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Interactive Virtual and Augmented Reality Mobile Application For Museums

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ABSTRACT: Augmented reality technology is a technology that can be used in all areas of life and will make our lives easier. With the innovation brought by technology, it is possible to use this technology in many areas. In this study, a mobile application was developed using Unity 3D Game Engine, which supports augmented reality and virtual reality technologies and provides an application development environment for these technologies, for museums that are losing their attractiveness and the number of visitors is decreasing day by day. In addition, augmented reality technology has been included in the application by utilizing the Vuforia Engine, which is a Unity plug-in. Asian, Egyptian and Greek civilizations have been successfully modeled in experiments.

KEYWORDS: Augmented Reality, Virtual Reality, Unity, Vuforia Engine, Museum.

1. INTRODUCTION

Virtual reality is a realistic computer-generated simulation of a real or imaginary world (Uçar, 2021). The person navigates through a virtually created mini-world. In other words, virtual reality distances people from the real world but allows them to watch this world enriched with virtual elements (Slater et al., 2016). Augmented reality, on the other hand, is a technology that tries to integrate the virtual world and the real world. In other words, instead of bringing the person into the virtual world, it enriches the sound, text, picture, and three dimensional (3D) models in the virtual world with visual effects and brings them to the real world (Berryman, 2012). It is clear that these technologies have significant potential, since augmented reality and virtual reality strengthen interaction with the virtual world, making the sense of perception close to the physical environment. Since they are open spaces for development, the continuity of studies related to these technologies is important.

In the literature, there are many studies based on virtual reality and augmented reality, especially in recent years. For example, Gargrish et al. presented a study based on augmented reality technology for the learning difficulties of 3rd-grade high school students in a geometry course. In their study on application design and coding with Unity Game Engine, the authors aimed to overcome the learning difficulties of children with 3D models, to attract their attention, and, moreover, facilitate their learning (Gargrish et al., 2020). Chang and his friends have presented an interactive solution with augmented reality for the application of augmented reality technology to motor skill learning in

physical education (Chang et al., 2020). Zhang et al. developed augmented reality-based astronomy simulation software for students to experience interactive learning (Zhang et al., 2014). Kamarainen et al. have developed an application based on augmented reality technology to address the ecosystem science learning goals of middle school students and help them understand and interpret water quality measurements (Kamarainen et al., 2013). Efstathiou et al. examined the contribution of augmented reality technology in improving the historical empathy and conceptual understanding of 3rd-grade students in an inquiry-learning environment (Efstathiou et al., 2018). Rohil and Ashok carried out a study involving augmented reality technology to assist urban planning. In the application developed by the authors, 3D layout plans of critical places for urban development are presented to the user (Rohil and Ashok, 2022). Menon et al. designed an augmented reality simulation to complement existing content in the nursing physical assessment course and improve both psychomotor skills and clinical competence (Menon et al., 2022). Pimentel has developed a mobile augmented reality app called 'Penguin Rescue' to facilitate interaction with wildlife and support biodiversity conservation. In their study, the authors help the penguin by rehabilitating a virtual penguin (Pimentel, 2022). Smith and Friel developed an augmented reality application for mental transformations from two-dimensional representations to three-dimensional cognitive understanding in the field of chemistry. Students can view 3D models with augmented reality with their mobile devices, and they can also examine the model by making changes with touch screen movements (Smith and Friel, 2021). Nakamoto et al. presented a SPECT/CT augmented reality study for intraoperative localization of sentinel lymph nodes in head and neck melanomas (Nakamoto et al., 2022). Finally, Smith et al. discussed the effect of the spatial position and movement of the augmented reality graph on driver behavior. SensoMotoric Instruments eye-tracking glasses and iView ETG 2.6 software were used to record the gaze position of the individuals and analyzed the gaze of the individuals with the SensoMotoric Instruments BeGaze 3.6.40 software (Smith et al., 2021).

