Combining Multiple Image Targets in Augmented Reality for Cultural Heritage Presentation

Fejzic Rijad*
Sijercic Tarik†
Ivkovic-Kihic Ivona‡
Supervised by: Rizvic Selma§

Faculty of Electrical Engineering
University of Sarajevo

Abstract

The paper suggests the method of using Multiple Image Targets in Augmented Reality applications in order to present Cultural Heritage sites. The general idea is to present the condition of the same site at different time points and to present different sites at the same points in time. When the two image targets are connected, one containing object image or logo and the other time period, a historical event or any other time determining information, augmented content is presented. In this paper, 3D reconstruction combined with the information about the site will be used. After implementing the idea on several sites, user evaluation has been done in order to determine whether the approach benefits learning and understanding of cultural heritage.

Keywords: Augmented Reality, Cultural Heritage, Mobile application

1 Introduction

Augmented reality applications found use in cultural heritage presentation and preservation, primarily in the shape of applications as part of the museum exhibitions. Being able to show various augmented content when looking at the real world, and being affordable while doing so, makes this technology attractive and efficient.

Showing historical phases and events is part of the cultural heritage presentation and the way history is told plays a major role in understanding it. In this paper, augmented reality will be used to show states of the same object in different eras, using augmented reality.

One of the methods for showing augmented content is a marker-based augmented reality application, meaning that the user scans images in order to see the content. We suggest a method of combining multiple images, one of them representing the object, and the other one representing the era, and the application shows how the object looked like in that era when the two pictures are joined and scanned. The aim of the paper is to present current progress in developing such a system, including target images, content, and the application itself, and the results of a preliminary user study conducted to examine whether this approach would be usable.

The paper is structured as follows. In Chapter II related work is presented. The augmented reality application, it's functionalities, development process and phases are described in Chapter III. In Chapter IV the results of user evaluation are presented and discussed. The last chapter contains conclusion and future work plans.

2 Related work

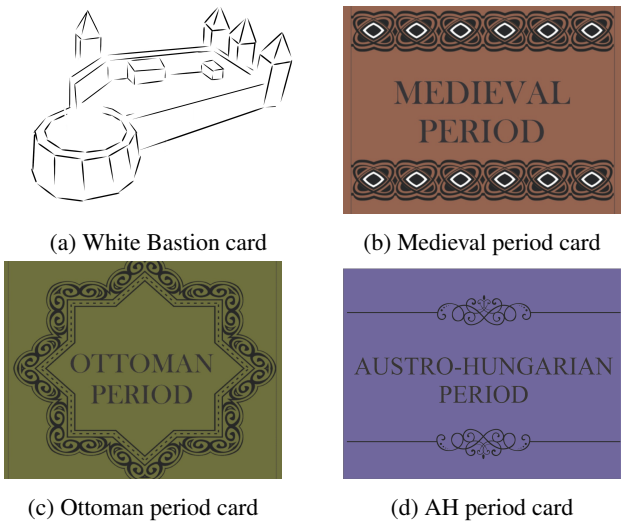
In [4], the authors presented an Augmented reality application for presenting local historical photographs in Trondheim. The application allows the user to see historical photographs of the object as an overlay of the present view, and to read some information about the observed artifact. Authors concluded that Augmented reality is applicable for this use case since users enjoy the experience, but also tend to achieve some knowledge. In [6], the museum Augmented Reality application is presented, which has a goal to enable contextual awareness of the visitor by superposing site image with augmented informational content. This allows museums to show the context of the artifact exposed in the museum itself, which is unfeasible to do with the physical setting of the museum.

In [2], the importance of using modern technologies in preserving and exploring cultural heritage is highlighted, with the focus on augmented reality, on the case of the application allowing users to explore the 3D model of a fortified church. In [3], the authors concluded that usage of augmented reality improves student's learning experience related to cultural heritage. They also point out the advantage of augmented reality, the ability to be applied in a formal environment such as classrooms, but also the

*rfejzic1@etf.unsa.ba
†tsijercic1@etf.unsa.ba
‡ivona.ivkovic@etf.unsa.ba
§srizvic@etf.unsa.ba

informal ones, such as museums, cultural heritage sites, etc.

Augmented reality application that uses the method of combining multiple targets to recreate chemical concepts was presented in [1]. The user makes interactions between virtual objects using physical markers, similar to the approach we suggest. In the study, the authors concluded that the augmented reality tool has significant supplemental learning effects.



