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3D modeling of a stone sarcophagus at Kanlıdivane Ruins

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Abstract

Türkiye has a wide cultural heritage inventory. Many historical monuments have survived until today without being damaged. However, these historical monuments are destroyed due to natural and human reasons. In order for these works to regain their original state after being worn out, their current condition must be modeled in three dimensions (3D) in a computer environment. In this study, photographs of a sarcophagus, made of stone material, located in Mersin Kanlıdivane Ruins were taken with a mobile phone. Using the photographs obtained, a 3D model of the sarcophagus was created on a computer. The 3D model created can be used both to promote the region in tourism and to restore the sarcophagus when it is damaged in the future.

1. Introduction

Türkiye has hosted many civilizations throughout history. These civilizations have left us many cultural heritages. It is our duty to protect, promote and transmit these heritages to future generations. The original structure of historical monuments is damaged by the materials used, climate, natural disasters, air pollution and the influence of people.

The petrographic and physical properties of the material used affect the life of the structure (Karataş et al. 2022a). The amount of protein, fat, salt and CaCO₃, pH value and the ratio of other minerals affect the life of the structure. Physical properties such as loss of ignition, sieve analysis and compressive strength also affect the life of the structure.

The climate of the region, with dry summers and very rainy winters, creates temperature differences on the stone structure. It also causes the salt and moisture in the stone structure to penetrate deeper. In addition, water causes chemical reactions in the stone structure and the development of living things such as fungi and algae.

Natural disasters such as earthquakes, landslides, rock falls and floods have a negative impact on historical buildings. Gaziantep Castle was damaged due to the 06 February Maraş earthquakes (Karataş et al. 2023).

Air pollution creates surface pollution on stone material and causes color change. Factors such as fire, car exhaust and coal stoves cause air pollution.

The unconscious actions of people in the region and the unconscious excavations of treasure seekers have a negative impact.

In this study, a 3D model of the current version of a sarcophagus located in Kanlıdivane was created. Many studies have been carried out on the ruins of Kanlıdivane.

Karatas et al. (2022b) examined the surface degradation of the Aba mausoleum using unmanned aerial vehicle (UAV) photographs. They found that surface contamination, color change, fracture formation, joint deterioration, plant growth, peeling and piece breakage were observed. They stated that UAV photogrammetry is extremely useful in determining surface degradation.

Alptekin et al. (2019) created a 3D model of a mausoleum located in Kanlıdivane Ruins with high resolution and precision using a terrestrial laser scanner (TLS).

Kanun et al. (2022) created a 3D model of a village house in Kanlıdivane Ruins using UAV photogrammetry. The lengths of the village house have been determined.

Kanun et al (2021) created the 3D model of the Aba Mausoleum in Kanlıdivane Ruins using UAV photogrammetry. The length dimensions of the Aba mausoleum have been determined.

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2. Study Area

There are many archaeological sites in Mersin province, which is characterized by the typical Mediterranean climate (Alptekin and Yakar 2021). One of the most important among these is Kanlıdivane Ruins located in Erdemli District (Figure 1). There are churches, mausoleums, tombstones, sarcophagi, oil production areas, stone reliefs and a large sinkhole in the ruins, which was an important city of the Olba Empire. The ruins inform us about the religious beliefs and lifestyles of people who lived in the past.

Natural stone, the oldest building material, is observed in many historical buildings. Historical stone structures that carry the living spaces and beliefs of past societies are constantly deteriorating due to environmental and human-related reasons. These stone structures, which are representatives of cultural heritage, need to be protected to be passed on to future generations. The properties of the material in the internal structure of the stone and environmental factors cause the stone material to deteriorate.

