

Implementing Augmented Reality at the Imperial War Museum

Christiaan Burrett-Bijlstra

Student

Middlesex University

London, United Kingdom

CB1291@live.mdx.ac.uk

M00608813

ABSTRACT

This paper describes the process of the development of our augmented reality application for visitors of the Imperial War Museum, London, United Kingdom. It also seeks to explore the proof of concept of augmented reality within a museum environment.

AUTHOR KEYWORDS

Augmented Reality; Vuforia, Unity, Blender, Meshroom

INTRODUCTION

For any project to succeed it must have a clear and concise goal and objective. For our second coursework, we were tasked with trying to enhance the overall experience of museum visitors. With this in mind, we concluded that the best way to conceptualise a truly significant concept would be to experience the museum in our own individual ways. We, therefore, decided that we would visit a museum to which none of us had been before. As a child, I was always fascinated with the concept and scale of war, I self-educated myself from a young age and to this day I still try to continuously educate myself in the historical facts of these horrendous events. Although I had visited many museums in London I had not yet visited the Imperial war museum. Our team concluded that this was a great museum for our project.

RESEARCH AND OBSERVATIONS

After experiencing the museum in its entirety we had mixed feelings about specific exhibits. We felt that the newer exhibits on the upper levels of the museum instilled profoundly captivating emotional responses from both us and the other visitors. With some visitors being visibly moved by the stories of the Holocaust and the battles in the trenches at Verdun. The exhibitions on the lower levels of the museum, however, lacked such an emotional response. We observed this in both ourselves and the visitors. The most obvious difference that stood out to us was the lack of attention that some of these objects were getting from visitors as they seemed to wander past them trying to find an exhibition that would resonate and spark interest within them. If I had not known the stories behind some of these relics I could imagine myself doing the same. After observing some of these exhibitions that were not receiving a great deal of attention we decided to focus on one that stood out to me the most. It was a section of the museum that was dedicated to objects of the second world war. The main three objects in that section are a complete Sherman tank, a Nazi

eagle statue that was taken from the Reichstag and a Japanese A6M Zero wreckage.



Figure 1. The wreckage of Mitsubishi A6M “Zero” in the Imperial War Museum.

We decided to observe this specific exhibition and the visitors behaviour in that section. We soon saw that although people were taking some pictures of the wreckage they were not compelled to read the small panel of information regarding the wreckage, I believe this is mainly due to its location being somewhat inconvenient and out of the way and it was also not very noticeable. We saw people spend a much greater amount of time observing the Nazi eagle and the Sherman tank. I believe a contributing factor to those artefacts being more popular is the greater significance they have in the European theatre of war. Due to the location of the museum being in London, it is far more likely that most visitors are being or have been educated in the European theatre of war during the second world war. The A6M, however, was never really deployed in scale in Europe during WW2 and so the audience may not be familiar with it or its history. Therefore we decided that we wanted to start our project with the aim of making that particular object more engaging with visitors and possibly educate them on the history of the A6M.

Throughout the museum, we observed that visitors were more likely to engage with artefacts and exhibitions if they had some form of sensory interactivity. For example one of the most popular and striking exhibitions was a simple wooden bar that visitors

would be asked to rest their ear on. This wooden bar would resonate a low-frequency bass through it. The source of the bass was an audio recording that took place on the 11th of November 1918 at approximately 10:58 AM, 2 Minutes before the official end of the first world war. One could hear the artillery shells strike with unrelenting force. Until exactly 11 AM, when all that could be heard through this wooden bar was an eerie silence after such explosive devastation. It was such a simple exhibition yet it conveyed so much emotion to every visitor that spent the time to rest their head on this wooden bar. This was a clear example of the use of sensory interactivity between exhibitions and visitors and how effective it was at conveying and educating the visitors on the scale and severity of the first world war. After conducting further research we concluded that sensory interaction between exhibitions and users was extremely important[1]. We would keep this in mind whilst producing our prototype. Our research also found that there have numerous studies on how to measure the engagement of audiences with museum exhibitions. One such study found that “Meaningful experiences” were an incredibly important measurement[3]. With all these findings considered we realised our design need to achieve two outcomes. It needed to attract more attention to such a significant artefact and it needed to create a meaningful experience for the audience by informing them about the artefact.

DESIGN CONCEPT

With our general guidelines set out, we needed to determine what the objectives of our AR app would be and what kind of user interactions it would have. We wanted our application to be easy to use, help bring insight to some artefacts and overall our application had to enhance the user's experience.

We determined that because of our artefact being a wreckage and its original form being unfamiliar with the audience we could transform the wreckage into its complete state with the use of augmented reality. By showcasing the original scale and beauty of the A6M on our application whilst of course having the wreckage displayed in front of the visitor we believed that the severity of the war and the destruction it produced could be brought to light. The user would have an active comparison of the wreckage and its original form and this could enhance the users experience substantially and thus create a meaningful experience. We also conceptualised the possibility of adding features such as a possible display of the cross-section of the aircraft or possibly showing the pilot within the aircraft to further show the scale of the plane. We also discussed possibly being able to dissect the aircraft by clicking on individual parts. For example, if the user would click on the engine it would showcase the engine components and possibly inform the user about that individual part.

