



5th Intercontinental Geoinformation Days

igd.mersin.edu.tr



3D modeling of cultural heritage: Commagene Kingdom funerary monument

Cem Erol*¹, Nizar Polat²

¹Harran University, Engineering Faculty, Department of Surveying Engineering, Sanlıurfa, Türkiye

²Harran University, Engineering Faculty, Department of Photogrammetry, Sanlıurfa, Türkiye

Keywords

Cultural Heritage
3D Modelling
Photogrammetry

Abstract

Our historical and cultural assets are undergoing deformations day by day. With today's technology and science, these historical structures can be processed and stored in three dimensions. These three-dimensional data; It provides the opportunity to work without damaging the architectural texture of the building during the visualization, restoration works and reproduction phases. Historical buildings have a significant contribution to the city's economy. These contributions are; It can keep the city economy alive for many reasons such as visiting that historical building, staying in the city, tasting the food culture of that region, shopping. One of the most important factors is to make a project that will attract the attention of domestic and foreign tourists in order to introduce our cultural assets by presenting them in digital environment for individuals who will not be able to visit those historical structures and to make them a center of attraction. In this study, a 3D (three-dimensional) model of this artifact was obtained with 60 photographs taken by the terrestrial photogrammetry method in the Karakuş Tumulus of Adıyaman Province, Kâhta District, with approximately 3.5 million point clouds, and it was possible to present it in digital environment.

1. Introduction

Historical artifacts are cultural heritages that host hundreds of years of information, and this information should be passed on to future generations. While these historical heritages reflect the lifestyle and aesthetic understanding of the ancient civilization; They have changed over time due to natural and artificial effects such as wars and earthquakes. Documenting and preserving the natural texture of historical artifacts without damage is an indispensable element for transferring them to future generations (Varol et al. 2021). It is a fact that cultural heritage is damaged not only in our country but also in many parts of the world. For this reason, the documentation of cultural heritage is among the popular topics all over the world (Polat et al. 2021).

Documenting historical sites and cultural heritage is a complex and multifaceted process. Documentation of a historical or cultural building includes all the steps of study, process, storage and presentation necessary to determine the current state (shape and location) of the building in three-dimensional (3D) space. There are

several techniques for documenting cultural heritages. Photogrammetry and scanning methods are at the forefront of these very important and necessary techniques. At this point, it is a great advantage that photogrammetry can provide reliable information in a short time (Polat et al. 2021).

Today, documentation of cultural assets is done quickly and reliably with photogrammetry technique. 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. Another important advantage of photogrammetry is that it allows 3D representation of objects by modeling them in accordance with their originals (Uslu et al. 2016).

Cultural heritages are in danger of extinction due to natural or human reasons (Cömert et al. 2012; Tercan, 2017). As technology advances and human beings do more detailed studies on science, the interest in these unique areas and structures increases and the studies to protect them are developing day by day. One of the most

* Corresponding Author

(cemerol0234@gmail.com) ORCID ID 0000 - 0001 - 8781 - 1890
(nizarpolat@harran.edu.tr) ORCID ID 0000 - 0002 - 6061 - 7796

Cite this study

Erol, C., & Polat, N. (2022). 3D Modeling of Cultural Heritage: Commagene Kingdom Funerary Monument. 5th Intercontinental Geoinformation Days (IGD), 156-159, Netra, India

important studies that emerged as a result of these developments is the documentation of cultural artifacts. Different and many techniques have been used for many years to document and digitize historical artifacts, but no technique used so far has offered more practical solutions than taking photographs (Ulvi et al. 2019; Şasi and Yakar 2017). For this reason, it is very important that the cultural heritage values that can survive, cannot be reproduced, and cannot be returned should be documented in a non-destructive way down to the smallest point (Hamal et al. 2020; Kanun et al., 2022).

In this study, the 'Lion Statue', which was destroyed over time and detached from its column, in the Karakuş Tumulus located in the borders of the Kâhta District of Adıyaman Province, was modeled in three dimensions by making measurements with the terrestrial photogrammetric method.

2. Method

Information about the study area, the equipment used and the methodology are explained in this section. The characteristics of the camera used in the study are given.

