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***Review Article***

# Mapping Methods With Unmanned Aerial Vehicles "A Review"

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**Abstract**

A map is a bird's-eye view of a part of an area with a certain scale to be used for a specific purpose. All of the methods and processes used to create a map can be called mapping. In the map creation process, many images are combined into a whole. Although the images required for creating maps, were obtained in the past years by terrestrial methods, with the development of technology in time, they were taken from airplanes and balloons by aerial methods. Later, unmanned aerial vehicles (UAV) developed and became widespread in the field of mapping because they are more advantageous compared to other methods.
In mapping with unmanned aerial vehicles, firstly the determined area is scanned and the take-off, landing points and potential dangers of the UAV are determined. A flight plan is made for the UAV. The UAV takes flight and photographs of the land are taken. Then, these photographs are uploaded to the computer to create a map, and the map is created by making corrections with the help of a map creation software such as PhotoScan and Pix4D. On the created map; Information such as position information of any point, direction information, height information of some objects in the area can be found. This mapping method with UAV is useful for many fields such as forestry, highway projects, agricultural fields, support works in natural disasters, military applications.
The aim of this study is to examine the studies about mapping methods with UAV and to create a review article. In the light of this information, this article will make it easy to determine the materials and methods to be used in future studies.

**Keywords:** Unmanned Aerial Vehicles, Mapping, Photogrammetry, Ortophoto

# İnsansız Hava Araçları ile Haritalandırma Yöntemleri

**Öz**

Harita; bir alanın, belirli bir amaç için kullanılan ve belirli bir ölçeğe sahip kuşbakışı görünümüdür. Bir harita oluşturmak için kullanılan bütün yöntemler ve işlemler haritalandırma olarak adlandırılabilir. Harita oluşturma sürecinde elde edilen birçok görüntü birleştirilerek bir bütün haline getirililr. Geçmiş yıllarda haritaların oluşturulması için gerekli olan görüntüler karasal yöntemlerle elde edilmiş olmasına rağmen, zamanla teknolojinin gelişmesiyle birlikte havadan uçaklar balonlar ve daha sonra insansız hava araçlarından elde edilmiştir.
İHA'lar ile haritalandırmada, öncelikle belirlenen alan taranarak İHA'nın kalkış- iniş noktaları ve olası tehlikeler belirlenir. İHA için bir uçuş planı yapılır. Uçuş işlemi gerçekleşir ve arazinin fotoğrafları çekilir. Daha sonra bu fotoğraflar Pix4D, Photoscan gibi yazılımlara yüklenerek burada düzeltilir ve bir harita haline getirilir. Oluşturulan harita üzerinde; herhangi bir noktanın konum bilgisi, yön bilgisi, alandaki bazı nesnelerin yükseklik bilgisi gibi bilgilere ulaşılabilir. İHA ile bu haritalama yöntemi ormancılık, karayolu projeleri, tarım alanları, doğal afetlerde destek çalışmaları, askeri uygulamalar gibi birçok alanda kullanışlıdır.
Bu çalışmanın amacı, İHA ile haritalama yöntemleri ile ilgili çalışmaları incelemek ve bir derleme makalesi oluşturmaktır. Bu bilgiler ışığında bu makale ileride yapılacak çalışmalarda kullanılacak malzeme ve yöntemlerin belirlenmesini kolaylaştıracaktır.

**Kelimeler:** İnsansız Hava Araçları, Haritalandırma, Fotogrametri, Ortofoto

## 1. Introduction

Mapping a region provides access to different information about that region and has been used since the past. First of all, the photographs required for mapping were obtained by terrestrial methods, and then they were obtained from the air with the development of technology. In the aerial mapping methods, balloons were used initially, and then airplanes, and with the emergence of UAVs, they started to be used.

UAVs are used in many areas in today's technology. One of these areas is the acquisition of the terrain map and three-dimensional models by combining the images obtained from the air with the UAV. This map obtained provides access to a lot of information about the field displayed and the planned operations can be done in a much shorter time and with less cost. There are some advantages of using UAVs in photogrammetry;

1. The spatial and temporal accuracy of the data obtained from the UAVs is higher than the data obtained from other methods.