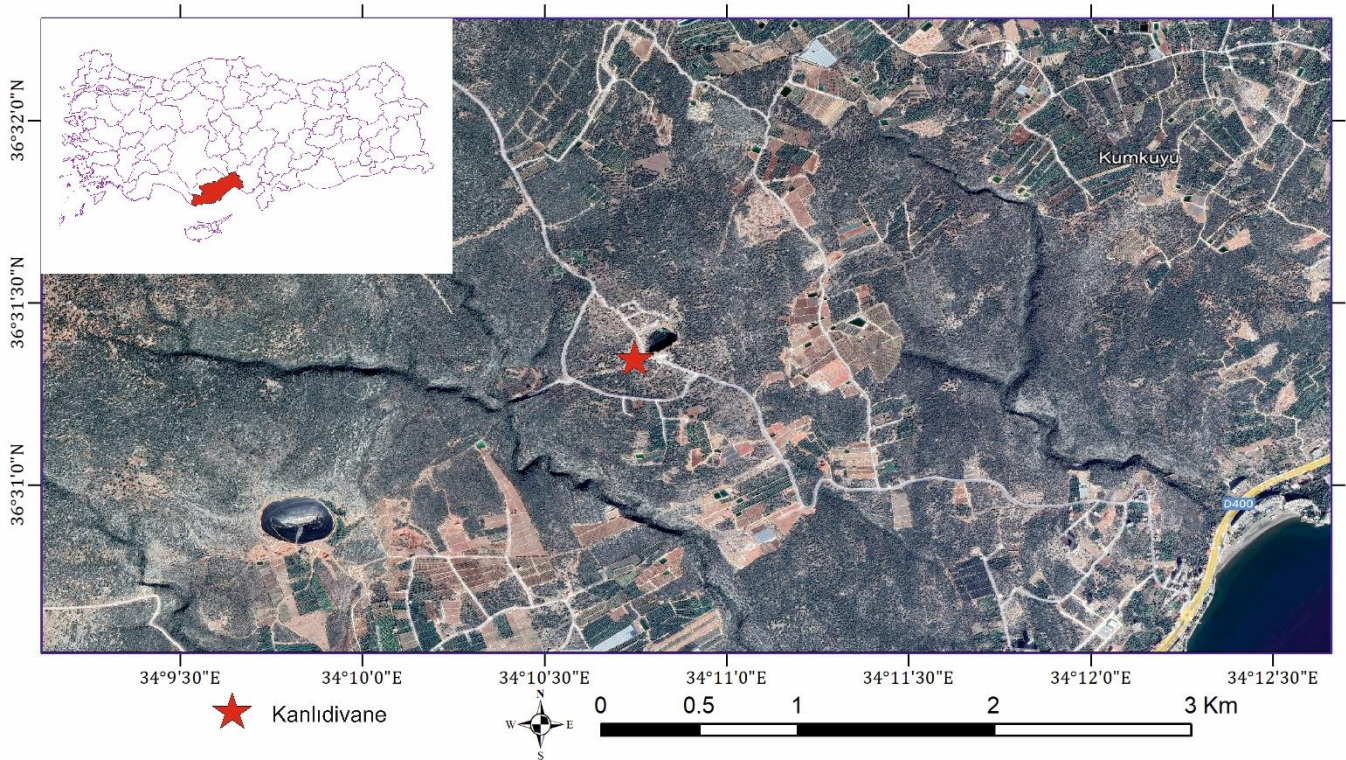


Figure 1. Location map of the study area

3. Method

Remote sensing methods allow us to model objects without damaging them. Unmanned aerial vehicles (UAV) and terrestrial laser scanners (TLS) enable objects to be displayed in detail and with high resolution and precision in a computer environment with the point clouds they obtain.

Karataş and Alptekin (2022) have used photogrammetry, visual inspection and TLS to determine the deteriorations in a stone historical building. They suggested restoration proposal for the historical structure.

The photogrammetry method is becoming widespread in cultural heritage studies because it is practical and economical. With photogrammetry, pictures of the works can be taken in high resolution. In this way, the fine details in the work can be seen clearly. By taking images of historical artifacts as overlays, a 3D model can be created from 2D images.

Pictures of a sarcophagus made of stone material found in Kanlıdivane Ruins were taken with a Samsung Galaxy S10 smartphone. The images were modeled in the

Agisoft Metashape program. The 3D model of the object has been obtained (Figure 2).

4. Results and Discussion

Known for its strength and durability, the stone was frequently used in ancient times. The cultural heritage consisting of stone materials undergoes various deteriorations over time. The corrosive effect of rainwater and sunlight has been identified in many studies.

Point cloud technology is frequently used in engineering projects. It has been used in determining pond volume (Alptekin and Yakar, 2020), landslide area modeling and mapping (Kuşak et al. 2021), rockfall area modeling (Alptekin et al. 2019), coastal line determination (Unel et al. 2020) and cultural heritage studies (Alptekin and Yakar, 2021).

For the restoration of historical buildings, it is necessary to determine their physical, chemical and mechanical properties as well as their visual models.



Figure 2. 3D model of the stone sarcophagus

5. Conclusion

It can be seen that even the types of material problems can be detected based on the smallest detail. It shows that, as a result of exposure to climate-induced sun and water effects, color change and surface loss and deterioration on the stone surfaces have reached advanced levels. Restoration methods should be attempted to stabilize deterioration and replace the most deteriorated stones. It is recommended to use water-repellent surface coatings to protect natural stone, especially against the intense effects of water on the structure.

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