



## Mapping with Unmanned Aerial Vehicles Systems: A Case Study of Nevşehir Hacı Bektaş Veli University Campus

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### ABSTRACT

Today, remote sensing techniques are one of the most frequently used working methods in planning and design studies. Especially thanks to the data produced by photogrammetry with the help of UAV, it is frequently used in commercial and academic periods. Especially thanks to the advantages such as speed, cost, and accuracy provided by UAV, high-resolution data of smaller areas can be obtained. Thanks to these data, orthophoto images and Digital Elevation Model (DEM) data of the land can be produced. The Orthophoto and Digital Elevation Model (DEM) contributes to the creation of many digital bases as it transfers the land to the spatial environment. In this study, aerial photographs of Nevşehir Hacı Bektaş Veli University Damat İbrahim Pasha Campus were taken with UAV. These photographs produced orthophoto and Digital Elevation Model (DEM) images with a spatial resolution of 2.31 cm using 3D Survey software. The mesh model created after processing the products obtained from the UAV of the campus area was published on the internet address (<https://cbs-uzam.nevsehir.edu.tr/tr/projeler>).

### ÖZ

#### Anahtar Kelimeler:

Nevşehir,  
 Kampüs,  
 İHA,  
 CBS

Günümüzde planlama ve tasarım çalışmalarında uzaktan algılama teknikleri sıklıkla başvurulan çalışma yöntemlerinin başında gelmektedir. Özellikle İHA yardımıyla fotogrametri ile üretilen veriler sayesinde ticari ve akademik son dönemlerde sık sık kullanılmaktadır. Özellikle İHA'nın sağladığı hız, maliyet ve doğruluk gibi avantajları sayesinde daha küçük alanlara ait yüksek çözünürlüklü veri elde edilebilmektedir. Bu veriler sayesinde araziye ait Ortofoto görüntüleri ve Sayısal Yükseklik Modeli (DEM) verileri üretilebilmektedir. Ortofoto ve Sayısal Yükseklik modeli (DEM) araziye uzamsal ortama aktardığı için birçok sayısal altlıkların oluşturulmasına katkı sağlamaktadır. Bu çalışmada, Nevşehir Hacı Bektaş Veli Üniversitesi Damat İbrahim Paşa Yerleşkesi hava fotoğrafları İHA ile çekilmiştir. Bu fotoğraflar 3DSurvey yazılımı kullanılarak 2,31 cm mekânsal çözünürlükte Ortofoto ve Sayısal Yükseklik Modeli (DEM) görüntüleri üretilmiştir. Kampüs alanına ait İHA'dan elde edilen ürünler işlendikten sonra oluşturulan mesh model model <https://cbs-uzam.nevsehir.edu.tr/tr/projeler> internet adresinde yayınlanmıştır.

### 1. Introduction

Nowadays, the use of different data produced from images obtained by unmanned aerial vehicles in which the cameras are integrated into the map, planning, and design studies has increased a lot. UAVs have been widely used in different working groups due to the many advantages they provide such as speed, cost, and accuracy. The studies

carried out with the help of UAV approach the sensitivity in terrestrial photogrammetry and have the opportunity to be applied in many different areas to complete the studies in a short time [1]. It is used extensively for mapping and 3D land modeling for commercial purposes and scientific studies after military applications [2]. The use of such tools is geography, landscape, cartography, etc. brings many advantages in its fields.

In this study, an Orthophoto and Digital Elevation Model (DEM) application for Nevsehir Hacı Bektas Veli University Damat İbrahim Pasha Campus was discussed in detail. The data obtained from the land in this way will constitute a basis for the projects to be used later. The purpose of this modeling is the project work to be carried out for the Damat İbrahim Pasha Campus Information System to collect, transfer, store, analyze and present the information of the university in the desired manner.

Today, one of the main problems of public institutions is that information cannot be easily accessed at any time. Since the existing information does not have a regular structure, it cannot be archived systematically. Besides, generating new information from the information available in the archive and having healthy information is the most demanded by today's institutions. Such requests are important for university institutions as well as many public institutions [3].