2. Much higher image resolutions

3. Low cost

4. The shots are programmable

5. Having the ability to fly repeatedly

6. It provides easy access to hard-to-reach areas.

Mapping with UAVs; it is used in forestry, mining, highway projects, disaster management, emergency rescue works, etc. effectively. In this article, we will examine previous studies in the field of mapping with UAV.

In this article, we aim to examine the studies on UAV mapping and to shed light on future studies on this subject. Before the literature rewiev, there are some definitions to be made.

**Orthophoto Image:** Images obtained by eliminating the effects of inclination and rotation of the aerial photographs and the height differences of the land, having a fixed scale at each point and showing the real situation of the land at the time it was taken (Özbalmumcu, M.).

**Orthomosaic:** It is the image obtained by combining orthophotos properly.

**Ortophoto Maps:** They are maps created by combining and scaling orthomosaics (https://agrifeat.wordpress.com/2017/10/09/ortofoto-nedir/).

**Ground Control Points:** In order to fit the map obtained with the UAV to the real world scale, it is necessary to geographically position its data. To perform the positioning process, the image processing software must know the real-world GNSS coordinates of a small number of points that can be visibly identified in aerial images. These points are called ground control points (GCP) in the UAV mapping content (Mahmod A., 2017). Before the study, ground control points are determined depending on the size of the area. The real world coordinates of the determined ground control points are measured by spatial methods. Then, by calculating the differences between the coordinates measured from the orthophoto obtained with the UAV data and the coordinates accepted as real, the position errors of the study can be determined.

Generally, the stages in mapping with İHA are as follows;

- Flight planning,
- Establishment and measurement of ground control points,
- Flight and obtaining aerial photographs,
- Correcting images by uploading them to the software and obtaining other products and maps.

## 2. Literature Rewiev

[1] (Yılmaz et al., 2013) In this study, it is aimed to reveal the location accuracy of the UAV in orthophoto map production. Gatewing X-100 unmanned aerial vehicle and RICOH GR DIGITAL IV camera were used in the study. 11 ground control points were determined and their coordinates were measured using the RTK GPS method. The horizontal accuracy of the orthophoto map obtained as a result of the study was calculated to be approximately 7-8 cm. It was concluded that the images obtained from cameras mounted on UAVs are sufficient for orthophoto map production.

[2] (Kayı et al., 2015) In this study, the effect of the different overlap ratios on the accuracy of the Digital Surface Model (DSM) was investigated. In the study, firstly, photographs were taken with 70% forward and 60% lateral overlap ratios and digital surface and digital terrain model was created. Later, these rates were changed to 40% and 60%, and finally, 70 and 20% rates were used. In these research studies, it has been observed that DSMs made using high-overlapping aerial photographs give more successful results. Especially the forward overlap ratio affects the result accuracy more.

[3] (Ayyıldız et al., 2015) In this study, unmanned aerial vehicles and aircraft platform were compared in map production. SmartOne-C unmanned aerial vehicle and Pentax Ricoh Gr digital camera were used in UAV studies. Aircraft used part of the test was carried out with the ISLANDER BN-2T type airplane belonging to TGKM. Image acquisition was done with the Zeiss / Intergraph DMC digital aerial camera belonging to TKGM. Since narrow angle camera is used in photogrammetric study with the aid of UAV, it is less to move away from the main axis compared to the wide angle camera. However, the UAV is more affected by adverse weather conditions. It has been observed that it can be preferred to produce maps in small areas by using UAVs in terms of cost reduction, time and ease of use. In the study, it has been concluded that in possible natural disasters such as earthquakes, landslides and floods, both

traditional photogrammetry and UAV can be used in the production of orthophotos belonging to the natural disaster area, considering the size of the natural disaster area and the cost of the study.

[4] (Karkınlı et al., 2015) In this study, images of a 600x800 m area were obtained by UAV and digital terrain model (DTM) was obtained from these images. DJI S800 spreading wings hexacopter and 18 MP Canon EOS 550d camera were used as equipment. The flight altitude is 100m, the forward overlap rate is 25% and the lateral overlap rate is 70%. Flight planning was made using DJI mission planner photogrammetry tool. The processing of UAV picture blocks, which are closer to close-range photogrammetry in terms of structure, can be more complicated than classical photogrammetry. The main reason for this is that the image overlay rates cannot be provided very precisely, flight stability can be deteriorated more easily, strong radiometric and geometric changes, image scale and covergent image geometry. Despite all these limits, the accuracy provided by these methods seems to be sufficient for many different purposes. In the study, it was calculated that the positional accuracy was on average 6.6 cm and the height accuracy was 8.5 cm on average.

