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HASAN KALYONCU UNIVERSITY

GRADUATE SCHOOL OF

NATURAL & APPLIED SCIENCES

A STUDY ON REPRESENTING CULTURAL HERITAGE BY VIRTUAL AND AUGMENTED REALITY

M. Sc. THESIS

IN

ELECTRONICS AND COMPUTER ENGINEERING

GÜRCAN SERBEST

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A Study On Representing Cultural Heritage

By Virtual And Augmented Reality

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Supervisor

Assoc. Prof. Dr. M. Fatih HASOĞLU

Gürcan SERBEST

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M.Sc. ACCEPTANCE AND APPROVAL FORM

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Prof. Dr. Mehmet KARPUZCU

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT
A STUDY ON REPRESENTING CULTURAL HERITAGE BY
VIRTUAL AND AUGMENTED REALITY

SERBEST, GÜRCAN

M.Sc. in Electronics and Computer Engineering
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This study gives an overview of education, preservation and virtual learning of cultural heritage through virtual and augmented learning. Works that have been done on cultural heritage have a responsibility of replicating, visualizing and representing a virtual environment as if they were in a real world through the presentation of the virtual reality. The explains that cultural heritage is an important accept when it comes to learning and learning is not based on what the developer of the system wants but what the user is looking for. However, even if most virtual and augmented environment is done from what the developer thinks is appropriate still it offers learning environment and the preservation of the culture is still done (Central European University, 2017). This is because learning can take place to advance technology that the virtual and augmented reality offers to mean that individual who can do reach the cultural environment can still have the learning experience. It is also important to identify the need for the users of the system on what exactly they would like to learn and see for the creation of the virtual environment to be said it is successful to offer learning environment.

Technology is what has facilitated the use of the virtual and augmented reality but this also has posted a challenge since not all users can assess the advanced technology. The users of the virtual environment would also like to have an opportunity of interacting with the objects in the virtual environment which still is a challenge to the developers of the system. The study gives evidence that the virtual and augmented environment offers educational, learning and preservation opportunity for culture.

Keywords: Virtual Environment, Augmented Environment, Cultural Heritage, Learning and Advance Technology

ÖZET
KÜLTÜREL MİRASIN
SANAL VE ARTIRILMIŞ GERÇEKLİKLE TEMSİLİ ÜZERİNE BİR ÇALIŞMA

SERBEST, GÜRCAN

Yüksek Lisans Tezi, Elektronik Bilgisayar Müh. Bölümü

Tez Yöneticisi: Doç. Dr. Muhammet Fatih HASOĞLU

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74 sayfa

Bu çalışma, sanal ve güçlendirilmiş öğrenme yoluyla kültürel mirasın eğitimi, korunması ve sanal öğrenilmesine yönelik genel bir bakış sunmaktadır. Kültürel miras üzerine yapılan çalışmaların, sanal gerçeklik sunarak sanal bir ortamı çoğaltıp, görselleştirip temsil ederek, gerçek dünyadaymış hissi yaratma sorumlulukları vardır. Bu, kültürel mirasın öğrenme açısından önemli bir konu olduğunu ve öğrenmenin, sistemi geliştirenin ne istediğine değil, kullanıcının ne istediğine bağlı olduğunu ortaya koyar. Öte yandan, sanal ve güçlendirilmiş ortamların birçoğu, geliştirenin uygun gördüğü şeyden meydana gelmiş olsa da, öğrenme ortamı sunma ve kültürün korunması amaçlarına hizmet etmeye devam eder (Orta Avrupa Üniversitesi, 2017). Bunun nedeni, sanal ve artırılmış gerçekliğin, kişilerin kültürel ortama ulaşarak öğrenme deneyimi elde etmelerine yarayacak bir araç sunduğu gelişmiş teknoloji ortamında öğrenmenin gerçekleşebilecek olmasıdır. Ayrıca, sistem kullanıcılarının tam olarak neyi öğrenmek istediklerine ilişkin ihtiyaçlarının belirlenmesi ve sanal ortamın nasıl yaratıldığının görülmesi de, söz konusu sanal ortamın öğrenme ortamı sağlama konusundaki başarısının ortaya konulmasında önemlidir.

Her ne kadar teknoloji, sanal ve artırılmış gerçekliğin kullanımını kolaylaştırmış olsa da, bu sanal ortamın kullandığı gelişmiş teknolojiye tüm kullanıcıların ulaşamıyor oluşu bir sorun teşkil etmektedir. Sanal ortam kullanıcılarının sanal ortamdaki objelerle etkileşime girme isteği de, sistem geliştiricilerinin çözmeleri gereken bir başka meseledir. Bu tezimde, sanal ve artırılmış gerçeklik ortamının kültürel açıdan eğitim, öğrenme ve koruma fırsatları sunulmasında önemli bir rolü olduğunu göstermeye çalıştım.

Anahtar Kelimeler: Sanal Ortam, Güçlendirilmiş Ortam, Kültürel Miras, Öğrenme ve Gelişmiş Teknoloji

To My Family

ACKNOWLEDGEMENTS

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LIST OF ABBREVIATIONS

3D	Three Dimensional
AR	Augmented Reality
CAVE	Collaborative Virtual Environment
DWARF	Distributed Wearable Augmented Reality Framework
EPOCH	Excellence in Processing Open Cultural Heritage
FBX	Film box
GPU	Graphics processing unit
ICT	Information and Communication Technology Academic & Science
MPEG4	Moving Picture Experts Group 4
MR	Mixed Reality
OCR	Optical Character Recognition
SDK	Software Development Kit
UNESCO	United Nations Educational, Scientific and Cultural Organization
VR	Virtual Reality
VRML	Virtual Reality Modelling Language

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CHAPTER 1

INTRODUCTION

This chapter gives an overview, background, aims and the objectives of the study.

1.1 Introduction

Heritage can be defined as a property that belongs somewhere and it is inherited or has an element that is passed to future generations from the past generations. Cultural heritage is a way of living of a particular people in their community in relation to their food, beliefs, ways of doing things, religion, tradition, customs, practices, places, expression that are done through artistic ways and their values. These cultures are continuously passed from one generation to the upcoming generations. Culture has a bond that makes the individuals of a particular community identify and bond to each other that gives them a feeling of belonging [1]. Different communities have different cultural practices but communities that neighbour each other sometimes can share some of the cultural practices. Cultural practices can either be tangible and intangible in nature. The tangible practices are also visible in nature while the intangibles are not visible in nature. The tangible forms of heritage can be in artefacts such as paintings, drawing, prints, mosaics and sculpture, buildings or even the landscapes while intangible forms can be in their values, tradition, voices or the history of their culture through an oral form. This is always emulated through their dressing, songs, social practices, storytelling, and ceremonies. Cultural heritage can be distinguished by environmental building such as the buildings, landscapes, archaeological remains that are found in the area or the natural environmental nature. Artefacts that is available on written literature such as books, photographs, manuscripts, documents, objects and pictures [2].

Cultural heritage has become diverse and has been learned from different communities. It can be shared within those communities, for example, the painting for Mon Lisa don by Leonard Da Vinci preserved from the 16th Century and it has displayed in the Museum du Louvre in Paris, yet the painter of the painting was an Italian. It is believed that when Leonard went to work in France for the King L's court he went with the painting with him to which the king acquired the painting from him. The painting then became one of the royal collections that the king had since the painting was very unique,

but it had the Italian culture and now the French borrowed the Italian culture through this painting. This is a culture that has passed down from the Italians to the French people [1].

Virtual reality is an environment that has been created artificially with the use of software which is presented to the user as the natural environment or the real environment. Virtual reality is created mainly by the two senses which are sound and sight by the use of a computer.3-d images are the simplest form of virtual reality that can be explored through a computer and the interaction can be done through the computer keys or the mouse that allows the image contents to zoom either in or out or in whatever directions that has been commanded by the user. Virtual reality is divided into two parts which are: An environment that is simulated for training and educational purposes and the creation of an imaginary environment for the purposes of games or the interaction of stories [3].

VR is typically achieved by wearing a headset equipped with the technology (see Figure 1.1) and is usually used in two different ways:

- To create and enhance an imaginary reality for gaming and entertainment.

- To enhance training for real life environments by creating a simulation of reality where people can practice beforehand such as flight simulators for pilots.

Virtual reality can be coded through a programming language known as VRML (Virtual Reality Modelling Language). VRML can be used to create a series of images and specify what types of possible interactions for them.
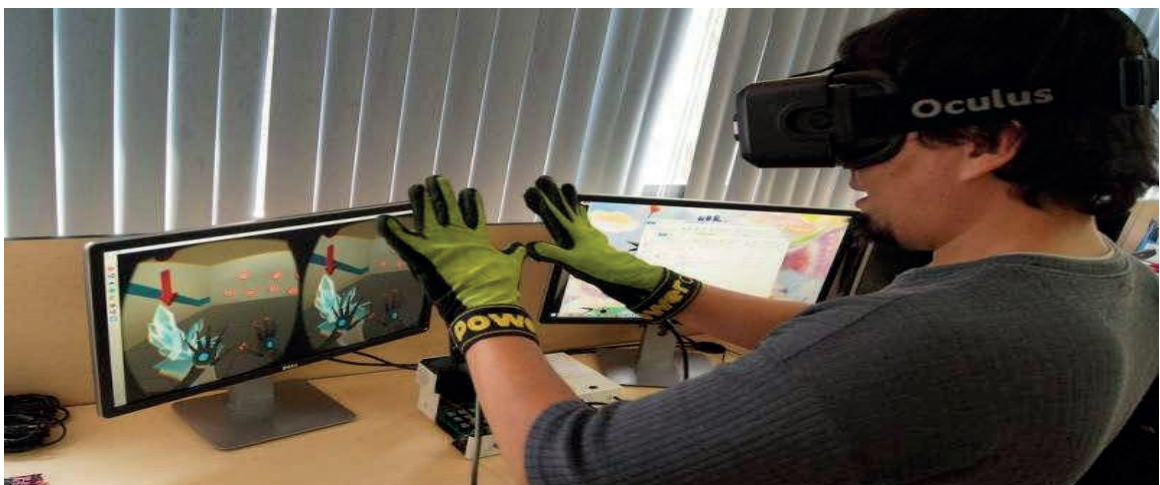
Figure 1.1: An example of using VR application [4].

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Virtual heritage is a term used to apply information and communication technologies (ICT) to cultural heritage, which refers to sites, monuments, buildings and objects "with historical, aesthetic, archaeological, scientific, ethnological or anthropological value. The virtualization of heritage means to actualize the heritage content digitally and to simulate it by using the computer graphics technology. The features of "virtual heritage" include facilitating synthesis, conservation, reproduction, representation, digital reprocessing and displaying cultural heritage by using the advancements of VR technologies.

Advantages of Virtual Reality	Disadvantages of Virtual Reality
1. VR creates a realistic world 2. VR helps explore places and sites. 3. Through VR, users can experiment with an artificial environment.	1. The equipment used in VR are very expensive. 2. VR consists of complex technology.

Augmented Reality is the use of digital information that is integrated within the user existing environment in real time and it overlays information that is new to it (see Figure 1.2). Augmented reality is a technological methodology that has emerged that has allowed the reconstruction of the historical sites and the monument that was in the past generations and era for the user to experience that environment in reality or through a virtual scene that is created. It encourages a certain way of learning that presents the user a platform for earning with experience, understanding, motivation and exposes the user to external elements that encourages understanding [5].
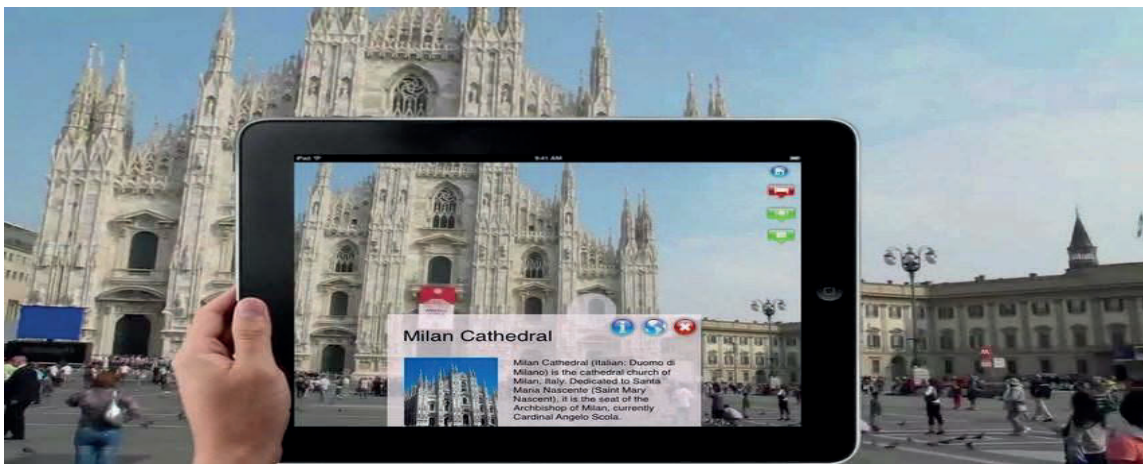
Figure 1.2: An example of Mobile AR application [6].

