Augmented Reality for Enhancing Cultural Heritage

Mona TURKI

Teacher-researcher at the High Institute of computer and Multimedia, Sfax.
She is a doctor in sciences and technologies of design

Abstract:
This research focuses on the improvement of Tunisian cultural heritage using augmented reality technologies. Indeed, augmented reality and virtual reality are the most important topics among new technologies, especially in the field of patrimony and cultural preservation.
The aim of this paper is to consider the motivation of young UI / UX designers of the Higher Institute of Computer Science and Multimedia in Sfax to create augmented reality apps during the academic year 2020-2021. In that, the main target is to review the issue of immersive technologies at the service of patrimony and cultural preservation. Therefore, "Ksour^{AR}" is an innovative AR application conceived through UI software (Adobe XD),game engine (Unity 3D; Vuforia) and 3D software (3 Ds Max).

Keywords: Augmented reality; 3D image; UI / UX Design; application; cultural patrimony;

1. Introduction

Today, as the world is transitioning into the hyper-digital epoch, novel technologies, especially augmented reality and virtual reality, are being used in the fields of patrimony and cultural heritage. These immersive technologies are employed by visitors who are deeply engaged in digital culture. Digital technologies have applied a process that allows the conservation and rebuilding of material and unmaterial cultural heritage. In this context, augmented reality (AR) is utilized in a wide range of related technologies to integrate virtual content and data with live and real–time media. In other words, it is a combination of technologies that enables the real-time mixing of computer-generated content with reality. This digital content is different from virtual reality (VR), whose objective is to create immersive 3D environments.

Even better, the development of new immersive technologies has assisted in the field of cultural

Citation: **Mona TURKI**, *Augmented Reality for Enhancing Cultural Heritage*, International JournalofCurrent Business and Social Sciences. 9(2), 01-10, (2023).

preservation and historical patrimony enhancement. In this way, improving cultural heritage and patrimony can be further advanced by digital art (such as augmented reality and 3D computer graphics). In doing so, augmented reality (AR) considerably contributes to the transmission and improvement of cultural heritage, an area that is increasingly capitalizing on these technologies to provide new entertainment and interactive applications. In addition, 3D computer graphics offer several possibilities for juxtaposing 3D reconstructions with the real environment (its appearance in previous years or its metamorphosis in the future, virtual guides, additional information, etc.).

This manuscript presents a new vision of approaching archeological site in Tunisia using new immersive technologies like augmented reality and to create new interactive experiences that impact archeological site visitors. In fact, the new figures of archeological sites could change to adopt our new perception of AR apps for traditional heritage based on technologies and virtual contents (3D scenes). Indeed, new exhibitions, such as the new AR apps for archeological sites and historical musuem, have taken place during last years.

With the advent and evolution of the new technologies of augmented reality and virtual reality, specialists of cultural heritage in Tunisia (teachers-researchers, experts, museum curators, cultural artistic directors, etc.) have been focusing on the enhancement of cultural heritage by applying the new immersive technologies. It is in this context that the present study falls. It deals with the valorization of archeological sites in Tataouine using AR technology, as viewed by young Tunisian UI/UX designers in the Higher Institute of Computer and Multimedia of Sfax (ISIMS). This application go by the name " Ksour RA".

The main addressed issues are written below:

✓ To what extent does AR technology contribute to the archeological sites of Tataouine in Tunisia?

✓ What are the characteristics of the dynamic and interactive approach to Tunisian traditional cultural heritage ?