[5] (Papakonstantinou et al., 2016) The aim of this study is to develop a new methodology for UAV mapping along the coastline. The scope of this paper is to detect the coastline and to identify the coastline zones by applying geographic object-based image analysis (GEOBIA) to high-resolution orthophotos produced by an unmanned aerial vehicle (UAV) combined with a structure from motion (SfM) algorithm. In the study, it was stated that small changes occurring on the coastline cannot be noticed in satellite images and more precise measurements can be made with UAVs. There were two areas to study Within the scope of this study, applications were made on two coast; Eressos and Neapoli Beaches. The average flying height of the UAV was 100 m above ground level (AGL), while the camera was programmed to capture the nadir photograph every 3.5 s with an acquired image footprint of 123.4 m _ 91 m. Photograps were taken with 80% overlap ratio during the study. The dense 3D point cloud and the total images were used to create a 3D mesh of the orthophotos, digital surface models (DSM), and digital terrain models (DTM) for both study areas. Within the scope of the study, it was concluded that UAVs can be used effectively in shoreline applications due to their ability to fly repeatedly, their low costs, their ability to reach hard-to-reach areas, and their high image quality.

[6] (Teke et al., 2016) Within the scope of this project, irrigation and fertilization models will be developed for smart agriculture applications. For these models, images are taken with a drone system with hyperspectral camera in the aerial data acquisition part of the project. A second drone system with multispectral and thermal cameras was also used in large areas for summer planting in 2016. It has been stated that it is possible to detect situations where plant growth is affected by nitrogen deficiency or water stress by fusion of data from multispectral and thermal cameras, and that the data obtained from thermal cameras are effectively used to detect water stress in plants. Within the scope of the project, in order to be able to locate satellite and drone images, 1 x 1 $m^2$ sized black-white colored plates were assigned as ground control points to be placed in the work area. These plates are like checkerboards and they are used for the positioning of the patterns taken by thermal cameras since they have different temperature values in black and white colors. The study examines the feasibility of precision farming practices using remote sensing methods. As a result of the inferences to be obtained with all the data used, appropriate methods will be determined and recommendations will be made to the farmers.

[7] (Menteşolu et al., 2016) This study is conducted considering that UAVs can be used effectively in forestry. Forest areas can be difficult to access and dangerous areas. It is advocated that UAVs are suitable for use in forestry due to their mobility. In the study, photographs were obtained with 70% lateral and 80% forward overlap. With these photos; point cloud production, digital elevation model, Digital surface model, Digital terrain model and Orthophoto map was produced. The first results obtained in this project emerge as technologies that cannot be ignored in terms of providing fast, inexpensive and reliable solutions to the problems encountered in forestry studies of the data produced by evaluating the photographs taken from UAVs. however, the mathematical models used are not yet fully adequate. But, it is thought that this problem will be solved with the developing technology in UAVs.

[8] (Erdoğan A., 2016) In this study, maps were created in two different software using the Digital Elevation Model (DEM) obtained by an unmanned aerial vehicle on a route of approximately 2 km on the ring road of the 3rd Regional Directorate of Highways. Flight planning is prepared in Pix4D Mapper Capture program. The products were obtained by processing the images with Agisoft Photoscan Pro and Pix4D Mapper Pro software. When products created in Agisoft Photoscan software are desired to be used later, data extraction should be done, but there is no need for such a process in Pix4D software, the products obtained are automatically extracted to the extension folder. Coordinate accuracies and precision were calculated using 5, 10 and 15 ground control points in Agisoft and Pix4D programs, respectively. Thus, 6 different products were obtained and compared. As a result of the study, when all these products were compared, it was seen that the most accurate result was the product created by using Photoscan software and 15 Ground control points. This study proves that the excess of ground control points is directly related to the accuracy of the work result.

