

A New Environment: Augmented Reality



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Abstract In brief, augmented reality can be defined as a new “environment”, which is created by simultaneously transferring virtual data such as sound, image, graphic produced in virtual environment to real environment. It is seen that the augmented reality has great potential in idea generation, development, presentation to users and information transfer as a representation (presentation) tool with its current applications. Accordingly, the purpose of this study is to evaluate the use of AR technology in cultural heritage areas, to study application examples in archaeological sites and to examine the potential contributions that different uses can provide. Within the framework of this research, AR application is planned to be developed for the ancient city of Alexandria Troas, one of the important cities of the Troas region, located in Çanakkale. With the application created, it is aimed to understand the value of the historical artifacts and structures unearthed during the excavation, to transfer them to the people who will experience the area, and to keep the city alive within the framework of virtual heritage values.

Keywords Augmented reality (AR) · Environment · Archeology · Cultural heritage

1 Introduction

In the field of information technology, the rapidly developing augmented reality technology has the opportunity to apply itself in many fields such as medicine,

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entertainment, engineering, architecture, education, art. It can also be said that it has become accessible to the ordinary user and has started to become a part of everyday life in this direction.

In summary, AR is a technology that enables users to experience augmented media by simultaneously transferring virtual data such as audio, images, graphics generated in their virtual environment to the real environment. AR systems are also used in cultural heritage areas. The historical significance of a ruin, the culture it reflects, the processes it goes through are very difficult to understand by only looking at the ruin. Augmented reality seems to be a very convincing tool in cultural heritage sites with its powerful presentation technique and interactive experience that it combines various layers of data. AR is a valuable technology in terms of increasing the awareness of the masses in the areas of cultural heritage, experiencing the real place of the historical environment, as well as the survival and sustainability of historical environments that are threatened with extinction by environmental factors.

In this research, the use of AR technology in archaeological areas, will be examined through different examples. This information will be used to understand another ancient site: Alexandria Troas. This study aims to develop a location based AR application in order to understand and explain the cultural value of Alexandria Troas, one of the important ancient cities of Anatolia, where excavations have been carried out since the nineteenth century. The main purpose of the application is to understand the historical value of many ruins in the ancient city of Alexandria Troas in the Dalyan district of Çanakkale, to ensure the sustainability of the ancient city and to pass it on to users.

2 What is Augmented Reality?

Viewed from a certain perspective augmented reality is accepted as a special branch of virtual reality. And for another perspective augmented reality has a more general scope than virtual reality. Virtual reality puts the person in a fully synthetic world with the generated virtual data, but augmented reality overlaps the real world with virtual data produced in digital media such as sound, picture and video. Instead of creating a fully synthetic world or displaying the real world as it is, it creates a new environment by mixing these two environments. Therefore, it is certain that augmented reality does not detach the person from the real world like virtual reality [1, 2]. Milgram and Kishino described the relationship between augmented reality to virtual reality with concept of virtuality continuum. As shown in Fig. 1, they described an axis with virtuality at one end and reality at the other. At the left side the environment consists of entirely real objects while at the right side the environment consists of entirely virtual objects. The virtual world with added real world views is called augmented virtuality, and AR is between the real world and augmented virtuality [3].



Fig. 1 Milgram and Kischino's virtuality continuum [3]

3 Why New?

Briefly, AR consists of adding virtual data produced in computer environment, 3D visuals and animations, and video to the physical environment simultaneously [4]. With AR, the user does not step into a fully synthetic, real-world independent environment, where the real world is not perceived as pure and complete, but also filled with virtual objects. Instead of all this, it is a new and increased level of perception where virtual and real environment overlap each other, where virtual data is fed from real environment components and the real environment can be experienced with objects that cannot be physically located.

With AR, users who are able to experience the virtual data added to the environment as well as the physical environment are faced with a new level of perception. Through this environment, where the level of perception is increased visually and audibly, the obstacles become unobstructed for the users, and the invisible becomes visible. At the same time, the user moves out of the passive audience position with the interactive aspect of AR technology, making it an active part of the experience. It is thus a new environment in which the user becomes an active part, both mentally and physically, between all the embodiment of real life and the infinity of the virtual world.

