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Nemzetközi tudományos konferencia a Magyar Tudomány Ünnepe alkalmából

International Scientific Conference on the Occasion of the Hungarian Science Festival

Sopron, 2022. november 3.

3 November 2022, Sopron

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Application Areas of Drones: Exploratory Research from Residential and Corporate Perspectives

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Abstract
UAVs (Unmanned Aerial Vehicles), aerial robots, drones - whatever you call them, there is no doubt that their popularity has grown at an astonishing rate in recent years. Although for a very long time they were only seen at military bases and in movies, drones have now conquered the consumer market and revolutionised many industrial sectors. Today, drones are frequently used not only for military missions but also for simple everyday tasks. Whether it's for rapid parcel delivery, aerial damage assessment or even scientific projects, these remote-controlled flying devices offer a whole new range of possibilities for both everyday users and specialists. The paper is based on the review of the relevant literature and aims to explain the fields of application regarding the various flying devices.

Keywords: UAV, drone, logistics, military
JEL Codes: L62, L91, L93, O18

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1. Introduction

There are several definitions of drones. According to the NMHH, a drone, i.e. an unmanned aerial vehicle (Unmanned aerial vehicle), is an aircraft that travels in the airspace without a crew on board, under ground control or autonomously (Bodzsák, 2019). The use of drones in many areas has spread in recent years, mainly due to the technological progress and developments. Private individuals mainly use it for entertainment purposes or for security tasks, but many people also create businesses based on this device or supplement their range of services with it.

The use of drones dates back to the early 1900's. When it comes to the application of a new technological advancement for civilian purposes, there is a fairly high chance for it to be originated from military use. The earliest significant deployment of an early version of radio-controlled drones occurred in the middle of World War I in 1916, when the DH82B Queen Bee aircraft were initially used as aerial targets and soon after as Hewitt-Sperry automatic aircraft torpedoes. In the years following World War I, more and more emphasis was placed on the development of unmanned aircraft, as it was quickly realized that various combat tasks could be performed without the sacrifice of a pilot.

2. Classification of drones

Drones can be grouped according to different aspects. In their study, Füzesi et al. (2018) classifies them according to the following criteria:

Table 1: Classification of drones

Classification criteria	Structure	Weight	Performance
1	Fixed-wing	Very heavy weight	High performance
2	Unmanned helicopter	Heavy weight	Medium performance
3	Tilt-wing	Medium weight	Low performance
4	Multicopter	Light weight	
5		Micro weight	

Source: Füzesi et al. (2018)

Drones can be also distinguished by the method of take-off and landing (HTOL – horizontal; VTOL – vertical), or according to the location and number of wings and control planes, or even based on the body of the aircraft structure and the design of its landing gear (Békési & Seres, 2020).

The civil application of unmanned aerial vehicles can be divided into three large groups:

- Unmanned toy aerial vehicles,
- Unmanned aerial vehicles,
- Unmanned governmental aircraft.

The first group includes aircraft belonging to the toy category. The second group includes all civil drones that perform recreational, hobby or commercial activities. The third group includes applications and tasks performed by governmental bodies and organizations in the public interest. These are collectively called public service applications. The use of state aircraft can be aimed at performing a specific task more efficiently, such as law enforcement, environmental protection, border protection, assistance, disaster prevention. The tasks of the second and third groups are not sharply separated from each other, there may be overlaps to be noticed (Füzesi et al., 2014).

Depending on the area in which such a system is used, its building blocks will differ greatly, from the type, structure, and size of the drone to accessories suitable for the task, such as sensors and cameras, but this also includes software support. A drone system and its complexity can range from a very simple leisure system, through aircraft performing commercial activities and public duties, to a structure with special knowledge applied to various scientific researches. Thus, the field of application greatly influences how complicated a system is required to be, how many components it will be built from, what tasks it will have to perform and with what accuracy it will solve the goal set for it. That is why unmanned aerial vehicles can be classified and grouped according to many different parameters. In many cases, there is no clear definition of terms for each property or function by which the primary grouping is formed.

3. Application of drones

3.1. Security and protection

A site is defined as an object within which protected material such as equipment, process or person are located, and the boundaries of which are well defined. In the event of a security incident involving a site (whether a peaceful demonstration or an armed attack), the success of

the response may depend on the commander's understanding of the area of operations, the location and movement of the perpetrators. This requires the premises to be covered by CCTV, which can be extremely costly over large areas. This system usually consists only of normal CCTV cameras, so they are not usable in limited visibility conditions and may even provoke protests from employees or trade unions (due to the lack of continuous surveillance and privacy in the workplace). In the case of a more serious prepared attack, the operational capability of the existing CCTV system cannot necessarily be counted on, as the initial step may be to disable or disrupt it. These problems can be overcome by deploying one or more UAVs, similar to military applications (Kovács-Viplak, 2017).

At the start of the incident, a drone controlled from the watch centre (or from a deployed command post) drone sent from the command post towards the area of operations, the perpetrators and their clothing, equipment and weapons can be identified. Their movements can be tracked, if necessary using infrared or thermal cameras. The image can be relayed to the commander of the intervention force on the ground, making it easier for him to identify the target to be neutralised (in the case of a demonstration, the people to be extracted from the crowd). In addition to the perpetrators, the movement of the own forces can be monitored, ensuring that they are deployed in the right place. The footage, if recorded, can be used for subsequent investigation and evidence, and can also be replayed for evaluation and training purposes in the case of exercises. An exercise using unmanned aerial vehicles for this purpose was carried out in the United States in 2004, where more than a hundred law enforcement and emergency response professionals were able to see the use of drones.in various scenarios (Herwitz et al., 2004).
Industrial facilities and sites are often established far from settlements, which results in them being surrounded by areas that are difficult to walk, but an invading force can approach the protected object, even through hidden routes or paths. That is why it may be necessary to develop some kind of detection.