2.1. Study Area

Karakuş Tumulus located in Adıyaman Province, Kahta District has been determined as the study area.

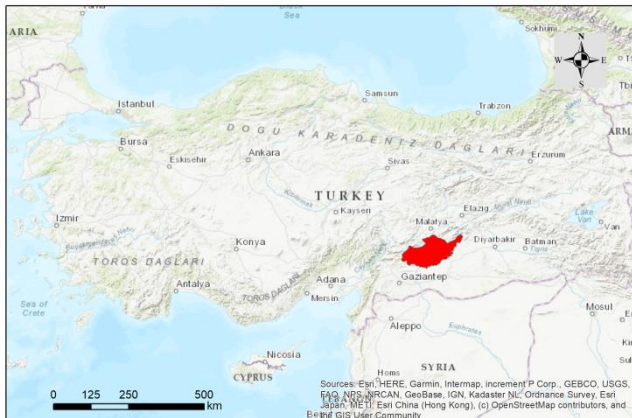


Figure 1. Study area

Karakuş Tumulus is a mausoleum belonging to the Kingdom of Commagene, whose history dates back to the 1st century BC. Eagle on the column in the south, Lion and Bull on the columns on the east, and a mausoleum belonging to the Commagene Kingdom family on the column on the west (1st century BC). Although four columns were built in the east, west and south directions, only 4 columns remain today. Two of them are in the East and one is in the West. Karakus is located in the south (Internet Source).

Since there is no information about the lion head statue found in the study, it was not mentioned. The visual of the lion head sculpture is shown in Fig. 2.

Canon EOS 2000D camera with 24.1 mega pixels, 6000*4000 maximum image resolution and 475 g weight was used in the study.



Figure 2. The image of the Lion Sculpture



Figure 3. The digital camera used in the study

2.2. Using photogrammetric methods in 3D modeling of cultural heritage

Photogrammetry means measuring with the help of photographs. Photogrammetry is a branch of science in which reliable information about objects and the environment is obtained as a result of recording, measuring and interpreting the photographic images shaped by the rays emanating from the objects and the environment they form, and the electromagnetic energy they emit (Senol et al. 2021).

Classical two-dimensional photogrammetric applications are insufficient for many applications. For this reason, the three-dimensional calculation, questioning, analysis, simulation and visualization of the geographical area have gained importance. With today's CAD technology, a perspective view of a geographical area can be obtained, three-dimensional visualization is possible, it is possible to fly over the land in the virtual environment and to wander around the city (Uslu et al. 2016).

In digital photogrammetry, sequential and overlay images must be taken from different stations in order to obtain three-dimensional data and achieve high accuracy. In order to realize this condition, it is necessary to design the camera layout well and to choose the most suitable mathematical model for the operation. In addition, reaching high measurement accuracy, how many cameras can be placed, called camera network design, where and how, the number of control points on the object and how their positions

should be, are provided by using the appropriate optimization method (Uslu et al. 2016).

Photogrammetry is divided into branches by terrestrial and aerial photogrammetry methods. These methods have advantages and disadvantages relative to each other. In terrestrial photogrammetry, the objects are equipped with a denser point cloud, since the overlapping ratio is higher with the images taken consecutively, and thus the zoomed and zoomed model can be viewed with better quality. However, aerial images are needed because images of high-rise buildings cannot be taken with terrestrial photogrammetry. Roof, minaret, etc. with aerial images. Measuring tall buildings has become easier.

In addition to documenting with traditional methods, today unmanned aerial vehicles, terrestrial photogrammetry, laser scanning, etc. techniques are developing (Yakar et al., 2015; Şenol et al., 2020; Karataş et al., 2022). Although laser scanning, GPR (Ground Penetrating Radar), aerial photogrammetry, model creation with classical measurement methods etc. for the detection and documentation of archaeological sites. In this study, historically important objects extracted from archaeological sites were modeled with terrestrial photogrammetry technique (Polat et al. 2020; Alptekin & Yakar, 2021).