4 Potential Uses

AR technologies, which can be defined as the simultaneous transfer of visual and audio virtual data produced in digital environment to the real environment, come up with different applications in every area of our lives. AR applications have become more accessible with the development of technology [5]. Today, there are examples of application in many fields such as entertainment, health and architecture.

Many games for entertainment purposes have been produced with AR technologies that enable users to enjoy pleasant moments by adding virtual data to the real world view. The most known application of such games is Pokemon GO application. With this application, the user tries to find the location of the virtual characters and collect them. When the user reaches the location where the character is located, the virtual character appears on the screen, as shown in Fig. 2, and the user taps the screen to collect the character [6]. Such games are used for educational purposes today, besides providing users with pleasant moments.



Fig. 2 Pokemon GO application [20]

Due to its structure that enriches the real world with virtual data, AR technologies are also used as a presentation tool with the possibility of effective visualization. Audio, video and 3D visual support help architects to visualize their projects more effectively, while providing an impressive display of historical buildings and artifacts in museums and historical sites. Figure 3 shows as an example of use for presentation purposes.



Fig. 3 AR application for presentation [21]

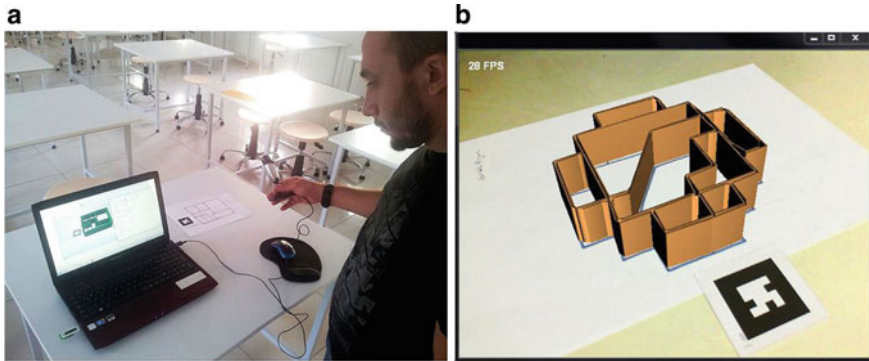


Fig. 4 a and b Various examples from SketchAR program [7]

AR, which provides the opportunity to translate information into practice with its interactive structure, is also used for educational purposes. SketchAR developed by Köymen can be given as an example for AR applications produced for use in architectural education. 2D sketches drawn in the early stages of architectural design are made digitally with SketchAR. It is an educational application that aims to improve students' 3D perception and at the same time enrich the architectural design stage [7]. Figure 4a and b shows a student experiencing the program.

5 Possible Uses of AR in Archeology

Augmented reality with its advantages is also used for many different purposes in archaeological areas, which are important representation sites of cultural heritage. With the virtual heritage it creates, AR offers the opportunity to combine past culture with today's user [8]. El-Hakim and others explain the motivations of creating virtual heritage as follows; [9]

Documentation for Restoration and Reconstruction of Historic Buildings

Historical buildings that are in danger of extinction as a result of natural disasters such as earthquakes, floods or various human activities need to be documented in order to ensure restoration or reconstruction in the ongoing process. At this point, AR technologies are an aid to architects, archaeologists and art historians. With the help of the data transferred from the paper plane to the virtual database, documentation of the historical structures can be provided and it can make it easier for the experts to continue their work.

Virtual Reconstruction for Historical Buildings that no Longer Exist

For historical structures that cannot be physically sustained or partially sustained for various reasons, even if AR cannot eliminate these factors, AR can ensure that it is kept alive with virtual reconstructions and passed on to future generations.

Interacting With Structures and Objects Without the Risk of Damage

In places that are cultural heritage sites, users cannot physically connect because there is a danger of damaging historical buildings and objects. However, due to the interactive environment that AR systems offer to the user by combining real environment and virtual data, it can connect with the historical environment without any risk factor and the user who is dominating the field has a sense of belonging. As a result, the user gets more information about the field.

