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Promotion of Cultural Heritages Through A Virtual Museum Platform: Case Study Hagia Sophia

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ABSTRACT

The Digital World has become the most significant platform for spreading the written and visual documents about cultural and historical heritages in accordance with the recent developments on web based technologies. All kind of digital platforms are the primary tools to transfer local values to global scale. Nevertheless, it is not possible to say that these technological opportunities are efficiently used to promote museums keeping the inheritance and memory of societies. The aim of this study is to create a virtual museum platform including all kind of written and visual materials by 3D game technologies. Hagia Sophia has been selected as the case study area of this study and digitally reconstructed to use in the project. Unity game engine has been used in the study to prepare the application where people are capable to see and interactively walk through the Hagia Sophia in a digital environment. As a result of the study, a virtual museum platform working on Windows, Mac, Ios, Android, VR and similar digital platforms has been built.

Keywords: Virtual Reality, Cultural Heritage, Hagia Sophia, Istanbul

1. INTRODUCTION

Historical environments, museums and galleries are the bridges that connects past and present to each other in the human mind (1). However, in Turkey, visitor numbers of museums and archaeological sites are dramatically decreasing. The decrease rate was 5,6% between 2014 and 2015 while it has been 38,7% between 2015 and 2016 in the places affiliated to the Ministry of Culture and Tourism (2). The main aim of this study is to encourage people to visit museums more often by the help of latest information technologies but firstly it is necessary to understand the main reasons of this situation.

Unfortunately, many people think that they are too busy and have no time for such activities because of their heavy living conditions. Museums are boring places with their atmosphere and people have many alternative activities, which may make them happier. Children go to museums by school trips because they have been told to, not by their free will. Entrance fee is high especially for the popular places. Museums may be too crowded and distracting because of the people taking selfies everywhere. Many people have no idea about what they are looking at in a museum in despite of explanations next to the historical artifacts or sculptures. In museums, most of the objects are kept out of sight because of limited space to exhibit all items. We live in a digital age but still the interactive guides and informative screens are generally useless or out of order. It is possible to increase the number of reasons but we need a

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solution for all of them. The new museum proposal must appeal to the expectations of digital age people who use all kind of platforms to reach information. Creating accessible web based virtual museum platforms will attract tourists, students and researchers from all ages.

The main goal of this project is to create an international virtual museum based on 3D game technologies. This platform is a computer based unreal world giving user the illusion of being present in an actual museum (3). Today, game engines are highly capable to create this kind of complex virtual environments which may serve to historical teaching and learning processes (4).

The advantages of virtual museum are much more than a traditional visit in accordance with its accessibility and ease of use. People are capable to reach this platfom just by using a computer and internet to see the virtual reconstruction of a cultural heritage with all components and to navigate the environment interactively. The users have capabilities to reach everywhere by walking like in a first person shooter game, by flying like a bird or by following a predefined path which show visitors round. Moreover, they can discover the points of interest in the museum and get information about them by mouse clicking on information buttons next to them.

Hagia Sophia Museum, a world heritage site of UNESCO since 1985, has been chosen as the case study area of this study.

Figure 1. A general view of Hagia Sophia Museum

Hagia Sophia is one of the most important historical buildings for all humanity. Its magnificence, size, functionality and architecture is unique in accordance with the similar structures. It is the biggest church that was built by East Roman Empire in Istanbul. The name of the first building was Megale Ekklesia (Big Church, A.C. 360) which was renamed as Hagia Sophia (Holy Wisdom) in 5th century. After it was burnt down in the year of 404, it has been rebuilt by Emperor Theodosios II in the year of 415. Then, the church was demolished again in 532 but reopened by Emperor Justinianos in 537 after a five years of construction period. Hagia Sophia served to Christendom as a church until 1453, the Conquest of Istanbul. Right after the conquer of Ottoman Empire, Hagia Sophia was renovated into a mosque and then minarets have been designed and implemented in the following years. Hagia Sophia served Muslims as a mosque until the year of 1935, the date it was converted into a museum (5). Today, it is the most popular museum in Turkey by its national and international visitors more than 3,500,000 per year.

