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Using of hybrid data acquisition techniques for cultural heritage: A case study of Pompeiopolis

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Keywords

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ABSTRACT

Various studies have been carried out on the documentation of cultural heritage using different methods. The method of collecting correct data is as important as the selection of the method to be used in the studies. Documentation studies focus on saving time and cost rather than the method of collecting data. However, obtaining accurate and complete data will increase the accuracy of the documentation work. In this way, projects prepared as a base for works such as a restoration will be designed correctly. At this point, image-based documentation studies such as photogrammetry provide important contributions to operators. As it is known, the photogrammetry method is basically classified into two as close-range and aerial photogrammetry according to the acquisition position of the image. Although a single data collection tool is preferred in most of the studies with the photogrammetry method, image acquisition from different locations (ground and air) was required for accurate and complete data. Recently, the term UAV photogrammetry has emerged with the use of unmanned aerial vehicles (UAV) in documentation studies. Thus, a complete model is created in documentation studies to be carried out by collecting both local and aerial data. In this study, three different data collection methods were used for documentation. The hybrid data collection approach is presented by selecting laser scanning (TLS) and Close range photogrammetry (CrF) and UAV photogrammetry techniques. The TLS, Crf, and UAV photogrammetry techniques used in the study were processed separately and the accuracy of 0,21-1,1-2,3 cm was calculated respectively. By combining the point clouds created from both data collection methods, 1.2 cm sensitivity was calculated. Finally, three-dimensional (3D) data of Soli-Pompeiopolis were created by combining these point clouds.

1. INTRODUCTION

Historical artifacts are damaged over time due to natural or unnatural reasons. In addition, archaeological sites are also affected by this situation, as well as the destruction of structural artifacts. The restoration, restitution, and excavation works of the destructions that have occurred contribute to the correct research and transfer of the artifacts or archaeological sites. The first step in the work to be done in an artifact or archaeological site is documentation studies.

Various studies are carried out on documentation studies using different methods. Ulvi et.al (2020) classified the documentation of cultural heritage into two titles as traditional and modern methods and included TLS, CrF, and UAV photogrammetry, which also includes the subject of this study, in modern methods. The

photogrammetric method is one of the most often used techniques in documentation studies. The photogrammetric method is 100-130 times more efficient than traditional methods, 25 times more advantageous in terms of graphics, and 10 times more accurate in terms of accuracy (Sağiroğlu, 2004; Yakar et.al, 2016; Ulvi & Yiğit, 2019; Şenol and Kaya, 2019; Alptekin and Yakar, 2020). In addition, Yakar et.al (2015) stated that the photogrammetry technique saves time and cost compared to traditional documentation techniques. Especially in documentation studies, it is desired to save time and cost in collecting data (Çelik et.al, 2020; Yakar et.al, 2021;). However, while trying to save cost and time, choosing the wrong data collection method can push the operator to collect incomplete data. Collecting correctly and complete data is an important

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factor in method selection. For this reason, several data collection methods should be used to collect all data belonging to the study area. For this reason, in the study, data were collected using TLS, CrF, and UAV photogrammetry methods, which are among the modern methods.

The use of a single method in modeling complex structures, especially in the photogrammetry technique, in the documentation of cultural heritage does not allow accurate and complete documentation. Because, with ground-based systems (TLS and CrF), the data of the bottom part of the structure can be taken, but the top of the structure cannot be collected. The data deficiency arising from this situation can be overcome by changing the location where the device is installed or by using another data collection tool to collect the data of the upper fronts. UAVs, which have been used by many disciplines in recent years, have been integrated into this area and this problem has been overcome.

In the documentation made in this study, TLS, Crf, and UAV photogrammetry techniques, which are among the modern data collection and documentation techniques, were used. The hybrid data collection approach is presented by selecting laser scanning (TLS) and Close range photogrammetry (CrF) and UAV photogrammetry techniques. An accurate and dense set of 3D points belonging to all facets of the structure was acquired with hybrid data collection techniques. The TLS, Crf, and UAV photogrammetry techniques used in the study were processed separately and the accuracy of 0,4-1,1-1,3 cm was calculated respectively, and finally, three-dimensional (3D) data of Soli-Pompeiopolis were created by combining these point clouds.

2. METHOD

The methods used in the study and the chart of work-flow are given in Figure 1.

