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Application of terrestrial photogrammetry method in cultural heritage studies: A case study of Seyfeddin Karasungur

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Abstract

Since mankind began to adapt to settled life, it has established various settlements. In these areas, they have built many structures for accommodation and social activities. Some of these structures are still in use today, but most of them are waiting to be underground for various natural or unnatural reasons or have been destroyed due to indifference. Survey studies play an important role in documenting, protecting and transferring cultural heritages that have survived for centuries or that were found during archaeological excavations. The cultural heritage handed down to us from past societies must be preserved for the benefit of all. In the era of globalization, cultural heritage helps us remember our cultural diversity and its understanding fosters mutual respect and renewed dialogue between different cultures. Transferring the cultural heritage that has survived from the past to the present to the societies that will live after us, without any change in its essence, contributes both to the development of a country and to new works to be done. A country's economic growth and social progress present both challenges and opportunities for the preservation of cultural heritage. In this study, the documentation and survey sample study of Syefeddin Karasungur tomb in Konya province was carried out. For the documentation work, a 3D model of the building was obtained in terrestrial photogrammetry software with pictures taken from various angles.

1. Introduction

Cultural Heritage is an expression of lifestyles developed by a community, including its traditions, and transmitted from generation to generation, including practices, places, objects, artistic expressions and values. Cultural Heritage is generally expressed as tangible or intangible cultural heritage [1-2]. The most important examples of tangible cultural heritage are architectural works that reflect the life style of a society [3-4].

Documentation is the process of collecting and recording all information, in both written and visual form, obtained during the inspection and repair of a historical building, when necessary, especially for the purpose of documenting cultural artifacts. Documentation allows us to physically preserve a cultural object and, more importantly, it allows us to understand and infer about the past [5-6]. Documentation studies are very important in order to transfer the physical effects of the period and the cultural environment on the structure to the next generations. In addition, it helps to reflect the cultural understanding of the period to which the work belongs to today's people by documenting the cultural heritages in question [7-9]. Cultural heritage provides a great perspective on how people look at who they are in the fascinating world. In this sense, the importance of documenting cultural heritage is increasing day by day [10-12].

Documentation and survey studies are the first and most important steps in order to preserve the cultural heritage and transfer it to future generations in accordance with its originality [13-15]. A survey is the expression of the current state of the building's interior and exterior architecture, original decoration, carrier system and building materials with scaled drawings in order to closely examine and document the urban texture or archaeological remains of a building, to evaluate it in terms of architectural history, and to prepare restoration projects [16-18].

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Today, documentation of cultural assets is done quickly and reliably with the photogrammetry technique [19-21]. With the digital photogrammetric method, the documentation, presentation, protection of historical buildings, and the detection of deteriorations that may occur in the works during and after the restoration works can be determined by the conservation experts [22-24]. Another important advantage of photogrammetry is that it allows 3D representation of objects by modeling them in accordance with their originals [25-26].

With this study, the use of Photogrammetry in Engineering and Architectural studies will increase its effectiveness in current application areas in parallel with the developments in science and technology, as well as provide application opportunities in many other areas. In addition, a survey and 3D modeling of the Historic Dome was carried out with millimeter-precision measurements and terrestrial photogrammetry technique, which can serve as a basis for architecture, restoration, restitution, documentation and registration of historical monuments.

2. Method

2.1. Seyfeddin Karasungur Shrine

Emir Seyfettin Karasungur is the contemporary of Hz. Mevlana. His exact date of birth and death is unknown. He is the brother of Celaleddin Karatay, who lived in the 1200s during the Seljuk period and gave his name to the Karatay District.

Seyfeddin Karasungur established a madrasah on the site of his tomb in the current Çiftemerdiven District and was its patron for years. After the madrasa was demolished, it was built on the site of the current Karasungur Tomb. The date of his death, the architect of the tomb and the date of its construction are not known exactly.

