive AR interface to represent artifacts or buildings. Later, in 2015, a new collaboration was made by authors, to carry out research on Parion archaeological site using MULTIRAMA.

In this study, a new collaboration was made between authors who aim to introduce and present the architectural heritage found in the archaeological sites using the "augmented reality" interfaces via MULTIRAMA. Having been carried out under the concept of "virtual archaeology", the projects have tackled the problem both technologically and in a presentational manner. In this study, an interface is suggested for both the visualization and presentation of the ancient Roman city, Parion (Biga/Turkey), which is one of the most important cultural heritages of Anatolia. Relating to the theme of the conference; com-
plexity vs. simplicity, the visualization is available for the use of architects, archaeologists, and restaurateurs; being user-friendly and an easy interface applicable on tablets for tourists, students; nearly for everyone who are interested in archaeology. This holistic and low-cost approach will focus on the problem of accurate visualization and representation in the cultural heritage of Parion (Ozer et al. 2016).

**AIMS AND METHOD**

This work has been carried out in three stages: i) documentation, ii) data process and modeling, and iii) presentation (see Figure 1). During the documentation stage, we enable the use of photogrammetric methods using 123D Catch software. In the processing and modeling stage, we provide tools for correcting 3D photogrammetric images using AR application with UNITY software. In the final stage, the resulting accurate 3D reconstruction of the cultural heritage site is presented to the audience with a viewer AR application. In MULTIRAMA, the models are united with other drawings and 3D models in the AR interface through the use of tablets to look at physical architecture models (Ozer et al. 2016).

**DOCUMENTATION**

Parion is an Antique Roman city which dates back to 600 B.C. Among many architectural structures, Parion Theater is an important discovery dates back to 1st and 2nd century A.D. In 2005, archaeological excavations started in the ancient city Parion, locating on the northwest of the Troas Territory (Biga- Turkey). Since then, excavations have been continuing in the south necropolis within the seven areas of theatre, roman baths, terraced structures, odeon and thermal plant archeopark fields (Basaran 2013).

Situated on a sloped terrain of the city, Parion Theater is a usual Anatolian theater in contrast to Side Theater. Excavations started in 2006, and still in 10 years, only the scene section is found and documented. There are surveys on the cavea part, but none of it has been revealed yet. There are some assumptions on the shape, form and height of the cavea and scene part, and the final visualizations are made depending this hypothesis. We should point out that, none of this visualizations is certain, they are only assumptions depending on historical findings and debates with archaeologists in the site.
Figure 2
Planimetric schema of taking photographs for 123D Catch.

Figure 3
A comparison of the real/real (left) and the virtual/real (right) of the scene of Parion Theater.
The site was documented during summer excavations in 2015 with a regular camera. With the help of a crane, aerial photos were taken which overlaps at each other at least 1/3 of the previous picture. It should be noted that 360-degree pictures should be taken for a good 3D Model (see Figure 2). After these pictures are taken, they were stitched in 123D Catch software, which is free to use up to 70 pictures. The stitched model is a mesh surface, and can be converted to a Rhino model to clean and work on it. The mesh model was a very good representation of the virtual/real except for being distorted a few centimeters in 10 m. span (see Figure 3). After the file is cleaned up for mesh holes in Rhino, it gets ready for 3Dprint, in .stl format.

In the final step, to make the AR, a target is needed as a marker. The AR software will read the tag (see Figure 4) for the visualization, and show the desired image in the app. For visualization, parion_AR_v1.apk file is installed on the tablet or smartphone which runs on Android. The .apk file was generated by the team and is reorganized for this project using UNITY software into an Android device (see Figure 5). The file was copied onto the device and the file manager app was used to launch the apk file.

In the exhibition, the 3d partial print of the theater is placed on the table with the marker on it. The user who uses the smartphone or tablet can visualize the AR via the app which can be downloaded to the device (see Figure 6). The user may choose three different visualizations mode; capture, sections, and upper structure (see Figure 7).

RESULTS

As in the results; The AR is presented in an exhibition setting in İstanbul Kemerburgaz University and the web site (www.deryagulecozer.com). The widespread effect will be increased with the use of this project results to the academicians, students and specialists in the related sectors of Digital Cultural Heritage.

Project results will be executed in two ways: Firstly, the results will directly contribute to the archaeological work (Parion, Biga) of visualization / representation and restoration / restitution process. In this related work, re(presentation) / preservation / restoration of Cultural Heritage Studies will gather speed. Secondly, deployment of VR / AR technology use in digital heritage, with the introduce of this method to the academia, will ensure the continuity of collaborative academic studies and collaboration.
Figure 6
A user using smart phone device via MULTIRAMA and visualizing the unseen.

Figure 7
MULTIRAMA Parion v1.0 Beta Interface.
The outcome of the research and the benefit to the related fields are summarized below:

- Use of a low-cost, holistic method utilizing AR technologies to represent digital heritage,
- Reviving the context connection with the architectural heritage since architects usually documents the heritage via 2D drawings,
- An easy interface and visualization tool for archaeologists to analyze their works in a 3D setting instead of 2D drawings,
- Providing tourists a different perspective about the ancient architecture while visiting archaeological sites,
- Suggesting an easily-usable, understandable and informative medium with an user-friendly interface running on a tablet / smartphone for the children and students interested in archaeology,
- Contributing to the presentation and preservation of Turkey's cultural heritage by documentation,
- Providing a means for the reconstruction of the historical architecture.

FUTURE WORK
There are two future studies which will follow this project. First is an MIT- Singapore University collaboration which will be focusing on structuring a new database for historic sites around the world, also some Turkish sites will be included such as Cappadocia. The second project is named as "Using Virtual Reality (VR) and Augmented Reality (AR) Technologies in Architectural Education", which will focus on integrating Cultural Heritage Visualization to architecture education. This study aims to integrate "Cultural Heritage Preservation and Documentation" and "Digital Design", through the development of a low-cost, holistic method that utilizes VR / AR technologies to represent Digital Heritage. This project also aims to visualize the AR on site (see Figure 8).

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