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3D study of modelling and animation of Kayseri Gülük Mosque

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ABSTRACT

The preservation of documents, which are described as cultural heritage, can be accepted as the common duty of delivery to future generations of humanity. In documenting the cultural heritage, the current state of historical monuments must first be determined. For this, various techniques are used in the literature. Recently, Close-range photogrammetry documentation of cultural heritage, which develops rapidly in line with technological developments, has an important place in the study. Documentation of close-range photogrammetry cultural heritage, which has developed rapidly in parallel with technological developments, has an important place in the studies. In this study, the study of documenting the Gülük Mosque in Kayseri/TURKEY with a photogrammetry technique was carried out. In this study, as a result, scaled drawings and three-dimensional model (3D) of the exterior of the mosque were obtained. Thanks to the photogrammetry technique, field and office work was completed in a short time according to classical documentation methods. With this method, works built throughout history can be archived with a 3D model in the digital environment. In addition, the 3D model obtained by the photogrammetry technique was animated and displayed in virtual museums.

1. INTRODUCTION

In Lands where Turkey is located, have lived thousands of civilizations throughout history. In this respect, Turkey has a rich cultural and historical heritage. According to the 2002 records of the Ministry of Culture and Tourism in Turkey registered 66 251 units in a single building scale cultural and natural heritage is available (URL-1).

At the same time, Turkey's Central Anatolia Region is an important center in terms of cultural artifacts. The number of registered buildings in Kayseri in this region is 829 according to the end of 2009 reports. 163 of these are religious structures (URL-1).

Documenting these works, conservation and needed to be restored, is of great importance in terms of cultural heritage studies. Cultural heritages are the history of nations, and history forms the identity of the nations. Therefore, the protection of cultural heritages means protection of the history and identity of the nations (Yakar and Doğan, 2017; Ulvi et al., 2019).

Documenting the cultural heritage process (Georgopoulos and İonnidis, 2004); '' History or cultural structure of the set of three-dimensional space in the current situation, the new size, it is necessary to determine the shape and position measurement, assessment, recording, and presentation process '' is defined as.

Various methods are used in the documentation of historical artifacts for different purposes. There are various methods such as classical manual inventory collection, topographic methods, photogrammetric methods and screening methods (Böhler and Heinz, 1999; Scherer, 2002). These methods provide great benefits to historical and cultural heritage objects in the future; The photogrammetry method used in this study includes scientific methodologies that calculate the three-dimensional coordinates of an object by measuring the corresponding points in the overlapping images (Akçay et al., 2017; Ulvi et al., 2020)

The most complex part of documenting cultural heritage seems to be to create three-dimensional modeling of these works. The close picture

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photogrammetry method was used for the easiest solution to this complex process. Close picture photogrammetry method; It is widely used in determining the structure of historical and archaeological value, making scale drawings of the building facade, preparing and implementing an urban conservation plan, cracks and deterioration analysis, damage assessment, restoration projects and in areas such as deformation detection studies (Yılmaz et al., 2000; Sienz et al., 2000).

In this study, the Mosque of Gülük documentation work is made with the close-range photogrammetric method. Detailed stone drawings were made on the exterior of the Gülük Mosque. In addition, a 3D model of the building was obtained and this model was presented as an animation on the virtual platform.

2. STUDY AREA

Gülük Mosque is located in the Gülük District of Kayseri, Melikgazi district. The Gülük Complex, built during the Danişmentlı period, consists of a mosque madrasa and a bath that is located next to them and is not available today (Figure 1).

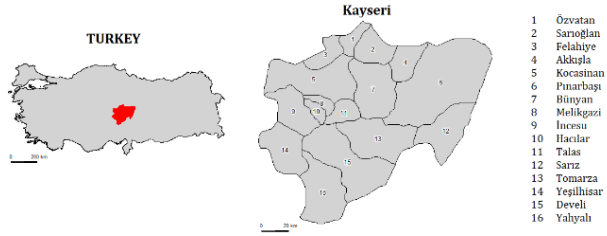

Figure 1. Güllük Mosque (Kayseri/TURKEY)

There is no epigraph that indicates the date and the construction of the complex or mosque. The older one of the two inscriptions on the building is on the crown gate on the northeast facade and added later. According to this inscription, the buildings were repaired in 1211 by the daughter of Yağıbasan Mahmut, Atsız Elti Hatun, the nephew of Sultan Mehmet Melik Gazi. This inscription on Taçkapı consists of three lines and the inscription of the inscription written with the Seljuk sulcus is as follows: "This building is the son of Keyhüsrev, the honor of the world and religion, the owner of the conquests, the partner of the Emir of the Believers, the time of the reign of the great Sultan Keykavus. Atsuz Elti Hatun, the weakest servant, chaste woman, daughter of Yağıbasan son Mahmud, repaired it in 607 (1210)"(URL-2).