The tomb is located in the center of Konya, at 37.874937° North latitude, 32.495539° East longitude, in Çifte Merdiven neighborhood. It is on an octagonal base, has an octagonal body and two floors, and is covered with a dome from the inside and a pyramidal cone from the outside. The main entrance door of the tomb is located on the east side, but this door has been canceled today and a new door and a window on the door has been opened on the west side. The main door, placed in a deep niche with a pointed arch, is limited by a high rectangular frame. The upper floor, which has an octagonal plan, is covered with a dome crossed with squinches. On the upper part of each façade, there is a thin and long rectangular window. There is a coffin inside. Today, it is not possible to enter the lower floor, which is completely underground. Stone, brick and marble were used as building materials in the tomb. The original door of the tomb is covered with marble. The dome, the cone, the skirt of the cone and the corners of the octagon are made of bricks. The rectangular panels on each exterior facade are covered with cut stone, arches on the windows and geometric decorations on the other surfaces are carved on the stone surfaces with the scraping technique. In the interior, the lower parts of the walls are rubble and the upper parts are brick.

Figure 1. Location map of the study area

2.2. Field study

Topcon GPT 7003i total station (Figure 2) measuring devices were used for field measurement and Nikon D5100 camera was used for photographing.

Figure 2. Topcon-gpt-7003i (url-4)

Before the field measurements in the field, the locations of the polygon points to be established around it were determined and their installation was made on the ground in order to measure the cultural heritage to be documented. The coordinates of the polygon points established in such a way that they can see each other are taken in the national coordinate system with the GNSS receiver with CORS-TR connection. By making polygon balancing with the total station on these polygon points, the measurement was continued by providing an accuracy of less than 0.5 cm. In addition, the picture of the building was taken and the reference points made on the building with the total station device were marked on the picture.

The measurement process of the study was completed in about an hour. Photographs were taken to see all sides of the building. At least 3 photographs have been taken from one side, the photographs taken are overlapped and have different shooting points. Photo shoot was completed in such a way that the focal length of the camera was fixed without zooming in.

2.3. Office Work

The values of the reference points made on the building in the project area were transferred in ncn format from the total station device, shown in Figure 2 and the properties of which are specified in Table 1. The camera used in photographing is shown in Figure 3, and the characteristics of the camera are given in Table 2. The polygon mesh is given in Figure 4. The data transferred from Totalstation was converted into txt format by Netcad 5.2 software, and the file was transferred to Photomodeler (PM) software and used to balance the pictures in a coordinated manner. The parameters of the camera were introduced to the PM software and the calibration process was carried out. For the calibration process, sample template papers were printed in A4 size in PM software. 10 photographs of the calibration paper were taken. After the calibration process, the balancing process was carried out successfully and the drawing process was started.

Table 1. Topcon-gpt-7003i features

Field of view	1 ° 30 ×
min. Focal Distance	1,3 m (4,29 ft.)
Measuring range	1,5 - 250m (5 - 820 ft.)
Measurement Display	11 steps
Laser Class	Class1 (disntaj measurement) Class 2 (Lazer Sign On)
Battery	4400 mAH
Maximum uptime	Including distance measurement: Approx. 5 hours Angle measurement only: Approx. 10 hours
Charging Time	4 hours

Figure 3. Digital Handheld Camera

Table 2. Properties of the camera

Weight	226 g
Turkish Language/ Digital Display	Yes/Yes
Video Record/ Wifi	Yes/Yes
Megapixel	14.2
Image resolution	4320 x 3240
Optical/Digital zoom	18x / Yes
Sensor width	6.16 mm
Sensor resolution width	4346 piksel
Pixel pitch	1.42 µm
Pixel density	49.78 MP / cm^2
Storage type	SD/SDHC/ SDXC

