The Value of 3D Modeling of Cultural Heritage Monuments with the Method of Digital Photogrammetry for Use in Augmented Reality Applications

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Abstract. Nowadays, the need to digitize cultural heritage sites and present them to the public in original and easily accessible ways is very important. The advantages are many both in times when Museums and archeological sites are open, and in times of forced closure such as the Covid-19 pandemic. As a result, there is more motivation and interest from the spectators, young and old, easy access and from remote areas, the ability to travel the collection outside the museums. Also due to the limited space of the museums there are exhibits that remain in warehouses and are not exhibited in the collections. The digital documentation enables the enrichment and display of a large volume of exhibits virtually. The dynamics of Photogrammetry with the rapid and continuous evolution of software and the ability to utilize them by many specialties gives rise to this study. The basic premise is that with simple media such as a compact camera and the right software, 3D exhibits such as the funeral masks and personal belongings of the 18 21 fighters can be reproduced, many of which are in storage. The conjuncture of 200 years since the beginning of the Greek Revolution gave even greater impetus to the investigation of ways of presenting them using AR Technology.

Keywords: Photogrametry · Cultural Herritage · Monuments digitization · Blender · Model decimation · Distance exhibition · Augmented Reality · Pandemic period

1 Introduction

In the course of the University of West Attica "3D environment design" and due to the celebration of the 200th anniversary of the Greek E-revolution of 1821, it was decided to create a series of works on this subject. The models were created with Blender software on the one hand and digital Photogrammetry on the other. For the Photogrammetry procedures, cooperation was concluded with three major museums: the National History Museum and the Athens War Museum and Tripoli department. The result was the creation of models of the funeral masks of the fighters of 1821 and other objects. Many of them were stored and inaccessible to the public. These specially processed models would have

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the potential to be utilized in an Augmented Reality application for public presentation and educational use.

The advent of the pandemic during the development of the project demonstrated even more strongly the need to digitize the cultural heritage and highlight it through digital applications. New needs emerged in areas such as education and culture. The result was a shift to distance education, both formal and informal during this period. Museum education that is identified with aesthetic education [1] had already begun to change form and move in a digital direction. In this way the Museum experience began to have the potential to become more attractive through the interactivity of the learning environment [2]. Museums today are exhibition spaces but at the same time provide education in various ways [3]. The use of augmented reality is nowadays more and more frequent, since museums use the advantages it provides [4]. A cultural institution or artists can use this technology to highlight their exhibits with greater originality [5]. To achieve this it is necessary to create the three-dimensional models of the exhibits that will then be utilized in this direction.

1.1 Purpose and Research Questions

Based on the above, the purpose of the work is to create accurate copies, using the method of Photogrammetry, of the funeral masks and objects of the fighters of 1821 for their digital presentation in the application of Augmented Reality. Sub-objectives were: to select the appropriate programs based on their fidelity, speed and possible free availability, to use simple media such as a compact camera, existing lighting and museum media, free software for further processing in order to include them into an AR application. Research questions that arose after the aforementioned targeting were the following:

- In what ways can Photogrammetry help highlight cultural heritage remotely even during a pandemic period?
- What are the quality parameters that will make possible the efficient process of collecting the digital material to import them into a photogrammetry program?
- What are the quality characteristics for a model produced by Photogrammetry to be imported in an AR application?
- How important is the role of the Blender program in this process in the final production of the model to be utilized?

1.2 Methodology

For this purpose, bibliography was utilized and a case study was created in the museum that controls and utilizes the above conditions. Action research with on-site photography work in museums, problem identification and solution by simple means are the dominant element in this study.

2 Using Digital Photogrammetry for Cultural Heritage Reconstruction

2.1 Benefits of 3D Modeling with Digital Photogrammetry

In addition to the use of design programs to create 3D models, the technique of Photogrammetry is increasingly used. The process of digital photogrammetry can be described as an input-processing-output system that requires the appropriate hardware and software. By taking photos from at least two different positions, so-called "visual contacts" can be developed by each camera as points on the object to be represented [6].