2. Augmented reality applied to cultural heritage patrimony

From a terminological point of view, the expression "augmented reality" is a combination of the two words "reality" and "augmented." In French, the term is "nonsense," since it is semantically incorrect to want to augment reality. The concept of "augmented reality" (AR) was originally introduced after Evan Sutherland developed the first HMD in the 1960s (Sutherland, 1968, p. 758). Since the 1990s, Tom Caudell and David Mizell (1992) first used the concept of AR to mean "augmented reality." Indeed, in 1992, Caudell and his research team invented the term "augmented reality" to describe the process of overlaying digital (computer-generated) information on the physical environment. Augmented reality, in general, is a technology that bridges the gap between the digital and physical worlds (Manuri and Sanna, 2016, Uluyol and Sahin, 2016, p. 19). According to Olivier Hugues (2011), the goal of augmented reality is to increase perceptions of reality, either by conforming to reality's rules or by transforming reality using imagination. Augmented Reality can be interpreted "as a view of a physical, real world environment whose elements are integrated with computer-generated sensory input" (Freina &Ott, 2015, p.3). The ultime aim is to "see and experience the real world mixed with various virtual objects, without losing the sense of reality"(Persefoni & Tsinakos, 2015, p.45). In this light, authors have to adopt the strategy of Azuna et al. (1997, 2001) to define the augmented reality system. Indeed, Ronald T. Azuna (1997) proposed to define AR as applications verifying the following three properties:

- ✓ The combination of the real and the virtual;
- ✓ Real-time user interaction;
- ✓ The recording of information in three dimensions (3D);

During this last decade (2010-2020) we have witnessed the deployment of VR-AR technologies to the general public. This period has been marked by the evolution of videogames, which have motivated and led to major and recent advances in the evolution of terminals (smartphone, tablet, VR headset, AR headset). Indeed, the last few years have seen the development of new technological hardware with very low costs and very good performance. According to Bruno Arnaldi and his research team (2015), the evolution of technological terminals is accompanied by the development of new software equipment from the video game industry such as the Unity 3D game engine and the Vuforia software. This has enabled new developers (game designers, serious game designers, UI/UX designers, 3D Designer, etc.) to create their digital solutions (AR applications).

In recent years, the development of augmented reality technology and its fields and sectors seems to have been ongoing. In this sense, the literature on augmented reality includes a wide range of multidisciplinary research in fields such as architecture, medicine, education, entertainment, tourism, online commerce, industry, marketing, and so on. Cultural and historical preservation is one of the studies covered by studies on augmented reality applications. In fact, AR apps are increasingly being tested in rich content environments, as they can enable visualization of unseen valuable content as well as provide added interactive educational in today's cultural heritage sites.The cultural heritage industry is currently going through a paradigm shift in terms of traditional economics, and this, combined with increased digitization efforts, makes AR interfaces an innovative and perfect way to display both tangible and intangible cultural artifacts.

Aiming to apply augmented reality, the sector of cultural and heritage preservation quickly realized how it may enhance its processes:

- ✓ Visualization of partially lost monuments, items, coins, sculptures, and mosaics made possible by augmented reality technology;
- ✓ Restoration of a historical location (castle, ramparts, troglodyte home, library, etc.);
- ✓ Accompanying a section of a museum's collection during scheduled visits and interacting with it using a variety of multimedia components (3D, video, music, etc.);
- ✓ Bringing a virtual tour guide who can speak multiple languages and provide remarks;

3. Method and tools

The challenges of enhancing our Tunisian cultural heritage (architectural, musical, traditional, clothing, etc.) through the use of virtual and augmented development tools confront my team of UI/UX designers. In fact, as a teacher-researcher in the High Institut of Computer and Multimedia of Sfax, Idealing essentially with subjects and workshops of the immersive environment, virtual sets and augmented reality. In fact, Tunisia's architectural landmarks, artifacts, and clothing from the various historical eras are so rich that they demand a fresh viewpoint.

In this vein, the given paper is at the heart of the problematic of this study: the valorization of archeological site in Tunisia through augmented reality application, from the point of view of young Tunisian designers and developers. It is in this context that the present study falls. It deals with the valorization of the Tunisian traditional cultural heritage in Tataouine using AR technology, as viewed

by young Tunisian UI/UX designers in the Higher Institute of Computer and Multimedia of Sfax (ISIMS).

