Advanced Engineering Days

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Modeling of the historical monument with mobile phone-based photogrammetry method

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Cite this study: Yiğit, A., Y., & Yakar, Y. (Year). Modeling of small-scale sculptures with mobile phone-based photogrammetry method. Advanced Engineering Days, 6, 97-99

Keywords
Cultural heritage
Photogramemtry
Mobile-phone
3D

Abstract

Efforts to obtain accurate and healthy data in the documentation of cultural heritages have led to the emergence of new techniques in the field of documentation. With the developing technology, traditional methods have left their place for modern documentation techniques, and this has allowed documentation techniques to progress rapidly. One of these developing techniques is the photogrammetry technique. With the photogrammetry technique, in digital documentation, a detailed examination of a structure with limited or complex access and 3D models of the elements can be obtained. The basic material of the photogrammetry technique photographs. All cultural artifacts should be documented digitally and photogrammetry is one of the best methods. In this study, a small-scale historical monument was photographed with a mobile phone camera and documented by the photogrammetry method.

Introduction

Cultural heritages are generally historical buildings, modern structures, bridges, statues, monuments, etc., that constitute the wealth of a place and its population due to its historical, cultural, and artistic significance [1-6]. It is defined as a set of related entities such as the Conservation and restoration of cultural heritage including the preservation of historical buildings using new technologies to preserve their original condition for as long as possible and to pass this knowledge on to future generations. Often, geometric research is associated with tracing and documenting heritage [7]. The protection of cultural heritage objects is a complex and multidisciplinary activity. A large number of cultural heritage studies are obtained by monitoring the risks to which a cultural heritage property may be exposed, or by recommendations on preventing or minimizing damage. Therefore, although the degree of importance of these works is a criterion, each work must be documented. Recently, experts in the documentation of cultural heritage have made various studies in the documentation of historical artifacts with photogrammetric applications [8]. When the literature is reviewed, studies on the documentation of cultural heritage generally stand out as the production of photogrammetric 3D or 2D models of the exteriors of buildings with different approaches [9-15]. However, there are few studies on the documentation of small works of historical importance. With the photogrammetry technique, in digital documentation, a detailed examination of a structure with limited or complex access and 3D models of the elements can be obtained. The basic material of the photogrammetry technique photographs. In this study, a column base was modeled in 3D from photographs obtained by photogrammetry using a mobile phone camera.

Material and Method

In photogrammetry, the 3D coordinates of points on an object's surface are determined by the camera positions and external orientation parameters of the overlapping images. External orientation parameters can be calculated if the overlapping images have at least three control points. Internal orientation parameters have to be known

beforehand, but thanks to new algorithms such as Structure from Motion (SfM), the necessity of knowing internal orientation parameters is eliminated with the self-calibration technique. Thanks to SfM algorithm-based photogrammetric software, 3D modeling and reconstruction of surfaces from photographs taken with conventional cameras have become quite easy. SfM; A photogrammetric technique or algorithm that automatically solves the geometry of the scene, camera positions, and orientation without requiring pre-definition of a target mesh with known 3D positions. SfM is a measurement method based on computer visualization techniques; With the use of digital cameras, video cameras, or smart phones with cameras in this area, it has gained popularity with its frequent use in various studies by many disciplines. For this reason, its use in scientific research has become very common and has had a transformative effect on earth science research due to its low cost, extremely fast results, and easy 3D measurement capability. In the SfM method, a series of overlapping picture frames are used to create 3D structures. It works by finding and matching commonalities across a series of overlapping photos. This study has tried to document a monument of historical importance with the methods of close-range photogrammetry. In total, 41 images were collected. The photos were taken with a mobile cell phone camera with a resolution of 12 megapixels (Table 1). The 3D model of the monument was made with the Agisoft Meteshape software.

Table 1. Smartphone camera specifications

Parameters	Value
Focal length	27 mm
Aperture	F1.8
Camera Resolution	12 MP - 1.25µm
Number of pixels	16 Million

Results

In the study, as shown in Figure 1, photographs were taken as superimposed and 360 degrees around the work. Overlay ratios are set completely manually.