Any digital camera can be used to take pictures. 3D model reconstruction methods based on SFM (structure from motion) algorithms also require overlapping images with angular displacement [7]. In this way the photos are connected in order to create a point cloud, which with the appropriate processing turns into a grid (mesh), and then into a three-dimensional object. At the end, the color, materials and texture are added, information that is in the collected photos.

The most obvious reasons for the importance of 3D modeling of monuments are: their precise documentation for restoration in case of destruction, the creation of valuable educational resources for students and researchers, the visualization from a point of view that is impossible to access from the world due to either of size or accessibility, interaction with objects without the risk of damage and finally virtual tourism especially in a period when museums are closed such as the pandemic period [8].

2.2 Photogrammetry in the Museum with Simple Tools

Photogrametry consists mainly of three phases [9]: the preparation where practical issues such as photography issues are defined, the digital capture of photographs by simple means [10] and finally the processing of data by photogrammetry software. In relation to the present work, which aims to utilize the models from a toy machine, we add the stages of reducing the number of triangles/polygons [11] and reducing the file size of the uv map produced by the photogrammetry program.

Fig. 1. Funeral mask of Nikitaras, National and Historical Museum of Greece

Based on all the above, the preparation included the permission of the museums for the Photography and specifically of the National Historical Museum and the War

Museum respectively. In it, the objects that would be photographed were precisely determined. This request was also accompanied by a visit to the museums to determine the available conditions. A simple Nikon Coolpix compact camera, a table provided by the museums for the placement of objects and the lighting in the room were used for the photography. A very important role was played by changing the white balance of the camera for better control of the glosses that existed. A patterned cloth (Fig. 1) was placed on the table as a base, to facilitate the operation of the algorithm in distinguishing object background as there was movement around the subject for taking photos.

2.3 Combining Photogrammetry with Blender

After the capture of the pictures the Reality Capture and 3df Zefyr programs were used for the reconstruction of the models and comparative evaluation of the performance. Both programs delivered reliable models (Fig. 2), with Reality Capture having an advantage over costume models in the performance of details and a difference in the speed.

Fig. 2. Phptogrametered model of Funeral mask of Theodoros Kolokotronis

However, today there is a great evolution and improvement in 3df Zefyr and these differences are smoothed out. After the export of the models it was necessary to reduce the number of triangles. Blender and the decimate modifier tool were used for this purpose. This program also made it possible to intervene in micro imperfections that arose in the event of an excessive reduction of the triangles that might be deemed necessary. This was very important to maintain the uniformity of the model and its fidelity compared to the original. It was also very important to reduce the volume of the uv map file. The above two steps lead to efficient utilization of phogrametered models by gaming machines.

2.4 Types of Digital Presentation of Photogrametered Models

Many forms can be used for the presentation of the 3D models. A very significant tool is Sketchfab. There the models can be uploaded and can represented in many ways including VR and annotation tools. Simple manipulations such us rotate and scale can give the user the freedom to see the object from many aspects. A link is provided for each model and also embedded code. With the use of QR codes the access is possible from printed forms such as posters, brochures etc. Further more AR applications that

use image targets can be used from museums for more enhancing results that gives to the users more interesting learning experiences [4] and also gives flexibility to the exhibitions inside or outside the museum with physical or digital ways.

3 Conclusion

In conclusion, we can say that digital Photogrammetry is a valuable tool that can be used to highlight Cultural Heritage Monuments through interactive, expansive applications with success. It makes it possible to overcome the limitation of the physical space of museums and to highlight the cultural heritage treasures that are stored or not even in the period of violent closure such as the period of the pandemic. Photogrametry programs can be used simply and produce satisfactory results. Simple tools as compact digital cameras, the existing lighting with white balance regulation can give very good results. Futher work with free programs like Blender can giveeven more excellent results.

To create models that will be used in gaming machines and Augmented Reality applications, necessary steps are: preparation, capturing photos, inserting them in the photogrametry program, reducing triangles/polygons, reducing the volume of the uv map file in an image editor. Utilizing the Blender program gives great possibilities both for the stage of reducing polygons in an easy way and in the further processing of the model.

4 Further Prospects

For the close future is critical point, the use of the produced models in an organized user friendly mobile app. The combination of printed media with many different forms with the use of mobile phones or tablets will give an additional pedagogical value to the monuments and museums.

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