SELÇUK ÜNİVERSİTESİ
SOSYAL VE TEKNİK ARAŞTIRMALAR DERGİSİ
1.Uluslararası Sosyal ve Teknik Bilimler Sempozyumu
USTEK'2022 Özel Sayısı
Dergi Ana Sayfası: http://sosyoteknik.selcuk.edu.tr

Kasım, 2022

ISSN: 2146-7226

Examining the types of unmanned aerial vehicles and their usage areas

Fuat BAŞÇİFTÇİ [a,*], ***Yusuf DOĞAN*** [a], ***Abdullah KARAAĞAÇ*** [a]

[a]*Karamanoğlu Mehmetbey University, Vocational School of Technical Sciences, Map and Cadastre Program, Karaman 70200, Türkiye*

Article Info

Article history:
Received 30 September2022
Accepted 1 November 2022

Keywords:
Cartography industry
Technology
Unmanned aerial vehicle (UAV)

Abstract

Recent advances in technology have led to the introduction of some innovations into people's lives. New studies in the field of aviation have led to the development of Unmanned Aerial Vehicles (UAVs), which are used for different purposes in military and civil areas, with the combined use of communication, electronics, and navigation technologies. UAVs are pilotless aerial vehicles that carry payloads and are automatically flown with their own power system by remote command. Unmanned aerial vehicles are preferred in engineering studies and different professions due to their high resolution, speed, low cost, and multiple flights. In addition, UAVs are used in many areas, as they allow easy measurement in areas that are dangerous for people and require precise movement. UAVs, whose usages are becoming more and more widespread day by day, are used primarily in cartography studies, geological and meteorological research, archaeological studies, agricultural applications, mining, disaster management, forestry, etc. used in professions. In this study, the possibilities, and types of use of unmanned aerial vehicles by different professional disciplines are emphasized. In this context, the areas where UAVs are used, and data collection and production methods are emphasized.

* Sorumlu yazar E-posta adresi: ffanbasciftci@gmail.com

1. Introduction

Today, developments in technology and science have helped some innovations to enter human life [1]. The increasing population, the decrease in natural resources, and the effects of people on air, water, and soil have made it important to measure and monitor the environment. With modern weather, and terrestrial and satellite-based technologies, data is obtained more accurately and quickly, and the results can be presented in different ways by making the necessary analyses [2, 3].

Studies in the field of aviation have led to the development of Unmanned Aerial Vehicles (UAVs), which are used for different purposes in military and civil fields today, with the use of communication, electronics, and navigation technologies together. Thanks to the cost, speed, and time benefits of the UAV, it has become widespread all over the world as it is in our country. In applications performed with the UAV, which is offered as an alternative to conventional methods; better spatial and temporal resolution and lower cost data generation are provided.

With the developing technology, UAVs are used in military studies, meteorological and geological investigations, natural disaster management, examination of archaeological sites, examination of landslides, international border patrol, forest fire detection, and examination of radiation levels [4–9]. In recent years, the Global Navigation Satellite System (GNSS) and high-resolution cameras have been integrated and it has started to be used in scientific studies for remote sensing, digital map production, and photogrammetry [10].

2. Unmanned Aerial Vehicle (UAV) Definition and Classification

In addition to various definitions of UAV made by more than one institution, there are also definitions made by academics.

According to the North Atlantic Treaty Organization (NATO), UAV; is defined as an aircraft that does not contain any living things, can fly remotely or autonomously, can be removed by loading certain equipment on its fuselage, and can return and land after completing the mission [11].

According to the Turkish Language Association, UAV; is defined as a vehicle equipped with the tools needed for the surveillance and control of a certain area in terms of security and flown by remote command [12].

According to the General Directorate of Civil Aviation (SHGM), affiliated with the Ministry of Transport and Infrastructure, a UAV; It defines it as an aircraft operated as a component of Unmanned Aerial Vehicle Systems, capable of flying continuously through aerodynamic forces, commanded by a UAV pilot remotely without a pilot on it, or designed and flown by an autonomous flight UAV pilot [13].