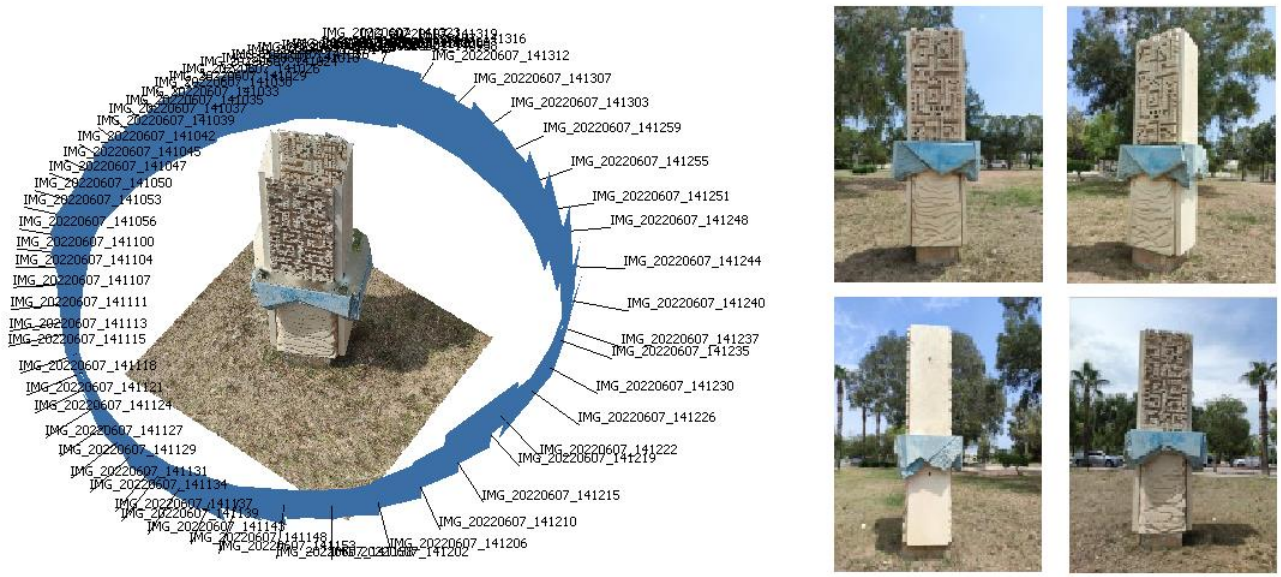

Figure 1. Photograph capturing method and sample photos

Then the photos taken were transferred to the software. First, a sparse point cloud was produced by applying the self-calibration method and the images were aligned. Then, a dense point cloud was created with the SfM algorithm (Figure 2/a). Finally, the 3D Mesh and 3D Wire Frame models necessary to produce the 3D model were created (Figure 2/b).

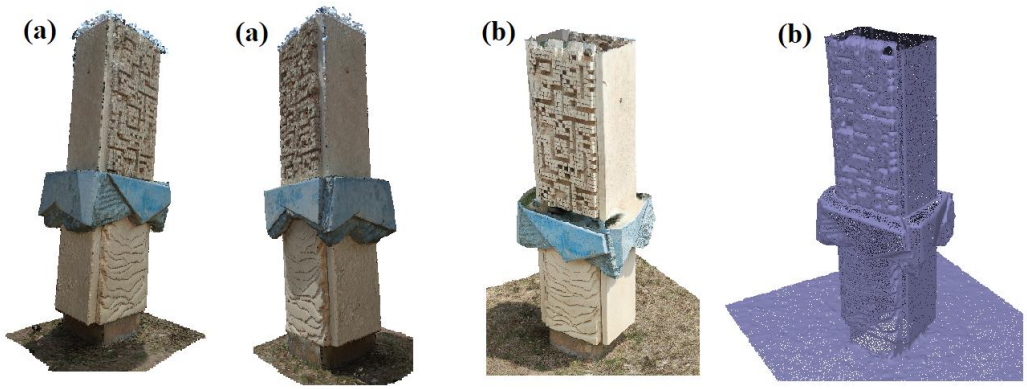

Figure 2. Dense point cloud (a) and 3D model (b)

Conclusion

The development of computer technology and software has contributed positively to the determination of the behavior of complex structures by 3D modeling, and the digital model of the structure has become easily created. 3D models are frequently used in documentation studies because they contain many details of the structure. 3D models created with the photogrammetry method are formed in real size and appearance. Photogrammetric measurement systems enable the determination of the actual object geometry as well as the modeling of the object. In addition, these technologies enable 3D models with real images, especially since they are processed with the real image of the object.

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