In today's world, especially museums are faced with the problem of increasing the number of visitors and sustainability. The decrease in the number of visitors to museums is seen as a negative result in terms of financial, social, and educational impact (Aytekin, 2016). Although there are many reasons, the most important factor is that museums find themselves in competition with the products of the entertainment industry. Unable to continue this competition,

many museums have had to close or are about to close. In addition, there are not enough guides for visitors to museums. For this purpose, museums that are considered guides of a certain period and region should interact and communicate with their visitors in accordance with the requirements of the era and developing technology in order to maintain their existence. In this study, it is aimed to make the historical monuments that we cannot reach and the people who left their mark in history suitable for the present day by using virtual reality and augmented reality technologies. In addition, it is aimed to make it an attraction for museums that have fallen into oblivion and whose visitors are decreasing. It is believed that the application developed in this study will make a great contribution to the tourism sector of our country.

Especially in the augmented reality-based studies carried out in the field of tourism, it was seen that only one problem was addressed. For example, Sites in VR application (Sites in VR, 2016) offers the opportunity to travel in virtual reality to museums, and natural attractions. An application developed for the Geneva Museum of Art and Museum History (Geneva Museum of Art and Museum History, 2020) has a 3D model of the Achille and Penthésilée Statue only. An application, that was developed using Wikitude Studio for a literature museum about the famous Italian novelist Italo Svevo living in Trieste, has only 2D images come to life and there are no virtual guides and 3D models (Fenu and Pittarello, 2018). In the above studies in which augmented reality and virtual reality technologies are used, there are no stages that are visiting with a virtual guide or visiting virtual exhibitions using augmented reality and virtual reality. Our study differs from these studies in this respect.

2. MATERIALS AND METHODS

2.1. Unity 3D Game Engine and Unity Virtual Reality

Unity is a game engine developed by Unity technologies. It can be used to develop games, augmented reality and virtual reality applications, simulations, and animated films for computers, mobile devices, and consoles. An important feature of Unity is that it gives the developer the ability to write program code during the game development stage. Graphics and code work together with Unity. This working logic provides flexibility to the developer and reduces the application development time. Figure 1 presents the Unity application development screen. Since Unity is a cross-platform game engine, a game can be compiled for different platforms without the need for any infrastructure changes. With this ease of use, a game prepared for PC can be made to work for Mac with a single click without the need to change the code (Venture Beat, 2022). In addition, with the "Virtual Reality" feature in it, virtual reality applications can be developed without the need to use any external plug-ins (Unity Game Engine, 2016).

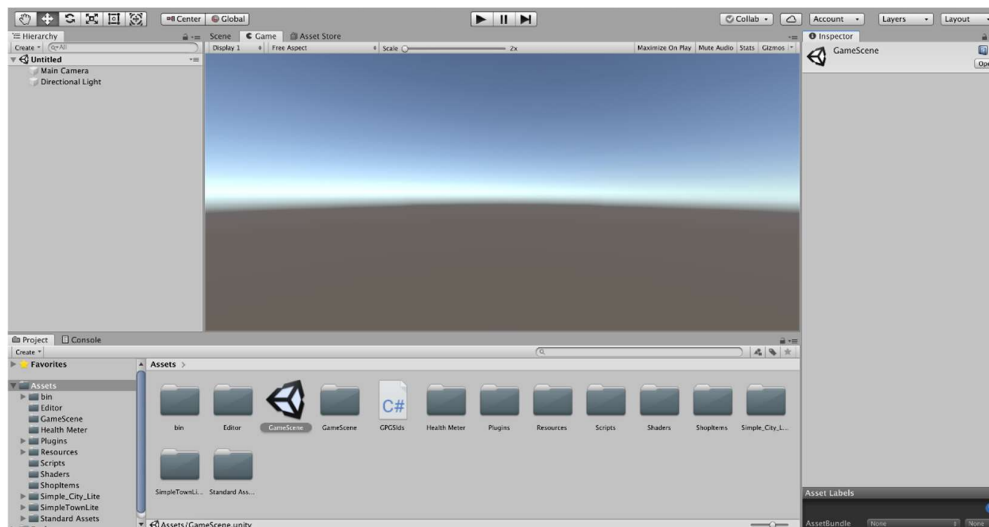


Figure 1. Unity 3D application development screen

2.2. Vuforia Engine

Vuforia Engine, introduced by Power to Create a company, is a software platform where augmented reality applications are developed. In order to use it in Unity, it must be downloaded as a plugin and added to Unity. It is highly preferred in augmented reality and virtual reality studies, as its ease of use and in-app optimization are at a high level. Vuforia; Area Target, Model Target, Image Target, etc. It enables the active use of augmented reality technology with services (Vuforia Engine Library (a)).