[9] (Özemir et al., 2016) In this study, In this study, in order to investigate the accuracy of the photogrammetric data produced from the images obtained by the UAV, the data obtained by the GNSS measurement technique were processed and accuracy analysis was performed. 4 ground control points have been established on the area where the work is done. 70% forward and 80% lateral overlap ratios were used in the study phase. Mission Planner program was used for flight planning. The Agisoft PhotoScan Professional program used in the study uses the intensive image matching method by finding common pixels in aerial photographs. The dense image matching method maps common pixels in each photograph to neighboring photographs. Digital Surface Model, 3D point cloud and orthophoto were produced with the obtained images. In order to investigate the accuracy of the orthophoto produced, the existing map of the region produced before 2007 was used. Common objects were used between the existing map and the orthophoto produced, and comparisons were made to these objects. The UAV was allowed to take photographs at the turns between the blocks in the flight plan, resulting in gaps in the generated point cloud. It has been observed that these gaps cause tears on the orthophoto. However, these tears did not pose a problem as they were outside the project area. For this reason, it is recommended that

the UAV not be allowed to take photographs during turns between blocks in the flight plan. In line with all these results, it has been observed that UAVs have advantages such as providing high accuracy, obtaining data in a short time, having high temporal resolution with repetitive measurement capability, and performing applications with low cost for photogrammetric data generation etc.

[10] (Gültekin et al., 2016) In this study, mapping studies were carried out in two different regions with two UAVs, one fixed wing and the other octocopter. A 3D point cloud was obtained by processing 82 images obtained from an octocopter in the province of Tekirdağ at an altitude of approximately 70 m, in Agisoft Photoscan Professional software. 3D digital surface model and 3D street model were obtained from this data. In the second study, it was aimed to obtain a road map of the drilling well tools required for the construction of a dam planned to be built in the area of Soğullu Village of Istanbul Province Şile District. In the first field, GCP was not used and the data could not be converted to photogrammetric data since there is no defined coordinate system. In the second field, in the second study, 3 GCPs were established, digital surface model and orthophoto map production was made. When the UAVs were compared, it was concluded that the rotary-wing UAV does not need a runway for flight and landing, but it is less resistant to wind, the fixed-wing UAV requires a flight and landing pad but is more resistant to weather conditions. It can be understood from here that it is appropriate to use different UAVs in different situations.

[11] (Genç et al.,2016) In this study, true orthophoto images and digital surface model were produced with the images obtained by unmanned aerial vehicles at the Istanbul Water and Sewerage Administration (ISKI) General Directorate Site. 24 ground control points were established in the study area and the coordinates of these points were measured with the Topcon GR5 GNSS receiver. In the flight plan, the altitude was determined as 150 m, the estimated flight time was 15 minutes, and the image overlap rates were 60% transverse and 80% longitudinal. Point cloud, three-dimensional surface model and True orthophoto were created by processing 413 images obtained by the UAV with Pix4D software, and map drawings were made with point cloud and true orthophoto.

[12] (Özcan O., 2017) In this study, the positional accuracies of the images and digital surface models (DEMs) produced by the UAV in two different areas, at different heights were investigated. Differential Global Positioning System (DGPS) was used to determine the locations of ground control points. An area within the Ayazağa Campus of Istanbul Technical University has been chosen as the study area. In the first area, 97 photographs were taken by flying at an altitude of 30 meters, then 70 photographs were taken by flying at an altitude of 50 meters. In the second area, 111 photographs were taken by flying at an altitude of 30 m. Orthophoto maps of the areas were obtained by processing the obtained images with Pix4D software. Since the point cloud densities produced from the images obtained at different heights will affect the measurement accuracy, the number of points in $1m^3$ volume was determined (average 5000-6000 points). When the orthophoto maps created from images obtained from different heights were compared, it was observed that the flights made from low altitudes were more successful with a small difference. As a result of the study, it is estimated that obtaining orthophoto maps with UAVs will replace classical photogrammetry planes in many future projects.

[13] (Tercan E., 2017) In this study, an orthophoto view and digital elevation model (DEM) of an ancient city and caravan route (Antalya Province Akseki District) belonging to the Ottoman Empire period were obtained. In the study, 731 high resolution images were obtained with 80 meters height, 85% longitudinal and 65% transverse overlap. Flight planning and simulation operations were done with Mavinci Desktop software. 8 ground control points have been established in the area. Images were processed with PhotoScan software. The accuracy of the UAV system was compared with the traditional terrestrial method, and it was determined that there was an elevation difference of approximately 0.4-4.3 cm between the two methods. It was concluded that UAV photogrammetry systems are a suitable method to obtain detailed and precise 3D data.

