AUGMENTED REALITY FOR HISTORIC STORYTELLING AND PRESERVING ARTIFACTS IN PAKISTAN

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Abstract

Pakistan is the home of numerous ancient sites and historic structures. These historic assets are not only the likeness of the present but also heavily depends on past occurrences. The fundamental problems in preserving and maintaining historic buildings and artifacts in Pakistan are economic pressures, urban growth and often lack of coordination and planning to the world heritage sites in Pakistan. The artistic and historical value of a monument, mosaic, or an artifact ascends from the originality, and the development it represents in a specific field and in a specified time. Hence, it is vital to preserve and interpret those valuable flashes of pastime in a way that it maintains authenticity in all aspects. Despite being a part of UNESCO's World Heritage sites, unfortunately, there is not enough work come to pass for preservation and protection of historic structures. In the era where everything is digital, the latest technologies of 3D Imaging of the artifacts are contributing a lot in the preservation of the cultural assets. In such a frame, the current technology of AR provides fundamental help for preserving/ restoring purposes and as a storytelling tool to bring back the structures to its original historical value. Several possibilities that arise from (AR) tools, which combine the real world with virtual reality (VR) settings. This article attempts to illuminate augmented reality in VHS (Virtual Heritage System) and the overview of techniques that can serve as a tool for preservation and historical storytelling.

Keywords: Augmented Reality, historic storytelling, Virtual heritage system, Pakistan cultural heritage

Public Interest Statement: This research explores the urgent need to preserve tangible and intangible cultural heritage in Pakistan as most of the structure have gone through profound changes due to numerous reasons. Hence it is essential to protect and interpret those valuable flashes of a past era in a way that it maintains authenticity in all aspects. Media technology is rapidly developing with each passing day, and the modern technology of Augmented reality could offer a fundamental solution to this challenge. This article is an overview of AR techniques which can serve as a tool for preservation and historical storytelling.

1 INTRODUCTION

The "Cultural Heritage" definition of UNESCO highlights the importance and interconnection of tangible and intangible aspects: "the legacy of physical artifacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations" [3]-[16]. Pakistan is a treasure house of an ancient heritage spanning over scores of centuries. It is the home of Mughal Architecture and Indus Valley Civilization. Not only of ancient sites and historical monuments but equally the historic urban cores, that stretched from the peaks of the Khyber in the farthest north to the southern-most edge of the mighty river Indus, and scores of other living cities with their historic environments, all valuable in our search for an understanding of our cultural diversity [7]. But with the passage of time, due to urbanization, pollution and many other things harm heritage sites. Several

conservation projects, including World Heritage sites, are underway in Pakistan; however, we often neglect the aspects of authenticity from different angles [14]. There are many museums in Pakistan with the collection of Historic artifacts, i.e., Taxila Museum which has a collection of Buddhist stone sculptures from Indus Valley (Gandhara) civilization and Lahore Museum holds the oldest collection of miniature paintings, rare manuscripts and old coins [10]. Over time most of the historic structures and landscapes have undergone profound changes because of earthquakes, urbanization, and lack of coordination and planning and there is an increasing gap building between the tangible places and dimensions of the intangible as the intersection between memory and everyday life [3]. This may lead these places being forgotten or unreachable to all the world. In this context, the current technology of AR serves as a fundamental help for reconstruction/ preservation purpose of bringing back structures to its original historical value. AR offers many possible applications and tools in a wide range of fields such as education, construction, public health, manufacturing, games, and entertainment. Several pieces of research have shown how the use of this new technology has enhanced the cultural experience and benefits the number of people who can access knowledge. VH (Virtual Heritage) is considered one of the important fields in the computer-based interactive technologies using augmented, virtual, and mixed-reality techniques. It has created a visual representation of monument, artifacts, building, and culture presented openly to a global audience [17].

1.1. Problem Statement

Pakistan is blessed to be the home of plentiful historical sites and museums. But over the years, most of the places and artifacts are sabotaged due to urbanization, environmental factors and lack of coordination and planning. Despite being a part of UNESCO's World Heritage sites, unfortunately, there are not enough projects come to pass for preservation and protection of historic structures with authenticity. Hence, it is essential to adopt new technologies to derive a solution, which not only preserves the historical sites and artifacts but also maintain the authenticity for historic storytelling for the visitors. This research paper aims to look through the possible solutions AR technology offers for historic preservations and to study past AR based Virtual Cultural Heritage projects.