The building has two lower and three upper windows on the south facade wall. One of these windows belongs to the upper and lower mosque section and the rest to the madrasah section. The lower window on the western facade belongs to the upper rooms of the two-story madrasa. The east facade wall has four rectangular windows 2.5 meters high on the floor. The north facade wall of the mosque is the front wall of the mosque and the madrasah. On this front, Taçkapı, located in the northeast and built by Atsuz Elti Hatun, has a mosque door 11 meters away from it (west) and an entrance door of the madrasa about 8 meters away from the mosque door. The courtyard of the mosque is bordered by three arches and four feet of different apertures in the east and west directions, and the top is covered with a double-centered cradle vault as in the entrance section. 3.80x5.80 m in the middle of this vault. It has a rectangular opening. It was determined that there was an opening (skylight) in the middle of the mosque, which was first seen in Seljuk architecture. This opening was later converted into squares with additional arches to the east and west directions, and 3.60 m. The image of the restoration works of the building is shown in figure 2.

Figure 2. Güllük Mosque

3. METHODS

The handheld camera which does not have any special equipment was used in the study. The main goal in the use of the digital handheld camera in practice is to investigate the success of modeling historical artifacts with photographs taken by people without a special purpose.

The method used in the study is the photogrammetry method.

Photogrammetry is a method that allows the re-creation of object properties without contact with the object (Krause, 2007).

Photogrammetry is an independent method in the documentation process. This method is based on at least two images with a sufficient amount of overlap between each other (Yakar & Doğan, 2017). Therefore, there is a need for at least two pictures taken from different angles of the object to be photogrammetry. In order to be successful, the first and most important stage of the object to be documented is the photographing stage. After photographing the object, measurement is done with a sensitive measuring device to scale the work to be done.

3.1 Field Studies

In the field study, the photos of the object to be documented are taken first. Photos of the historical building were taken with a Canon digital handheld camera. The digital handheld camera is shown in Figure 3. Technical features are shown in table 1.

After taking the photos, the detail points of the building should be measured. The purpose of this is that it is desired to form a more sensitive and real scale model of the building. Natural details, which can be easily distinguished in photographs, should be measured. Or, ready-made signboards in appropriate colors and forms should be placed and measured.

Measurements should be made with at least three detail points in each image (Burns et al., 2009). The number of detail points varies depending on the size of the surface. In the study, 32 detail measurements were made. Measurements were made with the Topcon GPT-3007 geodetic instrument shown in Figure 4.

Figure 3. Canon IXUS 180

Table 1. Canon IXUS 180 Technique Specifications (URL-3)

Canon IXUS 180	
Effective megapixels	20
Total megapixels	20.5
Sensor size size	1/2.3"
Max. image resolution	5152 x 3864
Crop factor/Optical zoom	5.62 / 10x
ISO	Auto, 100-1600
Focal length	24 - 240 mm
Max aperture	f3 - f6.9
Max. aperture	f16.9 - f38.8
Min. shutter speed	15 sec
Max. shutter speed	1/2000 sec
White balance presets	5
Screen size / resolution	2.7" / 230,400 dots
Max. video resolution	1280x720 (25p)
Weight	138 g
Dimensions	95.3 x 56.8 x 23.6 mm

Figure 4. Topcon 3007 Totalstation

3.2. Photogrammetric Work

After collecting the necessary data in the field study, office work started. In-office work, first of all, the detail points measured in the field are checked. Then, data is transferred to the necessary software to obtain a 3D model from 2D photos (Yakar et al., 2016).

In this study, PhotoModeler photogrammetric software was used for documentation study. PhotoModeler software is a Windows-based software program developed by EOS System. This software enables the digital images of an object to be used to obtain a three-dimensional model and to create a metric scale. In this three-dimensional software model; includes points, corners, and/or a series of curves.

Photos are first import to photogrammetric software (Figure 5). 56 photographs were used to model the Gülük Mosque. Then the detail points are marked on all pictures one by one and the photos are orientated.

All 56 photographs used in the study were balanced with 2.10 rms (Figure 6). After the photos were oriented, all the details of the building were drawn (Figure 7).

Finally, the real model and the surface were applied to the 3D model created as the basic structure (Figures 8 and 9). Then, the 3D model obtained was transferred to Sketchup software and the missing facades were completed (Figure 9).