Nevsehir Hacı Bektas Veli University Damat İbrahim Pasha Campus is one of the most important reasons for the establishment of the Campus Information System is the absence of digital map bases showing the physical condition of the campus. Digital maps of the campus are provided with the created orthophoto and 3D modeling. Also, landscape arrangements and designs can be made quickly and easily thanks to these bases.

### 1.1. Unmanned Aerial Vehicles

Unmanned Aerial Vehicles are defined as a motor aircraft that does not have many vehicles and pilots on it [2]. The control mechanism of UAVs consists of remote, semi-automatic, automatic, or a combination of several of them. When the UAVs are compared with other aircraft, the most important difference is the absence of a pilot physically in UAVs. [4]. UAVs are one of the most important technologies in many aviation applications, especially civilian and military purposes and applications, due to their low performance. UAVs have a short wingspan (fixed or rotary wing) and a light structure, as well as a sensitive structure during flight [5]. It is very easy to operate and produce. Many of them are a vehicle that can be used by one or two people and can be transported by hand and can be launched from the land by hand. UAVs are designed to fly from a low height to observe objects in the field. However, flying from a very low height increases the probability of a UAV crash. Therefore, strong and accurate autopilot systems are needed to increase the performance at low heights. [6].

UAVs can be integrated with various imaging devices with sensors such as thermal, infra-red, hyperspectral, radar, chemical, and biological and provide day and night images. Along with the real-time data transfer feature, UAVs can transfer important information such as fire, flood, and weather conditions to the ground station. [7]. With the real-time GPS integrated on UAVs, it can work with the ground control station to observe and be guided by the images it collects, so systems that operate in this way are also called fully automatic navigation systems. The image obtained can be processed in the laboratory or at the ground control station immediately. UAVs can record all their actions and forward them to ground control points for image processing. [8]. UAVs for photogrammetric purposes can take photographs in three-dimensional spatial positions planned previously independently, but experienced pilots are needed for takeoff and landing by the flight plan [9]. A multi-rotary UAV, which is frequently used in photogrammetry studies, can be seen in Figure 1.



**Figure 1:** AtmacaX8 UAV with rotary-wing sold by Geomatics Group (URL-1)

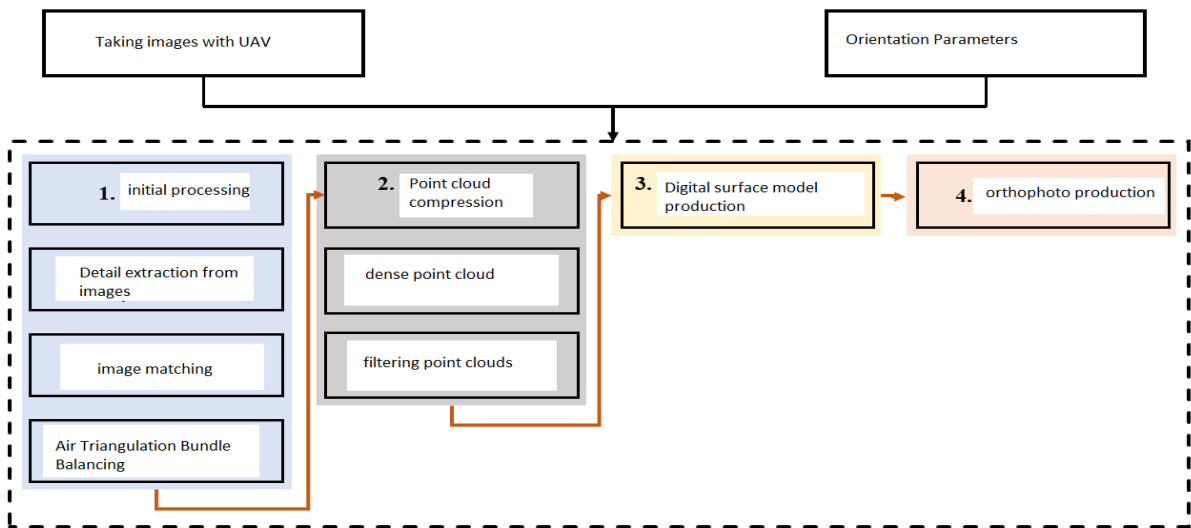
Although UAVs have many advantages, they also have disadvantages. These; Since they can carry limited loads, it is possible to list them as being insufficient in applications involving large areas, having low airtime, limited opportunities to apply in windy weather, and problems in landing, take-off, and flight stages.