2. METHODOLOGY

It is significant to use the latest information technologies and to choose the best software to create a virtual museum environment, which will work on an online digital platform (6). In accordance with the uprising computer technologies, the museum buildings and included items can now be archived digitally (7). There are different methodologies for this purpose.

The simplest and cheapest method is a web-based virtual tour application based on 360 degree panoramic images widely used by many governmental and non-governmental organizations all around the world. Effectiveness and usability of these tours were widely discussed in literature. It is seen that, one of the most common application areas of this technology is cultural heritage but points of views are pre-defined places, so users are not capable of navigating through the application freely. That means the user has to see environment from a fixed point without moving whereas people want more interactive and self-directed platforms.

In addition to this technology, 3D laser scanning outputs are also used to create 3D reconstruction of cultural heritages (8). 3D models of buildings are generated from millions of point clouds and then merged with images (9). This method gives accurate and meaningful results but it requires a long time and hard post-processing steps to get a meaningful output (10). In addition, laser scanning equipments for 3D data capturing are very expensive, so organizations can not meet the necessary budget to create virtual platforms based on this technology (11).

Besides these techniques, there is a much cheaper, effective, practical and useful technique to exhibit the museum environment to all people all around

the world. In this study, a game engine will be used to generate a 3D interactive virtual museum platform. Of course, it is a long and challenging process including many phases. Some of these important steps are given below in general (Figure2):

- 3D modeling of terrain and integration with orthophoto for a realistic environment,
- Architectural 3D modeling of Hagia Sophia,
- 3D modeling of the near environment with buildings, roads and landscape,
- Integrating all 3D models into a game engine for a free, interactive and self-directed navigation environment,
- Adding informative texts and sounds about the points of interest in the museum.