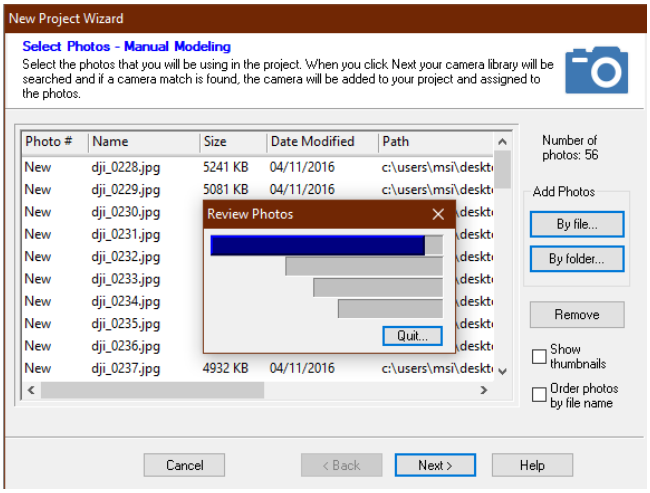

Figure 5. Photographs import to Software

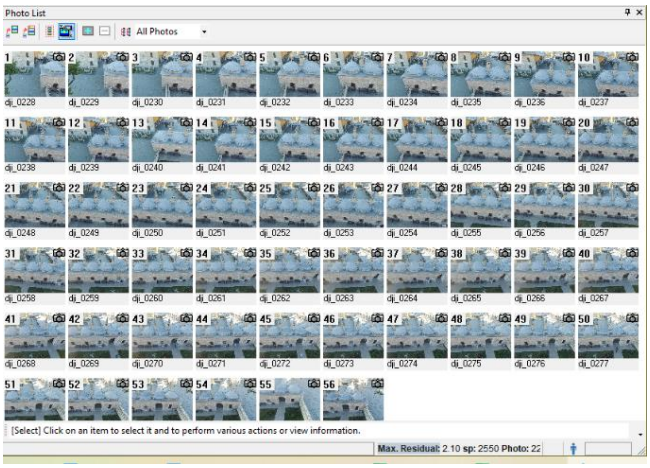

Figure 6. Result of oriented process

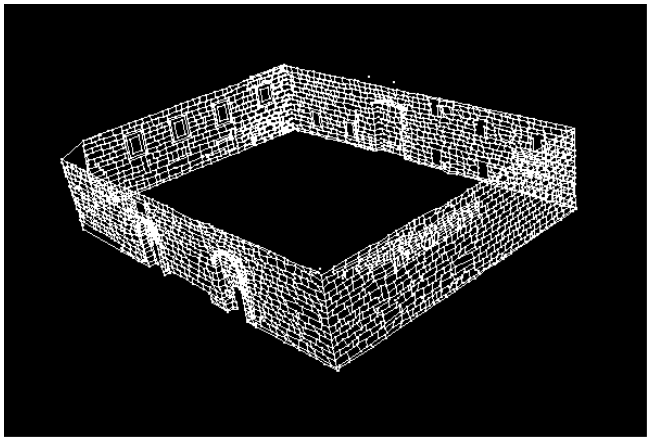

Figure 7. Güllük mosque 3D model

Figure 8. Textured model of Güllük Mosque

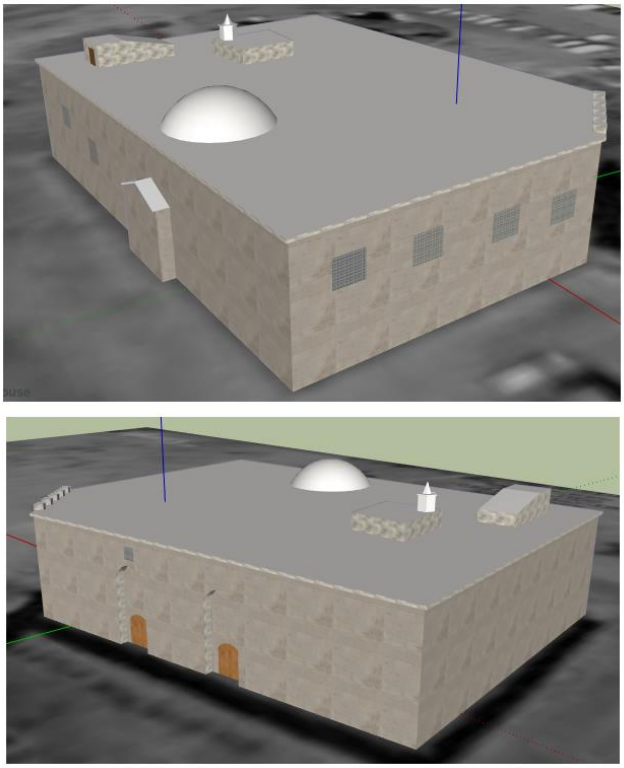

Figure 9. Adding top façades in Sketchup software

4. CONCLUSION

Cultural heritage documentation is a very important issue in terms of human history. It needs to be protected due to neglect and indifference or the destruction of a large part of these artifacts for various reasons. Creating a digital archive is of great importance in order to restore the damaged structures.

Close-range photogrammetry showing great improvement in parallel with the rapid advances in computer also effective when used in the documentation of cultural heritage and is a very efficient method. Drawing at the desired scale of the structure of cultural heritage, taking advantage of the opportunities provided by the current technology in the creation of 3D models can be made quickly and accurately by close-range photogrammetry. The original image 3D model can be obtained by adding texture data with the close-range photogrammetry method. 3D models obtained in the digital platforms are used especially in restoration works. Documentation works for the protection of cultural heritage provide great benefits in a short time and economically with the photogrammetric method.

It is impossible to model the photographs taken with the close-range photogrammetry technique because they do not have upper facades. Such deficiencies resulting from the shooting location of the camera can be corrected by taking new photos from different locations. For example, this deficiency can be overcome by using platforms that enable shooting from the air, such as unmanned aerial vehicles (UAV), which have been preferred by many disciplines recently.

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