[14] (Çam et al., 2017) In this application, the temporal effects of aerial photographs with different overlap ratios and different resolutions on the production process have been investigated. In the first test phase, the ground sampling distance (GSD) were kept constant and the overlap ratios were changed. At this stage, forward and lateral thrusting ratios are taken as 80%-60%, 60%-60% and 80%-30%, respectively. Naturally, the number of photographs obtained at each stage was different. There is about 2 times the difference between the 1st and the 2nd in terms of the number of photos. However, there is approximately 9 times the difference in orthophoto production time. In the second test application, the overlap ratios were kept constant and the GSD was changed. The GSD are 45, 30 and 12 cm, respectively. The fastest result was achieved in the study with 45 cm GSD. With the information obtained, the result is that the appropriate GSD and overlay ratio will be selected according to the size of the area to be studied and the urgency of the work to be done.

[15] (Öztürk et al., 2017) In this study, accuracy comparisons of orthographic images produced from different heights and different camera angles were made in ITU Ayazağa Campus. In the study, photographs were obtained by flying from heights of 60, 80 and 100 m, respectively. The camera angle is 90° at 60 and 80 m altitudes. In the Camera angles were set as 45°, 60° and 90° in the study carried out at an altitude of 100 m. Ortho-images of the area were produced by obtaining high-resolution digital images obtained with all the shots. Accuracy controls of the products were made using predetermined 5 GCPs. Comparison made with different camera angles showed that the highest accuracy was the products obtained with a 45° camera angle. In the comparison made at different heights, it was seen that the highest accuracy was the products obtained by shooting from 60 m height. As can be understood from the study, images obtained with an average camera angle and lower flights give more successful results.

[16] (Mahmod A., 2017) In this study, 3D model of Aksaray University mosque was produced. Agisoft photoscan software was used in the study. Photographs were obtained from flights were made from two different heights; 50 m and 100 m. In order to determine the accuracy of the model produced, the lengths of some horizontal and vertical facades of the mosque were measured by local methods. The same facades were also measured on the model created. It has been observed that there is a difference of 2-50 cm between these two measurements. Gaps were seen at points such as minarets because the UAV only measured vertically. A clear model of the minaret could not be created. In terms of general results, it has been observed that the most accurate study is the one from a height of 50 m.

[17] (Tamouridou et al., 2017) In this study, weed (Silybum marianum) detection and mapping is demonstrated with using multilayer neural networks. It was emphasized that weed mapping is important to find a suitable solution against the harmful effects of weed. The Multilayer Perceptron with Automatic Relevance Determination (MLP-ARD) was used to identify the S. marianum among other vegetation. Weeds and other herbs were introduced into the system for image detection. As a result of the study, the accuracy of MLP-ARD classification was calculated as 99%. The results show that the online classification of S.marianum with MLP-ARD can be used operationally to perform UAV-based weed mapping.

[18] (Tercan E., 2017) In this study, the usability of the UAV photogrammetry in the calculation of the digital land model production and the amount of earthwork in highway projects has been investigated. A digital terrain model of a 1500-meter highway corridor was produced using a UAV and terrestrial method. Topcon Hyper V GNSS device and CORS-RTK method were used to determine the positions of the ground control points, and the Lecia-LS 10 electronic digital level device was used to determine the heights. Mavinci Desktop software was used for flight planning and simulation processes. Photoscan software was used to process the images. The flight altitude is 160 m, the longitudinal overlap ratio is 85% and the transverse overlap ratio is 65%. When comparing the model created with the images taken from the UAVs and the measurements made by terrestrial methods, an overlap was observed. Even in some parts of the area, because of the geographic conditions, groundwork measurements could not be made sufficiently and accurately, so the amount of earthworks calculated with the numerical land model obtained with the UAV was calculated more precisely and accurately. It was concluded that the application with UAVs is very effective, but in some cases where UAVs are insufficient, it should be supported by local methods.