Although there is no specific definition in the academic environment for UAVs, the most preferred definition is They are aircraft that are not piloted, that are remotely commanded with various devices (camera, video camera, laser scanning device, GNSS, etc.) on them in accordance with the purpose of measurement, or that are flown autonomously by pre-planning the flight path [14].

As a result of commercial uses and developing technology, UAVs have been classified in various ways. Although UAVs are classified according to their altitude status in international environments because of the definitions made [15], SHGM classifies UAVs according to the load weight they can carry and their wing structures. UAVs are divided into the fixed wing (Figure 1a) and rotary wings (Figure 1b) in terms of wing structures.

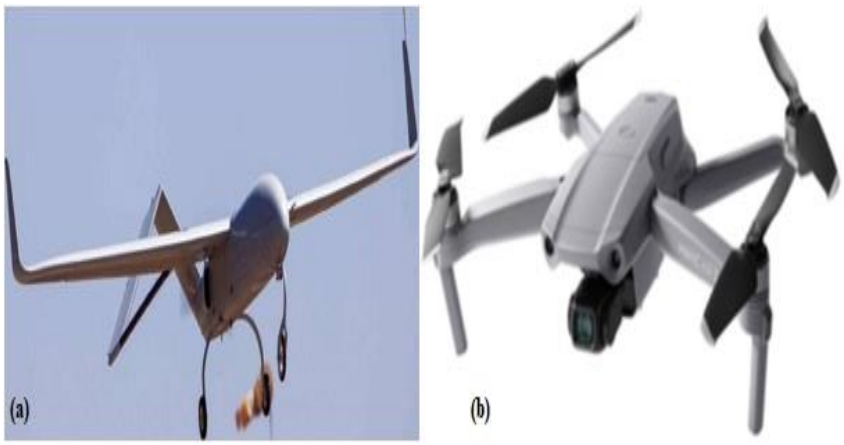

Figure 1. a) fixed-wing UAV, b) rotary-wing UAV

Fixed-wing UAV systems enable it to accelerate in the air by taking its power from the electric or internal combustion engine in the tail, which neutralizes air friction thanks to its thin wings. Thanks to the control surfaces inside its wings, it provides directional control and elevation in the air. Although these vehicles, which can glide in the air with this wing structure, have a long stay in the air, the limited ability to take off and land vertically is the shortcoming of fixed-wing UAVs [16]. Except for autonomous flight, it requires experienced skill when it is desired to control it with manual use. In these systems, due to the difficulties experienced during take-off and landing, a parachute is opened for landings and a launch pad or manual launch method is used for take-offs [17].

Rotary-wing UAVs are more preferred by users today in terms of ease of use and cost. In these systems, the motors simultaneously turn clockwise or counterclockwise to take off and gain manoeuvrability. Thanks to the balanced thrust of the propellers located at the front and rear, it is ensured to stay in the air stably [16]. The biggest advantage of rotary-wing UAVs is that they can land manually or automatically at a fixed point vertically during take-off and landing. This feature enables users to use it easily without the need for professional training. In addition, its high manoeuvrability, and ability to turn around and hang at a fixed point provide many advantages. In addition to the advantages of rotary wing UAVs, there are also disadvantages. Since they have a complex structure electronically and mechanically, their maintenance and repair are difficult. Due to their slow movement in the air and low flight times, multiple take-offs and landings are required to scan the work area. This increases operational time and budget [18].

UAVs are classified under four different headings according to the weight they lift [13]. These are

a) UAV0: Maximum take-off weight between 500 g (included) – 4 kg,
b) UAV1: Maximum take-off weight between 4 kg (including) – 25 kg,
c) UAV2: Maximum take-off weight is between 25 kg (included) – 150 kg,
d) İHA3: UAV3: UAVs with a maximum take-off weight of 150 kg (including) and more.

UAV0 and UAV1 group systems are mostly used in areas such as archaeological sites, disaster areas, mine sites, and construction areas, especially mapping studies in civil usage areas of unmanned aerial vehicles, according to the UAV Systems Instruction legislation.

When the worldwide classifications of UAVs are examined, it is seen that there are similar regulations with minor differences in the laws of China, Russia, Malaysia, England, Canada, India, Japan, EU and USA. Countries such as the UK, Canada and Malaysia accept the UAV1 upper class as 20 kilograms. [19].