To answer the problematic of this study, the following hypotheses are evoked:

Hypothesis 1: Augmented reality technology enhances the traditional cultural heritage in Tunisia thanks to their specificities and particularities.

Hypothesis 2: The main perspectives of this research are the association between the Tunisian cultural heritage in Tataouineand technological evolution of AR in order to create a new perception of archeological sites.

Using new immersive technologies to serve the traditional cultural heritage in Tunisia is part of a strategy applied by the young Tunisian UI/UX designer to achieve several objectives:

- ✓ Reconstruct the past history of archeological site in Tataouine city;
- ✓ Discover the specificities of building the troglodyte house in the caves of Tataouinecity in the south of Tunisia;
- ✓ To improve the immersive experience of the users of "RAقصور " app;

4. Results and their discussion

The main goal of this study is to make it as easy as possible for a visitor to a museum or archaeological site to learn everything they are able (works of art, gateways, windows, objects, clothing, details, etc.). Furthermore, the objective is to enhance the attractiveness of the visits in order to create a captivating, immersive experience.Actually, it is a question of guiding oneself towards a sensory approach to the heritage monument when being guided towards experimentation in order to transcribe the evolution of its components. Consequently, all these elements were taken into consideration in the conception of the projects for the enhancement of the archaic habitats of Tataouine. In this sense, AR applications will enrich the knowledge of the public through direct contact with the heritage monument and stimulate their creativity."RAقصور"is an application of RA Within the framework of the end-of-study projects in the higher institute of computer science and multimedia of Sfax. In this, we focus on the following end of study project entitled "RAقصور".

Figure 1: Home interface of the RA application "RAقصور", boussaâda, 2021.

The founding idea is to design an augmented reality application concerning the troglodyte houses: underground constructions that are helter the local Berber population of Tataouine, a small town in southern Tunisia. This application allows the visit to be assisted by avirtual guide "محمد عم". Indeed, AR

technology brings real added value to the visit of an atypical archaeological site. Better still, this visit to the cave houses of Tataouine requires the added value of AR to provide a fun and engaging experience. This virtual visit is animated by the virtual guide who will provide answers to the different questions. In this sense, this application is in line with the growing applications of virtual visits to new figures of museums or archaeological sites. It is a new approach of e-tourism which specifically uses new technologies that present heritage information in the form of real virtual interaction.

We propose an analytical study of the application entitled " "قصورRA," which is based on augmented reality to present heritage information in the form of virtual real interaction. This application is in line with the new approach of e-tourism. In fact, immersives technologies like augmented reality present heritage cultural informations in the form of real interaction.

4-1-Enhancement of the troglodyte habitat through 3D scenes

To create an interactive augmented reality application, the UI/UX designer has to start by modelling 3D scenes. In fact, the particularity of these 3D computer-generated images is that they allow immersion in virtual worlds of striking realism. Indeed, the 3D image, which is significant to the three-dimensional image or the 3D computer-generated images, is defined as a synthetic (digital) image represented on the screen in a three-coordinate reference frame (X, Y, Z) giving an illusion of depth and realism.

This 3D image synthesis (three-dimensional computer graphics) is currently used in digital art as much in the immersive applications industry (AR/VR and Mixed Reality). Indeed, AR is built on an artificial supplement of contextual information that allows the user to perceive their surroundings.Thus, this mobile AR app considers these 3D scenes:

- The caves or troglodyte houses of tataouine city ;
- Virtual guide;

Such modeling is done using several software packages, namely Maya, Blinder, 3DS max and 4D Cinema. Moreover, it depends on the 3D object to be modelled: architectural monument or a humanbeing. In the case of our application "RAقصور", the 3D designer makes the modelling of the virtualBerber guide and the cave houses of Tataouine the through3DS Max software. To do this, the author uses a lot of the polygonal modeling tools, extrude, connect, make planar, selection by vertex, polygon,. . . etc.