1.2. Augmented Reality

Augmented reality is a concept that integrates 3D virtual objects into a real-time environment. In other words, augmented reality can be defined as the interactivity of humans with virtual objects that are located in the real environment to help the user in executing a task in a physical setting [9]. AR is one of the important forms of MR (mixed reality), in which real and virtual objects are combined and showed in a single display at the same time and location. There are multiple dimensions in MR, which reality-virtuality continuum describes the span between real and virtual environments, with Augmented Reality (AR) and Augmented Virtuality (AV) in between. AR is close to the real world, and AV is close to a virtual environment [11].
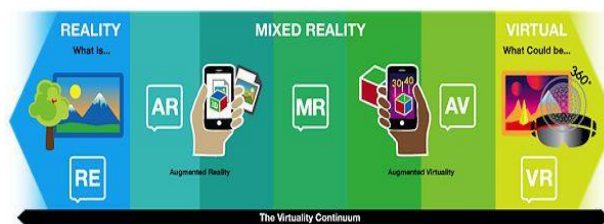

Figure 1: The reality-virtuality continuum

An AR system typically has the following characteristics, i.e., (i) It combines real- world and virtual objects (ii) It runs in real time (iii) It allows the user to interact with virtual objects. AR does not replace reality, as the virtual reality (VR); it complements real environment with digital information, virtual and computer-generated graphics, and/or virtual objects as shown in Fig. 2.


Figure 2: Pokémon Go game

In the digital era, Augmented reality is being used in many areas such as travel, education, medicine, archeology, astrology where the real-time view is superimposed with digital data in any format [7]. It enables us to easily demonstrate any object as it creates an illusion of it with the live world that is more understandable. The amalgamation of technology associated with cultural and archaeological sites gave birth to new concepts of Virtual History, Virtual archaeology, Virtual Museums, AR heritage, and more. The adaptation of high new virtual dimension in heritage profited in reconstructing/ preserving damaged historical sites virtually [6].

2. VCH AND STORYTELLING IN AR

Virtual heritage in AR can be defined as an interactive computer-based technology, which can be used to achieve visual reconstruction, assist scholars and educators of traditional entities, for example, buildings, artifacts, and culture. This technology is used to maintain delicate historical buildings from natural disasters and sabotage. There are seven main design principles to create VCH, which must be taken into accounts such as high geometric accuracy, high level of automation capture for all details, low cost, photorealism, flexibility, portability, and model size efficiency. Cultural heritage layers are proposed to visualize historic media such as drawings, paintings, and photographs of buildings and historic scenes seamlessly superimposed on the real environment through video [9]. Mixed reality is one which embraces all the fields of reality, including physical reality, augmented virtuality, and virtual reality. It consists of real and virtual elements that can interact with each other. This technology and user experience are now implemented in various applications, including sociology to informatics and from art to architecture [17]. Artifacts preserved in museums of Pakistan are the least informative in history and importance, and the visitors rely only on labels and descriptions provided. Generally, museum installations that do not introduce new technologies are rightly or wrongly regarded as less exciting and attract fewer visitors [19]. The creation of a creative environment that is responsive to human presence adapts dynamically and supports mobile technology making the visit path more appealing, opening new avenues in both tangible and intangible CH [12]. AR technology plays a vital role in enhancing the visitor's experience indoor and outdoor, based on the cultural asset's location. Multiple virtual elements used, such as descriptions, virtual-human characters, or guide maps are superimposed on the user's current real-world view. For instance, in the virtual representation of Pompeii [13], the computer-generated characters were superimposed on real environments, which help visitors to see the storytelling drama on the site of Pompeii. The main goal for this project was to push the limits of current AR and storytelling techniques to provide a high degree of realistic immersion. Fig. 3 represents the revival of ancient life in Pompeii with virtual characters interacting with the real environment and real-time plant simulation.