Creating Educational Resources

AR technology, which creates a strengthened perception level with the overlapping of the virtual environment and the real world, makes the learning activity easy and permanent. AR applications, which transform information into practice with its interactive structure, are also educational resources.

Visualizing Scenes

AR technologies are an important tool for archaeological sites, in terms of inaccessible locations or the reconstruction of virtual assets of historical environments for users with physical disabilities.

6 Why AR for Archeology?

Various methods are used to understand the importance of archaeological sites and develop cultural heritage awareness. Augmented reality allows virtual objects to be exhibited in real environments, while interacting with the user, enabling them to be used for reasons such as exhibiting, documenting, training [10]. With different uses augmented reality is a powerful presentation technique as it transfers information interactively with the simultaneous expression technique enhanced with video, sound, 3D visuals and presents the past-today comparison in a comparable way to the user. In this way, the navigation becomes enjoyable for the users who experience the area and the information is provided to be more descriptive and permanent [11]. With AR technology, the ruins that contain a certain historical process are exhibited not only in the present state but also in the three-dimensional virtual representation of the past, and enables it to navigate around like a real object. A complete view of the ruins provided with AR sheds light on the past and allows the user to learn more about the ruins. It is useful not only for tourists, but also for architects, archaeologists and art historians [12]. They can better conduct their work with augmented data. Also in areas of cultural heritage that are threatened with extinction due to environmental factors, data can be reproduced in virtual ways to ensure that historical remains can live in their own place as long as desired. With such contributions, AR provides many potential uses in cultural heritage areas.

7 Research Focus: AR and Archeology

Archaeological sites are of great importance because they have witnessed history and have a certain cultural heritage. The fact that physical intervention is not possible in such cultural heritage areas causes different solutions for keeping history alive and transferring it to the masses. At this point, AR enables the redefinition of these environments with virtual data without any intervention. It makes it easier for users to access more information about the historical environment by not only seeing the ruins but also experiencing the original state of the structures. In addition to the physical environment, virtual data that are experienced interactively by the user during the navigation, increase the interest in the field, and gain the awareness of the historical heritage, thus transferring that culture to other generations.

In the light of the advantages it provides, AR technologies are used in many different ways such as presentation technique, documentation method, and educational purposes in archaeological areas that have important cultural heritage. AR expands its usage area with the development of technology day by day.

8 Various Cases

8.1 *The Ancient Pompeii Project*

Many archaeological and research studies have been done to show the history of Pompeii and the effects of the disaster it experienced, and much work is still being done today. Technology is also used to protect the cultural heritage and display it to the masses. One of these is the LIFEPLUS project, which adds virtual data to real scenes in the cultural heritage site, completed in the year 2000. It is an electronic tour guide for tourists coming to the site. Based on the fresco paintings in the area, plant and animal models were made and an artificial life was designed with human simulations reflecting the lifestyle of the period. Face and speech simulations, voice data, and clothing simulations were made to the characters according to the stories [13]. Figure 5 exemplifies the production of virtual clothing.

In the Pompeii project, users get the chance to experience an interactive environment with animations acting according to fictional stories, enriched with virtual data during their visits. As Pappagiannakis and others explain, the opportunity to experience with storytelling broadens the visitor's perspective. With AR technology and virtual storytelling technique, which is the main purpose of the study, as shown in Fig. 6, visitors have stepped into the past and went on an interactive and immersive trip [13].

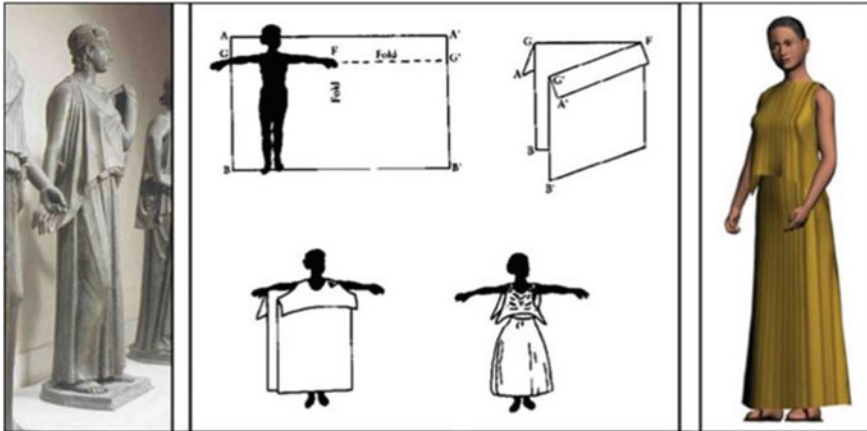


Fig. 5 Virtual garment based on a real ancient dress [13]