The modeling is based on two methods: either spline editable or polyone editable. In the first method, the 3D designer starts by drawing a 2D primitive design, converting it to spline editable in order to make the 2D shape evolve into a 3D volume. As for the second method, the designer starts by adding 3D primitives, converting them into editable poly in order to draw the global shape of the object. Then, she uses the edit geometry panel to obtain the final 3D object. Finally, she employs the Material Editor and the Material / Map Browser to add faithful materials to each 3D object.

In a first step, 3D designer realizes the ringing or "skeletonization" of the character" عم محمد", the coloring, the texturing, the addition of hair and the animation necessary in order to obtain the 3D model. Indeed, this Tunisian Berber character, wears traditional berber men's clothes (the headcover, the sadria, the farmla, and the sarouel). As for animate this character, the 3D designer choose to simulate the gesture of hand salute according to the Berber customs of Tataouine city.

Figure 2 : 3DModel of virtual guide (3DS Max, Vray5), Boussaâda, 2021.

In a second step, the young3D designer creates the modelling of the troglodyte houses. To do this, she carried out the modeling using splines by selecting the Editable spline tool to draw the overall shape. Then, she used the extruder to make it into a volume (3D model). Next, the designer added the rock's texture in order to rebuild the monument like the original reference. Finally, she used the realistic 3D virtual image synthesis technique to get the final rendering as shown in the figure below.

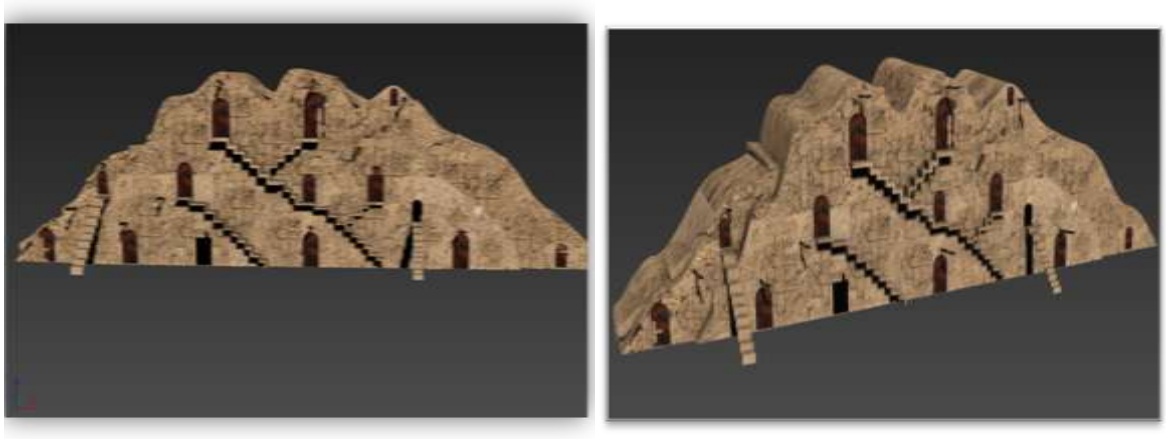

Figure 3: 3D Model of the troglodyte cave of Tataouine (3Ds Max,Vray 5) , Boussaâda, 2021.

4-2- "RA قصور": recognition-based AR application

In the case of our "RAقصور" application, the developer chooses recognition-based AR or image recognition. The operation is relatively simple, the application would film the environment in order to detect image markers and locate the 3D positioning of the 3D models (virtual guide, cave houses of Tataouine). Indeed, the markers used (image Target) are easily locatable and identifiable images that tell the application where it should display given virtual information. In this perspective, the developer created the graphical interfaces, below, to play the role of image markers.