(a)   (b)
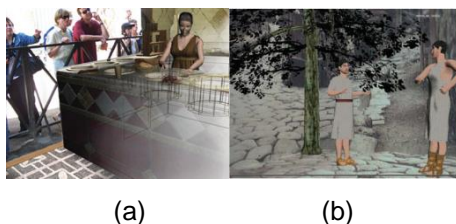
**Figure 3: Virtual Characters interacting with real-time environment**

This Virtual storytelling technology can be implemented on the Indus valley civilization ruins and Mughal Architecture like Lahore Fort to provide the immense virtual experience of that era and to provide historical details for students, educators, and tourists. AR is an excellent tool to reconstruct views of tangible and intangible Cultural heritage. Such applications allow users to visualize cultural heritage assets that existed only in the past or exist partially. AR and MR are best suited to tangible and a blend of tangible and intangible because both technologies can superimpose the reconstructed views over their historical location [2].

2.1. Domains of VCH

According to the research of Alonzo C. Addison [1], digital tools and techniques now emerging from academic, government, and industry labs offer new hope to the often painstakingly complex tasks of archaeology, surveying, historical research, conservation, and education. These emerging second-generation technologies can be grouped into three domains:

• 3D documentation (everything from site surveys to epigraphy),

• 3D representation (from historical reconstruction to visualization), and

- 3D dissemination (from immersive networked worlds to augmented reality).
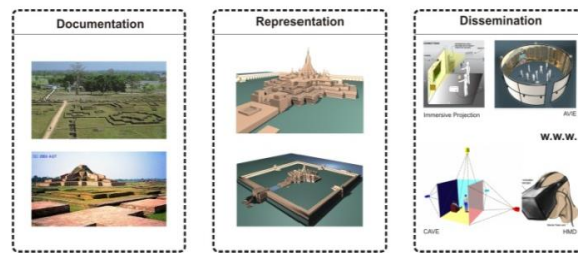
Figure 4: Basic Domains of Visual Heritage

Figure 4 demonstrates the method required to develop and disseminate Virtual heritage. The first process is to document the information, analysis, and gathering official data from cultural and architectural resources. The second process involves developing and representing the structure or asset conditioned by media and focusing on accuracy of visualization. The last step is to prepare and distribute this information to the audience through interactive media

3. AR BASED ON VCH LOCATIONS

Multiple techniques are being used these days in AR like bi-dimensional superimposing, chroma screen used in film production, a mixed reality where there is a sophisticated use of technology. However, looking at the AR used in Virtual Cultural Heritage, it can be categorized into five types i-e fixed indoor, fixed outdoor, mobile indoor, mobile outdoor, and mobile indoor/outdoor. But there are two significant notable differences in the environmental settings for AR applications which are indoor and outdoor. These systems are dependent on various methods of tracking and calibration, input devices, displays, and interfaces [15]. In general, indoor applications are widely used to enhance the exhibition experience as most of the museums use this latest technology for virtual tour guidance or historical storytelling. Outdoor applications are mostly used for reconstruction of historical sites that have been demolished or damaged by natural disasters and overlay it with the real world [9].

3.1. Indoor AR

Augmented reality used for preservation of indoor CH has taken the form of "Virtual Museums." The visitors use AR technology to see through the history or to display artifacts and the information which is no more accessible to them. This is either because that artifact is of great value or the fragility, or there is a lack of space inside the museum for such a large artifact, or it exists in some other museum [20]. The AR system used for indoor CH is marker-based or marker-less. The main issue of using a market-based system for indoor sites are the placement of markers for tracking the object and to ensure optimum use of the system for all age groups. The marker-based system is based on space trends tracking of a graphical marker, which is usually a black and white symbol called "confidence marker" on which you can attach a real-time three-dimensional input. This technology is generally practiced displaying artifacts in their original forms with the information. With the marker-based system, users can easily connect to the museums' website, print the graphic markers, turn on the camera and start the interaction with the AR application. This is a very useful home edutainment system [15].