AR is developed into apps and used on mobile devices to blend digital components into the real world in such a way that they enhance one another. It is used to display score overlays on telecasted sports games and for 3D emails, photos on mobile devices. People from the tech industry are also using AR to do amazing and revolutionary things with holograms and motion activated commands [7].

Advantages of Augmented Reality	Disadvantages of Augmented Reality
1. Increases knowledge and information 2. People can share experiences with each other in real time over long distances 3. Games that provide an even more "real" experience 4. Things come to life on mobiles and devices 5. No need of Headset or equipment unlike needed in VR applications.	1. Risk of Spam and Security 2. Social and Real-Time vs. Solitary and Cached 3. Using AR can be inappropriate in social situations. 4. Other people can develop their own layers of content to display

There is a minor difference between the two technologies and hence it is important to understand and able to distinguish those by keeping in mind their technical features. AR and VR are inverse reflections of one in another with what each technology seeks to accomplish and deliver for the user. VR offers a digital recreation of a real-life setting, while AR delivers virtual elements as an overlay to the real world. VR is usually experienced by the user through a head-mounted or hand-held controller. This equipment connects people to the VR and allows them to control and navigate their actions in an environment meant to simulate the real world.

AR is being used more and more in mobile devices such as laptops, smartphones, and tablets to change how the real world and digital images, graphics intersect and interact. VR and AR are two technologies to reconstruct the historical building and monument in the previous era, where the user experiences with the real environment or virtual scene.

1.2 Background of the Study

Due to different values that were attached to the monuments, buildings, artworks, artefacts, and the landscape is what lead to the rise of the concept of cultural heritage. The unique design of cultural objects leads to individuals and the events of the communities are what to keep and therefore this leads individuals to collect remains of a community to

be able to preserve the culture. This leads to the formation of a museum and the commissions of monument protection in the 19th Century.

The first use of virtual heritage was in the form of a museum exhibit as a virtual tour in 1994 and was providing a 'walk-through' of a 3D reconstruction of Dudley Castle in England that was built in 1550. Since that date on, many applications have been developed to virtually represent cultural heritage as an immersive interactive digital experience like CAVE systems, projection-based applications and etc. However, with the rapid developments in manufacturing VR technology, head-mounted displays for different platforms (like for PC and mobile) have been developed.

In the 20th Century, political groups and organization become more interested in the preservation of culture due to evolution. Organizations such as UNESCO worked on gaining the support of other organization in collecting national heritage of different nationality in order to preserve them and they introduced a concept that is known as the World Heritage and World memory to support the concept [8].

While the concept leads to the conservation of values and the cultural objects it also opened doors for to abuse for the cultures and chauvinists which was leading to the deliberate destruction of the values and objects of heritage which distorted the values behind it. In the 21st Century, a lot of disciplinary measures and methodologies have been put in place for the protection and the abuse of culture that can be used worldwide [9] The earliest example of heritage are not displayed as virtual objects in the early years but they were 3D images that were found in the museum's exhibitions, showcased in the technological web-based environment or an AR which was an academic test.

The first virtual heritage application that was constructed for Dudley Castel (opened by the late Queen Elizabeth II in 1994). Later, it was reconstructed in that the user could move a circular button to navigate the laser disc-stored computer model of the castle. The project was described by the web as a 'Virtual Tour' or "the VR Tour" but on the display, they were neither head mounted nor the viewpoint systems that was being changed by the wall projection when the position of the user was changed.

An example of the first web-based model of the virtual heritage was a cultural heritage site and the new technology showcasing. That was brought about by using VRML. This offered a second version of the VRML 2.0 evolved to the 3D model of the

web standard. VRML model of the ancient Aztec city of Tenochtitlan was created by the Silicon graphics. The VRML was created to be a single user model in which the software browser was buggy, large and very slow. Due to the same reasons, the VRML model of the Mexican City also had the same properties of slowness, buggy and the landscape was not external [10]. The aquatic surrounds were depended on by the city. The Aztec culture was a combination of the early Mesoamerican cultures. This was a breakthrough for the individuals that could not travel to Mexico or visualize in drawing an example with the latest technology of the Aztec site.

In the early 1990s, there was a computer based virtual project which had an Egyptian site of Buhen and gave a description of the side work and gave room for learning. In that decade a project was also released by the American Scientists known as Discover Babylon which was downloadable for free on the internet but the only disadvantage it was difficult to operate on a personal computer. By 1994 in America, there was the formation of the Centre for New Media and the History at George Mason University due to the distribution of the interactive CDs by the historian Roy Rosenweig on the history of American [11].

1.3 Statement of the research problem

Cultural heritage is the link or the bridge of the future from the past and presents through traditions, values, and ways of doing a thing in the community. Cultural heritage can be used in learning and educational projects using ICT for the individuals who cannot experience the reality of the culture. The research by J. Zara 2004 comments on how cultural heritage can be effectively used in learning, educating and promoting the cultures [10]. In order to effectively create the learning environment, also it is important to identify the need for the users of the system on what exactly they would like to learn and see for the creation of the virtual environment. For that purpose a questionnaires are given to both University and business environment users to get their feedbacks to figure out their expectations from such applications.

As an experimental study, we have developed an AR application for Muradiye Complex also known as Sultan Murad tomb (see Chapter 4). Muradiye Complex is located in Bursa in Turkey. This mosque has T plan inverse construction and for the current study, I have shown the entrance and inner parts through VR technology.

1.4 Aims and objectives of the research

Aims and objectives of this thesis is to explore the importance of the emerging possible uses of virtual heritage applications mainly in education, promotion and learning cultural heritage. In order to create an effective virtual environment for such applications, importance of user feedback is also studied (see Chapter 4.1- 4.3).

The objective of the study can be itemized as below:

- Whether the virtual heritage application is efficient and effective for learning and promotion of culture.
- Does it portray the data that is collected as it is in actual reality?
- If the cultural data collected is relevant for learning.

1.5 Research questions

The main questions for which we look for an answer in this study are the followings:

- Can cultural heritage be used for educational purposes?
- Why should cultural heritage persevere?
- How do cultural practices be promoted and used for learning?
- How do different audiences learn cultural heritage?
- Is the data captured accurately for learning purposes?
- Does the use of virtual and augmented reality help in portraying data in an effective and efficient manner for learning?

1.6 The Rationale of the Study

Cultural practices are being passed from generations to generations and it may be lost within the process of being passed from the generation and therefore the need for it to be preserved in order to be used to educate the future generations. The use of technology to create the virtual and the augment experience of culture is also important for it gives that individual an experience of the cultural events while they are in the actual sense not in that environment. This gives the aspect of the learner the actual experience that helps in the enhancement of the culture that they are learning. Therefore, the reason for this study is to find out how the cultural heritage can be used for educational, learning and promotional purposes.

In the second part of my thesis, as an experimental study I have developed AR for Muradiye Complex for which already 3D models were taken by VR Kronos (see Chapter 4). Our developed AR applications can be easily uploaded to App Markets and Websites in the future. Therefore, the people all around the world can have a look through virtual heritage environment without visiting it on place.

1.7 Limitations of the Research

The study is based on assumption that culture is accepted in all areas of the world and that there is interest for the learning and education purpose of the cultural heritage. It does not focus on a worldwide culture. The questioners are conducted at companies and universities only in Turkey. In order to make this study more comprehensive, companies and universities with international personnel are targeted.

It is a fact that some cultural practices and beliefs are not accepted worldwide due to the beliefs and cultures that affect different nationalities. Moreover, user perspective may be different and VR heritage technology is not designed to accommodate the needs of users of different professional and study backgrounds.

CHAPTER 2

LITERATURE REVIEW

This chapter give some explanation and review the study through the research literature of other researchers to give their views and opinions on the study based on secondary research methodology. Also some previous works done in this field are presented in details.

2.1 Learning from the Cultural Heritage

Individuals learn cultural heritage due to their personal curiosity and to benefit their conscious minds and needs. Culture varies from country to country and it depends if the countries will have the cultural programmes in their learning syllabus. Some schools in different countries have cultural weeks in their universities or schools in which the different nationalities can display their cultures. According to Rust 2016 [12], some international universities encourage exchange programmes with a different country so that the students can go and learn the culture of that particular country, but it is not always possible for all the students to attend the exchange programmers due to financial constraints and therefore the virtual and the augmented reality have encouraged the learning experience of even students who cannot afford the travelling and the experience of the real cultural experience.

Learning the cultural heritage of different countries opens the outlook of an individual and breaks down the barriers and breaks down the stereotype. There are countries that are well known to individuals due to media coverage, yet they are countries that are basically not known wide by individuals due to various reason. Countries like Germany, China, Japan or Russian are most known to individuals and their cultural practices yet countries like Georgia and Kyrgyzstan in Eastern Europe and Central Asia are mostly not known by a majority of individuals learning the cultural ways, cuisines, dance and way of the communities of this people opens the barrier that was present that was causing unawareness of this culture. It makes different individuals the state appreciates the ways of this people and breaking down the stereotype that existed since now the individuals are aware of the on ongoing ways and events of this people.

The learning of cultural heritage helps individuals create an environment for understanding and building perspective. This helps us understand that the world we all live in is different from each other and learning about other people's cultural practices help one have a mutual understanding of the other because it expands the horizon of your perceptive and helps one notice the difference that is around the world. This helps in building relationships and living in peace due to the understanding of the diversity that culture has.

A study by Lai, (2015) [13] identified that learning the culture of different countries help one to know how to live and handle different individuals due to the diversity of the environment that we currently live in. The country to country Immigration has also encouraged the diversity of culture and more understanding is has been acquired on culture due to this reason. This has encouraged individuals to learn more about culture and appreciate the way of living of different individuals.

According to a research that was done by Abner, (2015) [14] identifies that for a business to consider expansion to international markets the business, the management of the business must learn the way of doing things of that nationality which is the culture of those particular areas for the products and the business to be accepted.

A study by Tan and Rahaman, (2009) [15] has identified that virtual heritage normally or sometimes do not have what the user would like to learn or would want to know since it allows no interaction between it and the user. Most of the virtual heritage environments are designed with opportunities that have least interaction with the user. The user is given the viewing control, but the user has no role that they neither play nor perform any task especially when it is not predetermined. The design is made in such a way that users can move inside the environment without a goal or an objective which makes the user lost and bored in the process, but the user cannot use their objective or goals in the learning process.

In this thesis, I have investigated that the importance of engagement of the users in the development phase, especially to get the learning process through AR and VR more successful and efficient.

2.2 Development of Content Approach

According to the study that was done by Ibrahim et al, (2011) [16] they found out that the content that was presented for learning by the perversity of the heritage did not relate well to the user since in most occasions the user was not part of the development for the heritage process thus the lack of connection. The culture was mainly collected for preservation purposes and when the reservist had completed the perseveration process that is when the idea for using culture for learning came up and creation of the 3D environment was implemented without the involvement of the user. These raises an issue that since the users were left out in the development cycle it makes the virtual heritage project still not attaining the required learning environment for culture. One of the reasons that was behind to lack of the learning is that the user of the virtual heritage did not feel the connection to the past events and for them to have felt the connection then the virtual environment should have attained a more realistic look, activities that engaged the user and the utilization of the interaction of multi-sensory such as video and audio [17].

A study that has been done by Tan and Rahaman, (2009) [15] has identified that most cultural content in the virtual worlds does not have adequate content, had lack of engagement, realism, had a confusing design on its interface, the orientation and the navigation process was difficult, they are seen as static and lifeless. They explained that even though the architecture for the reconstruction of the photos are very impressive they were lack of elements that were dynamic such as humans, animals, rain wind, and fogs.

For instance, they give an architect of a building that can be used in different activities traditionally such as rituals and religious practices but the virtual construction of the three dimensional form of these monuments would not be sufficient content for learning since virtual heritage is limited to tangible and formal aspects of heritage and does not permit the content of the cultural heritage. Due to the factor that culture is always dynamic and has gone through different phases of changes meaning that it is believed that due to the constant change and the passing of the culture from one generation to the other there must be some information that would be missing in the process. For the reconstruction of this culture, the big puzzle is how the specific sections or periods are represented.

A study by Dave, 2008 [18] had suggested that the virtual reconstruction of culture should be evolving with commentary of arguments or interpretation than it is conclusive. However, this was not possible since the virtual reconstruction process is a rigid process and has only one way of data flow meaning that during the documentation process the concern is only authenticating the information while the representation stage aims at having accurate information and the dissemination process only has a focus on showing off the mastery of the technology and the process has no room for updates and interpretation of information. Critics of the virtual environment have found out that the user of the environment mostly are not fascinated by the virtual environment itself but they are more interested in the findings of the human parts and their way of life which is something most of the users can relate to than the built forms of the virtual environment.