Fig. 6 The user who experiences the created story [22]

8.2 Archeoguide Project

Archeoguide is an application that offers guidance to the user using augmented reality technology. By using the user's location, it enables the historical buildings to be displayed without any intervention by providing augmented reality reconstructions. It presents the reconstruction of the historical buildings in the area with AR technology, on-site and full-time to the user. This project, which has been tried in the ancient city of Olympia in Greece, also offers access to virtual tours and database with internet access [14].

Three different mobile units were implemented in Archeoguide Project; laptop, pen-tablet and palmtop. With this hardware, many 2D pictures, 3D models, audio, video and information content articles were provided to the users. With its GPS support, the system can overlap the actual data and virtual ones provide the user with increased views [14]. In Figs. 7a and b, the comparison of the real environment and the augmented environment is presented.

In addition to tangible heritage objects, abstract cultural actions are also included. As an example as shown in Fig. 8, the Ancient Olympic Games reconstruction was exhibited to the user with athletes competing in the stadium. In order to do this, Olympic athletes and virtual human models were created. It is animated by adding the necessary movements related to the sports on the created models [14].

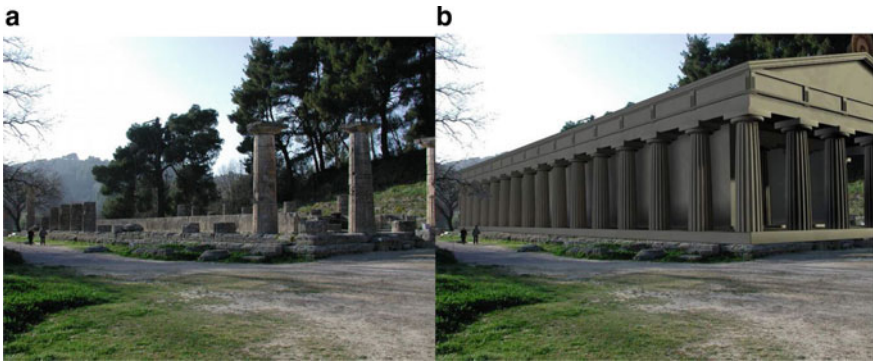


Fig. 7 a Real environment, b augmented environment [14]



Fig. 8 Ancient olympic games virtual reconstruction [14]

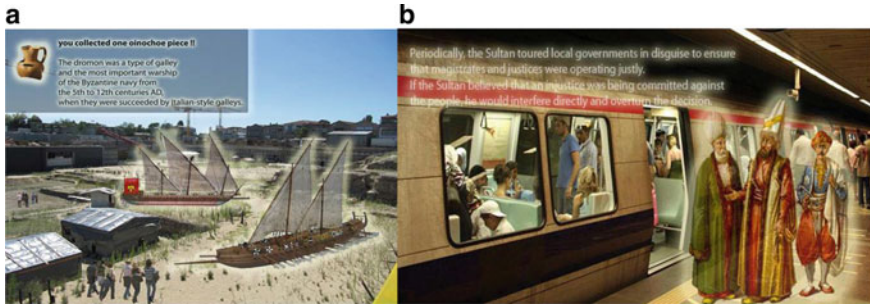


Fig. 9 a and b images from the game [16]

8.3 *Yenikapı Explorer Project*

Recent studies have shown that mobile games made with AR applications are also educational. With these games, it has been observed that the users interact more strongly with the space they are in. Yenikapı Explorer is also an AR supported mobile gaming platform created in 2012. The purpose of the study is to show the historical richness of Yenikapı to the users with the game designed. In order to solve the transportation problem of Istanbul, a transportation network project was wanted in Yenikapı, but archaeological excavations were carried out due to the historical importance of the area [15]. In these excavations, a lot of historical elements emerged. Necessary symposiums and competitions were organized in order to find a solution because it is impossible for the works to remain in place.

