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Modeling of Adamkayalar Reliefs with current techniques

İldeniz Leyla Öztürk¹, Mehmet Özgür Çelik¹, Erkan Baygöl²

¹Mersin University, Engineering Faculty, Geomatics Engineering Department, Mersin, Turkey

²Geomatics Engineering, Ankara, Turkey

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ABSTRACT

Throughout history, many civilizations with different ethnic and national values have lived in Anatolia. In many parts of Turkey's possible to encounter this civilization's cultural heritage. Cultural heritages in the world; Until today, it has been affected by natural events such as earthquakes, floods and fire. These have been completely or partially destroyed as a result of human activities. Cultural heritage is very precious to people and assurance. Quick and practical documentation is of great importance to this. Various methods are used for this documentation process. Among these methods, terrestrial laser scanning (TLS) and Unmanned Aerial Vehicle (UAV) photogrammetry are frequently preferred techniques in recent years. Both methods ensure recording cultural heritages and producing 3D realistic models. It is not always easy to collect data in places with cultural value because of their historical importance and location. At this juncture, the use of terrestrial laser scanners and UAVs makes an important contribution to the documentation of cultural heritage. This study aims to examine the Adamkayalar reliefs, by using TLS and UAV photogrammetry. By processing the data obtained from both methods, a 3D model of the study area was produced and the results were evaluated.

1. INTRODUCTION

Anatolian geography, which has hosted many different civilizations and cultures throughout history, contains numerous and unique heritages with historical, socio-economic and cultural values. It is extremely important to protect these cultural heritages, which offer clues about the life, traditions and customs of past societies. Studies conducted in recent years have focused on this issue in Turkey (Ulvi et al. 2020; Ulvi and Yiğit 2019; Çelik et al. 2019; Yakar et al. 2021). Within this scope, legislation has been created by taking into account the opinions and professional experiences of experts.

Efforts to identify, register, manage and preserve these cultural heritage works that mirror the past have gained momentum. Documentation has an important place in protecting cultural heritage and transferring it to future generations.

Documentation studies were done by traditional methods in the past, whereas today, terrestrial photogrammetry (Peña-Villasenín et al. 2017; Alshawabkeh and Haala 2004). Unmanned Aerial Vehicle (UAV) photogrammetry (Ulvi et al. 2019; Peña- et al. 2017; Döner et al. 2014; Westoby 2012; Bewley 2003),

terrestrial laser scanning (TLS) method (Çelik et al. 2020; Noor et al. 2018; Baik 2017; Dore et al. 2015; Rütther et al. 2009; Doneus et al. 2008; Lambers et al. 2007; Freitas et al. 2007; Robson et al. 2001 and together (Lambers et al. 2007; Luis Lerma et al. 2010; Al-kheder et al. 2009; Yastikli 2009) modern techniques are preferred (Yakar et al. 2021).

In the study, the TLS method was preferred primarily because it provides a fast and high-resolution method and it allows the effective creation of surface geometries of cultural heritage elements (Deniz et al. 2017; Ulvi and Yakar, 2014; El-Hakim 2001; Barber et al. 2001). Scans were carried out in order to produce a 3D model of the Adamkayalar relief. Secondly, In addition to the YLT method, UAV photogrammetry was used. Photographs of the reliefs in different areas in the region were taken with UAV overlapping. The 3D model of the heritage was produced by processing the data obtained from both methods.

2. STUDY AREA

The working area, Adamkayalar BC. third century. and the fourth century AD. It is one of our cultural

* Corresponding Author

^{*}(mozdurcelik@mersin.edu.tr) ORCID ID 0000-0003-4569-888X
(ildenizleylaa@gmail.com) ORCID ID 0000-0003-0598-9316
(ebaygul@gmx.com) ORCID ID XXXX-XXXX-XXXX-XXXX

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heritages, which is thought to have been built in the period between 6th and 15th. It is located in Şeytan Deresi Valley, which is approximately 5 kilometers away from Kızıkalesi District of Mersin Erdemli district (Kulturportali 2020). The archaeological ruin known as Adamkayalar, which consists of large reliefs, is one of the important cultural heritage of Mersin city (Figure 1).

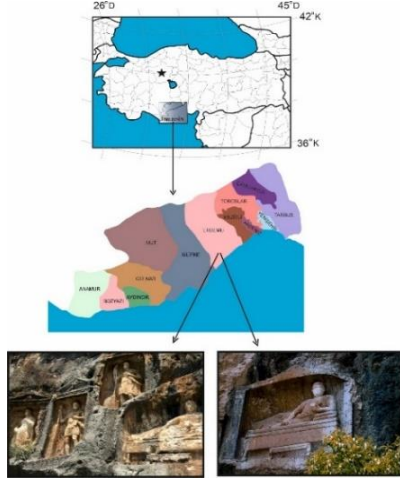


Figure 1. Study area

3. METHOD

Terrestrial photogrammetry has been used in 3D modeling of historical artifacts for many years, but it is insufficient alone (Uslu and Uysal 2017; Chandler et al. 2007). In this study, 3D modeling of Adamkayalar reliefs, one of the national assets, was carried out by using YLT and UAV photogrammetry in the documentation of historical artifacts that are cultural assets.

3.1. Terrestrial Laser Scanning (TLS)

The technique in which any object is scanned with the help of LIDAR (Light Detection and Ranging) technology is called laser scanning method (TLS). This technology is used in many fields such as cultural heritage recording, engineering projects and so on.

In this study, Faro focus^s 350 instrument was used as a terrestrial scanner. This device works according to the phase comparison method.