We thought of ways we could produce our concept with the current technologies available. We concluded that the best way to demonstrate our concept would be by making use of digital 3D models of the A6M. By overlaying the 3D model on the wreckage we could achieve our design concept. We were of the opinion that an application that made use of a 3D model would provide intrigue to the wreckage. This was important as our research we found that a large proportion of visitors were simply not intrigued by the wreckage itself.

We contemplated multiple design options for our application. We discussed what our application would have displayed on the screen when the artefact is not in view and what would be displayed when the object is in view. These are important decisions when designing an application as users will need context for the application to be easy to use. So in order to achieve the ease of use of our application, we decided that having the outline of our object displayed whilst the artefact wasn't in view, would be the easiest way to convey what artefact the user needed to be pointing at (Figure 2). Figure 2 is the view of our application when the camera is pointed at a blacked out surface, this has been done to showcase the outline more effectively.



Figure 2. The outline of the A6M wreckage on the application.

This design concept would signify to the user where to point their phone for the artefact overlay to become active. When the application recognises the artefact in view of the camera it would automatically overlay the 3D model on top of the wreckage. In figure 3 you can see the untextured 3D model of the A6M This would be scaled and aligned to the wreckage.

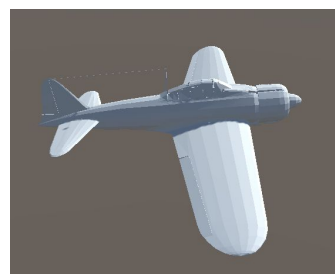


Figure 3. 3D model of the Mitsubishi A6M “Zero”.

This overlay would provide a new way of being able to interact with such objects. By showcasing a live reconstruction of the artefact users will be able to explore parts of the artefact that were previously unavailable, such as the wings and engine.

PROTOTYPE

To develop our prototype and to achieve the design we had planned we knew that we would have to make use of a variety of digital tools. For this prototype, we concluded that the best software for us to use were AliceVision's Meshroom, Blender, Unity and Vuforia.

From the onset of our project, we understood that the most challenging task would be to reconstruct a 3D model of the wreckage. This was deemed necessary as without it Vuforia would have no way to be able to accurately identify and vector the 3D model. After conducting a large amount of research on the topic of photogrammetry[8] and 3D digital reconstructions we concluded that we were going to make use of AliceVision's Meshroom[4]. Meshroom is an incredibly intelligent software that takes as input a large number of pictures of a specific object that is stationary. Meshroom then comparatively analyses every single picture to every other picture and tries to triangulate the location that each picture was taken from in the room. It does this by actively comparing background features and the target's features to each other and to every picture. We found meshroom to be incredibly powerful and intuitive software. After taking approximately one-thousand pictures of the object we compiled them and fed them into meshroom.



Figure 4. Digital reconstruction of the A6M.

In figure 4 you can see the complete digital reconstruction of the A6M purely from photographs. It is interesting to note that this is a textured version of the 3D model and that this version is more accurate in colour and texture than some of the photographs taken. It took about 14 hours for meshroom to complete this render on top-tier hardware. This goes to show how complex these kinds of computations are. We were incredibly impressed by the render and at this point of the prototype development, we were fairly confident that we could produce an impressive prototype.

One of the problems we faced at this point of the development was that although Meshroom had reconstructed the wreckage to perfection, it had also reconstructed the entire room(Figure 4). This was problematic as this would confuse Vuforia. This meant that we had to clean up and simplify our 3D render. We decided that to alter and process our 3D render we would use an open-source software called Blender[5]. Once we had imported our 3D render into Blender we soon realised how intensive this reconstruction was. The initial model that we had exported from Meshroom had over one million vertices. These vertices are basic triangles that make up the overall shape of a 3D object. To give some scale and context to how complex that model was - the 3D model we were going to use as our reconstruction (figure 3.) had about 1000 vertices. The process of cleaning up and scaling down the complexity of our 3D model was incredibly tedious and time-consuming. But eventually, we were satisfied with our 3D reconstruction to see figure 5. The final reconstruction had about 200,000 vertices.

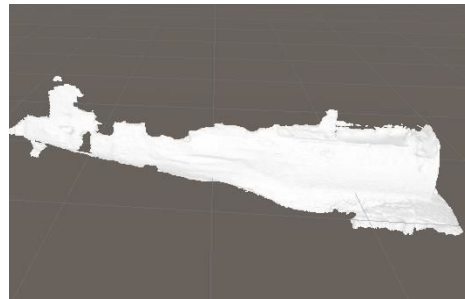


Figure 5. Digital reconstruction of the A6M wreckage at the imperial war museum.