3. Working Principle of UAV

UAVs: It is equipped with high-end devices such as GNSS, laser and infrared cameras. Unmanned aerial vehicles consist of cruise control mechanism, data link mechanism, launch/lift mechanism and power source. The front part of the UAV is where all the detectors and flight mechanisms are located. In the remaining part,

there are hardware and software mechanisms. The UAV is controlled manually with a remote command system. The rods on the control unit allow movements on different sides and allow the UAV to be adjusted by keeping the UAV in balance with the trim buttons. In addition, the screens in the remote-control mechanism are also used to obtain online video images from the fixed camera. In addition, UAVs can be flown independently with the help of GNSS at a certain altitude on a predetermined line. Autonomous flights made in this way have become more common today. This feature is an important reason for the increasing interest of civilian users in UAV technologies. [20].

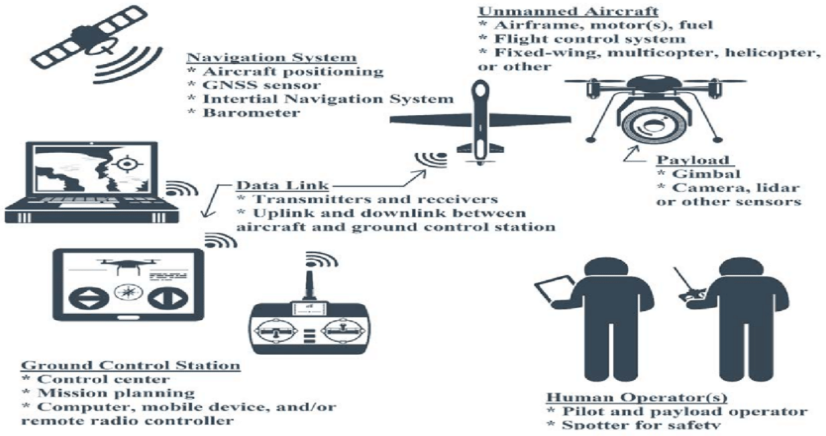

Figure 2. Components of UAV Systems

4. UAV Usage Areas

Due to the low cost and high performance, they provide, UAVs are among the important technologies used in aviation studies, as well as in military and civilian areas. The leading examples of UAVs in history were encountered during the First World War. In this context, UAVs have been used in reconnaissance, monitoring, surveillance, mapping, and offensive activities for military benefits. [21].

With the production of UAVs that can be used in civilian life because of technological developments, there are possibilities of use such as meteorological and geological investigations, international border patrol, natural disaster management, forest fire detection, mapping of the earth, 3D terrain or city modelling, deformation analysis, especially cartography activities [22]. Some usage areas of UAVs are explained below.

Usage in Agriculture: In agriculture, UAVs are generally used in precision agriculture. In addition, from UAVs; determination of plant diseases, rapid evaluation of biomass and vegetation, determination of the area covered by vegetation, investigation of plant status, determination of water stress in the plant, estimation of plant physiological changes, identification of weeds, identification of product damaged by natural events, observation of harvesting processes, It is also used for the purpose of estimating yield, determining the moisture status of the soil, examining the soil for the next growing period, and agricultural spraying [23, 24].

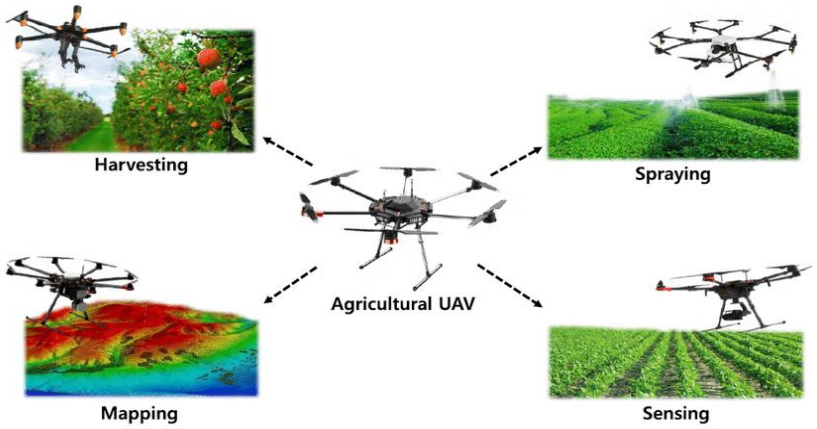

Figure 3. Use of UAVs in agriculture

Usage in forestry: It is used to determine the area to be intervened during the fire, to determine the area damaged after the fire, to monitor many activities that may harm natural life, such as unauthorized cutting or hunting activities in forest areas [25, 26].