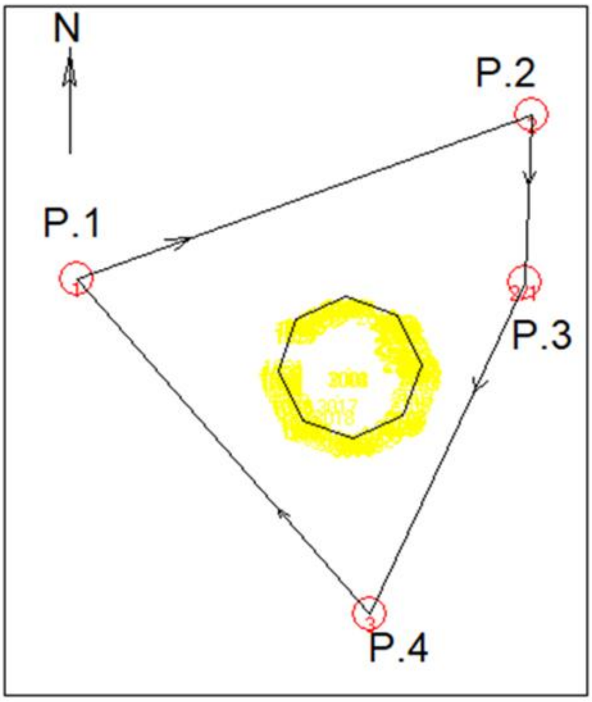

Figure 4. Polygon mesh

The top view of the drawing made from the stabilized photographs made in PM software is given in Figure 4, the front view is given in Figure 5, and the side view is given in Figure 6. After the drawing was made, the surface coating was made, given in Figure 8. In Figure 7, there is a height analysis of the building whose 3D model is made. The drawing of the main lines of the building in PM software has been completed with high precision.

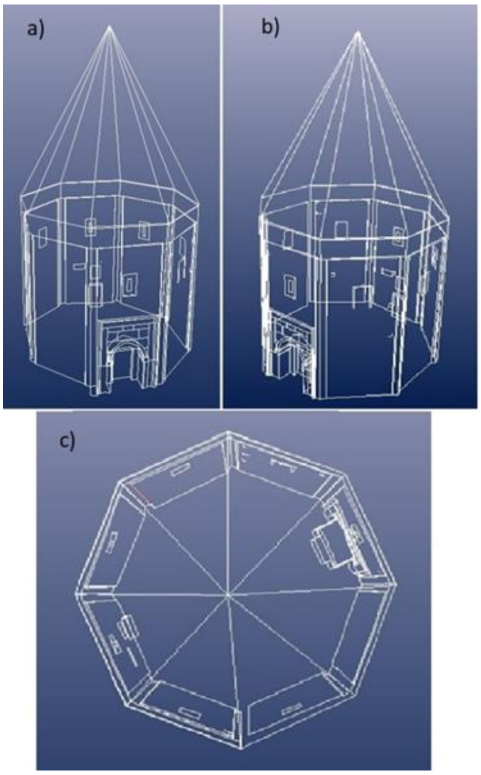

Figure 5. a) Front view of the tomb drawn in PM software, b) Side view of the tomb drawn in PM software c) Top view of the tomb drawn in PM software