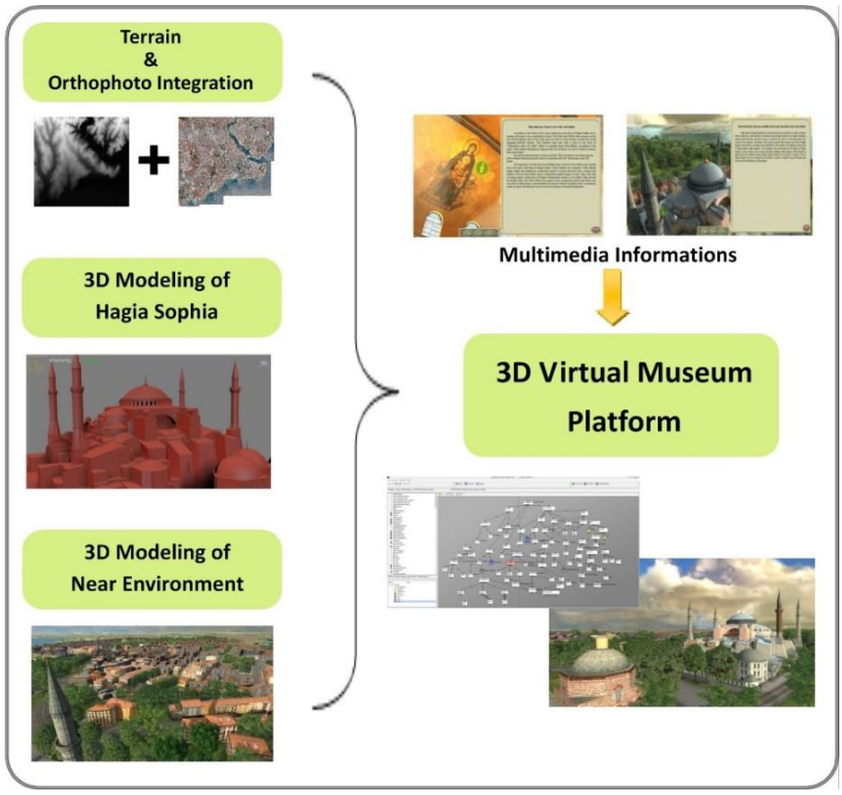

Figure 2: The schematization of methodology in general

3. CREATING THE VIRTUAL MUSEUM PLATFORM

The first step is to create a Digital Elevation Model beneath the museum with its near environment. The TIN (Triangulated Irregular Network) structure of the terrain model derived from 5 meters interval contours which have been converted into a 3D terrain model by a 3D modeling software (Figure 3). Near environment terrain of the museum has been modeled in detailed for a more realistic view.

After creating the 3D terrain model, it is significant to integrate a high resolution satellite imagery or orthophoto onto it. Therefore, 1 m. resolution orthophoto has been used to generate a realistic environment which will be used as a base for all 3D models that will be created in the context of this study (Figure 4).

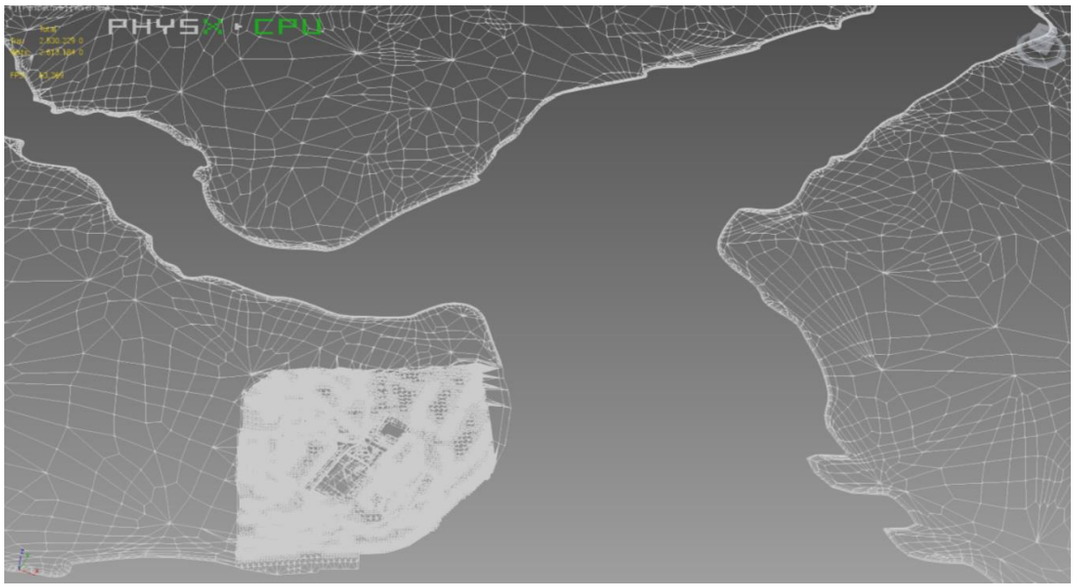

Figure 2: 3D terrain model of topography

Figure 3: Orthophoto of Hagia Sophia Museum

Through the 3D reconstruction process of a cultural heritage, it is significantly important to have accurate and precise drawings which are used as reference while modeling the building (Figure 5). The structure has three naves, one apsis, internal narthex and external narthex. The length between the apsis and the outer narthex is 100 m while the width is 69.5 m. The dome has 55.60 m height while it has 31.87 m radius in the North-South direction and 30.86 m radius in the East - West direction. There are 104 columns in the building where 40 of them are in the ground level and 64 of them are in upper gallery.