[19] (Yusoff et al., 2017) In this study, it is aimed to obtain a slope map using UAV in different heights and to compare them. The project consists of 3 basic stages: preparation for flight and flying the UAV, processing the UAV images with software and creating slope maps. Work was carried out in Kulim, Kedah, Malaysia because the slope area is prone to landslides. DJI Phantom 4 was used in the study. The slope area is not accessible. For this reason, GCPs are measured from point cloud data from the Pheonix AL-32 LiDAR system. Comparing the studies from different flight heights (20, 40, 60 meters), it was seen that the position accuracy increased in direct proportion to the height. As a result of the studies, it was observed that orthophoto and digital elevation model (DEM) were produced successfully. Finally, it was stated that the study will be expanded by using applications such as LIDAR, thermal camera and infrared to capture slope data.

[20] (Yılmaz et al., 2018) In this study, an orthophoto of Aksaray University was created using UAV. It is aimed to investigate the facilities and limitations of using UAVs in studies. Ground control points were determined and their coordinates were obtained with the TOPCON GR3 GPS receiver in the WGS84 coordinate system. Digital elevation model (DEM) and orthophoto map of the land was obtained with the photographs obtained by UAV. In order to measure the accuracy of the products obtained, horizontal lengths at 5 points and vertical lengths at 5 points were measured. The same lengths were also measured on the land using local methods (with Total Station). The position error in the products obtained by comparisons was calculated as mean ± 2.38 cm, and the height error was calculated as mean ± 9.94 cm. It was stated that when a 3D model is desired to be created, not only vertical but also oblique photos should be taken. It has been concluded that the use of UAVs is appropriate for obtaining products used in many disciplines such as digital elevation model, digital terrain model, orthophoto map.

[21] () In this study, a new technique is presented for the objective detection of geomorphic effects of floods using UAVs. It was stated that knowing the geomorphic response to flood strikes observed in a particular environment is necessary to understand the behavior of the stream system and to design effective risk mitigation measures. Object based image analysis (OBIA) module was used in SAGA GIS in the study. 3D digital elevation model and ortho-image are created, based on these, a workflow that includes the controlled classification method is proposed and tested. RGB images are combined with UAV images and 3D information, expanding the UAV imaging platforms. The proposed method has proven that flood effects can be applied quickly, cheaply and reliably with UAV.

[22] (Özcan O., 2018) In this study, unmanned aerial vehicles and mapping methods were used to examine 12 quarries located within the borders of Süleymanpaşa district of Tekirdağ province. A total of 5541 aerial photographs were obtained with unmanned aerial vehicles for 12 quarries. The images obtained were combined with Drone2Map for ArcGIS software to create orthomosaic images of the areas. The longest jointing process was the 10th stone quarry with 20 hours and 17 minutes, and the shortest was the 5th quarry with 3 hours 38 minutes. The reason for this can be shown that the number of images taken for the 5th stone quarry is the lowest (47) and the number of images taken for the 10th stone quarry is the highest (1215). In the study, studies were carried out based on the idea that digital maps with a horizontal and vertical precision of 10 cm and below can be obtained without using Ground Control Points, and area and volume can be calculated from it (Boy & Saraloğlu, 2016). It has been observed that the most decisive factor in this sensitivity is the consistency of the GNSS receiver on the UAV system. A hole was dug in the area to calculate the accuracy percentages of the UAVs in area and volume calculations. UAV images of the pit, whose volume was determined, were then taken and its volume was calculated with GIS (Geographical Information Systems) software. The area calculated from the UAV images was 99.03% and the volume was 82.5% correct. With this study, it was concluded that UAVs are suitable for area and volume calculation.

[23] (Marangoz et al., 2019) In this study, it is aimed to compare traditional photogrammetry (aircraft) with the result products produced from UAVs and to reveal the advantages of UAVs over traditional photogrammetry in terms of cost, time and accuracy. A flight was made on 545 hectares of land with the UAV on 23 November 2017, and on 3245 hectares on 30 January 2018. A non-metric camera was used in the UAV and a metric camera was used in the aircraft. The aircraft completed 3245 hectares with 11 columns with a 9.5 cm ground sampling interval, and the UAV completed 45 hectares with 19 columns with a 5.5 cm ground sampling interval. 7 GCPs were installed for the UAV and 38 for the aircraft. The coordinates of the points were measured with the Cors system twice at