Most users of the virtual environment do not feel connected to the environment that too much content in the environment for it is presumed that what they are looking for is not in the environment thus the reason for the disconnect. For example, it is like looking to a website for information and the website does not have any relevant information eventually making the user leave the website even though the website has been interestingly constructed. This is similar to a virtual environment with on relevant content included [16]. The users view in many occasions when a virtual environment project is commenced is not always taken into consideration and it is important for the users to view to be taken into account so that the content that is developed is always what the users would like to know. The virtual heritage project is mostly built on the expert's assumption what are the archaeologist, historians or the 3D designers but the user of the system such as the visitor to the museum, general public interested in history are not asked what they really want to know, and content built on that.

2.3 The Uniqueness of Every Culture

Culture is preserved due to the nature of every individual culture. Some cultures are good and passed to the next generation and some cultures are bad and are abandoned while moving to the next generation. An example of bad culture is the female genital mutilation that is practiced by some African countries which have led to the death of many girl children. This culture is being abandoned by the African continent, but some individuals are still holding on to it [19].

Krekaren, 2013 [20] agrees that preservation of culture is very important since the uniqueness of culture make one identify where they come from and due to immigration of people culture can be passed down to the other generation which can be shared with other immigrants and citizens so that people may learn from each other and identify and pick the good traditions that can still be practiced and have impact and advantages to the society since more is learned and experience in the process.

2.4 The System of Virtual Heritage

Heritage refers to the study of anything that is mostly inherited and recovered through the archaeological process, art, tradition, religious and cultural ways. Cultural heritage is encouraged to be preserved and protected for future generation to learn and experience the feeling [21]. The main objective of cultural heritage is to restore the old cultures in an environment that is created as a real environment that can be used by the user to explore what the ancient culture was and give them the experience and understanding of the culture. The link between the modern user and the ancient user of the culture is the virtual Heritage application [21].

Virtual reality refers to the transformation of the environment to feel like it is the real environment which is created by conventional videos displays or by no particular display of electronics. For instance, in museums, the visitors can always see the real museum or the real scene in an artefact. The virtual environment is also presented by the continuum which is also known as the virtual reality consisting of elements that are only virtual but with a real effect. With the use of technology, the virtual environment allows that users to interact with the virtual elements so that they can experience real environment or the one that is imagined. As an example, interactive virtual environment is shown in Figure 2.1. Some of the examples of virtual reality are the Moton Heilig's Sensorama that was done in 1962 which has a consideration of being the first immersive and multi-sensory device. Due to the development of technology and computing the field of the virtual reality that was being created progressed and in return produced a realistic and an environment that was interactive.

Figure 2.1: Example of interactive virtual environment [21].

2.4.1 Virtual Reconstruction of Culture

The reconstruction of cultural sites has become important since they preserve and present both the existence and the no-existence of historical sites, stories, culture, architecture, customs and way of life in different communities. For example, the reconstruction of the Zeugma Museum in Gaziantep. The Museum located in the South-eastern province of Gaziantep in Turkey and is currently being promoted to the world by virtual technology through a website that gives you a tour of the museum. According to a statement given by Gaziantep Chamber of Industry, 2016 in its daily news, it explained that the construction of the virtual environment was due to the factor that the country wanted to promote its ancient city that has significantly had a wide historical and cultural richness as well as the Zeugma mosaic museum to an audience that is wider. The website gives a 360-degree tour of the Zeugma virtually and the archaeology of the Gaziantep

Museum which offers translation in different languages such as English, French, German, Spanish, Turkish and Chinese [22].

According to daily Sabah, (2016) [23] the website has created a virtual platform that represents the antique city with its mosaics, archaeological and Zeugma mosaic museum, history, civilization, artworks and information that is up to date concerning the ongoing excavations.

The Selimiye Mosque is an Ottoman imperial mosque, which is located in the city of Edirne; Turkey has used latest VR technology to represent the tallest built minars (pillars) and for building information modeling and restoration (see Figure 2.2).

Figure 2.2: The Mosque of Edirne, Turkey – exterior view (left), detail view (centre) and interior view (right) [24].

The final VR experience was developed through the several stages

(1) Data acquisition using terrestrial laser scanning with the Riegl VZ-400 scanner, shown a few images as an example in Figure 2.3 .

(2) 3D modeling using point clouds for generating 3D meshes with Autodesk ReCap or Geomagic studio and for solid modeling with 3ds Max,

(3) Texture mapping of polygon models,

(4) Generation of videos of the textured 3D model,

(5) Data reduction (polygon decimation) for VR application,

(6) Data conversion for the import into the game engine Unity,

(7) Implementation into the HTC Vive including the programming for the motion control,

(8) Immersive and interactive visualization of the mosque in the VR system HTC Vive
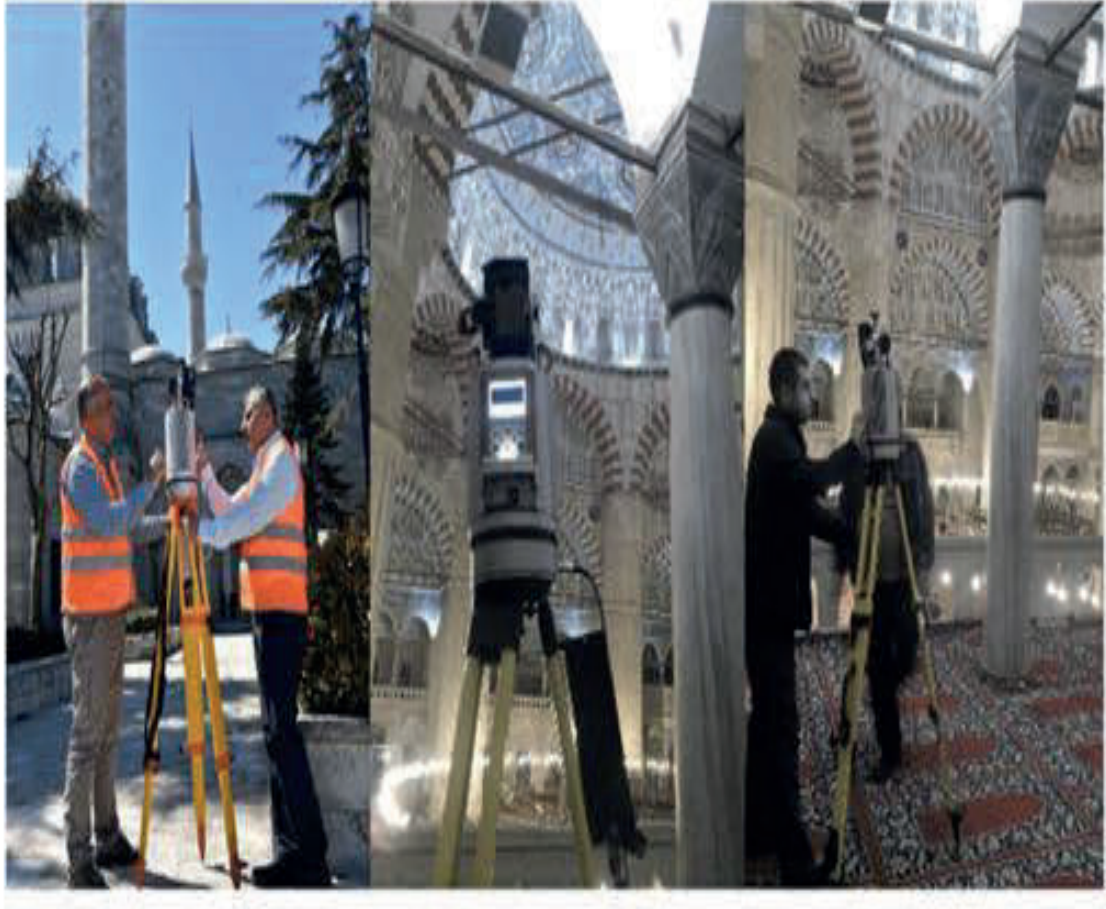
Figure 2.3: Data acquisition using terrestrial laser scanning for Selimiye Mosque [24].

Roussou, (2002) [25] identified in her study that virtual reconstruction has been mostly the work of the developers and the academicians but has always excluded the entertainment industry such as the movie production and it has required extensive labour and expertise that has been very high. However, the 3D model and environment which is the end product has highly remained within the scholar's domain and the academician. Very few of these works are normally published in websites or opened for public use such as in the museums shown in Figure 2.4 and Figure 2.5. This is due to the reason that virtual technology poses limitation to this group of individuals such as cost, development complexity and high maintenance cost . But it is believed that if move makes are included in these developments then they would be, more effective for users using the technology for learning since more individuals watch more of moves than using the websites.
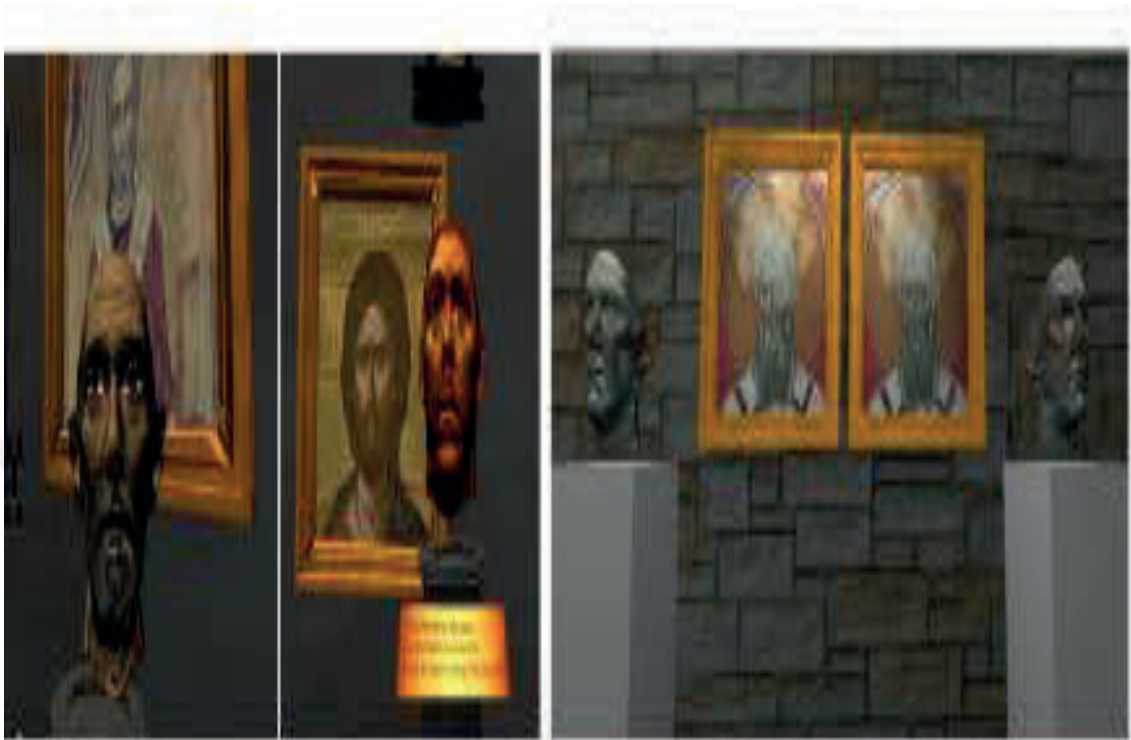
Figure 2.4: Images of the Byzantine Icon VR Museum [26].

Figure 2.5: Images of the real (left) and the virtual engraved museum (right) [26].

2.4.2 Virtual Heritage Domains

Virtual heritage can be defined as the recreation or visualization of culture with the use of technology [27]. Franchi, (2017) [1] defines virtual heritage as the use of media that is electronic to be able to recreate or interpret the cultural events, history, architecture and cultural artefacts in what they would appear to today but as what they were in the past. According to him the reason for the recreation is mostly for educational purposes and preservation.

There are three major domains in creating a virtual heritage. These are documentation, representation, and dissemination. Documentation involves the process of collecting the 3D information that is accurate and represents the accurate heritage of that particular community. It involves the process of investigating the information that is available, measuring it and producing epigraphy sketches [16]. Tan & Rahaman, 2010 [28] explains that it is the process of finding the relevant information, documenting and analysing the data that has been collected. There are different methods that can be used to capture the data which have a different technical expertise, hardware and devices such as the 3D laser scanner, laser triangulation, topography, photogrammetric, empirical, stereo-photogrammetric or structured light technique which is used according to the type of object and monument being collected. This is due to some of the data also being collected come from maps that are ancient, photographs, periodic paintings and written old documents [29].