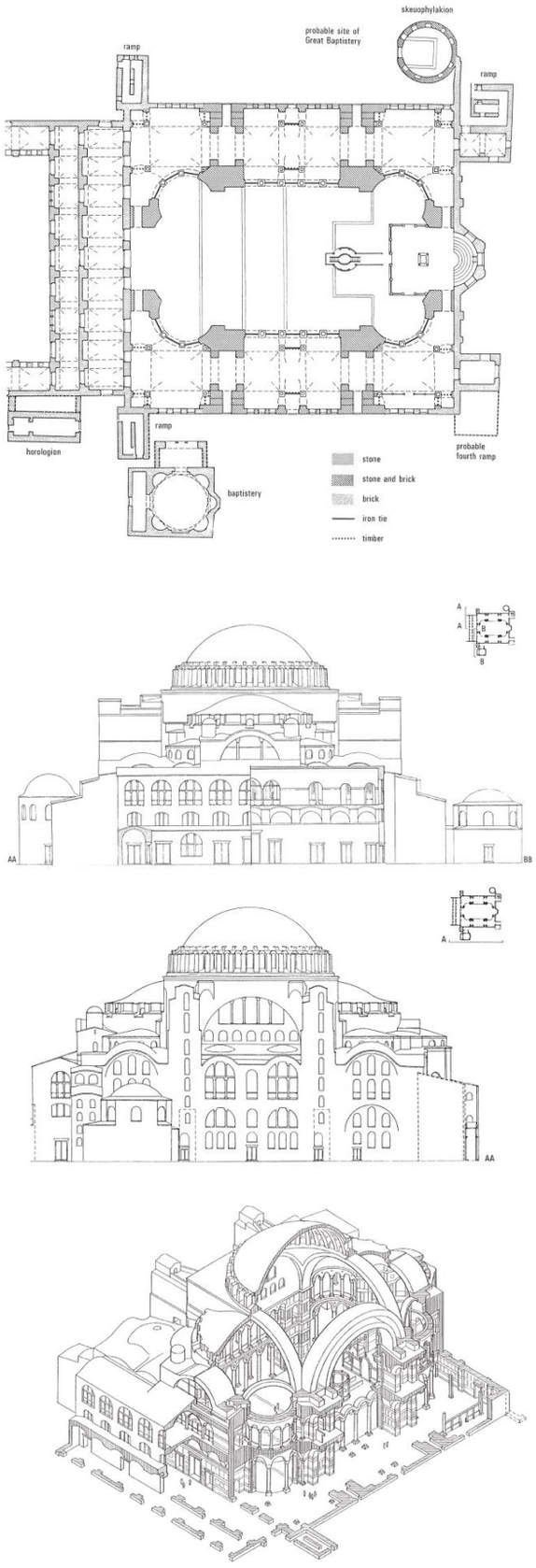

Figure 5: Plan, elevation, section and axonometric views of Hagia Sophia (12)

All the interior and exterior structures have been modeled and then texturized by high resolution photos taken on site. Then, the detailed 3d model of Hagia Sophia has been prepared (Figure 6).