## 2. Material and Method

The material and methodology used during the study are described below.

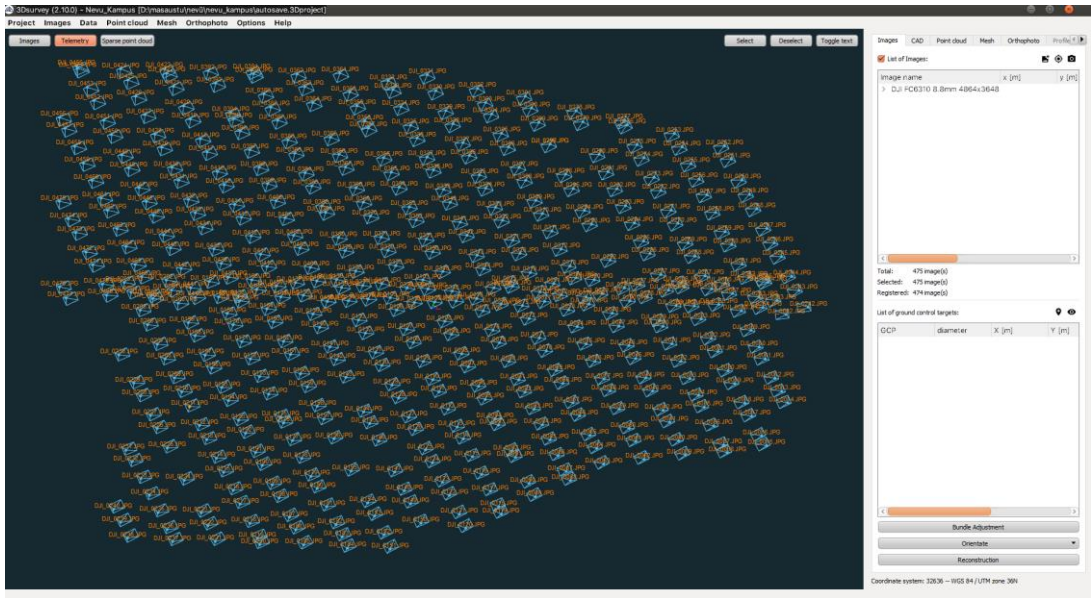
### 2.1. Data Production with UAV

Commercial software developed today has its algorithms to perform internal and external orientation processes, which are the main stages of photogrammetric map production. UAV images are directed by geometrically corrected with a high success rate [10]. The workflow for evaluating images using computer vision-based software is shown in Figure 2.



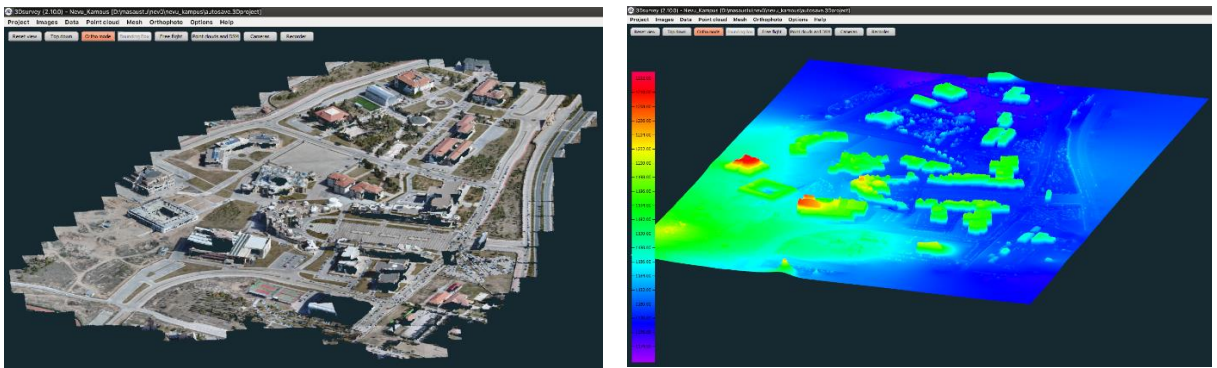
**Figure 2:** Evaluation of Computer Vision-Based Images [10].