Figure 4. Use of UAVs in forestry

Usage in Archaeology: Archaeological regions are places that change rapidly due to excavations and must be followed continuously. Unmanned aerial vehicles are frequently used to monitor excavations in archaeological sites [27] and to create digital elevation and digital terrain models of these regions [7, 28, 29].

Figure 5. Use of UAVs in Archaeology

Usage in mining: UAVs, which are used in all phases of open pit mining plans, in the creation of production maps, from field improvement studies to the control of step geometries and stability, are used extensively in the realization of short-time and sensitive area and volume measurements in mining areas [30].

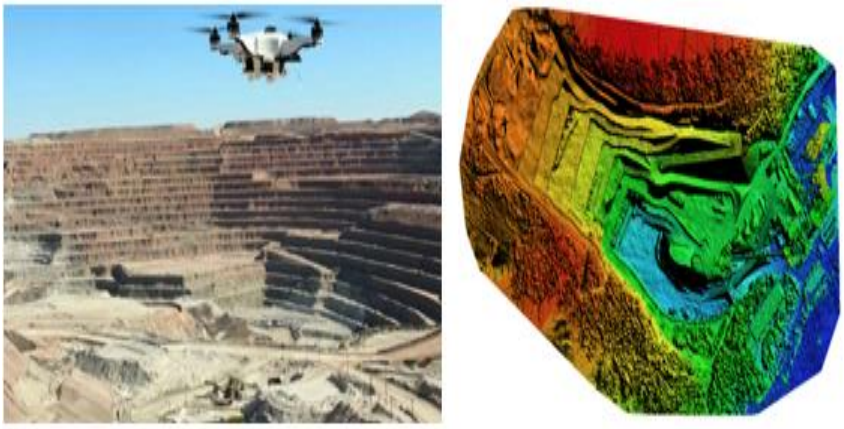

Figure 6. Use of UAVs in mining

Usage in Disaster Management: The development of the disaster management system is one of the biggest reasons to produce UAVs. UAVs are of great importance in quickly mapping the situation encountered in disasters caused by both artificial and natural causes and taking the necessary precautions. With the developing technology, UAVs are frequently used in the fight against disasters. These studies include monitoring the landslide areas and conducting situation investigations, rapid map production during and after the earthquake, evaluation of the current situation after hurricanes and storms, etc. can be described as studies [29].

Figure 7. Use of UAVs in Disaster Management

Usage in Energy and Telecommunication: It can be used in rural and mountainous areas where there are no base stations, in the detection of leakage on power lines, in the examination of thermal insulation in buildings and cities [26].

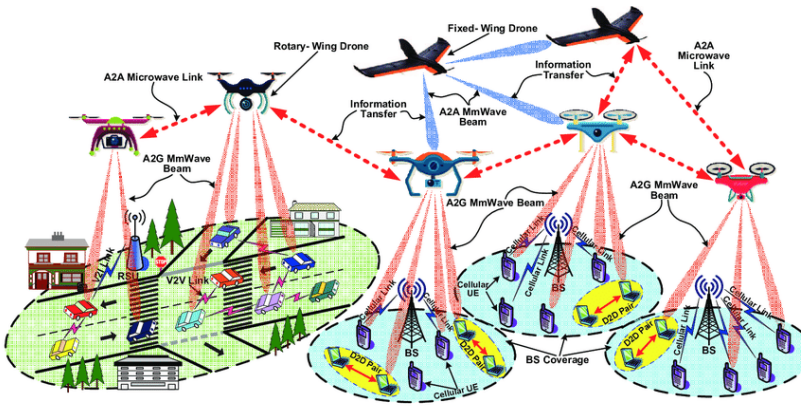

Figure 8. Use of UAVs in Energy and Telecommunication

4.1. Use of UAVs in Cartography

Today, UAVs in the cartography; It is used in many areas such as producing orthophoto maps and digital land models of settlement areas such as provinces, districts, towns and villages, mapping dam basins, mine sites, quarries, and consolidation and classification of lands in all volume/area calculations.