Figure 5: Marker-Based AR display original artifact

Marker-less application recognizes graphically a generic image or a portion of it, after which the tracking system can identify and set orientation [9]. The virtual museum of Pompeii discussed earlier is an example of a marker-less system where you can visualize the virtual characters interacting with the real environment into real space. Another example of showing realistic experience through virtual character is projected by Sajeongjeon and Gangnyeongjeon of Gyeongbokgung [8], which represents cultural heritages in Korea.
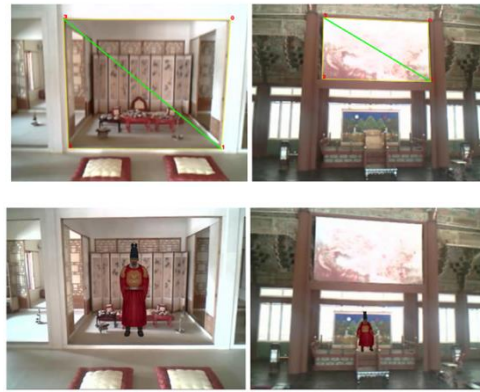
Fig. 6. 3D virtual character rendered in the target scenes

Indoor system is used for reconstruction views of tangible and intangible assets. It also serves as an aid to diagnose physical fragilities of artifacts like statues or paintings [2]. For the preservation of artifacts like paintings, a tablet-based AR system application ARtifact has been used in the project. Different imaging modalities such as infrared thermography and ultraviolet fluorescence is used in real-time tracking of artifacts, to enable users to study data which provides an augmented view of the artifact to aid in on-site diagnosis and restoration [15].

3.2. Outdoor AR

Developing AR system for outdoor realistic historical buildings or sites is more difficult from indoor as it required advancing effects like shadows, lighting, and the ability to detect sky like illumination on a virtual asset to the real object. It is also uncomfortable to use computer systems on outdoor locations, and it is costly using head-mounted device HMD. In outdoor AR the technology is executed using outdoor GPS, compass and gyroscope sensors [9]. Outdoor AR relies heavily on marker-less and hybrid tracking because it takes place in a relatively wide area. If users can approach the CH asset, then a marker-less method is a suitable choice; otherwise, long-range optical sensors and GPS localization are more appropriate. Outdoor AR applications for the reconstruction of tangible and intangible CH allow users to visualize the asset that existed in the past or that partially exist. One of the examples is the project of Girbacia [22]-[12] on a workflow for the restoration of religious heritage and to enable virtual reconstruction of the original heritage object by co-locating the reconstructed 3D virtual model with the real one. The model of damaged sculpture was created modeled through image-based modeling technique, and Architecture software was created for the visualization of the reconstructed 3D model in the co-located environment. Another project of providing information about the architectural heritage site in Mecca was proposed by Reffat [12]. This project was carried out as a guidance engine for Hajj and Umrah visitors. It is a handheld informative-based 3D that manifests physical world meeting the virtual world in the holy city of Mecca.

Figure 8: Representing Holy Kaaba superimposed with interior information through hand-held device [12]

L'Aquila Historical Centre project [3] is another example of historical storytelling that experiments with 3-D reconstructions of urban landscapes as they were in the past. AR applications make it possible to correlate visualizations to the current status of places, layering both didactic and shared information.

4. CONCLUSION

In Pakistan, there stands great importance of restoration and reconstruction of assets with historical and

artistic value, architectural sites, and cultural artifacts. This research paper discussed the meaning, significance and techniques of AR application that can be adopted in this frame and how this technology can widely impact the domain of cultural heritage. Most of the museums do not have enough space and resources to exhibit all the collections. Also, most of the assets are damaged and fragile, which compel museum curators to not display them to the public. Besides, most of the archeological sites in Pakistan are now restricted for visitors because of improper restoration, which means visitors cannot experience or study the place or artifacts from different angles. In this respect, the AR technology serves a great purpose to provide solutions that enable the visualization of 3D models of historical artifacts in both virtual and real environments. Due to the combination of reality with virtual objects, it enhances visitor's museum experience in a variety of ways i.e. they can compare the distinctive aspects of different artifacts from each other, the historic background of the assets and how they were made, to see hidden details with the artwork or to access the information which is otherwise available to museum professionals only. Furthermore, AR can serve as a great learning tool, as it involves the visitors not only mentally but also emotionally with the asset, that helps in memorizing and gives lifelong learning experience. The government of Pakistan needs to recognize the potential offered by this technology to preserve and reconstruct cultural artifacts, to provide background information through historical storytelling and create a more interactive and information-based environments on historical archeological sites and museums for the visitors.

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