(a) White Bastion card (b) Medieval period card

(c) Ottoman period card (d) AH period card

Figure 1: Cards used for image recognition

3 Augmented reality application

The application is intended to be used for educational purposes to show the evolution of the White Bastion throughout the ages. The idea was to find an interesting way to present the differences and the cultural impact of the imperial forces at the time. The fortification known as White Bastion“ is one of the most impressive and important historical sites in Sarajevo. It is located on the southeast outskirts of the City, with an overview on the city valley. During the history it had a very significant and strategic position. The fortification is a part of the dominant defense walls that were surrounding the old city of “Vratnik”. [5].

Because the application is supposed to be interactive and engaging, after considering multiple options, we have decided to use Augmented Reality to display the various models of the bastion. We chose multiple target images as the best option to combine the temporal meaning and the model of the site we want to present. The key functionalities of the applications are multiple target image recognition, where the end-user can combine two images in a certain way to get a different 3D model of the site. The user matches the main card of the bastion with cards that represent different eras. When a model is displayed, the user can interact with it by tapping on the model to show more information about the site at that point in time. Figure 1a displays the main card of the model and figures 1b,1c and 1d display the era cards.

There are different methods to implement augmented reality and target image tracking is one of them. For this process, a camera is used to give the application a view of the environment. When a predefined image is recognized, predefined objects are shown and rendered to the user relative to the image in real-life. Our application takes advantage of this technology and combines two real-life images into one digital image and maps the matching model to it. Because of this, it is crucial for the physical images to be placed in the correct order.

For the development process we chose the Unity game engine and Vuforia AR as they both are available for students to make non-profit projects for free. Vuforia is a platform that enables augmented reality functionality to be easily integrated in projects, without the need to implement everything from the ground up. The Unity game engine is very powerful and enables cross-platform support, meaning that we only have to implement the project once and deploy it to different platforms, such as Android, iOS and various AR headsets. In practice, different devices have better performances in different cases, but for ease of use and accessibility we chose to run the application on Android as a use-case example. The application can be easily adapted to run on other devices as well.

The first phase was to create an account on the Vuforia Developers web page in order to obtain a developer licence key. We then uploaded our target images and downloaded the Unity package that has information about the target images and important meta-data required by the Vuforia engine. The package, once imported, contains the target images ready for use.

The second phase, after importing the package, was to import the models into the Unity project and then set up the main scene. Models were made in Cinema 4D based on the available photos and remains, and exported to Unity. A more detailed description of the 3D models can be found in [5]. The main Unity scene is composed

of four target images and an AR camera object, which we added after deleting the standard camera. This way, the application uses the device's camera to recognize the images and then render and position the models properly when a certain target image is recognized.

The next phase was to assign all the White Bastion models to their respective target images. At this point the application is able to recognize the correct image targets and display the matching models. At first we had issues with the image recognition process while using the initial images with the same background color shown in figure 2. Most of the time the wrong models were shown on the joined cards. After changing the background colors of the era cards, we still had issues at times, because the main bastion card was still mostly green. When we changed the background to pure white with colored era cards, as displayed in figure 1, we had experienced much better results.

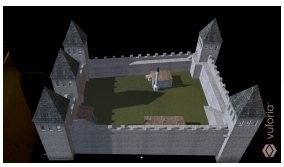
(a) White Bastion card

(b) Ottoman period card

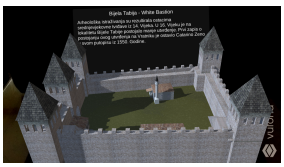
(c) Medieval period card

Figure 2: Initial cards used for image recognition

The fourth phase was to add more interactivity to the application, as it could only recognize images and display models. We implemented a script in Unity that detects user touch input and detects the object the user wanted to interact with. Once the touch input is received, the script displays a user interface. The user interface contains a panel with basic information of the bastion itself and information about era specific cultures that are connected to this monument of Sarajevo. The user interface can easily be extended to show images, audio and video information on the Bastion in a certain era. Figures 3, 4 and 5 show the models and their information panels.



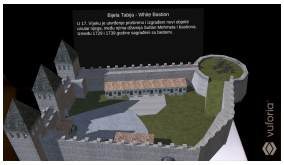
(a) White bastion model only



(b) With information panel

Figure 3: Demonstration of application usage for Medieval period tracker

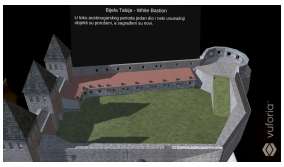
(a) White bastion model only



(b) With information panel

Figure 4: Demonstration of application usage for Ottoman period tracker

(a) White bastion model only



(b) With information panel

Figure 5: Austrian-Hungary period demonstration

4 User experience evaluation

To verify whether the suggested method is feasible for learning about cultural heritage, preliminary user evaluation has been conducted on 11 participants. The questionnaire had three groups of questions, with the first one considering demographics of the users, the second one application ease of use, and the third one considered education factors of application.