Figure4 :Graphic interfaces (image markers), Boussaâda, 2021

This type of AR technology, also known as recognition-based AR or image recognition, relies on identification of markers/user-defined images to function. An augmentation in marker-based AR must be activated by a marker. Markers are distinct patterns that cameras can easily recognize and process, and are visually independent of the environment around them; they can be paper-based or physical objects that exist in the real world. Maker-based AR operates by scanning a marker, which causes the emergence of an augmented experience (which might be an item, text, video, or animation) on the device.

Once the target image (image marker) is spotted by the camera of a smartphone, the visitor is able to instantiate the virtual guide to accompany him to a virtual tour of archeological site in Tataouine. In this sense, the developer uses the Unity 3D game engine. Thus, the management of augmented reality will be carried out by the Vuforia plug-in, which is compatible with Unity 3D. Indeed, image Targets refer to 2 D images which Vuforia Engine can easily recognize and track. In fact, we use full color images as image Targets. In that, it works in a similar way to QR codes: mention to the app where it should display a given virtual information (3D object, 3D animation, etc.). According to Vuforia Developer Library, the basic workflow for working with Image Targets is as follows: First, the UI/UX designer uploads the image to the Vuforia Target Manager online. He can also use one of the sample Image Targets. In that, Vuforia offers a very simple image detection system, through Vuforia Target Manager. Through its web portal, Vuforia offers the possibility to define all the target images that the developer wants to use in his application (2D images, cuboids, cylinders and 3D objects). In our case, the image marker is well chosen. In this case, Vuforia considers the image marker below as "a good target". The plug-in will detect the image easily. Second step, she downloads the updated Target Manager Database. Third step, he Add the image target to your project in Unity : Add the Device Database then add and configure the Image Target as a Game Object (Add an AR Camera ; Add an Image Target ; Assign Content to the Image Target). In that, once the image Target is spotted by the camera, the visitor is able to instantiate the different 3D objects that offer information about archeological site in Tataouine berber city.

.

Figure 5.Examples of augmented reality scenes on Unity 3D software,Boussaâda, 2021

Conclusion

AR technology is at an early phase, and despite its growing popularity, how to use it for cultural and patrimony preservation is still a complex challenge to address. Indeed, Tunisia is taking part of a universal trend of producing projects of new immersive technologies on all types of playful supports (PC, mobile, "smart" tablet, VR headset, AR headset, etc.). ISIMS participates in this new trend by teaching a variety of courses for various academic levels (professional master's degree or basic degree), including Augmented Reality and Virtual Reality, Immersive Environment, Virtual Sets, and Augmented Reality Workshop, as well as through national and international cooperation projects run by the Agency for the Enhancement of Heritage and Cultural Promotion in Tunisia.

This paper provides our vision for augmented reality (AR) in cultural heritage and patrimony preservation. Therefore, in this manuscripts Augmented Reality (AR) is introduced along with significant highlights from practitioners such as 3D designer, UI designer and Engine Unity 3D developer. Furthermore, this study gives a reflection about the relationship between this immersive technology and the field of culture heritage. Additionally, " ksour AR" is an example of AR apps which enhance the cultural heritage in archeological site. This application can provide a significant opportunity for immersion. In that, this experience plays a key role in extending the sensorial environment of visitors by mediating reality through technology. In fact, AR applied to cultural heritage preservation improves existent elements (image targets) with additional layers of meanings.

In this article, we have been able to answer the different hypotheses advocated by the study. **Hypothesis 1:** Augmented reality technology enhances the traditional cultural heritage in Tunisia thanks to their specificities and particularities.

Hypothesis 2: The association between the Tunisian cultural heritage in Tataouine and technological evolution of AR in order to create a new perception of archeological sites.