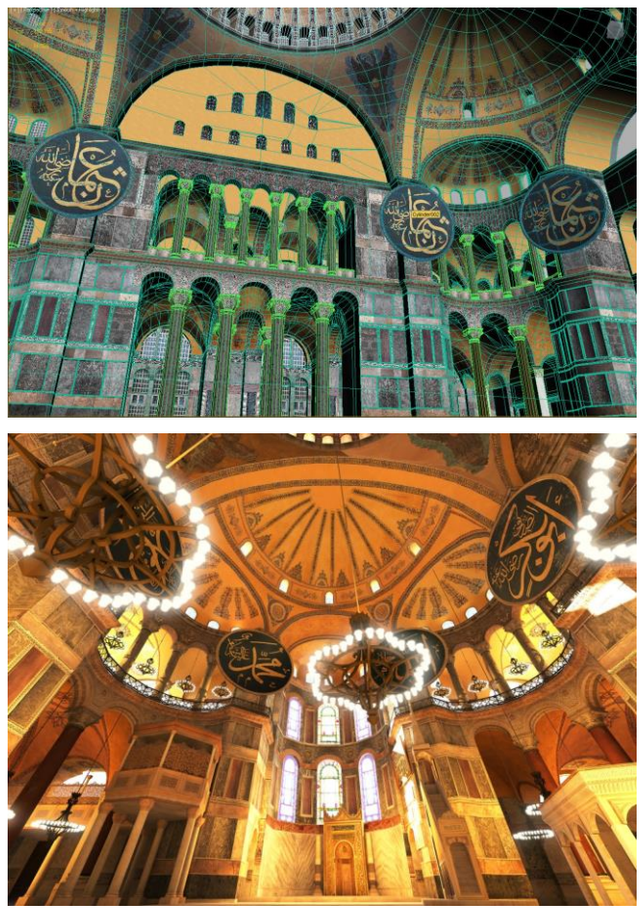

Figure 6: 3D texturized model of Hagia Sophia – Interior views

The 3D model has 630.574 polygons including inside and outside of the museum. This means 1.088.493 triangles, 1.462.310 edges and 602.391 vertices in total. Figure 7 shows the exterior views from the 3D model of Hagia Sophia.

After modeling the Hagia Sophia Museum, the next step is to model the near environment including the roads, buildings, historical city walls and landscape elements. Base maps and building footprints have been used to model the environment, and then building facade photos have been taken to texturize the solid models.

The 3D model of the environment has 2.400.244 polygons, 2.877.409 triangles, 5.014.530 edges and 2.877.568 vertices in total. Figure 8 shows some views from 3D model of near environment of the museum.