Representation is mostly done in 3D which involved the replication for the object of the heritage that still is in existence or visualization of an object that was badly damaged due to time and years that it has existed, or it has been lost and is not in existence anymore. The representational domain mainly focuses on the technical representation of the virtual heritage such as the 3D effects when modelling, the computational lightening and the processing of the raw material. The dissemination is the process in which the 3D image is going to be displayed to the users. In most occasions, virtual reality is the media that is normally used to display the content to the user. The major focus for researchers in this domain is the focus on secure data. Preservation of authenticity during the transfer of data from one network computer to another, a system to achieving and retrieval of content [16]. Figure 2.6 shows the process of creating a virtual heritage
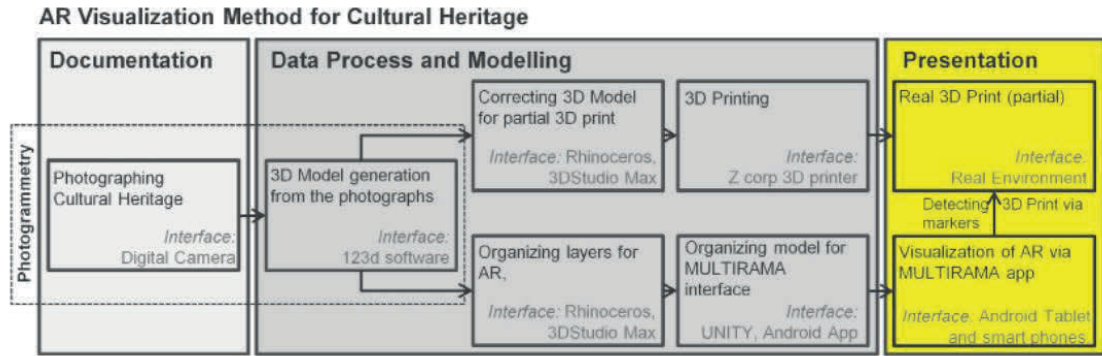
Figure 2.6: Process of creating a virtual heritage [30].

2.5 Augmented Reality System

Augmented reality is the use of the existing environment that was recognized as an emerging technology in 2007 and is integrated with digital information such as graphics and text. The augmented reality system gives an opportunity to the user to view a mixed scenario that is a combination of images that are virtually merged with the real environment in real time. The word augmented originated from the word augment which has a meaning of adding something. Augmented reality makes an addition of graphics, sounds, and touches to the real environment [31]. The major challenge for the augmented reality is the combination of the virtual environment, the real world and the time tracking of the user [32].

The AR services use various device sensors to identify the users' surroundings. The implementations generally fall into one of two categories — location-based or computer vision. Location-based offerings use a device's motion sensors to provide information based on a user's location. Computer-vision-based services use facial, object and motion tracking algorithms to identify images and objects. The business potential for AR has increased through improvements in location services and image recognition. The precision of indoor location services has increased significantly, and this greater accuracy allows businesses to use AR location features for vehicle, campus and in-building navigation and identification. Image recognition capabilities in AR solutions allow user organizations to use these AR capabilities in processes that require staff to visually identify objects and parts and for real-time decision making. These technologies together provide various benefits to using AR as an internal tool. This includes enhancing cultural heritage sites and preserving them [32]. It is a supplement of the real world with the virtual

environment which is through computer-generated objects that have a coexistence with the real world in the same space. An example of mixed reality is shown in Figure 2.7.
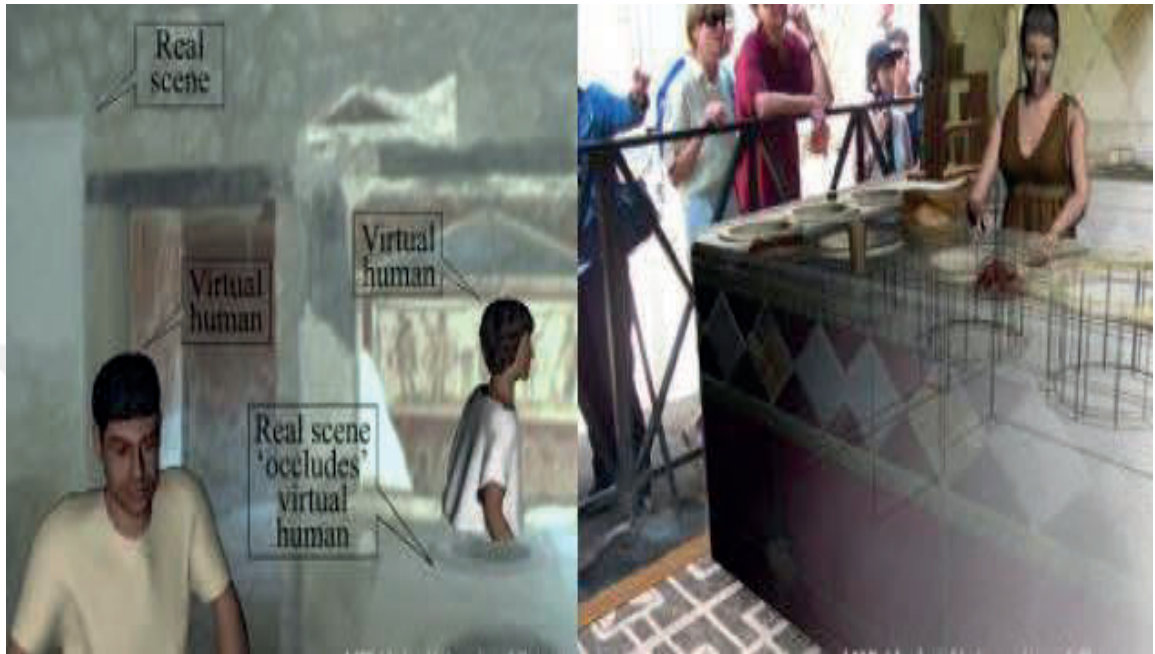
Figure 2.7: Example of MR telling story on the drama site of ancient Pompeii [33].

2.5.1 Visual Display Methods in Augmented Reality

There are three display methods used in augmented reality shown in Figure 2.8, those can be listed as below:

Through video display: This is where reality is video feed and the augmented reality overlays the digitized image.

Through see-through optical: This process uses transparent mirrors and lenses to display the augmented reality, but it does not display the real-world perception.

Through projective display: This approach involves the projection of the augmented reality overlay into objects that are real that results to the projective display [32].

The tools that are mainly used in augmented reality system are for example the augmented 3D reality viewer which allows the user of the system place life-size 3D model with both the use or without the use of a tracker. Trackers can be defined as simple imagines that are used by the 3D model to attach themselves to the augmented reality.

Another tool is an augmented reality browser which allows display of camera with contextual information, for instance, the ability for a Smartphone's to display the history of a building while it is pointed towards that specific building.

Augmented reality can also be experienced by gaming where the experience utilizes the actual surrounding, for example, playing a shooting game where the virtual objects walk in reality in the room.

Figure 2.8: Visual Display Methods in Augmented Reality [32].

2.5.2 Technological Requirements

There are three technological requirements for the development of an augmented system which are a framework, network and data storage. According to Tan & Rahaman, 2010 [46-30], augmented reality is improved with the recent developments in the technology such as, new interfaces and technical devices. Such technology can be used on mobile devices such as Smartphones and tablets, on personal computers that can be connected to televisions or on displays that are head mounted, glasses and lenses [34].

Framework

The augmented system performs some technical tasks such as tracking, sensing, displaying and interaction. This has to be first supported by prototyping frameworks that need development independently from the application. The integration of the system should be easy and created quickly for the user interface to be able to achieve the framework such as the ARToolKit which is the best known and is widely used. Other types of the framework include Studierstube, DWARF, D'Fusion, and Layar browser mostly used on Smartphone's [32].

Network and Database

The presentation of knowledge and information that is available in the augmented system is obtained through networks [30]. The system needs wireless or wired network to be able to transmit and support the retrieval of data and multiple user interactions in different distance perimeters. Information that can be transmitted and used in a mobile phone will use the wireless network connection through Smartphone's. The database design should be able to store information and be efficient since a lot of information is used in the system [34]

2.6 Technological Limitations

Cultural heritage has suffered some technological drawbacks due to challenges related to technology explained in the following subsections.

2.6.1 Internet Services in Different Countries

Due to low internet speed in some countries, for example, Bosnia and Herzegovina. Sometimes this has affected the model size of the virtual heritage since if it is big then it affects the download time making it slower and the user sometimes does not complete the download progress. Therefore, it focuses the 3D models to be optimized for such kind of models for these countries by the use of polygon reduction method which is also costly and requires a significant amount of time to be developed since the process cannot be fully automated. In some instance, the geometric itself may not be suitable since it cannot be used in optimization some objects like the one that has a hole in them, edges or faces which have a requirement for geometric clean-up or reconstruction [21].

2.6.2 Software Requirement

The software requirement for the user to view the model is an X3D player or the browser plug-in. This is not very popular software's for a normal internet user since it requires one to have adequate knowledge of computers and the risk that is related to the installation of this programs and know how to deal and prevent the risk so as to protect the computers from damages. This software programs also consume time and they need more resource for them to be installed in the specific computers [32].

Most computers that are for personal use normally have one CPU that limits that limits the user on the visual and the tracking which is hybrid. The computer that is mostly used by more consumers is not always suitable for real-time computing since most of them do not have ability for them to support graphics and sensors in their hardware functions [32].

2.6.3 Lack of Wide Distribution of Technology

The use of technology for virtual environment technology is not widely and evenly distributed everywhere. The technical expertise is also expensive and is not widely available to every nation and this is a challenge since some countries have to import this technical expertise for them to be able to preserve cultural knowledge which basically in some countries like the 3rd countries is not necessary for it is not one of the urgent and basic needs.

Some of the technological approaches that are used also have disadvantages that may affect the user such as the use of Head Mounted Display which causes nausea, disorientation with another sickness that is related to motion. It is also isolated from the real world and does not allow interactions of any communication process between the users.

Some of these systems are very expensive to be maintained, installed, and operated and the hardware requirements are also technical. The usability of this system also requires the users to be trained and all this require resources.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Research Design

In this research, I have used both primary and secondary data collection methods. The primary data collection method involves collection of first-hand information that is gotten directly from the field. The research will use interview with the use structured questions for it primary data collection strategy. The secondary method involves the collection of data from secondary sources such as literature from relevant books, articles, journals, reports and other relevant data to the research. Secondary data is usual data that has been researched by other researchers and has been published [35]. The collected data has been analysed through quantitative means to identify trends, thoughts and the opinion of the research environment.

3.2 Data Collection Method

The data collection method that will be used is the primary and the secondary data collection method. Primary data refers to the collection of first-hand information that is collected by the researcher himself or herself. It is important for the researcher to collect primary data according to what the researchers need and wants on what they would like to achieve. It can also be tailored according to the researchers need and involves a discussion with the respondent of the interview which gives a clear view of the study perspective. It also helps the researcher clear some issues that were not clear in the literature, questionnaires and seek for clarification from the respondent. An advantage that the primary data has over the secondary data method of collection of data is that the data that is collected in the primary data is always the current view of the respondent and it is time effective compared by secondary data that may be passed by time and the information may not be relevant to the current times [36].

The strategy that the researcher used to collect the primary data was through an interview with structured questions. The structured questions that were used in the questionnaires were the same questions that were used in the interview for this enable the comparison and clarity of the findings from both methods. Secondary collection of data is data gathered from other literature that is researched by others and published in books,

journals, reports, newspaper and other relevant reading materials. The advantage that the secondary method of data collection has to that of the primary method is that it is less time consuming, less expensive and that more information can be gathered within the limited time because the researcher will only use the relevant literature material to the study. The disadvantage of this method is that the information is bias according to the researchers' point of view. The other advantage of the use of the secondary data is that there is always a point of reference if the information is not clear enough. The study considers the use of a survey through a structured questionnaire to collect secondary data from the respondent [36].

3.2.1 Interviews

For the current study, formal and informal interviews were conducted with the hospital and university management to get their views and in-depth understanding of the people perceptions. They were generally asked about the need and importance of virtual heritage in learning, technological challenges, user perspective for VR, limitations in the software, and feature requirements, etc. The questions mentioned in the questionnaire were asked to determine the culturally diverse people perspectives and technological expectations. It was the pilot survey, and after that proper questionnaire was devised to expand the research area for the large population sample. It also helped in clearing the concepts and to get public reviews. The interview is an interactive section between two or more individuals. Interviews can be done in two methods informal and informal way. Both the methods were used in the study. The formal method involved scheduling an appointment with the respondent which has a particular date, time and place of the meeting while the informal meeting involved having the meet at the particular place that the respondent was meet and having the meeting right there and then.

The other methods that were used were through telephone conversations and emails that were sent randomly to the respondents.

3.2.2 Questionnaires

A questionnaire was designed that was comprised of about 25 questions. Close-ended questions were asked with the options, yes, no, neutral and not sure. The questions revealed the respondents' awareness level, access to technological advances, VR

importance in learning, future demands, and their views about the current devices. The analyses of the people view determined how the current technology can be improved and VR importance in heritage learning, etc. The questionnaire used in this thesis work has been presented as an appendix (see Appendix).

Questionnaires are a set of standardized questions that are put together by the researcher to help in the data collection process. The study used questions for it surveys with questions that were structured with a linked scale that had a measure of 1 to 5. The advantage of the questionnaire is that it has standardized questions that all the respondents get a chance to answer and therefore the response is also standardized. These help the study to be checked for reliability since the researcher can check the questionnaires for the constituency [37]. The research used a total of 600 questionnaires in which they were distributed in multinational university and business environment. The choice of the multinational university was because they were different cultures available in these institutions and therefore they were needed to get an opinion from a mixed cultural environment.