3. Results

In order to model the historical building in three dimensions, 62 photographs were taken around the model as overlay. Two of these photographs were not considered appropriate, so they were not processed. Processing of the photos was carried out in Agisoft PhotoScan software. Agisoft Photoscan; It is a software that provides fast, reliable and quality results in image processing and works with an interface that offers ease of operation.

Three-dimensional models were produced with point cloud, compacted dense point cloud and texture overlay by processing the photographs of the working area. Approximately 3.5 million points were produced in the model, which was textured with the terrestrial photogrammetry technique. In Figure 2, the image with texture coating is given, and in Figure 3, the image of the solid model.

The study area was visited before noon, and attention was paid to produce a smooth model by combining the common details in each photograph so that the image becomes clear without being exposed to sunlight and the model produced has a void-free structure.

4. Discussion

The study has many important contributions in terms of the tourism sector. Considering these contributions, it can be a guide for future studies. First of all, many destroyed, forgotten or neglected cultural heritage artifacts can be brought back to life by performing the most accurate restoration works with 3D modeling techniques and offered to the service of tourism sector stakeholders. In addition, virtual tours can be made around and inside cultural structures with

the most realistic 3D modeling. 3D applications in cultural heritage sites will help visitors improve their learning experiences by visualizing historical events in their minds. Thus, it will be possible to contribute to tourist guides and virtual museum applications for tourists

Unfortunately, as a guide model that will lead and guide these studies is not undertaken in our country, our cultural heritage cannot be recorded sufficiently and sufficient preliminary studies cannot be carried out in restoration works. Only with this study and similar studies, virtual museology is becoming widespread and digital archiving of historical artifacts is carried out.



Figure 4. The image of the Lion Sculpture in the study area in the raw dataset

5. Conclusion

In this study, the modeling of the lion head statue in the Karakuş Tumulus was carried out by terrestrial photogrammetric method. The digital record that emerged as a result of the modeling will contribute both to the digital recording of the works and to the creation of the virtual museum archive.

With the protection of the lion head sculpture in the study, it will provide the opportunity to work on the sculpture sensitively in case it deforms in the following years, or it will be possible to reproduce it with a model to be taken from the digital archive in case the sculpture is destroyed.

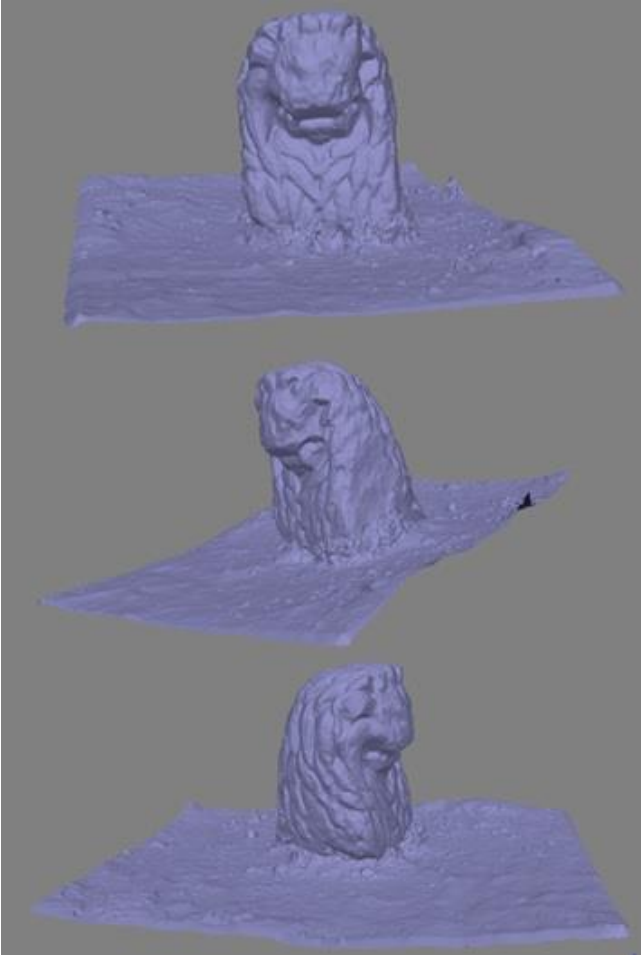


Figure 5. Image of 3D solid model obtained in Agisoft Photoscan software

References

- Alptekin, A., & Yakar, M. (2021). 3D model of Üçayak Ruins obtained from point clouds. *Mersin Photogrammetry Journal*, 3(2), 37-40.
- Cömert, R., Avdan, U., & Şenkal, E., (2012). İnsansız Hava Araçlarının Kullanım Alanları ve Gelecekteki Beklentiler. IV. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu (UZAL-CBS 2012), 16-19, Zonguldak.
- Hamal, S. N. G., Sarı, B. & Ulvi, A. (2020). Using of Hybrid Data Acquisition Techniques for Cultural Heritage a