2.3. Vuforia Area Target

It is an environmental monitoring feature that allows applying augmented reality technology to specific interiors, spaces, and monitor spaces. An accurate model of the field is required to create the field target database. These models are created using 3D scanners. In this way, interactive games with the environment, navigation applications, and spatial instructions are created. It can be applied to offices, apartments, museums, hospitals, and many more (Vuforia Engine Library (b)). In order to take advantage of the Area Target feature, first of all, it is necessary to scan the interior with 3D scanners and

extract the 3D model of the space by the reverse-engineering method. The created model is converted into a Unity Package with the help of Vuforia and imported into the Unity environment (Vuforia Engine Library (c)).

2.4. Vuforia Image Target

Vuforia Engine target refers to the image that it can detect and monitor with the help of the source. When the application is made and the phone camera is accessed, a target source is needed for the objects to come to life on the phone. The system detects the image by comparing the image with a known target source database. When the image target is detected, the object comes to life on the mobile phone. The target image needs to be uploaded to Vuforia Engine's website. Vuforia issues a special license key for the uploaded target image. It is necessary to import this license key and the image uploaded to the site into Unity by downloading the customized package for Unity (Vuforia Engine Library (d)). At this stage, Unity recognizes the target image and detects it every time it sees it. In this way, when the image target is detected, the object is displayed on the mobile phone.

2.5. Developed Application

3D models have been taken from the Unity Asset Store (Unity Asset Store (Unity Asset Store(a)) website which is a store created by Unity Technologies. Anyone who is a member of the Unity community can publish the project examples, animations, and models they create in this store (Unity Asset Store (b)). A virtual museum consisting of artifacts from Asian, Egyptian, and Greek civilizations has been created in the Unity environment for a museum tour with virtual reality. While creating the museum, first of all, the works were placed in the museum and the museum design was carried out. In this way, the user can enter the application and walk around the museum with virtual reality glasses and a phone in the virtual reality section. In other words, when the visitor enters the "Virtual Exhibition with Virtual Reality" section within the application, he/she can examine the museum in virtual reality by putting his/her mobile phone on virtual reality glasses.

When the mobile phone camera is turned on, the target images have been added to the "Target Manager" section of the Vuforia Engine website so that the phone can recognize the artifacts, and the Vuforia Engine plugin has been imported into Unity. Afterward, 3D models of artifacts in different museums around the world were added to the mobile application for the virtual exhibition of Asian, Egyptian, and Greek civilizations. Thus, 3D models of the images determined by the mobile phone come to life on the user's screen. Figure 2 presents the workflow chart of the developed application.

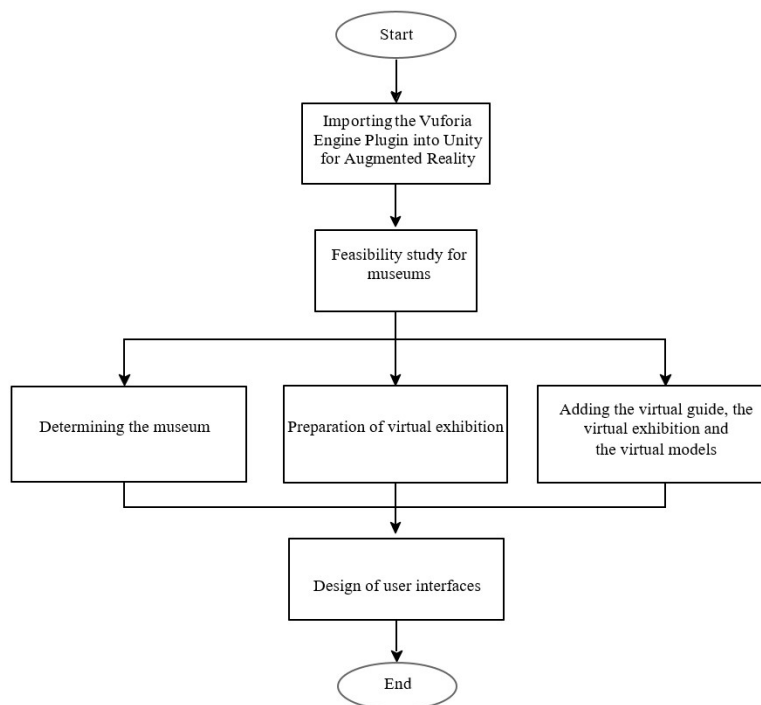
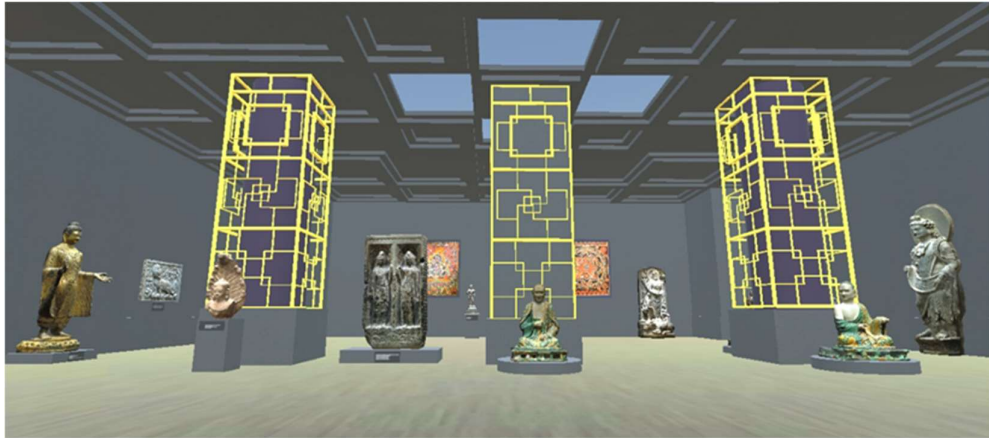