3D position accuracy is very important in UAV systems used in cartography activities. Thanks to the developments in technology and science in recent years, UAV systems have been strengthened with additional equipment to minimize this position sensitivity. UAVs used in photogrammetric studies are equipped with special camera systems suitable for their areas of use and different sensor systems suitable for their purposes. Generally, these sensor systems can be digital cameras, video cameras, thermal cameras, multispectral cameras, LIDAR systems or a combination of these [26].

Figure 8. Use of UAVs in Cartography

5. Advantages and disadvantages of UAVs

Some of the superior aspects of UAVs over classical measurement methods are listed below [22].

- It can give healthier results than classical measurement methods in cloudy weather.
- The most important advantage of UAVs over other methods is that they can be used easily in life-threatening areas and in application areas with high-risk potential. An example of risky areas; are volcano zones, chemical storage areas, earthquake zones, floods, etc. areas such as natural disasters and nuclear power plants.
- In classical methods, data is usually obtained after office work. However, in UAVs, this situation provides rapid and simultaneous data acquisition.
- UAVs are also used in the creation of high-resolution texture maps for digital surface models and 3D models. Rotary-wing UAVs can take pictures from a fixed point by moving the cameras on them horizontally and vertically, as they can take off vertically and stay in the air in a suspended manner. Thanks to these features, it can be used easily in creating 3D models or in special research.
- Although the cost varies according to the variety of technology used and the type of application, the studies carried out with UAVs can be done at a lower cost compared to other classical methods.

Besides the advantages of UAVs, there are also disadvantages [20]. These;

- Limited opportunity to work in windy weather,
- Limited time in the air,
- Limited flight altitudes,
- Problems during landing, take-off, and flight phases,
- Low carrying capacity,
- Being vulnerable to air attacks and defense systems,

Its ability to grasp hazards is weaker than piloted UAVs.

6. Conclusion

In this study, the types and usage possibilities of UAVs were investigated. Today, atmospheric research, investigation of archaeological sites, an inspection of high voltage lines, land monitoring, agricultural studies, natural disaster monitoring, landslide prediction, etc. UAVs, which are among the advanced technological tools, are used in engineering studies. In addition, UAVs are used in 3D land and city modelling, cadastral studies, and earth mapping applications.

Thanks to the developing technology, the use of UAVs in military and civilian studies has become widespread. The use of UAVs is increasing rapidly in engineering applications as a result of their convenience in hard-to-reach areas, the completion of the works in a short time, and the opportunities they provide in terms of economy and accuracy. By designing UAVs according to their intended use and equipping them with technical devices, they have surpassed other aircraft and classical measurement methods. With the increase in the use of UAVs, the demand for these vehicles is increasing.

Acknowledgment

This study was presented at USTEK 2022 (1st International Social and Technical Sciences Symposium) both as an oral presentation and as an abstract paper in the abstract book of the symposium. In addition, it was found appropriate to be directed to the "Selcuk University SosyoTeknik" journal by the USTEK 2022 scientific committee.

References

[1] Ö. Yıldırım, T. Susam, S. Yaprak, A. Delen, S. İnyurt, "The Availability of UAV Systems for Agricultural Purposes", *Journal of Agricultural Faculty of Gaziosmanpasa University*, c.33, s.3, ss.111-120, 2016. http://dx.doi.org/10.13002/jafag1127.

[2] F. Döner, S. Özdemir, M. Ceylan, "İnsansız Hava Aracı Sistemlerinin Veri Toplama ve Haritalama Çalışmalarında Kullanımı", *5. Uzaktan Algılama-CBS Sempozyumu (UZAL-CBS 2014)*, İstanbul, Türkiye, 14-17 Ekim 2014.