Özgan, who emphasizes the potentials of augmented reality in cultural heritage areas, proposed an AR game to display the history of Yenikapı. In order to achieve this, 3D reconstruction of historical objects in the area has been carried out and characters belonging to different time periods have been created. Users participating in the application have experienced these historical objects virtually in their original places [16].

Yenikapı Explorer is a location-based AR game where the user has the chance to watch virtual scenes by collecting all virtual objects. The user must answer the questions asked about the object correctly in order to collect the objects. All objects belong to a certain collection. When all the pieces are collected and the collection is completed, the user gets the chance to observe scenes, exemplified in Fig. 9a and b with more detailed information and data about the area [16].

8.4 *Research on Alexandria Troas Ancient City*

The region located in the northwest of Çanakkale in 1000 BC was called Troas. It was the most important region of Anatolia due to its connection point between Anatolia and Thrace and its location on trade routes in ancient times. There were 18 cities in

the region. One of these cities was the city of Alexandria Troas, famous for its trade and maritime activities.

The ancient city of Alexandria Troas is located within the borders of the village of Dalyan in the Ezine district of Çanakkale. The city BC Antigonos, the commander of Alexander the Great (Alexandros) in 310, is a port city founded by Monophthalmos under the name of Antigoia. The city took its present name as Alexandria Troas, which means the city of Alexander (Alexandros) by Lysmimakhos after the death of Alexander the Great [17].

The city has become one of the most important cities with its theater, stadium, baths, temples, fountains, waterways and the walls surrounding the city. It has attracted the attention of many researchers and archaeologists because it is home to many civilizations. The city, which has attracted the attention of travelers since the sixteenth century, has hosted research and excavation works since the nineteenth century [18]. Excavations were carried out in the city for a short time in 1997 by a German team. Since 2011, archaeological studies are ongoing by Prof. Dr. Erhan Öztepe [19].

Within the framework of above-mentioned approaches, this research plan to carry out a BAP project in ESOGU. The project aims to set out the interconnection of scientific fields (such as architecture, computation, archaeology, history, psychology), trying to emphasize issue of user experience in a multi-layered historical/archeological field. It plans to develop and test a location-based mobile application supported by AR system, which is a powerful tool in terms of identifying and documenting the remains in the Alexandria Troas ancient city and reflecting the historical significance by transferring the discovered remains to the users who experience the area. In line with the data acquired from the field, it is aimed to bring users to the past while experiencing the physical environment by making 3D models together with various audio and visual data, and to demonstrate the historical importance of the field in an educational and enjoyable way.

9 Conclusion

AR technology has found many uses for itself with the new environment created by the combination of virtual and real world. It has been determined that with the contributions of AR technology, different applications have been developed with various motivations. Different examples of AR applications in the archaeological areas, which are the main subject of the research, have been examined and their advantages have been revealed at points such as protecting the historical structures and cultural values of the environments by understanding them and transferring them to future generations.

It is seen that historical artifacts and structures presented using AR in archaeological areas make the experience enjoyable as well as the ease of learning with the interactive structure provided by AR technology. Learning action, which has become enjoyable for users, is very important in terms of reaching different audiences

and triggering cultural heritage awareness. AR applications, which are documented not only for tourists who experience the area but also for architect archaeologists and art historians, facilitate the interpretation of historical works. Many historical monuments can be transferred to future generations by ensuring that historical environments, which cannot be destroyed due to various human activities and environmental factors, are kept alive with virtual reconstructions. Due to such reasons, AR technologies are seen as a powerful tool in archaeological areas day by day.

Based on these motivations, the application, which will be developed for the Alexandria Troas region in the continuation of the study, aims to reveal the cultural value of the area and to present it to the users and to provide the historical accumulation that has come up to centuries ago.

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