Figure 2. Workflow diagram of the study

The section "Virtual Exhibition with Virtual Reality" consists of works belonging to the Asian, Egyptian and Greek Civilizations. In this section, the visitor will be able to see the works from his/her location with the virtual reality application without going to the museum. Figure 3 presents sample screenshots containing he stages of the developed application.



a)



b)



c)



d)

Figure 3. Virtual Reality application's user interfaces; a) In-museum virtual exhibition with Virtual Reality, b) In-museum virtual exhibition with Virtual Reality, c) In-museum virtual exhibition with Virtual Reality, d) A bird's eye view of the virtual exhibition inside the museum with Virtual Reality

In addition, when the visitor uses the application within the museum and holds his camera in the space reserved for the virtual exhibition, he will be able to view the works of museums located in different countries as a virtual exhibition within the museum with augmented reality. The virtual exhibition section consists of 3 civilizations: Asian Civilization, Egyptian Civilization, and Greek Civilization. There are 8 works for each civilization and 24 works in total. With the help of buttons, it Dec possible to switch between civilizations and artifacts. Information and descriptions about the works are written in the fields located under the works. The screenshots of the virtual exhibition section of the mobile application animated with augmented reality taken from within the application are presented in Figure 4.



a)



b)



c)

Figure 4. Screenshots of the augmented reality part; a) a screenshot of “Stone Funeral Statue of an Officer” of Asian Civilization, b) a screenshot of “Statue of Dancing Heavenly God” of Asian Civilization, c) a screenshot of In-app image of “VII. Cleopatra Statue” of Egypt Civilization.

Moreover, the visitor chooses the museum he will visit by going to a museum and opening the mobile application from his phone, a short 5-question questionnaire is conducted about that museum. According to his answers to the questionnaire, his interests are determined and a virtual museum tour is created. After that, the camera on the individual's mobile phone turns on and a virtual guide modeled in 3D with augmented reality appears in front of him. A person can follow the virtual guide and visit the museum and get information. In addition, when he examines works related to his camera, the relevant objects come to life on the screen of his phone in three dimensions. In addition, artifacts in different museums can be viewed and virtual tours can be made with augmented reality in the virtual exhibition section.

4. RESULT AND DISCUSSION

In this study, virtual and augmented reality-based mobile application has been developed for museums. The application has been developed with the ease of interface provided by Unity and the augmented reality support of the Vuforia Engine plugin. The virtual exhibition feature of the application consists of carefully selected works from museums that we could not find the opportunity to visit for various reasons. In the future, it is aimed to include features such as hiding some treasures in the museum with augmented reality in order to provide more interaction with the visitor, gaining points by finding these treasures and using these points in the developed application. Virtual reality and augmented reality technologies, which are very popular today with their features, should be used especially in the defense and medical fields.

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