The business environment was chosen and the business that was targeted as an international company in business for more than ten years. The reason for this choice was because a multinational company had a mixed of employees from different cultural background and therefore diverse feedback was expected from them. Three hundred questionnaires were distributed to the multinational universities and 300 were distributed to the multi businesses.

A total of 502 questionnaires were returned for use since 102 of the questionnaires were not suitable for use since some questionnaires were not appropriately completed and some of the respondents did not return the questionnaires. Interviews were conducted and questionnaires were distributed to get people views on the VR heritage for learning. All the responses from business and university sites were in the favor of VR heritage for the learning of the real world. They said that more advancements are needed in this technology, such as developers must improve the device according to the user' perspective to make it more learning and informative. They said interaction with the virtual environment and behaviors and social patterns of ancient people are missing.

3.3 Data Analysis

In this study, I have used quantitative analysis to analyse the results obtained from the interview and the questionnaire. Analysis of the data can be considered as the interpretation and the evaluation of the findings of the research. The qualitative analysis gives an analysis that is easy to understand because it is quantifiable [38]. In this study the analysis focus on the common trends that are available in the responses and a critical evaluation and analysis done on them based on the aims and the objective of the research. The analysis is based on figure and numbers also the reasons behind the findings are tried to be explained. In the study, the comparison between the primary and the secondary findings is critical where the emphasis put on areas that have a common trend. The use of tables and graphs are used in the analysis and presenting our findings.

3.4 Justification of the Methods used in the Study

For the current study quantitative data analyses approach has been considered. The cumulative response rate has been presented graphically and all the questions have been explained with a general description. Interviews were also asked to get the in-depth view of the study scope and level of people awareness. All the concerned issues have been justified. The use of quantitative analysis method that was used is an easier method gives a better understanding of the variables that are in relation to the study. It quantifies the findings of the research using numerical data which are measurable, and trends are able to be measured from this numerical data. The method also gives an easier way for comparison to be done between the variable and how they relate to each other.

The survey method has been used in order to be able to cover a wide area of the respondents within a shorter time by the use of the questionnaires. For the research to be able to attain a 100 % response of the research, I developed the 25 structured questions in the questionnaire to conduct the interviews so that a good response rate can be achieved for the research. The interview was used as a method to help clarify areas that were not very clear to me and I was able to get an immediate response from the respondents and the opportunity to answer questions. The questionnaires and the interview questions were structured so that the questions are standardized and that they would be a systematic response and that the respondents would stay within the boundaries of the research topic.

3.5 Ethical Consideration

Ethical considerations are the norms that the researcher had while carrying out the study. They help the researcher distinguish what is wrong and right during the research process. It helps in the prevention of fabrication and falsifying of the data. Ethical consideration helps build accountability, trust, and respect that are mutual for both the researcher and the respondents [39]. We have made sure the following ethical considerations have been met during this study:

- There was no harm that was subjected to the participants.
- The information that the participant shared was treated as confidential and in case that the information needed to be shared out to a third party then consent was to be acquired from the respondent.
- All the respondents were treated equal and no discrimination was shown at any particular time to them.
- There was anonymity of both the participant and the organization that participates in the research due to some of the participants felt they would get penalized if their identity was known.
- The researcher made sure they were no exaggerations in the research aims and objectives.
- All the information that was relied upon to the participants was true and the researcher made sure that no false information as given to the participants.

3.6 Reliability and Validity of the Information

Reliability refers to the process the information that is provided can be related upon. If the study would be done for the second time would the same findings be found and if the same findings are found, then it means that the information can be relied on.

Validity refers to the process of credibility of the information or the believability of the information to find out if the data and information obtained is genuine. The research confirmed that the information that he /she had collected was reliable by comparing the findings of the primary data to that of the secondary data to come firm the frequency of information and trends that was among them. For the secondary data they were a reference to the information and therefore the researcher could confirm its credibility. Data that

seemed bias in the research has been removed. For the current study, Muradiye complex model has been developed through AR and VR techniques. But, the use of ICT to visualize or to create the virtual environment of the culture may sometimes exaggerate the experience or the cultural heritage and this may not give the actual information. This can be seen as the limitation of the study.

Interviews were conducted to get the scale of survey and awareness about VR heritage. Questionnaire responses were obtained from authentic business and university complexes. Similarity among the views of people suggests that there is less variation among the views which is a point to authenticity. Furthermore, literature references also broadened the thesis subject matter understanding. All the articles have been given by authentic writers and reliable sites.

CHAPTER 4

RESEARCH FINDING

In this chapter, we have presented our research findings obtained from the questionnaires to figure out how to create an effective virtual environment in AR and VR applications. Our questionnaire is composed of 25 questions. The questions 1-5 are aiming to figure out the importance of VR heritage technology for better learning, questions 5-10 are about technology and user perspective to determine what technological modifications are needed to make it appropriate for learning. Similarly, questions 11-15 are associated to find the level of linkage between virtual and augmented reality, it will determine people awareness level, questions 16 to 25 are about to determine the people desired features in the future VR products, to determine people awareness level and exposure to technology, software positives and limitations for learning and user perspectives. Results are evaluated in Section 4.2 and results analyses gave an in-depth view of VR importance in learning and feature advancements for future. Furthermore in this chapter, AR application has also been developed for Muradiye Complex.

4.1 Research Findings from the Questionnaires and Interview Administered

The research administered 600 questionnaires of which has been divided into two groups. The research has targeted to administer as the questionnaire to an international business environment where the companies must have operated in the country at least for a period of 10 years with an international base in which at least a quarter of the staff in the organization would have to be international and the rest national. 300 questionnaires has been given to this sector. The other 300 have targeted the education sector in which consideration has been given to the university sector in which the university must be international with the condition that at least a quarter of the students or more must be from other international countries and their teaching and administration staff would also be a quarter from the international environment. In the university environment, the questionnaires were divided into two which 150 went to the university staff while 150 went to the students. In order to attain 100% of the response to all the questionnaires 100 copies of the structured questions in the questionnaires have been used to administer the

interviews. The interviews have been held both in the universities and the international business environments. The questionnaires have been distributed in that manner in order to avoid clashes of the responses that have been received.

4.2 The Survey findings

Questionnaire has 25 questions and respondents' views have been analysed in the following sections.

Questions 1-5: Importance of learning Heritage and Virtual Heritage
Did you have an overall perspective of what Cultural heritage is?

About 80 % of participants gave positive responses while 20 % showed negative or neutral responses. International businesses site response was 70 % yes and 30% no. In the same way from university, 84 % of the staff and students said yes, while 16 % answered no. Awareness about cultural heritage questionnaire results are shown in Figure 4.1.
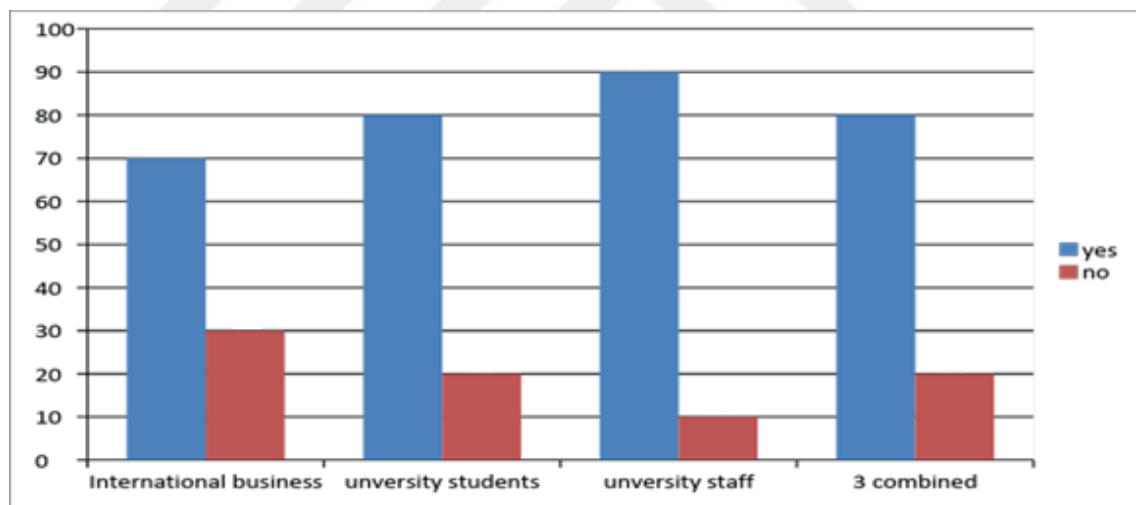
Figure 4.1: Questionnaire responses for the importance of learning heritage.

Do you think learning of culture is important?

Results showed that 82 % of the respondents said that the learning of virtual heritage is important and 18 % said that it is not important. The response from the international businesses has been that 80 % saying yes while 20% saying no. The response from the university institution is that 75 % of the students said yes and 25 % of them said no. The same question has been asked of the staff of the university and 90% staff said yes

while 10 % said no. Finding on the importance of learning heritage are shown in Figure 4.2
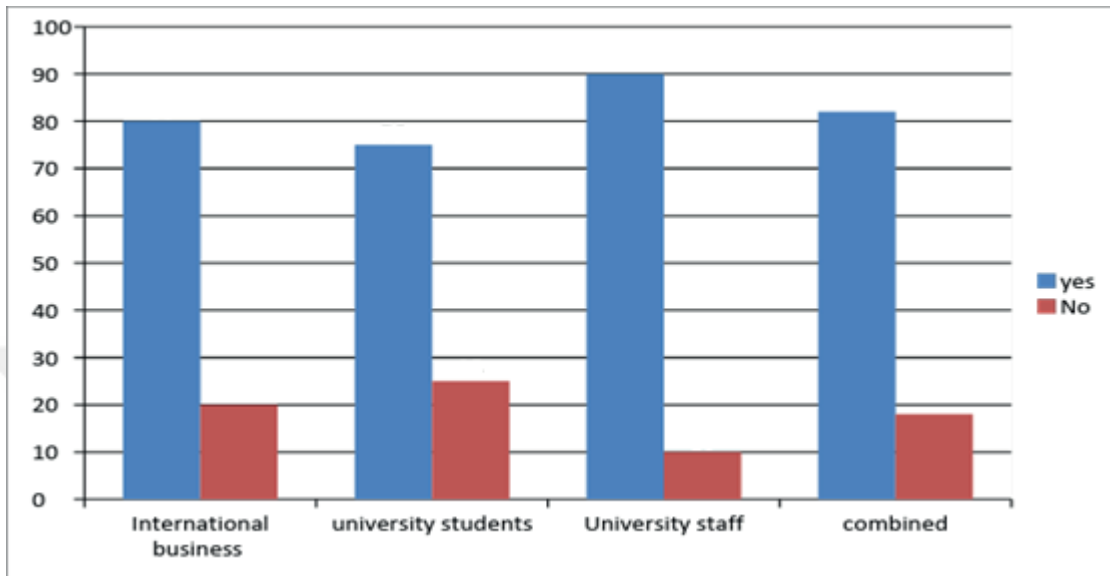
Figure 4.2: Questionnaire responses for the importance of learning virtual heritage.

Do you think learning of culture through virtual heritage or VR is important?

Approximately, 80% of the respondents in the international business environment said yes and 20 % said no. In the university, 75 % said yes while 25% said no while the teaching staff 90% said yes and 10% said no.

For the questions 4 and 5, "Do you think virtual heritage improves the learning environment of culture?" and "Do you think technological challenges affect the learning of culture?", results showed that we obtained 80 % cumulative response rate in the form of yes, from university and business sector. However, only 20 % cumulative response rate was obtained from both sites in the form of no.

Questions 6-15: If virtual and augmented environment helped in preservation of culture and how virtual environment and augmented reality is widely used.

- Do you think every individual is exposed to technology and can use it for virtual learning?

The response rate from the international businesses was 60% as yes while 40% said no. The response from the university institution was 50% for students as yes and the 60% of staff said yes.

-   Do you think that the information that is available in the virtual and augmented culture is relevant to learning and preservation of cultural heritage?