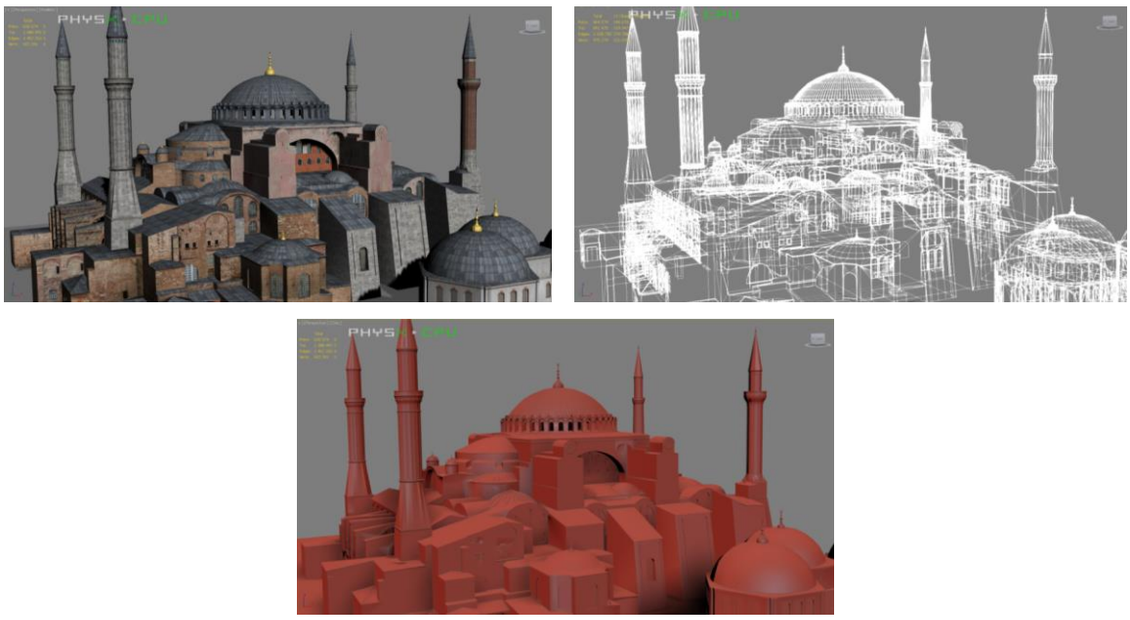

Figure 4: 3D model structure of Hagia Sophia – Exterior views

Figure 5. 3D model of near environment

4. RESULTS

All 3D models have been prepared and transferred into Unity game engine for an interactive, online and self-directed virtual museum platform (Figure 9). There are different types of game engines in the market such as Unreal Engine, Godot, Urho3D, CryEngine, Blender and etc. Unity platform has been chosen among many other alternative game engines because of its striking features. Currently, 34% of the top 1,000 free mobile games are made with Unity (13). It is one of the most widely used system by developers to create 2D and 3D games. Rapid editing and iteration system, powerful animation tools, instant play mode, user friendly GUI and multi platform suitability are the prominent features of the software. In addition, it supports Windows, Mac, Ios, Android, Playstation, Xbox, Windows Phone, Tizen and more. It is also widely used in rapidly growing Virtual Reality market, too. Today, 90% of the Samsung Gear VR games and 53% of the Oculus Rift games at launch have been prepared in Unity platform (13). It is continuously updated in accordance with the latest technological developments and it works on all desktop, mobile and web based platforms in addition to the traditional game consoles. Moreover, it has a flexible structure, a rich asset store and predefined special functions to create complex environments in shorter time than its competitors. It supports the popular languages like C# and Javascript. It is selected to prepare the Hagia Sophia virtual museum platform because of these advantages.

This study concerns about not only showing the Hagia Sophia Museum with all details, but also informing people about points of interest.

gives some detail views from the 3D model of the museum. In addition to the general history of Hagia Sophia, each detail has a unique story which must be known by the users. Each point of interest has a visible green button which is activated by clicking on it. The button includes both informative texts and sounds which were prepared in two languages, Turkish and English (Figure 11).