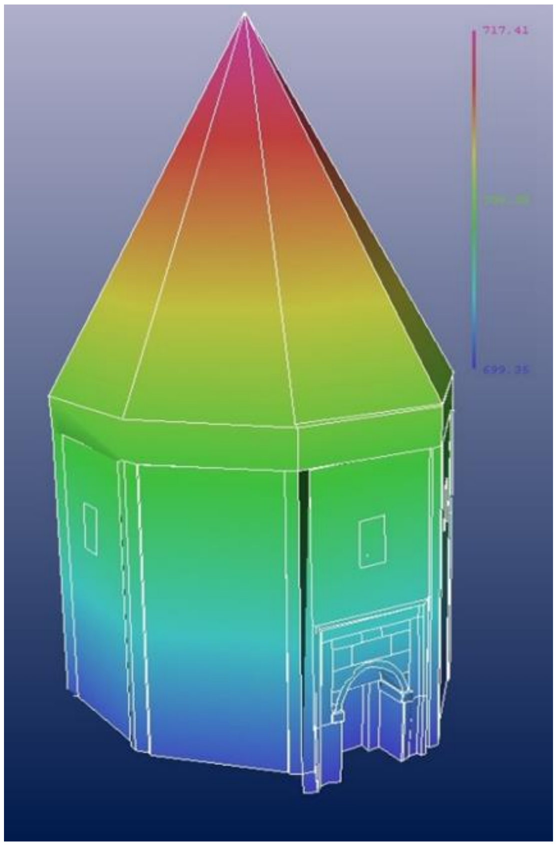

Figure 8. The height analysis of the tomb, which was drawn in PM software

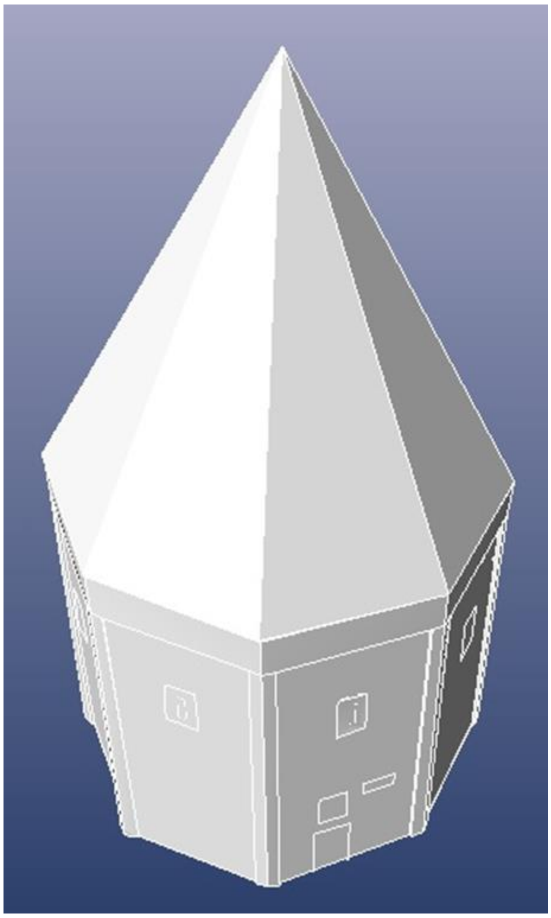

Figure 9. Surface coated view of the tomb drawn in PM software

Figure 10. Surface coated and picture dressed view of the tomb drawn in PM software

3. Conclusion

Terrestrial photogrammetry technique, which is the most effective method in documenting historical artifacts, is superior to classical methods in terms of time, cost and accuracy. The fact that field data can be collected with a simple handheld camera and that classical surveying techniques are supportive play a major role in the preference of this method. With the 3D model we created from the data obtained by this method used in the documentation of Seyfeddin Karasungur Cupola, every detail of the structure was drawn in its real size. Then, these drawings were covered with the help of photographs taken in the field, and the real image of the surface was obtained as a 3D model. Extremely sensitive measurements can be made on the model of the work and it can be easily used in restoration projects.

Author contributions

Adem Kabadayı: Literature review, Field study, Modelling, Writing; **Alperen Erdoğan:** Editing

Conflicts of interest

The authors declare no conflicts of interest.

References

1. ICOMOS (2002). International Cultural Tourism Charter. Principles And Guidelines for Managing Tourism at Places of Cultural And Heritage Significance. ICOMOS International Cultural Tourism Committee.
2. Uysal, M., Polat, N., Toprak, A. S., & Yakar, M. (2013). 3D Modeling of Historical Doger Caravansarıes by Digital Photogrammetry. Remote Sensing and Spatial Information Sciences Volume XL-5/W2.
3. Kaya, Y., Yiğit, A. Y., Ulvi, A., & Yakar, M. (2021). Arkeolojik Alanların Dokümantasyonununda Fotogrametrik Tekniklerinin Doğruluklarının Karşılaştırmalı Analizi: Konya Yunuslar Örneği. Harita Dergisi 87 (165), 57-72.
4. Yakar, M., & Yilmaz, H. M. (2008). Kültürel miraslardan tarihi Horozluhan'in fotogrametrik rölöve çalişmasi ve 3 boyutlu modellenmesi. Selçuk Üniversitesi Mühendislik, Bilim ve Teknoloji Dergisi, 23(2), 25-33
5. Ulvi, A., Yiğit, A. Y., & Yakar, M. (2019). Modeling of Historical Fountains by Using Close-Range Photogrammetric Techniques. Mersin Photogrammetry Journal, 1(1), 1-6.
6. Yakar, M., Kabadayı, A., Yiğit, A. Y., Çıkıkcı, K., Kaya, Y. & Catin, S. S. (2016). Emir Saltuk Kümbeti Fotogrametrik Rölöve Çalişmasi Ve 3Boyutlu Modellenmesi. Geomatik, 1 (1), 14-18.
7. Asri, İ., & Çorumluoğlu, Ö. (2007). Büyük Objelerde Tarihi Dokümantasyon ve Tanitim Amaçli Gpssit Destekli Digital Fotogrametrik 3b Modelleme.
8. Kabadayı, A., Yunus, K. & Yiğit, A. Y. (2020). Comparison of documentation cultural artifacts using the 3D model in different software. Mersin Photogrammetry Journal, 2(2), 51-58.
9. Ulvi, A., Yakar, M., Yiğit, A. Y. & Kaya, Y. (2020). İHA ve yersel fotogrametrik teknikler kullanarak Aksaray Kızıl Kilise'nin 3 boyutlu nokta bulutu ve modelinin üretilmesi, Geomatik, 5, 1, 22-30.
10. Şasi, A. & Yakar, M. (2018). Photogrammetric modelling of Hasbey Dar'ülhuffaz (Masjid) using an unmanned aerial vehicle. International Journal of Engineering and Geosciences, 3 (1), 6-11.
11. Yilmaz, H. M., Yakar, M., Gulec, S. A., & Dulgerler, O. N. (2007). Importance of digital close-range photogrammetry in documentation of cultural heritage. Journal of Cultural Heritage, 8(4), 428-433.
12. Yakar, M. (2011). Using close range photogrammetry to measure the position of inaccessible geological features. Experimental Techniques, 35(1), 54-59.
13. Mırdan, O. & Yakar, M. (2017). Tarihi Eserlerin İnsansız Hava Aracı ile Modellenmesinde Karşılaşılan Sorunlar. Geomatik, 2 (3), 118-125.
14. Kanun, E., Alptekin, A., & Yakar, M. (2022). Cultural heritage modelling using UAV photogrammetric methods: a case study of Kanlıdivane archeological site. Advanced UAV, 1(1), 24–33