The response from the international business environment 85% of the response was yes, 10 said no while 5 % not sure. The response from the university student is that 80 % of the students said yes, 10 % said no, 5% said they did not know while 5% said they are neutral. The response from the university staff said 85 % yes, while 10% no, while 5 % were not sure. See Figure 4.3 for this information.
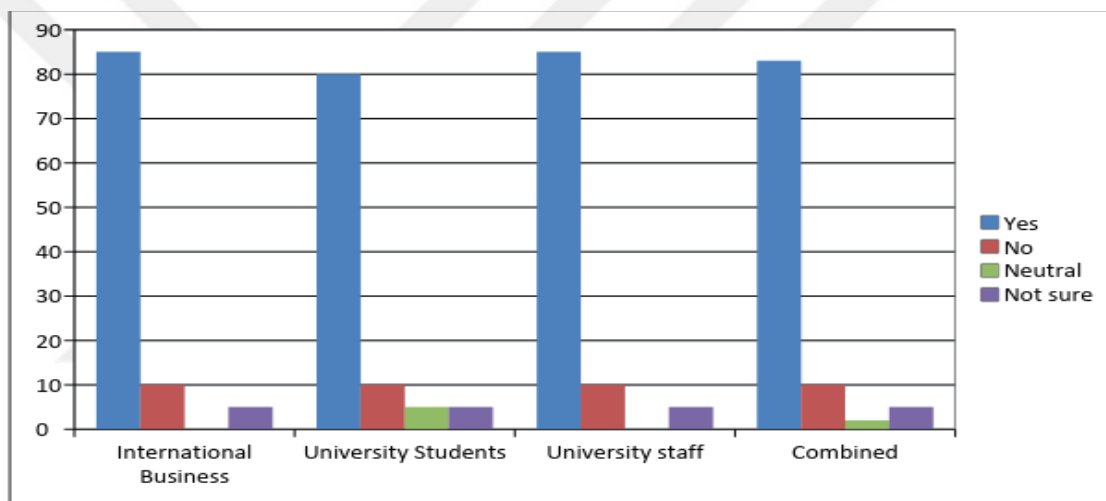
Figure 4.3: Questionnaire responses if virtual and augmented environment helped in preservation of culture.

For the question, "Do you think the developers of the system have in consideration the user in mind?" response rate was higher toward no and neutral responses. In the interview, people gave suggestions for this question and said that more enhanced features are needed to promote better learning by using this device.

For the questions, 9 and 10, "Do you think virtual heritage lead to the preservation of culture? And "Do you think the virtual environment offers an adequate environment for learning?", the response rate was mostly neutral. During the interview, respondents said that VR leads to preservation of cultural heritage and to make it better for learning it needs more features, however, respondents said that it definitely supports learning and understanding of ancient heritage and far distant places.

In the response of technological challenges, people have agreed that technological challenges are barriers to access to the virtual environment for all. Questions, 12 and 13 were related with Virtual reality and Augmented reality to determine people awareness level for the two. Business sector people were more aware while in the educational site, there was less awareness about the two.

- **Do you think virtual and augmented environment is widely used?**

The business environment response was 50 % is widely used, 30% said no while 10 % not sure. The university students response was 50% was yes being utilized,35% said no,15% not sure while for the university staff 55% said yes,25 said no while 10 % not sure and 10 % were neutral. See figure 4.4 for this information.
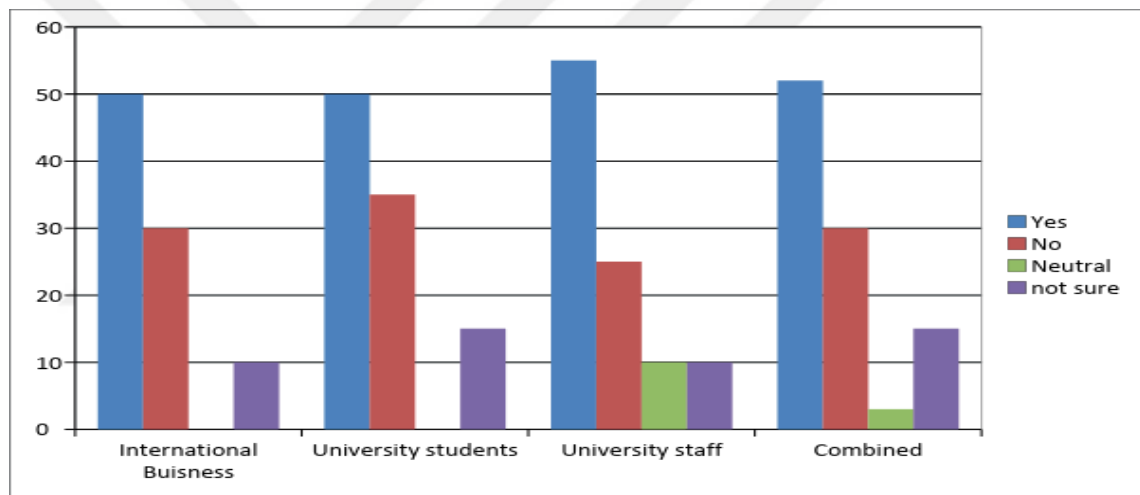
Figure 4.4: Questionnaire responses for how virtual environment and augmented reality is widely used.

Questions 16-25: Responses for content is relevant to the user.

- **What are the factors that affect the development of virtual environment?**

The response to the question that asked what factors affect the technological development of the virtual and augmented environment the majority of the responses were technological factors such as the software requirements and hardware requirements, advanced expertise and technological knowledge of computers.

Similarly, questions related to the interaction between virtual and augments environment, and technology role in the creation of a virtual environment were also asked in the questionnaire and in interviews. People said that interaction between two environments enhances the architectural perfection of objects. They said that VR

technology is very expensive and further advance technology will definitely contribute in the enhancement of application features, that will be in correspondence of all user requirements and highlighting the components with descriptions for the learners.

-   Do you think Virtual Reality and Augmented reality present the Cultural heritage and augmented reality content was relevant to the user?

The response for the international business thought that 50% of the content in the virtual and augmented environment was relevant, 10% were not sure and 30% said no and 10 % did not respond to that question. Figure 4.5 shows this that in the university, the students said 60% was relevant while 30 5 said no while 10 % were not sure while the teaching staff said 50% of the content was relevant. About 30 % said no and 20% was neutral response rate.
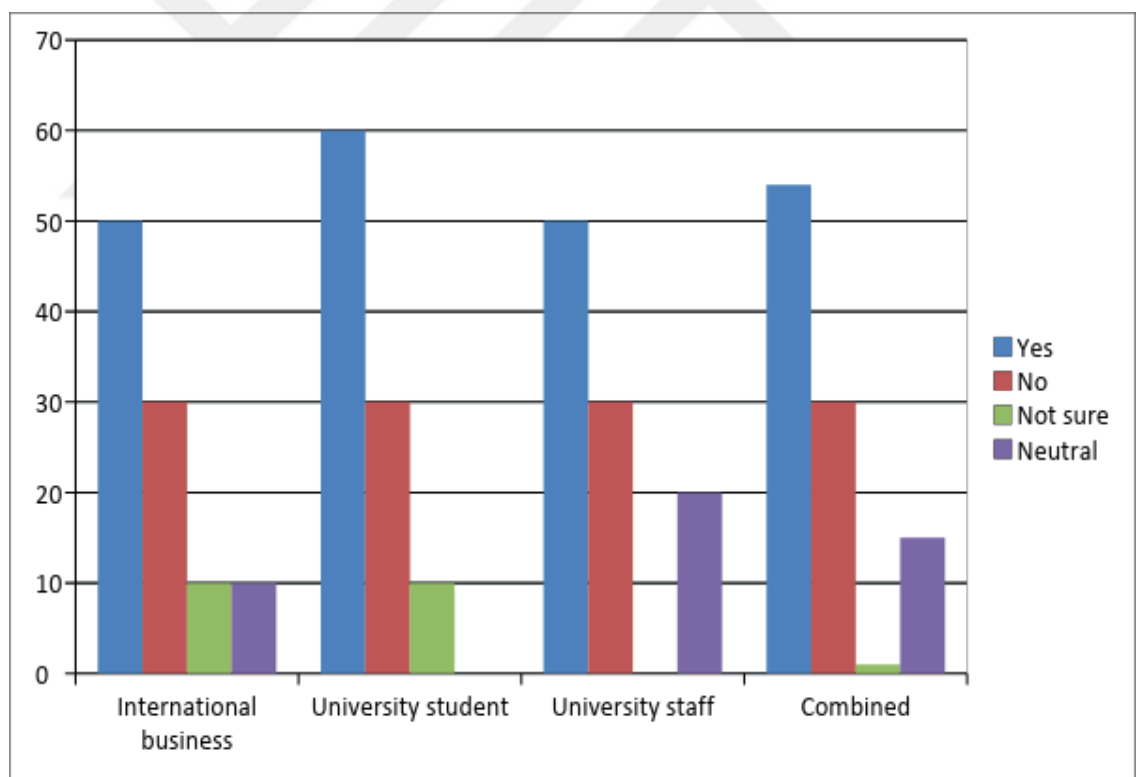

Figure 4.5: Questionnaire' responses for content is relevant to the user.

Other questions were asked about the technology advancement to get the user' perspective related to augmented and virtual reality were asked and mentioned in the questionnaire. Respondents gave their views that have been briefly described under the recommendations section.

4.3 Experiments on Virtual and Augmented Reality by Complex of Muradiye

In this study, the entrance of Muradiye Madrasa and the inner parts of Muradiye complex have been developed in VR heritage view. Muradiye complex was constructed by the Ottoman Sultans making it the last complex to be established by the Bursa. The complex of Muradiye, was built in the years following the completion of the Yesil Complex and consists of a mosque/dervish lodge (zawiye), madrasa (medrese), soup kitchen (imaret), a Koran school for boys (sibyan mektebi), a bath (hammam), and twelve mausolea (türbe) belonging to the Ottoman family. The mosque was completed in 1426/830 AH, and an endowment document naming a number of staff and resources earmarked for the complex dated to 1430/833 AH suggests completion of other buildings before that time. The design and the architecture of the complex was done according to the norms and the traditions of the 19th century [41]. The construction of the Muradiye mosque started in 1425 and completed in 1426 which took approximately a year. Its characteristics of the mosque which includes U-shaped corridor are almost similar to those of tabhanes (see Figure 4.6, Figure 4.7, Figure 4.8 and Figure 4.9)

Figure 4.6: The Muradiye Madrasa [42].

Figure 4.7: The Muradiye Madrasa [42].

Figure 4.8: Showing the Complex of Muradiye [42].

Figure 4.9: Showing the Complex of Muradiye [42].

UMAY Museum Design & Technologies

The UMAY Museum Design & Technologies boasts of numerous VR and AR projects including 3D Modelling arts. The experiment involves exploring some to the technologies in the company with a view of realizing the preservation of the cultural and virtual heritage. Umay is known not only in Europe but across the world because of the development of new ideas in the modelling and VR industry. Ideally, the organisation was co-founded by the faculty of fine arts of Anatolian University as a R&D Company.

The innovation of new ideas of modelling and museum designs has been attributed to the team having extensive knowledge in virtual reality and content development. Virtual reality technologies offer some motivation in some of the R&D works in the company. We did this for the mosque and the steps that are explaining the process are in section 4.3.3.

VR Kronos is one of the mobile platforms projects developed by the Umay Museum Design & Technologies using virtual reality and 3D technology. Essentially, the VR Kronos time navigator was developed by the company allowing individuals to view at any given time the historical monuments and buildings of the past. The application

which can be downloaded and installed in the mosque, device can be used with a VR headset (Figure 4.10) [43]. Ideally, the use of the technology has enhanced the travelling experience across the globe with both local and foreign tourists using the project to explore new place and learn the rich monumental history archives.

Through vigorous and in-depth research and development process, it led to the development of the VR Kronos project with the use of fictitious scenarios and historical text. Today, the exploration of the historical moments has been made easier thanks to the founder of the Umay Museum Design & Technologies across the world. As a result, the project has contributed immensely in the cultural preservation and tourism across the globe. Besides, it has helped to rejuvenate and bridge the gap between art and technology. To date, the project has partnered with several stakeholders in the arts and culture industry including the WalkOvr which is a control platform that enable combination of body movement with virtual reality [44].

Figure 4.10: VRKronos Cardboard

The artists in the company are in a position to employ creativity couples with the use of the virtual reality technologies to produce exemplary projects that have human interest at heart. In regard, the implementation of both AR and VR technology aids in the museum presentations and content development [31]. Before engaging in project development, the staff first makes illustrative productions using character design to

identify the suitable methods of addressing the problem at hand. Museums are known to be rich in numerous arts such as paints and 3D modelling which enhances the cultural heritage in the world. The use of the VR Kronos had brought people together hence fighting divisions and conflicts that come from diversity and hostility of resources [45].

4.3.1 3D Modelling and Virtual Reality

The technological based 3D modelling involves use of a computer to create a virtual model of real world things such as museum design and other projects before building them (AnimationArena.com, 2015). In the modern word, most of the designs and technologies have adopted both virtual reality and augmented reality to create exemplary designs of different prospects for instance the Umay Company. The models enable one to explore sight lines, experiment on thing and visualize which represents the creativity of the initial parts of any given project. Before the establishment of the VR Kronos and VR Kronos cardboard, the respective 3D models were first established as part of the foundation of the project.

These models help artists and engineers to make sense of how the building will look like to be ale toe make the necessary adjustments to suit the required image. In essence for museum designs and projects, the 3D models is used to carry out visual reference to be able to perform various analysis including photometric calculations hence being able to make the appropriate placements and decision making.