[3] H. Yılmaz, Ö. Mutluoğlu, A. Ulvi, A. Yaman, S. Bilgilioğlu, "İnsansız Hava Aracı İle Ortofoto Üretimi ve Aksaray Üniversitesi Kampüsü Örneği", *Geomatik*, c.3 s.2, ss.129-136, 2018. http://dx.doi.org/10.29128/geomatik.369553.

[4] F. Chiabrando, F. Nex, S. Piatti, F. Rinaudo, "UAV and RPV systems for photogrammetric surveys in archaelogicalareas: twotests in the Piedmont region (Italy)", *Journal of Archaeologica Science*, c.38, ss.697-710, 2011. https://doi.org/10.1016/j.jas.2010.10.022.

[5] U. Niethammer, M.R. James, S. Rothmund, J. Travelletti, M. Joswig, "UAV-based remote sensing of the Super-Sauze landslide: Evaluation and results", *Engineering Geology*, c.128, ss.2-11, 2012. https://doi.org/10.1016/j.enggeo.2011.03.012.

[6] L. Xiaofeng, P. Zhongren, Z. Liye, L. Li, "Unmanned Aerial Vehicle Route Planning for Traffic Information Collection", *Journal of Transportation System Engineering & IT*, c.12, s.1, ss.91-97, 2012. https://doi.org/10.1016/S1570-6672(11)60186-4.

[7] A.T. Mozas-Calvache, J. Perez-García, F. Cardenal-Escarcena, E. Mata-Castro, J. Delgado-Garcia, "Method for photogrammetric surveying of archaeological sites with light aerial platforms", *Journal of Archaeological Science*, c.39, s.2, ss.521-530, 2012. https://doi.org/10.1016/j.jas.2011.10.007.

[8] J.P. Malet, T.A. Bogaard, "Integration of technologies for landslide monitoring and quantitative hazard assessment", *Engineering Geology*, c.128, s.1, 2012. https://doi.org/10.1016/j.enggeo.2012.02.001.

[9] V. Yılmaz, A. Akar, Ö. Akar, O. Güngör, F. Karslı, E. Gökalp, "İnsansız Hava Aracı İle Üretilen Ortofoto Haritalarda Doğruluk Analizi", *Türkiye Ulusal Fotogrametri ve Uzaktan Algılama Birliği VII. Teknik Sempozyumu*, KTÜ, Trabzon, 2013.

[10] O. Öztürk, B. Bilgilioğlu, M. Çelik, S. Bilgilioğlu, R. Uluğ, "İnsanız Hava Aracı (İHA) Görüntüleri ile Ortogöruntü Üretiminde Yükseklik ve Kamera Açısının Doğruluğa Etkisinin Araştırılması", *Geomatik*, c.2, s.3, ss.135-142, 2017. https://doi.org/10.29128/geomatik.327049.

[11] B. Pakkan, M. Ermiş, "İnsansız hava araçlarının genetik algoritma yöntemiyle çoklu hedeflere planlanması", *Havacılık Ve Uzay Teknolojileri Dergisi*, c.4, s.3, ss.77-84, 2010.

[12] Türk Dil Kurumu Güncel Türkçe Sözlüğü 2022. "İnsansız Hava Aracı", https://sozluk.gov.tr/ Erişim tarihi: 05.08.2022.

[13] Sivil Havacılık Genel Müdürlüğü (SHGM) 2022. "İnsansız Hava Aracı Sistemleri Talimatı (SHT-İHA) ", https://web.shgm.gov.tr/documents/sivilhavacilik/files/mevzuat/sektorel/talimatlar/SHT-IHA_WEB.pdf. Erişim tarihi: 05.08.2022.

[14] M. Kahveci, N. Can, "İnsansız Hava Araçları: Tarihçesi, Tanımı, Dünyada Ve Türkiye'deki Yasal Durumu", *S.Ü.*

Müh. Bilim ve Tekn. Derg., c.5, s.4, ss.511-535, 2017. https://doi.org/10.15317/Scitech.2017.109.

[15] P.V. Blyenburgh, "UAVs: an Overview. Uninhabited Aerial vehicles (UAVs)", *Air and Space Europe*, Vol:1, No:5/6, pp. 43-47, 1999.