an interval of one hour, and the average of the measurements was formed. The images obtained were processed with Agisoft MetaShape software. After the automatic linking of the pictures, the sparse point cloud was created, and then the project optimization was carried out by marking the ground control points on the pictures and the balancing process was completed. Later, the dense point cloud was automatically produced with the MetaShape program and after this process, the Digital Elevation Model was produced by taking the dense point cloud as a reference. After the DEM was produced, the orthophoto image was obtained by dressing the pictures on the created surface. In DEM comparison, it was observed that the UAV images were higher resolution, so the data obtained with the UAV were more sensitive. When the accuracies of GCPs were compared, the UAV method gave more precise and reliable results, as it was shown that the image resolution was high in the photos obtained with the UAV. When the UAV was compared with traditional methods, it was seen that the UAV produced more precise and economical solutions.

[24] (Yılmaz Ü., 2019) In this study, it is aimed to determine the usage areas and importance of unmanned aerial vehicles in disaster relief activities. The use of UAVs in aid activities is deemed appropriate for reasons such as the ability of UAVs to reach places that people cannot reach due to the infrastructure that deteriorates after the disaster, to be able to carry the necessary materials as a useful load when necessary, to provide field information by instant image transfer, etc. Common application areas of unmanned aerial vehicles in disaster operations management; To map the affected areas after disasters, to analyze the collected images, to coordinate the unmanned aerial vehicle networks, to detect disasters through some chemical sensors, to integrate drones with other communication tools and to provide fast and quality information transmission (Değirmen et al, 2018: 13). In addition, unmanned aerial vehicles were used to display and map the general view and damage status of the region after the 7.8 magnitude earthquake that took place in Ecuador in 2016 (Sampani, 2017: 4). Unmanned aerial vehicles were used to map the effects of Hurricane Matthew on Haiti in 2016 (NBCNews, 2016). As a result of the study, it was stated that the use of unmanned aerial vehicles in this area is insufficient and should be increased.

[25] (Şener E., 2019) In this study, it was aimed to map an area of 4.5 km2 with UAVs in Süleyman Demirel University. The point cloud of the area, Digital Terrain Model (DTM) and orthophoto map were obtained by processing 485 images with 80% overlap ratio obtained from UAVs in Pix4D software. 18 ground control points were placed homogeneously in the determined area and accuracy analyzes were made through these points. Accuracy analyzes were calculated using the Square Mean Error method. Mean Square Error (KOH) was calculated as 3.87 cm. Within the scope of this study, the point cloud produced by the Pix4D software belonging to the Süleyman Demirel University campus contains a total of 264.679.719 points. By using this point cloud, digital terrain model was prepared and by using digital terrain model, an orthophoto map of the area was obtained. In order to make more precise calculations in the amount of filling and excavation in the studies with UAV, it is necessary to minimize the effects of vegetation and objects by processing the point cloud. In addition, a 3D model was created in the study, and gaps were created in some buildings due to the camera angle of the UAV. However, it has been stated that this 3D model can be used. Again in this study, it was stated that one of the most important parameters affecting the product accuracies is the uniform and homogeneous distribution of the ground control points.

## 3. Results and Discussion

In this study, mapping applications with unmanned aerial vehicles were investigated and studies in this field were examined. Studies performed with UAV in a more economical and short time also give more efficient results than other traditional methods. This article is intended to be a reference to the desired studies in this field.

In the literature, the suitability of using the UAV in different areas has been investigated and the product accuracies have been found suitable for studies in that area. Unmanned aerial vehicles are preferred in this field due to their advantages such as reaching difficult areas, taking photos from low altitude, accessing the desired information in a short time, and low cost etc.

## 4. Conclusions and Recommendations

In addition, it is necessary to study how the UAV works under different conditions. What kind of precautions should be taken under these conditions should be specified and developed with future studies. Despite some difficulties, the use of UAVs in this area is appropriate for most studies.

Herd UAVs can be developed and used for both safety and mapping, especially in military, emergency management. The disadvantages such as; short battery life, not being able to fly for a long time, limited useful load carrying capacity, not being able to be used effectively in 3D modelling with vertical camera angles and being quickly affected by adverse weather conditions will also be corrected with the advancing technology.

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