In a first perspective, we note the value of AR technology in enhancing the Tunisian cultural heritage.This is made possible through the specificities of augmented reality technology (3D modeling and texturing, marker – based Augmented Reality, UI design of the application, UX design of mobile AR app, etc.). In that, 3D computer graphics allow an immersion in virtual worlds of a striking realism. In fact, the 3D designer builds a reconstruction in three-dimensional for the troglodyte houses in Tataouine. More, she creates a virtual guide (Berber character) like her imagination. Consequently, AR

relies on an artificial complement of contextual information, especially 3D scenes. In that, the application's user may apprehend the immersive environment that surrounds him. So, "ksour AR" is based on the main 3D scenes of the archeological site in Tatouine berber city. In this way, this process allows rebuilding the past history of some elements of Tunisian patrimony and reinforcing the attractiveness of Tunisian archaeological site.

In a second perspective, we determine the main perspectives of this research. In fact, we evoke the association between the Tunisian cultural heritage in Tataouine and technological evolution of AR. This is in order to create a new perception of archeological sites. The main objective is to make application visits more attractive in order to create a captivating immersive experience: To assist the visitor of a museum or archaeological site to grasp all possible knowledge; To guide towards a sensory approach to the heritage monument; To guide towards experimentation in order to re-transcribe the evolution of its components. In conclusion, we can see that AR applications will enrich the knowledge of the public in direct contact with the heritage monument. In addition, these applications will stimulate their creativity.

To conclude, "Ksour AR", this mobile AR app reflect our new vision of archeological sites in Tunisia. In that, we introduced along with significant highlights from practitioners: Tunisian young designer in the Higher Institute of Computer and Multimedia of Sfax (ISIMS).

5. Bibliography List

1. Books :

Sutherland, Evan. (1968) A head-mounted three-dimensional display. In Proc. Fall Joint Computer Conf., pp. 757– 764, Washington, DC, Thompson Book;

2. Theses:

Hugues, Olivier. (2011), Réalitéaugmentée pour l'aide à la navigation maritime. PhD thesis. University of Bourdeaux I. supervized by Pascal Guitton;

3. Journal article :

1. Azuma, R.T. Baillot, Y. Behringer, R Feiner, S. Julier, S. and MacIntyre, B. (2001). "Recent advances in augmented reality," IEEE Computer Graphics and Applications, vol. 21, no. 6, (pp. 34-47) Retrievedfromhttps://www.researchgate.net/publication/3208983_Recent_advances_in_augmented_reality_IEEE_Comput_Graphics_Appl (Accessed March, 15 2021).
2. Caudell, Thomas P. &Mizell, David W. (1992). Augmented reality: an application of heads-up display technology to manual manufacturing processes. Material Science. System Sciences. Proceedings of the Twenty-Fifth Hawaii International Conference on. vol. II. Retrieved from https://www.semanticscholar.org/paper/Augmented-reality%3A-an-application-of-heads-up-to-Caudell-Mizell (Accessed March, 12 2022).
3. Freina, L., &Ott., M. (2015). A LiteratureReview on Immersive Virtual Reality in Education: State Of The Art andPerspectives. In *Proceedings of eLearning and software for education (eLSE)* (pp. 133-141). Bucharest, Romania: dituraUniversităţiiNaţionale de Apărare„Carol I".
4. Manuri, F., &Sanna, A. (2016). A survey on applications of augmented reality. (pp.18-27). Advances in Computer Science: an International Journal, 5(1). Retrieved from http://www.acsij.org/acsij/article/view/400 (Accessed March, 10 2021).
5. Milgram, P. Kishino , F. (1994) . A Taxonomy of Mixed Reality Visual Displays. (pp. 1321-1329). *IEICE Transactions* on *Information* and *Systems*.vol. E77-D. Retrieved from

https://www.researchgate.net/publication/231514051_A_Taxonomy_of_Mixed_Reality_Visual_Displays (Accessed March, 5 2021).

6. Persefoni, K., &Tsinakos, A. (2015). Use of Augmented Reality in terms of creativity in Schoollearning. In *Make2Learn 2015 workshop at ICEC'15* (pp. 45-53). New Heaven, CT: CEUR Workshop Proceedings.