[16] H. Eisenbeiß, "UAV Photogrammetry", ETH Zurich for the degree of Doctor of Science, ISNN 0252-9335, ISBN: 978-3-906467-86-3, Zurih, Switzerland, 2009.

[17] A. Kesikoğlu, "Düşük irtifa görüntüleme sistemlerinin ortofoto üretiminde kullanımı", Doktora Tezi, Harita Mühendisliği Ana Bilim Dalı, Erciyes Üniversitesi, Kayseri, 2020.

[18] E. Gençerk , "İnsansız hava aracı fotogrametrisi uygulaması ile inşaat projesi imalat durumunun araştırılması", Yüksek Lisans Tezi, Geomatik Mühendisliği Ana Bilim Dalı, İstanbul Teknik Üniversitesi, 2016.

[19] M. Hassanalian, A. Abdelkefi, "Classifications, applications, and design challenges of drones: A review", *Progress in Aerospace Sciences*, c. 91, ss.99-131, 2017. https://doi.org/10.1016/j.paerosci.2017.04.003.

[20] A. Kabadayı ve M. Uysal, "İnsansız hava aracı ile elde edilen verilerden binaların tespiti", *Türkiye İnsansız Hava Araçları Dergisi*, c.1, s.1, ss.8-14, Aralık 2019.

[21] F. Remondino, L. Barazzetti, F. Nex, M. Scaioni, D. Sarazzi, "UAV photogrammetry for mapping and 3D Modelling Current Status and Future Perspectives". *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Vol. XXXVIII-1/C22, Zurich, Switzerland, 14-16 September 2011.

[22] M. Yakar, O. Mırdan, "Tarihi Eserlerin İnsansız Hava Aracı İle Modellenmesinde Karşılaşılan Sorunlar", *Geomatik*, c.2, s.3, ss.118-125, 2017, https://doi.org/10.29128/geomatik.306914.

[23] A. Urbahs, I. Jonaite, "Features of the use of unmanned aerial vehicles for agriculture applications", *Aviation*, c.17, s.4, ss.170-175, 2013. https://doi.org/10.3846/16487788.2013.861224.

[24] M. Akkamış, S. Çalışkan, "İnsansız Hava Araçları ve Tarımsal Uygulamalarda Kullanımı", *Türkiye İnsansız Hava Araçları Dergisi*, c.2, s.1, ss.8-16, 2020.

[25] G.J. Grenzdörffer, A. Engel, B. Teichert, "The photogrammetric potential of low-cost UAVs in forestry and agriculture", *Int. Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, Beijing, China, c.37, s.B1, ss.1207-1213, 2008.

[26] R. Çallı, "İHA Sistemleri ile Elde Edilen Ortofoto Haritaların Doğruluk Değerlendirmesi", Yüksek Lisans Tezi, Harita Mühendisliği Ana Bilim Dalı, Tokat Gaziosmanpaşa Üniversitesi, Tokat, 2021.

[27] M. Sauerbier, H. Eisenbeiss, "UAVs for the documentation of archaeological excavations", *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, Vol. XXXVIII (Part 5), Newcastle upon Tyne, United Kingdom, ss.526-531, 21-24 June 2010.

[28] M. Hendrickx, W. Gheyle, J. Bonne, J. Bourgeois, A. De Wulf, R. Goossens, "The use of stereoscopic images taken from a microdrone for the documentation of heritage–An example from the Tuekta burial mounds in the Russian Altay", *Journal of Archaeological Science*, c.38, s.11, ss.2968-2978, 2011. https://doi.org/10.1016/j.jas.2011.06.013.

[29] R. Çömert, U. Avdan, E. Şenkal, "İnsansız Hava Araçlarının Kullanım Alanları ve Gelecekteki Beklentiler", *IV. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu (UZAL-CBS 2012)*, Zonguldak, Türkiye, 16-19 Ekim 2012.

[30] M. Kun, B. Özcan, "Maden ocaklarında insansız hava aracı kullanımı: örnek bir saha çalışması", BAUN Fen Bil. Enst. Dergisi, c.21, s.2, ss.554-564, 2019. https://doi.org/10.25092/baunfbed.624484.