The design of the Muradiye mosque illustrates the presence of the virtual and augmented realities in the nineteenth century. The mosque has an inverse T plan with a portico at the front. Besides, it has four major domes with its interior decorated with hexagonal tiles. With virtual reality and augmented reality modeling, people tend to gain deeper understanding of the situations hence being able to have an insightful experience of the real-world phenomenon (https://wikivividly.com/wiki/Muradiye_Complex). The use of virtual reality has enabled Umay museum designs & technologies to create an exemplary prince where visitors can relate to the happenings of the past by reading some of the design of the buildings. Owing to the challenges of VR and AR, the company has struggled to implement more projects thus taking time to develop new projects. Some of these challenges include complexity of the technology, labour intensity, and high costs involved.

4.3.2 The Creation of Video Sequence

To be able to create a sequence of the tourist application the solid model of the complex. was exported in a file format of FBX in a computer for the use of the visual software Unity from the OSX 3D. B.V. Unity software enables users of the program to be able to create videos and images without any training that may be prior. It enables the user to edit the environment that is generated in real-time and extremely fast rendering by the use of GPU technology rendering. Atmospheric and light effects were prepared in this software before the rendering.

4.3.3 The Game Engine Unity

Unity Game Engine is a platform that supports 3D and 2D graphics. It is widely used for gaming and video graphics development. It can be interfaced on the desktop and even on mobile phones for developing applications. The game engine unity was used for the virtual reality application. A game engine unity is software that is used for the creation and development of video games, mobile devices, and computers. The functionality that a game Engine provides is: the rendering of engine for 2D or 3D graphics in order to display textured 3D model that allows interaction of objects, audio and emission of sounds, scripting, animation, artificial intelligence, networking, streaming, memory management, threading, localisation support, scene graph and support for videos. A game engine is what is responsible for controlling the game, visual appearance and the rules of the game.

Unity has highly optimized rendering pipeline can help one achieve exceptional frame rates. Also, the Unity editor's rapid iteration capabilities can be used for VR development platform and for Augmented Reality Applications. Cardboard support and Vuforia are available to the developers using the Unity platform.

Cardboard SDK for Virtual Reality

It has VR Api for third-party engine integration (not required for Unity or Unreal).It supports a native application framework for building high-performance VR Applications from scratch. It has additional libraries providing support for GUI, locale, and other functionality. The native project sample applications and source are available to

provide a reference model for creating VR applications to the developers along with tools and resources to assist with native development.

Vuforia for Augmented Reality

Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that enables the creation of Augmented Reality applications. It uses Computer Vision technology to recognize and track planar images (Image Targets) and simple 3D objects, such as boxes, in real-time. It can be integrated with the Unity Game Engine platform for the development of AR applications.

Steps for Augmented Reality

Step 1: Creating the environment

Same environment objects used with Umay's VR Kronos project. Environment created support with environmental plan (see Figure 4.11). Figure 4.12, Figure 4.13, Figure 4.14, Figure 4.15 and Figure 4.16 showing created environment of Virtual Muradiye Complex.
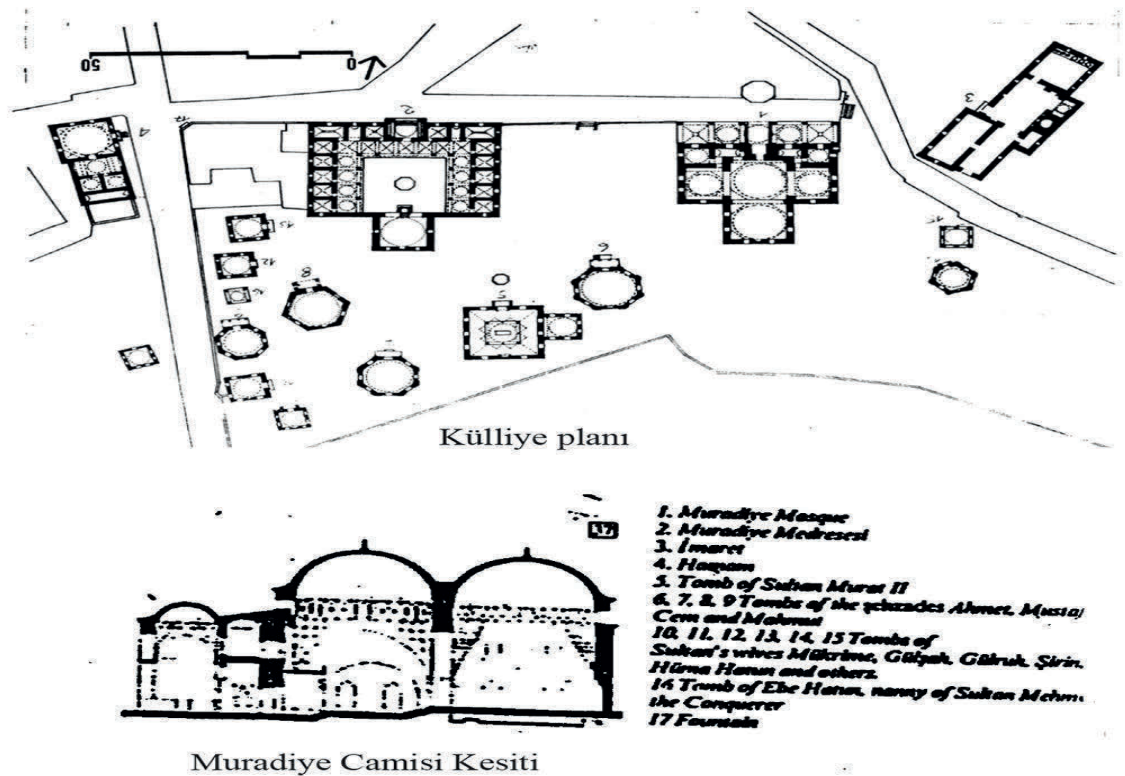

Figure 4.11: Plan of Complex of Muradiye [46].

Figure 4.12: A look from top view to the created environment.

Figure 4.13: A look from another view to the created environment.

Figure 4.14: A look from another view to the created environment.

Figure 4.15: A look from another view to the created environment.

Figure 4.16: A closer look from another view to the created environment.

Step 2: Marker creating with Vuforia Augmented Reality Marker Generator

Figure 4.17 showing different target types for Vuforia. Single image marker created with Vuforia Target Manager. A book cover used for marker. The size of the target should be on the same scale as used augmented virtual content. Vuforia uses meters as the default unit scale. The target's height will be calculated when uploading image. (https://developer.vuforia.com)
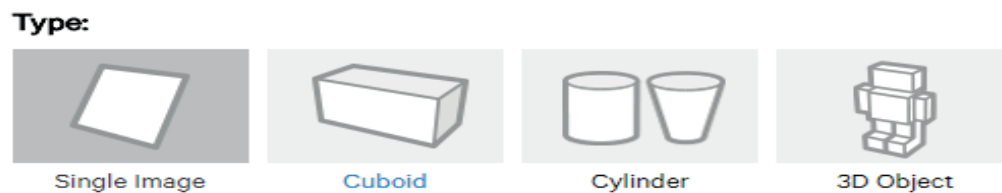
Figure 4.17: Different Target Types for Vuforia.

The uploaded target rated 4 stars by Vuforia Augmented Reality Marker Generator as seen Figure 4.18.

Target Name	Type	Rating	Status ❯	Date Modified
marker	Single Image	★★★★☆	Active	May 22, 2018 14:25

Figure 4.18: Rating of uploaded target.

Step 3: Importing Vuforia Plugin in Unity

Unity Vuforia 6-2-10 extension downloaded from Vuforia Developer Portal and imported to project. Vuforia ARCamera prefab placed to Unity3D scene. App License Key generated with Vuforia License Manager and entered the project under ARCamera object (see Figure 4.19).

Figure 4.19: Vuforia Plugin Configuration.

Step 4: Importing the image database in Unity

The target created on developer.vuforia.com was downloaded and imported into the project. Vuforia ImageTarget prefab placed to Unity3D scene. Type chosen as Predefined. Figure 4.20 showing Image Target Behaviour configuration.

Figure 4.20: Vuforia Image Target Configuration.

4.4 Comparing Modern Technology with Traditional Methods

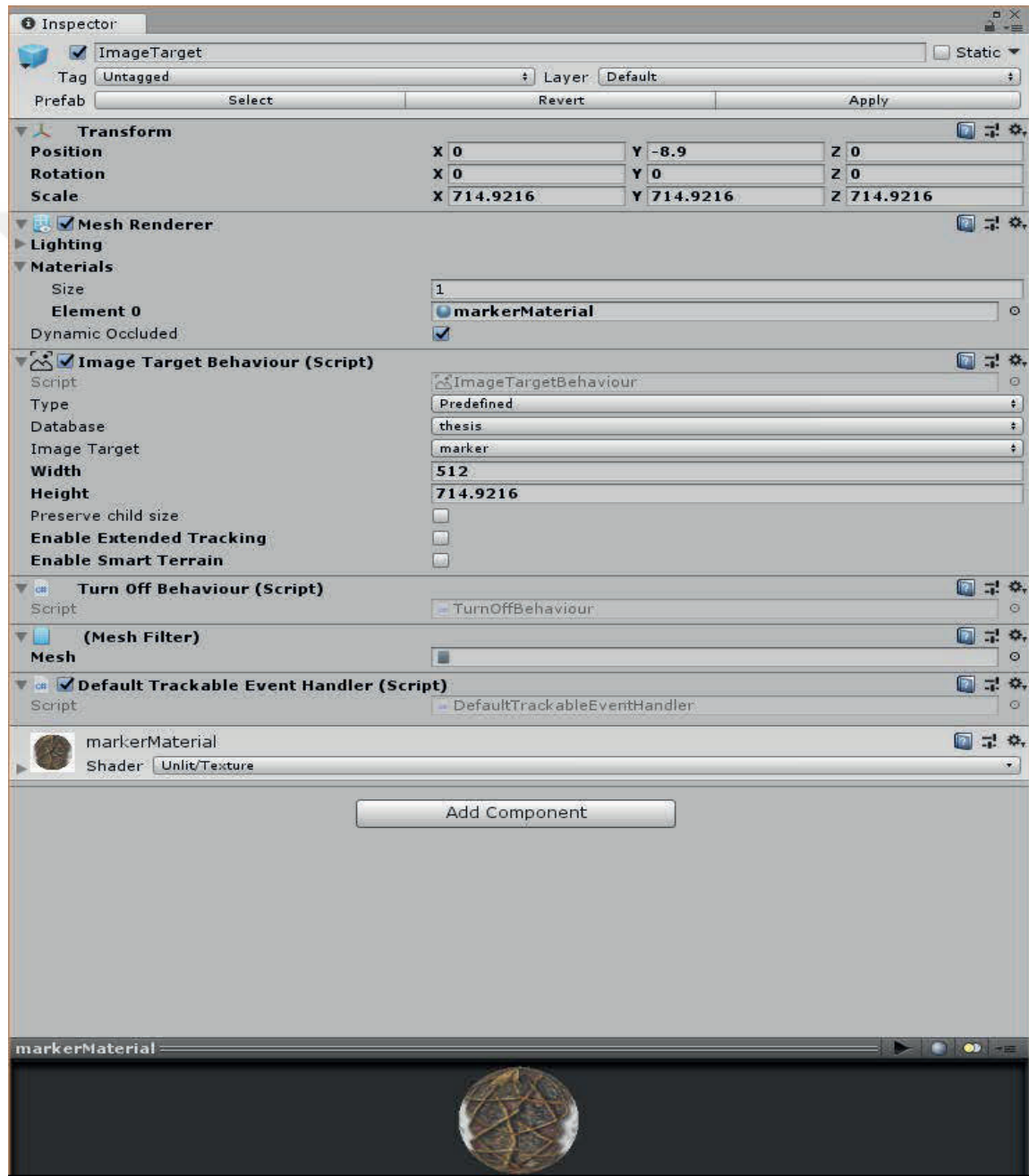In this thesis, one application for Augmented Reality has been developed and i used Umay's VRKronos application for Virtual Reality. We can consider a sample demo of a cultural site for study. A book (Figure 4.21 and Figure 4.22) and two different technologies are used to represent the same model. Considering the book that describes our project Muradiye complex, we can have a comparative study of the book with our project applications, one of which is Virtual Reality Application developed using Unity3D and the other is an Augmented Reality Application developed using Unity3D. When the cultural heritage site is studied through the following different medium and technologies, we can conclude the following. This book is a comprehensive study of the tomb-sanctuary on Muradiye complex in Turkey. The aim of the book is to introduce the Muradiye complex, which is included on UNESCO's official list of world monuments. The book can be more descriptive and represent the statue or model in the form of a picture or a painting. To understand the importance of a cultural site, one has to scan through several pages and absorb the knowledge in order to physically understand the dimensions and details of the complex. It increases the imagination skills of the brain.
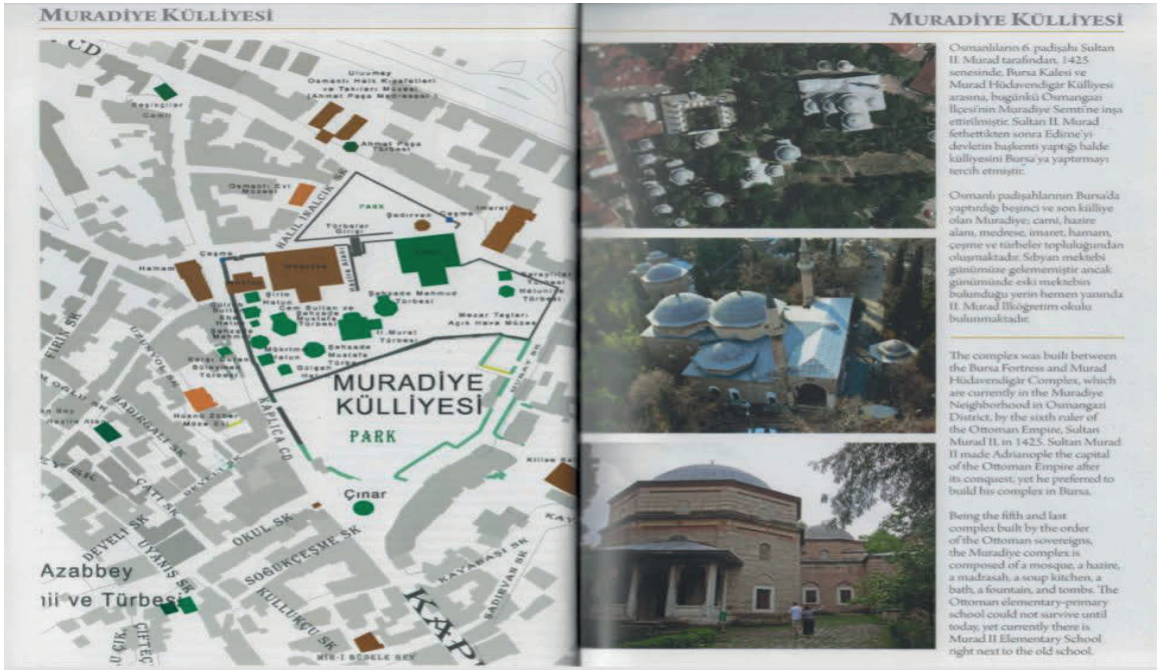
Figure 4.21: Complex of Murad II from book [6].