15. Yakar, M., Yılmaz, H., Yıldız, F., Zeybek, M., Şentürk, H. & Çelik, H. (2010). Silifke-Mersin Bölgesinde Roma Dönemi Eserlerinin 3 Boyutlu Modelleme Çalışması ve Animasyonu. Jeodezi ve Jeoinformasyon Dergisi, (101).
16. Doğan, Y. & Yakar, M. (2018). GIS and three-dimensional modeling for cultural heritages. International Journal of Engineering and Geosciences, 3 (2), 50-55.
17. Şahin, İ., & Yakar, M. (2008). Farklı kaynaklardan elde edilen sayısal yükseklik modellerinin ortofoto doğruluğuna etkilerinin araştırılması. Harita Dergisi, 74(140), 45-59.
18. Alptekin, A. & Yakar, M. (2020). Heyelan bölgesinin İHA kullanarak modellenmesi. Türkiye İnsansız Hava Araçları Dergisi, 2 (1), 17-21
19. Yakar, M., & Yilmaz, H. M. (2011). Determination of erosion on a small fairy chimney. Experimental Techniques, 35(5), 76-81.
20. Yakar, M. & Doğan, Y. (2017). Mersin Silifke Mezgit Kale Anıt Mezarı Fotogrametrik Rölöve Alımı Ve Üç Boyutlu Modelleme Çalışması. Geomatik, 2 (1), 11-17.
21. Yakar, M., Yılmaz, H. M., Güleç, S. A., & Korumaz, M. (2009). Advantage Of Digital Close-Range Photogrammetry İn Drawing of Muqarnas İn Architecture'. Information Technology Journal, 8 (2), 202-207.
22. Yakar, M., & Mohammed, O. (2016). Yersel Fotogrametrik Yöntem ile İbadethanelerin Modellenmesi. Journal of Technical-Online, 15(2).
23. Kanun, E., & Yakar, M. (2021). Mobıle phone-based photogrammetry for 3D modelıng of shıp hulls. Mersin University Journal of Maritime Faculty, 3(1), 9-16.
24. Alptekin, A., Çelik, M. Ö., & Yakar, M. (2019). Anıtmezarın yersel lazer tarayıcı kullanarak 3B modellenmesi. Türkiye Lidar Dergisi, 1(1), 1-4.
25. Yılmaz, H. M., Aktan, N., Çolak, A. & Alptekin, A. (2022). Modelling Ozancık village (Aksaray) in computer environment using UAV photogrammetry. Mersin Photogrammetry Journal, 4 (1), 32-36.
26. Kaya, Y., Şenol, H. İ. & Polat, N. (2021). Three-dimensional modeling and drawings of stone column motifs in Harran Ruins. Mersin Photogrammetry Journal, 3 (2), 48-52.