Nevsehir Haci Bektas Veli University Damat İbrahim Pasha Campus has been flying with a DJI Phantom brand unmanned aerial vehicle. After the flight process, 474 aerial photographs were transferred into the 3D Survey 2.10 software and processing started. (Figure 3).



**Figure 3:** Uploading images to 3D Survey 2.10 software

After the pictures are loaded, the coordinate correction is completed by matching the photographs. After this process, point cloud and digital surface model (DSM) and the mesh model were created with the tools in the program, respectively. Point cloud data consists of 27635264 points in total. With the 3D Survey software, the orthophoto of the work area was produced at 2.31 cm spatial resolution. (Figure 4).



**Figure 4:** Point cloud and surface model

With the 3D Survey software, the orthophoto of the work area was produced at 2.31 cm spatial resolution. (Figure 5).

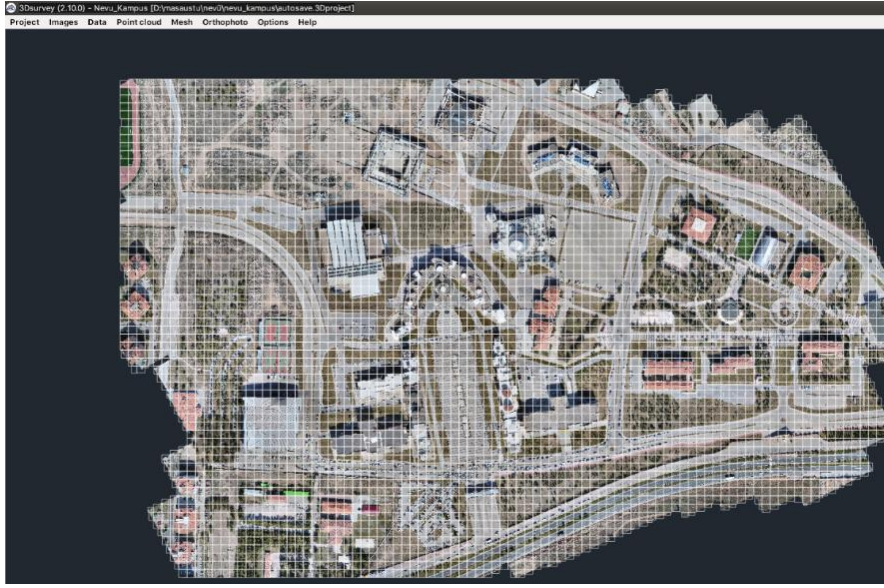


Figure 5. Orthophoto produced

### 3. Results

The study area is Nevsehir Haci Bektasi Veli University Campus is shown in Figure 6.



Figure 6. Study Area

After the products obtained from the UAV of the campus area were processed, the mesh model created was recorded to be published on the internet. The created model has been published on the website <https://cbs-uzam.nevsehir.edu.tr/tr/projeler>.

### **3. Conclusions and Suggestions**

Today, there are still lands that are difficult to navigate. UAV systems can be used easily in making maps of these areas. In addition to this advantage, UAVs can be used by geologists in studies for three-dimensional data production due to the rapid data production technique. UAV systems can be easily used in works to gain profit from components such as fast data production and time cost.

### **Competing Interest / Conflict of Interest**

The authors declare that they no conflict of interest. The none of the authors have any competing interests in the manuscript.

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We declare that all Authors equally contribute.

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