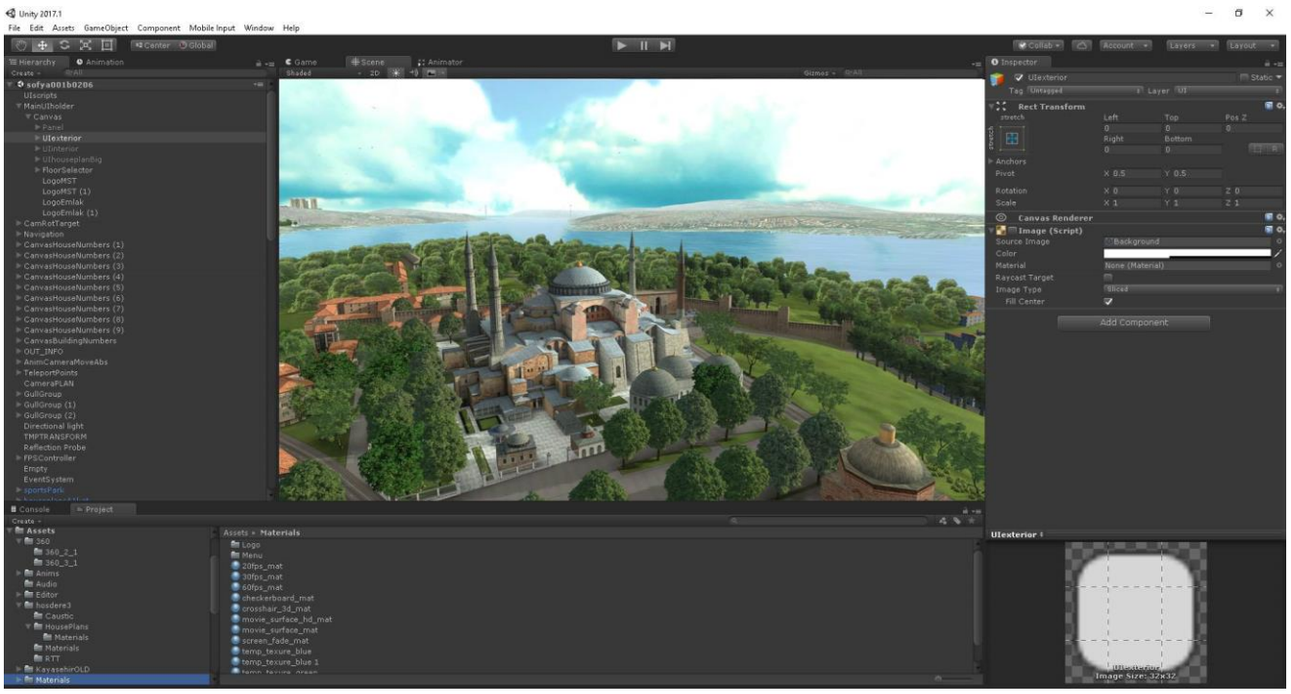

Figure 6: Screenshot from Unity game engine platform of the virtual museum project

After completing all the required phases, the virtual museum project has been exported to different platforms for the different types of end users. An executable Windows based PC version, Android based mobile version and Oculus Rift based VR version have been prepared. Figure 10 and Figure 11 include some screenshots from the PC version, while Figure 12 shows the mobile platform and Figure 13 shows the VR version of Hagia Sophia Virtual Museum platform. The users are able to freely navigate all through the project and to get information about important details.

Figure 7: Some detail views from interior 3D model of Hagia Sophia

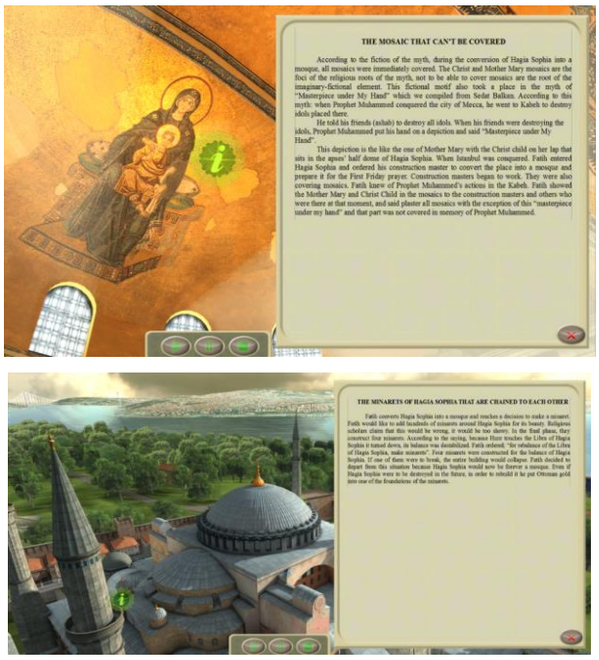

Figure 8: PC screenshots from the virtual guide platform

Figure 9: Android based mobile application of the project

Figure 10. Oculus Rift VR experience of a user in Hagia Sophia virtual museum platform

5. CONCLUSION

This study has given information about the necessary phases to create a 3D virtual museum application of Hagia Sophia. The same methodology can be applied for many other cultural heritages and other type of buildings. This manuscript may have major impacts for creating new virtual platforms all around the world. By this way, the museums and national galleries may increase their visitor numbers in digital environment.

It may be seen as a virtual and unreal rise of visitor number at first sight but actually the users will see those places and have information about them. The virtual visitors will be engaged by cultural heritage, historical artifacts, monumental buildings and social memory of the related places in global scale (14). Moreover; if this system is used for educational purposes, the learning process will be much more effective for children and young people. They will definitely like the new virtual museum platform because of their existing digital familiarities with this kind of technologies.

They will not see just some classical images and boring texts, on the contrary they will use interactive learning scenarios in digitally reconstructed 3D game like environments (15). In this way, museums and galleries will attract their interest and visitor profile will change by log in of these new actors. We must honestly see that the children of information age do not like visiting museums.

Children and young audiences of the digital age want new experiences in accordance with their needs rather than just read and view on a computer monitor (16). 3D virtual museum application may be a good alternative to traditional approach for reaching more people in both national and global scale.

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