Over the half of participants were age 19-30, with three of them younger than 19. Around half of the participants knew what augmented reality is, and 36,4% used augmented reality applications before. All of them use a mobile phone for more than one hour a day, with more than 60% using it for more than three hours a day.

Demographics overview is shown in Table 1.

Participants mostly agree that the application is intuitive and easy to use, and they did not face difficulties during usage. This is best shown in figure 6.

In the third part of the questionnaire, participants answered questions about their perception of the educational context of the application and its possible usage in presenting and learning about cultural heritage. What all participants strongly agree with is the statement that this kind of

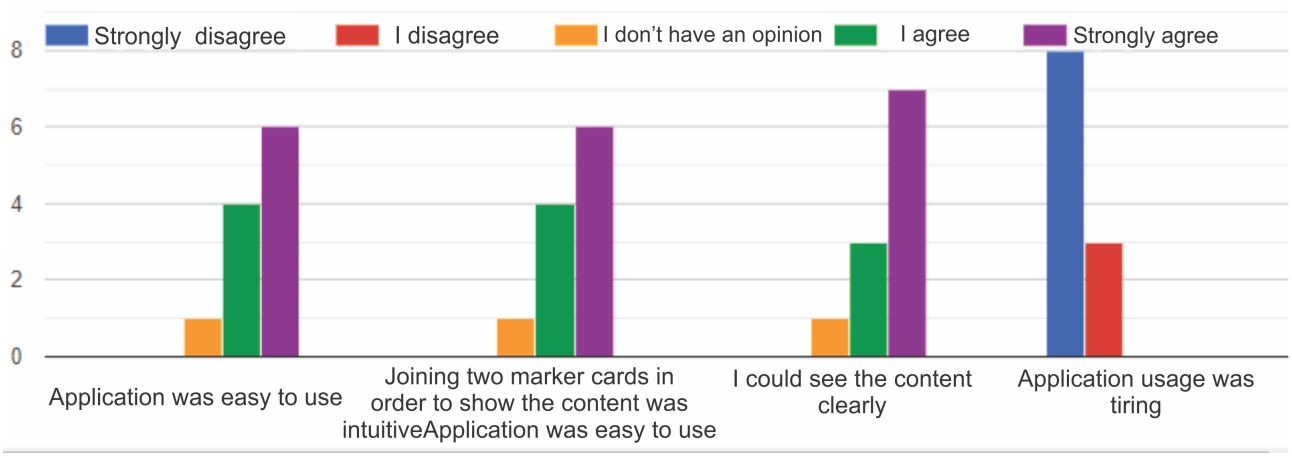


Figure 6: Ease of use questions overview

Question	Respons	Number	Percent
Age	<14	1	9,10%
	15-18	2	9,10%
	19-30	7	63,60%
	31-50	1	18,20%
How many hours a day you use a phone	1-3	4	36,40%
	>3	7	63,60%
Do you know what augmented reality is?	YES	6	54,50%
	NO	5	45,50%
Have you ever used AR application?	YES	4	36,40%
	NO	7	63,60%

Table 1: Demographics questions overview

application would be beneficial for history classes in primary and secondary school. Also, most of them confirmed that they noticed differences in 3D models of White Bastion in three eras and that the experience was interesting. 10 out of 11 participants agree or strongly agree that they remembered new information about the cultural site and that the physical combining of targets helps them remember the historical period in which the events happened. This is also shown in figure 7.

5 Conclusions

As shown in chapter IV, a preliminary questionnaire has shown that the users consider the augmented reality application which uses combinations of multiple image targets interesting and beneficial for presenting and learning about cultural heritage. Deeper evaluation will follow, in order to compare traditional way of learning about cultural heritage versus the the method proposed in the paper. Id In future work, we plan to continue exploring image combining as the way of creating an interactive context in augmented reality. The next step will be to try and define precise factors of combined image target quality, in order to produce a more stable system, and also try different ways of tracking two combined images. Also, adding more content to the same application, in the means of more cultural heritage sites, with its representation in the same time era is planned.

References

[1] Su Cai, Xu Wang, and Feng-Kuang Chiang. A case study of augmented reality simulation system application in a chemistry course. *Computers in human behavior*, 37:31–40, 2014.

[2] Mihai Duguleana and Cristian Cezar Postelnicu. Towards preserving transylvanian fortified churches in virtual reality. In *International Conference on VR Technologies in Cultural Heritage*, pages 34–45. Springer, 2018.

[3] Juan Camilo González Vargas, Ramon Fabregat, Angela Carrillo-Ramos, and Teodor Jové. Survey: Using augmented reality to improve learning motivation in cultural heritage studies. *Applied Sciences*, 10(3):897, 2020.