In the phase comparison method, the length of the object and the device is found by the phase difference between the reflected and emitted waves. The mathematical interpretation of the method is shown in Equation 1.

$$D = \frac{c \cdot \theta}{4\pi f} \quad (1)$$

*D: distance between device and object

**c: speed of light,

***f: frequency

****θ: phase difference

3.2. UAV Photogrammetry

Today, in photogrammetry, the Structure from Motion (SfM) technique is mostly used in UAV photogrammetry (Saritürk and Şeker 2017; Furukawa and Hernández 2013; westoby et al.2012). SfM is a method that aims to create a three-dimensional (3D)

model from photographs taken with two-dimensional (2D) overlays (Snaveley 2008; Dellaert et al. 2000). The main purpose of the method is 3D model production (Çelik et al.2020).

The SfM technique was preferred in the study due to its various features and advantages in creating 3D models. With the development of technology in the documentation and permanent documentation of cultural heritage, the 3D model has become a powerful option. In this context, aerial photos were taken with the SenseFly eBee UAV in order to obtain general information about the historical place. Images were taken by the Parrot Anafi UAV to better reveal the details of this work.

From these images obtained by UAV with different hardware and features, the 3D model of the work was created in the Agisoft Photoscan program, a commercial software using the SfM algorithm.

4. RESULTS

First of all, the LLS method, which is a fast and high-resolution technique and has become widely used in the documentation of cultural heritage assets, was preferred. 8 scans were carried out around the Adamkayalar reliefs with a local laser scanner (TLS) at suitable seating places. A land survey was made before the study in determining the residence locations. Care has been taken to ensure that the reliefs appear at the optimum level and have common details with the next scan. The data were transferred in Faro Scene software, where laser scanning data can be processed and used in 3D model production. The point cloud of the study area was created and a 3D model was produced from this point data set (Figure 2).



Figure 2. (a), (c) Point cloud obtained by TLS method (b), (d) 3D model.

As the second method; UAV photogrammetry was used together with the LLT method in order to make the 3D model more detailed. Two different UAVs were used in this method. First of all, the aerial (70 m height) images were taken with the eBee device in order to examine the study area as a whole and to obtain general information about the area. Then, photos were taken manually with the Parrot device in order to create clearly the facade and details of the reliefs in the 3D model. By processing the data obtained by both tools, point clouds and photo-

realistic 3D models of the heritage were produced (Figure 3, 4).

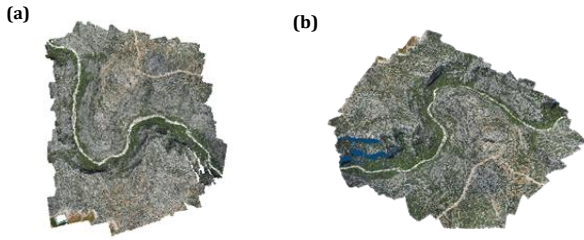


Figure 3. (a), (b) Point cloud obtained with SenseFly eBee UAV

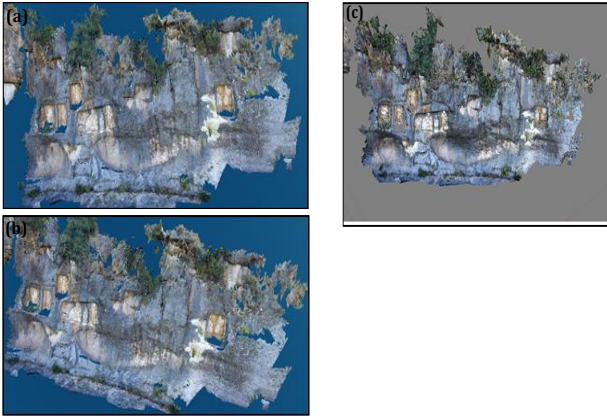


Figure 4. (a), (b) Point cloud obtained by Anafi Parrot UAV (c) 3D model

5. DISCUSSION AND CONCLUSION

The study area is the Adamkayalar relief, which has historical, sociological and cultural significance. In this heritage work, YLT and UAV photogrammetry methods, which have become widespread in documentation processes in parallel with the developing technological advances, were used. Although these techniques have advantages and disadvantages, each has its strengths.

With the work carried out, the positive and negative aspects of the techniques were tried to be determined. YLT method provides fast, high quality and resolution data in close range. In addition, accuracy and precision are extremely high. Although the positive features of this method are dominant, it also has some disadvantages. This method alone is insufficient for factors such as the relatively large size of the work or structure to be documented and the difficulty of access to the region.

The UAV photogrammetry method provides the opportunity to measure at close or far distances, without reaching the object. 3D model can be obtained directly or by means of point clouds by taking photographs of the object with overlapping. Within the framework of these features, this method can be used alone or in combination with different methods in the documentation of cultural heritage. This technique also has negative aspects. While the aerial view of the work to be modeled can be obtained easily, in some cases, facade photographs cannot be obtained properly. This problem causes the side surfaces and details to not be fully formed in the model of the work. In addition, it is not always

possible to benefit from UAV photogrammetry due to factors such as the geography and geopolitical location of the study area

In the study, different methods were applied, measurements were made, and photo-realistic 3D models of the field were produced in a hybrid way. In this way, a permanent document belonging to the working area has been created. The historical work of this document; It is predicted that it will contribute to the transmission, protection, documentation and management of future generations. In addition, it is highly possible to use the 3D model as a base for possible interventions to the work. It is assumed that this study is important for adding this historical region bearing the traces of past cultures and civilizations to the national heritage records and can set an example for other similar studies.

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