- Case Study of Pompeiopolis. *Türkiye İnsansız Hava Araçları Dergisi*, 2(2), 55-60.
- Kaya, Y., Polat, N., Şenol, H. İ., Memduhoğlu, A., & Ulukavak, M. (2021). Arkeolojik kalıntıların belgelenmesinde yersel ve İHA fotogrametrisinin birlikte kullanımı. Harran Üniversitesi, Mühendislik Fakültesi, Harita Mühendisliği Bölümü, Şanlıurfa, Türkiye.
- Kanun, E., Alptekin, A., Karataş, L., & Yakar, M. (2022). The use of UAV photogrammetry in modeling ancient structures: A case study of "Kanytellis". *Advanced UAV*, 2(2), 41-50.
- Karataş, L., Alptekin, A., Kanun, E., & Yakar, M. (2022). Tarihi kârgir yapılarda taş malzeme bozulmalarının İHA fotogrametrisi kullanarak tespiti ve belgelenmesi: Mersin Kanlıdivane ören yeri vaka çalışması. *İçel Dergisi*, 2(2), 41-49.
- Polat, N., Önal, M., Ernst, F. B., Şenol, H. İ., Memduhoğlu, A., Mutlu, S., Mutlu, S. İ., Budan, M. A., Turgut, M., & Kara, H., Harran Ören Yeri Arkeolojik Kazı Alanınının Çıkarılan Bazı Küçük Arkeolojik Buluntuların Fotogrametrik Olarak 3B Modellenmesi. E-ISSN: 2687-6590
- Polat, N., Önal, M., Kaya, Y., Memduhoğlu, A., Kaya, N., Ulukavak, M., Mutlu, S. İ., & Mutlu S. (2021). Harran Ören Yeri Kazısında Bulunan Kabartma Yazıların Üç Boyutlu Olarak Modellenmesi. *BEÜ Fen Bilimleri Dergisi* 10 (2), 594-601, 2021.
- Şasi, A., & Yakar, M. (2017). Photogrammetric modelling of sakahane masjid using an unmanned aerial vehicle. *Turkish Journal of Engineering*, 1(2), 82-87.
- Şenol, H. İ., Yiğit, A. Y., Kaya, Y., & Ulvi, A. (2021). İHA ve yersel fotogrametrik veri füzyonu ile kültürel mirasın 3 boyutlu (3B) modelleme uygulaması: Kanlıdivane Örneği.
- Ulvi, A., Yakar, M., Yiğit, A. ve Kaya, Y. (2019). The Use of Photogrammetric Techniques in Documenting Cultural Heritage: The Example of Aksaray Selime Sultan Tomb. *Universal Journal Of Engineering Science*, 7(3), 64-73. doi: 10.13189/ujes.2019.070303
- Uslu, A., Polat, N., Toprak, A. S., & Uysal, M., (2016). Kültürel Mirasın Fotogrametrik Yöntemle 3B Modellenmesi Örneği. e-ISSN: 1309-3983
- Varol, F., Yiğit, A. Y., & Ulvi, A., (2021). Kültürel Mirasın Dijital Ortamda 3B Arşivlenmesi: Magoki Attar Cami Sanal Model Örneği
- Web, Karakuş Tümülsü Tarihi. <https://www.azbibak.com/karakustumulusu->
- Yakar, Murat, Orhan O., Ulvi, A., Yiğit, A. Y., & Yüzer, M. M., "Sahip Ata Külliyesi Rölöve Örneği." TMMOB Harita ve Kadastro Mühendisleri Odası 10 (2015).