[4] Anne-Cecilie Haugstvedt and John Krogstie. Mobile augmented reality for cultural heritage: A technology acceptance study. In *2012 IEEE international symposium on mixed and augmented reality (ISMAR)*, pages 247–255. IEEE, 2012.

[5] Selma Rizvic, Vensada Okanovic, Irfan Prazina, Aida Sadzak, CE Catalano, and LD Luca. 4d virtual reconstruction of white bastion fortress. In *GCH*, pages 79–82, 2016.

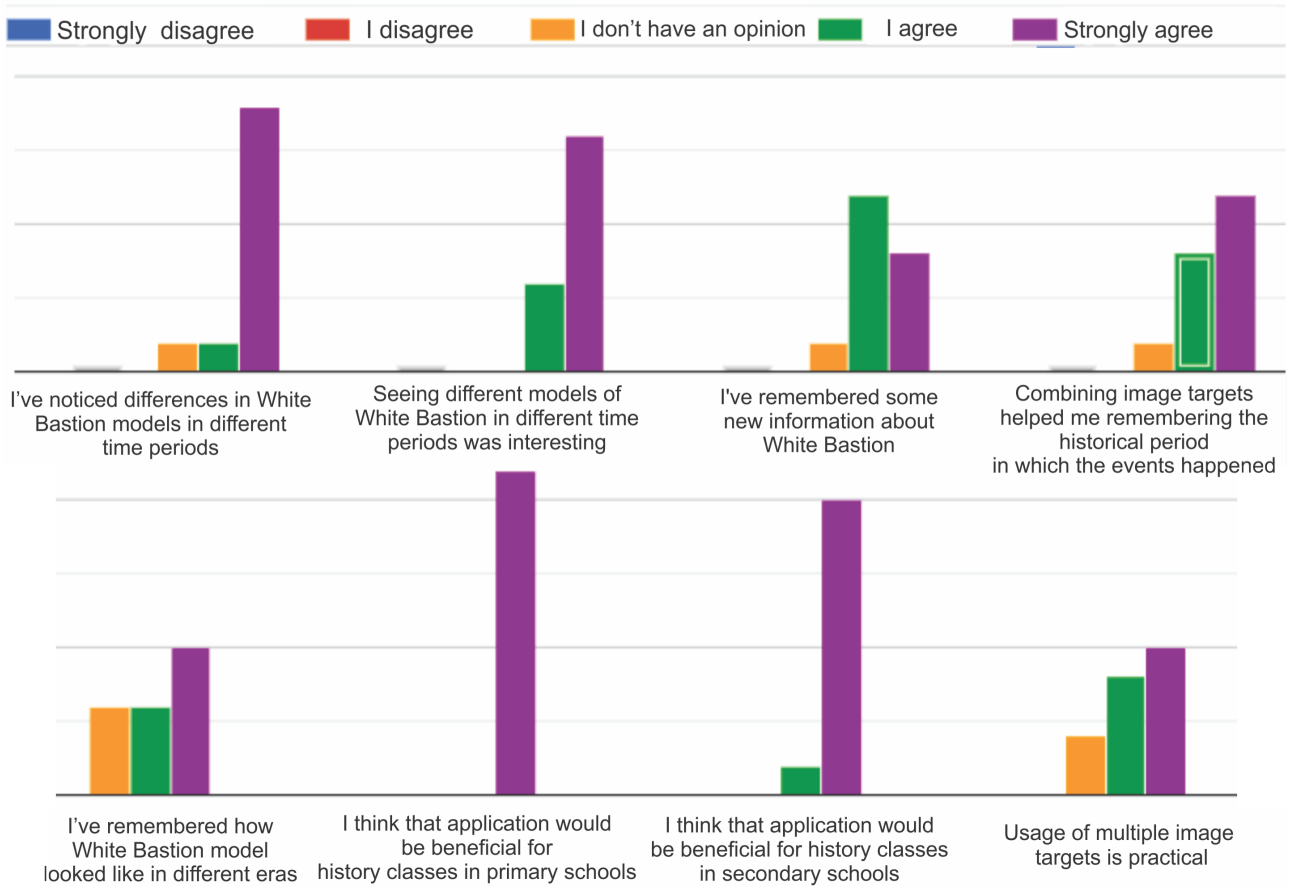


Figure 7: Educational context questions overview

[6] Michael Zoellner, Jens Keil, Harald Wuest, and Daniël Pletinckx. An augmented reality presentation system for remote cultural heritage sites. In *Proceedings of the 10th International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST*, pages 112–116, 2009.