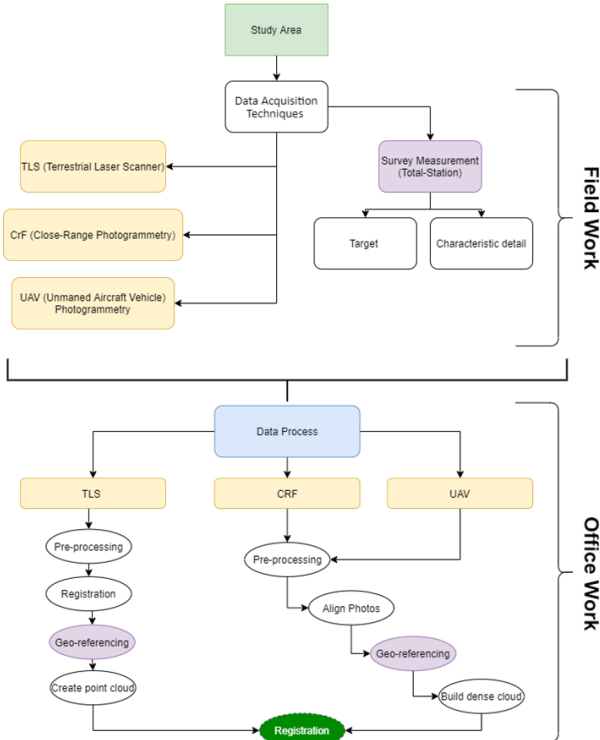


Figure 1. Workflow Chart

2.1. Study Area

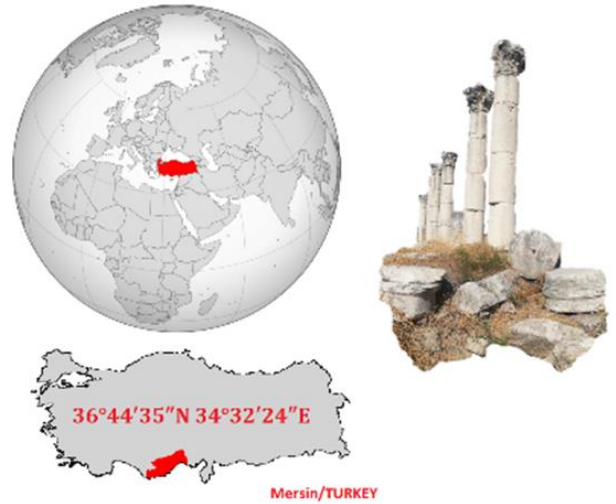


Figure 2. Study Area

Soli Pompeopolis located in Mersin / Turkey (Figure 2), it is one of the most important ruins of the province where it is located, and because it is close to the seashore, it is a large site with an ancient harbor (URL-1). According to the archaeological excavations started in 1999: BC. It has been among the important port cities of the Eastern Mediterranean since 2000. There are 33 giant columns on the site and the columns are in a complex structure with Corinthian type capitals (URL-2).

2.2. Data acquisition, Field-Work, and Office-Work

In the documentation made in the study, data were collected using TLS, Crf, and UAV photogrammetry techniques. For TLS, Crf and UAV, respectively; Faro Focus^S 350 - Nikon D300 - Anafi Parrot devices are used.

Scans were made at 49 different station points determined in the study area. The number and location of the station points have been determined in a way that the area to be scanned can see one or more areas. Overlapping photographs were taken for CrF and UAV photogrammetry. For CrF 326 image data were collected for 78 UAV. Photo data were collected manually for CrF and autonomously for UAV. In addition, Total-stations and target and characteristic details are measured in order to transfer the result products created from different data collection methods both for registration and to the same scale and coordinate system.

In the process of data processing, firstly, pre-processing was performed for all data collection techniques. Then, the process steps shown in Figure 2 were applied for TLS, CrF and UAV Photogrammetry.

3. DISCUSSION AND CONCLUSION

TLS, CrF, and UAV photogrammetry often have been used. By using these techniques together, complete data of the study area can be collected. In this study; Fast, high quality and resolution data can be collected at close-range with the TLS method. However, this method has two disadvantages due to its cost and ground-based data collection. Although the CrF method saves time and is a

low-cost data collection method, it has a disadvantage due to its ground-based data collection and not being able to be used effectively in large areas. UAV photogrammetry, on the other hand, has an advantage in terms of aerial data collection and cost, but it is affected by weather conditions and is not used in every area (prohibited area). For this reason, hybrid methods should be used as these methods are insufficient. TLS, Crf, and UAV photogrammetry techniques used in the study were evaluated separately and the accuracy of 0.4-1.1-1.3 cm, respectively, was calculated. Finally, by combining point clouds, the three-dimensional (3D) point cloud of Soli-Pompeipolis was created correctly and completely.

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