Figure 4.22: Old photo of Muradiye Complex from book [6].

The developed applications that display the same model using the technology of Virtual and Augmented reality tell us that these technologies are both immersive and on the other hand create a real-time experience for an individual which can be experienced virtually. VR and AR make the experience of such models livelier and more interactive with their developed applications and blended digital technology, own graphics and computer sets. Virtual reality and augmented reality are great examples of experiences and interactions fuelled by the desire to become immersed in a simulated land for cultural heritage and archaeological by adding a new dimension of interaction between digital devices and the real world [47]. Alone or blended together, they undoubtedly open worlds-both real and virtual alike. With evolving technological experiences and methodologies VR and AR will be deeply symbiotic and fascinating for various architectural sites, museums, and places of history to explore in the next few years (see Figure 4.23 and Figure 4.24).

Figure 4.23: A Screenshot from Muradiye Complex AR Application.

Figure 4.24: A Screenshot from Muradiye Complex VR Application of Umay.
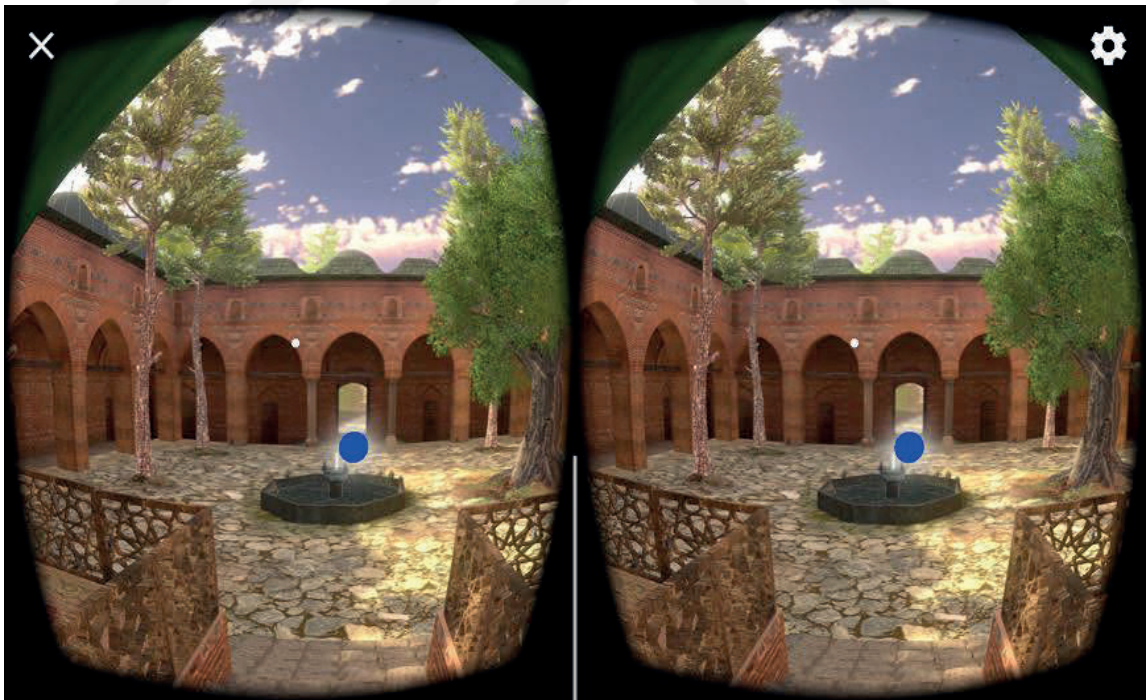
CHAPTER 5

CONCLUSION AND RECOMMENDATION

Finally, the major outcomes and concluding notes have been given under this section. The result analyses have helped us in reaching the following outcomes.

5.1 Conclusion

From the point of view of the user representation of virtual heritage through the augmented and virtual reality is significant for promotion and education of learning virtual heritage. In the current study, Surveys were conducted, and the response rate has been evaluated through the quantitative data analyses. General analyses of response rate suggested that people have awareness about VR architecture, and it can play an important role in enhanced learning and understanding of architecture, ancient cultures, and subjects or themes.

Respondents felt that through the virtual environment the user could have a view of a superposition of the real world through the virtual scenes that were representing the simulated characters fully living in the real time. Virtual and augmented reality has made a key contribution in preservation, education and learning in the virtual environment even though their challenges that the developers of the system face due to technology. A user would like to be considered when the environment is being created and what they would like to learn sometimes is not included in the virtual and augmented environment. The users would like to have or see an interaction between the real objects and the virtual environment and they would also like to have an interaction with the virtual environment. Technology enables the development of the virtual and augmented environment, but they are also challenges that the developers face and it this has made more users not be able to assess these virtual environments.

Virtual and augmented environment has given user the ability to experience the ancient cultural environment, but it does not give the users the ability to experience the cultural way of life of the particular people, for example, the Pompeii ancient city where the user would like to learn the behaviours and understand the social patterns of the people

who lived in the city in the Romans ancient times but this would not be available in the virtual and augmented environment.

Virtual reality (VR) and Augmented Reality (AR) offer cultural heritage many useful applications that deserve greater attention from tourism researchers and professionals. As VR and AR technology continues to evolve, the number and significance of such applications undoubtedly are increasing. Planning and management, marketing, entertainment, education, accessibility, and heritage preservation are six areas of cultural heritage in which VR and AR may prove particularly valuable. Part of VR's possible utility as a preservation tool derives from its potential to create virtual experiences that tourists may accept as substitutes for real visitation to threatened cultural sites and museums. However, the acceptance of such substitutes will be determined only by a tourist's attitudes and perceptions toward authenticity and his or her motivations and constraints. As AR and VR are further integrated into the cultural heritage sector new questions and challenges clearly will emerge. The sector will benefit from future research into the topics that are discussed and numerous suggestions for future research are presented.

Virtual Reality creates a realistic world and helps to explore places and sites. Therefore, users can experiment with an artificial environment. Augmented Reality Increases knowledge and information and People can share experiences with each other over long distances. It gives even more "real" experience and things come to life on mobiles and devices. Study aims were to explore the importance of the emerging possible uses of virtual heritage applications mainly in education, promotion and learning cultural heritage. The study revealed the importance of user feedback. As an experimental study, we have developed an AR application and Muradiye Complex, Turkey has been shown.

The study determined that the virtual heritage application is efficient and effective for learning and promotion of culture. It shows the data as it is in actual reality and by more advancements, cultural virtual reality can be made more effective for learning. Cultural heritage can be used for educational purposes and cultural heritage preservation. Cultural practices can be promoted because different audiences have different cultural heritage, it brings new ideologies, thoughts, and expressions of different cultures. Visual exposure to ancient heritage and far distant places give inspiration and thought of cultural

crucial factors. However, data must be captured accurately for learning purposes. Augmented and virtual reality components can be integrated for better learning purposes.

A questionnaire was designed that was comprised of Close-ended questions with the options, yes, no, neutral and not sure. Majority of the participants gave positive responses regarding the importance of Cultural heritage. Both International businesses and university staff were familiar with the importance of learning of culture through VR technology. Virtual heritage improves the learning environment of culture by the visually expressing the cultural components and technological challenges can be managed with a user perspective. Even in the modern age, every individual is not exposed to technology and it is not available to all. Moreover, the information that is available in the virtual and augmented culture provides relevant information for learning and preservation of cultural heritage however, some features need more development. In the response of technological challenges, people have agreed that technological challenges are barriers to access to the virtual environment for all. Business sector people were more aware of virtual and augmented reality technologies. Awareness and training are necessary to promote its wide use in educational institutions.

The interaction between two environments enhances the architectural perfection of objects. They said that VR technology is very expensive and further advance technology will definitely contribute in the enhancement of application features, that will be in correspondence of all user requirements and highlighting the components with descriptions for the learners.

5.2 Recommendations and Future Works

The study highlighted the technological limitations and innovation requirements with the user perspective. By considering respondents views, the following parameters can be considered for further improvement in VR architecture. It will make VR more purposeful for architecture study of ancient history and far distant places.

There are a number of factors that need to be improved when developing the virtual and augmented reality, for instance, the real-time camera that tracking performance should be improved, and training should be offered to users on how to assess the environment of the allocated website. In cases where the lightening condition on the real scene has been altered, a new database should be generated and the system to retrain. For the human

domain simulation of the virtual humans should be addressed more by the developers to enable interaction of the users and the virtual environment. More research should be done on how the technology can be used to create mixed notion where the user can learn both the ways and the cultural social environment of the people as it interacts with the environment.

The virtual cultural learning in virtual reality and augmented reality should be made more interesting for learning and be developed in forms of movies so that individuals who cannot be able to access the website due to technical issues they can buy the movies from video libraries and other institutions that markets. More training should be done to the public and the users of the virtual environment and how to use the websites even on personal computer and more information should be given on the technicality involved in the process.

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APPENDIX

A STUDY ON REPRESENTING CULTURAL HERITAGE BY VIRTUAL AND AUGMENTED REALITY

Questionnaire

I am Gürcan SERBEST a student of Hasan Kalyoncu University from Turkey.

I have selected representing cultural heritage by virtual and augmented reality. Your cooperation and views will be very much supportive in allowing me to achieve my research objectives.

Name	
Business Name	
Gender	a. Male b. Female
Age	a.10-20 b. 21-30 c. 31-40 d. 41 and above
Designation	
Working Experience	

	Yes	No	Neutral	Not sure
1. Did you have an overall perspective of what Cultural heritage is?				
2. Do you think learning of culture is important?				
3. Do you think learning of culture through virtual heritage important?				
4. Do you think virtual heritage improves the learning environment of culture?				
5. Do you think technological challenges affect the learning of culture?				
6. Do you think every individual is exposed to technology and can use it for virtual learning?				
7. Do you think that the information that is available in the virtual culture is relevant to learning and preservation?				
8. Do you think the developers of the system have in consideration the user in mind?				

9. Do you think virtual heritage lead to preservation of culture?				
10. Do you think the virtual environment offers an adequate environment for learning?				
11. Do you think Virtual reality and Augmented reality are related?				
12. Do you know the difference between Virtual reality and Augmented reality?				
13. Do you think due to technological challenges a majority of people have access to the virtual environment created?				
14. Do you think virtual and augmented environment is widely used?				
15. How important are cultural practices?				
16. What are the factors that affect the development of virtual environment?				
17. Is learning of culture important in whatever way not necessarily using virtual heritage?				
18. Would you like to see more interaction in the virtual and augments environment?				
19. Do you think the creation of virtual environment is affected by technology?				
20. Do you think Virtual Reality and Augmented reality represent Cultural heritage?				
21. Would you like to see more features in augmented and virtual reality?				
22. Do you feel that the development and the user of advance software will help a more advanced virtual environment?				
23. Would you like to see more interaction in the augmented and virtual reality in cultural heritage?				
24. Do you think the virtual reality that is currently available in the websites is more interesting?				
25. Do you think addition of more features would more the virtual environment more interesting?				