Once we were satisfied with the 3D model the proceeding step was to use Vuforia's Model Target Generator (MTG). According to Vuforia the MTG "converts an existing 3D model into a Vuforia Engine dataset" [7]. According to a study that has been conducted at Bulacan State University, Vuforia's MTG processes the 3D model into an object that is more efficient to track and recognise by Vuforia's engine. In figure 6 you can see the viewpoints we chose for Vuforia. This would allow Vuforia's AI to train the model to be more accurately detected at those specific viewpoints. We selected these viewpoints as they are the most likely positions for our users to be standing in when using our application.



Figure 6. Viewpoints that we chose for Vuforia's MTG.

After Vuforia's MTG completed its training process which took approximately 2 of computational time, we were ready to proceed into unity. Unity and Vuforia allow for incredibly easy interaction between each other. The importation of the Vuforia target was

seamless and we proceeded to import the complete 3D model of the A6M as seen in figure 3 into unity. We then had to scale, texture and align the 3D Model with the wreckage within unity. Once we were satisfied with our prototype we exported our application as an APK file which would allow for it to be installed on any android device. In figure 7 below you can see the first iteration of our prototype in use at the museum. As you can see in the live recording of our project in source 9, the user is able to completely walk around the artefact with no delay in the adaptive positioning of the model.



Figure 7. Screenshot of our AR application in use.

TEAMWORK

During the development of our project, we made use of various methods to increase the efficiency of our development. One such method was the splitting of tasks between our group members. Fortunately, Daniel, Alexandru and I have worked together in the past which means we are familiar with each other's strengths and weaknesses. All of the group members observed and contributed to the research tasks as it was critical to analyse each other's individual observations. Alexandru conducted further extensive research and photography tasks. Daniel and I focused on developing our project in Meshroom, Vuforia and Unity. All of us provided support and consultation during various stages of development. We were able to effectively split the work between group members which allowed us to achieve a great prototype.

EVALUATION

Although not a requirement to our coursework we were incredibly satisfied with our prototype and thus we wanted to explore methods to improve and optimise our design. We decided to conduct a small evaluatory survey with ten randomly selected Imperial War Museum visitors. Our survey consisted of five questions that would allow us to measure how our application enhanced the user's experience. The results were extremely positive, 100% of the people we surveyed found our application intuitive and easy to use. On a scaled question from 0-5 we asked "How much did this enhance your experience with this artefact", 100% of the people we surveyed scored our application 5/5. We were extremely thankful for the participation of the surveyees as they gave us great feedback on how we could improve our application. With some users suggesting that we could improve our application by adding animations to our 3D model and perhaps

providing some key facts on screen. We recognise that if we were to develop this application further we would need to conduct a much deeper analysis and evaluation of our application.

CONCLUSION

To conclude this report I would like to explore the successfulness of our application. The overall consensus seems that our application is a viable product for further development. With users stating that our application enhances their visit and their interaction with artefacts and thus creating a meaningful experience. Our application must, of course, be considered as a prototype as there are many aspects that we could improve upon. One such aspect is the quality of the reconstructive 3D model, with current hardware capabilities we could use a 3D model that would look almost real to life and would be incredibly detailed. However, this would cost an exorbitant amount of resources that would not be justifiable for a prototype.

One must also consider our application as a proof of concept. After the completion of our prototype, we have started further development on possible alternative applications at other museums across London. We seek to develop a second prototype for the National History Museum. This prototype will explore the possibilities of augmenting skeletal artefacts such as dinosaurs. We seek to augment these skeletons with real to life 3D models of dinosaurs overlayed on top of the skeletons. By combining the use of AR and educational material we believe there is incredible potential for this type of application in museums.

REFERENCES

1. Engagement with an Interactive Museum Exhibit - Naomi Haywood, Paul Cairns - <https://www-users.cs.york.ac.uk/~pcairns/pubs/Haywood.pdf>
2. The Interactive Museum Experience - Irida Ntalla - http://openaccess.city.ac.uk/17280/1/Ntalla%2C%20Irida_Redacted.pdf
3. Engaging Visitors in Museums with technology: scales for the measurement of visitor and multimedia guide experience - Mohd Kamal Othman, Helen Petrie and Christopher Power - <https://www-users.cs.york.ac.uk/cpower/pubs/2011INTERACTOthmanPetriePowerMES.pdf>
4. Photogrammetry Pipeline - Alicevision Meshroom - <https://alicevision.github.io/>
5. About Blender - <https://www.blender.org/>
6. Design and Development of Augmented Reality (AR) Mobile Application for Malolos' Kameztizuhan (Malolos Heritage Town, Philippines)-Dela Cruz, Dennis R, Sevilla, Jerico S.A San Gabriel, Joshua Wilfred D Dela Cruz, Angelica Joyce P Ella Joyce, S. -Is Part Of:2018 IEEE Games, Entertainment, Media Conference (GEM), August 2018, pp.1-9
7. Model Target Generator User Guide - <https://library.vuforia.com/articles/Solution/model-target-generator-user-guide.html>
8. Photogrammetry - <http://www.photogrammetry.com/>

9. Live recording of our application in use at the Imperial War Museum. - <https://www.youtube.com/watch?v=jHTMspk5FOg>