An extreme example of this in Canada, the building on the shores of Lake Huron, the nuclear power plant operated by Bruce Power is considered one of the largest in the world with its eight units. Its area is 932 hectares and mainly pine forest is surrounded (Global Security, 2002).

Another problematic area is the control of borders between countries, where often not only the difficult terrain, but also the large area to be controlled causes problems. Drones can help deal with these problems. In the designated areas, depending on the facility and protection purpose, regular or periodic patrolling is required at a higher level of defence readiness. Drones are able to fly under human control or on a pre-programmed route, to find, detect or identify persons appearing in areas. The recording can be recorded and retrieved later if necessary. In the case of programmed patrolling, continuous manpower is not required control, if the image of the infrared camera installed in the vehicle is analysed by video analytics and indicates if it finds a heat source similar to the human body. With proper programming, the drones detect a low battery charge and automatically fly back to the charging point, from where another UAV can take off and start patrolling. With this solution, it is enough to increase the presence of manpower in the monitored area or introduce other temporary measures in case of bad weather conditions when the drones cannot fly safely. In the early 2000s, the United States already used UAVs to control its borders for testing purposes. Although the technological development at the time and the operating costs did not yet justify the use of drones, due to their inherent potential, a 2010 report for Congress urged the initiation of extensive investigations in order to integrate the machines into border protection (Haddal-Gertler, 2010).

An example of its use is when a forcible intrusion into the area of a protected object leads to a firefight, during which a member of the repelling forces is hit by a shot. As long as the area cannot be secured, the workers of the rescue service cannot go near it. An unfortunate occurrence is the Los Angeles International airport was attacked on November 1, 2013, when a lone

gunman opened fire, during which a member of airport security was shot. Due to the poor coordination between the ambulances and the police, as well as the slow securing of the area, the wounded agent bled to death 90 meters from the ambulances (Pauli et al., 2004).

A drone in such a situation can deliver a first aid kit to the injured person without endangering the lives of others (the aircraft can also help the prevention forces by confusing and distracting the perpetrators). The injured person or his partner who is next to him can treat the wounds and stabilize his condition. In this way, not only equipment for treating the injured can be transported through the operational area, but also other vital equipment and items.

At a site, the first aid stations are not located at equal distances and facility ambulance services are not available everywhere. If someone is injured or knocked unconscious on the job, a high-speed drone can reach them with equipment faster than any patrol or paramedic. It can be seen from this that this method of use can be useful not only during extraordinary periods, but also during everyday life, thereby increasing the sense of security and satisfaction of employees (Herwitz et al., 2004).

3.2. Agriculture

Companies now offer a wide range of drones for agriculture. By introducing drone technology, farms can improve their long-term economic results. Drones can be very well used to collect a variety of image-based data that can be used to determine the condition of crops, fields and livestock. The most commonly monitored variables for crops include plant height, plant number, plant health, water supply, nutrient availability, disease presence, weed presence, wildlife damage, storm damage and internal water damage. With the help of high-capacity drones, fast and precise work can be carried out including spraying and spreading fertilizers. By flying unmanned systems at low altitude, the farmers can obtain reliable data at low operating costs, and the use of these devices also helps the planning and monitoring processes (Zhang & Kovacs, 2012).

UAV systems significantly contribute to the revolution of crop protection technology in agriculture. Devices equipped with microcontrollers, sensors, NIR and multispectral cameras, and GPS support the farmer in the effective use of plant protection agents, taking into account the properties and types of soil and plants. Thanks to the vertical movement, UAV devices can also fly into hard-to-reach locations (Anderson, 2012). According to the earliest reports of agricultural utilization, hobby-quality models were used, later, in the 1980s, they experimented with uniquely designed and built drones. Based on the pioneering researches of Tomlins and Lee (1983), Hardin and Hardin (2010) managed to identify more than 46 environmental applications where smaller drones could be useful.

The DJI Phantom 4 Multispectral is the most commonly used UAV in agriculture, given the fact that this high-precision drone of the Chinese company DJI was developed for mainly agricultural purposes. The new data collection drone with its built-in stabilized integrated multispectral imaging system can be used very efficiently for agricultural tasks, environmental monitoring and other purposes.

The UAV is built with 6 cameras, visible light (RGB), red edge (RE), near infrared (NIR), green (G), red (R) and blue (B) sensors, which makes it possible to take pictures with high resolution. Easy access to the aerial data produced in the production area and, after their processing, the application of plant-specific indicators and parameters can facilitate the implementation of more economical crop production (DJI, 2022).

American Robotics also develops drones specialized in agricultural automation. The ScoutSystem offers a fully automated drone solution for agricultural data collection from take-off to landing, from data collection to data processing, from drone storage to charging. After installation of the ScoutSystem, the data collection drone performs its task independently, ac-

cording to its programming, without any human control. Scout drones can even stay at a Scout-Base located near the crop area. Upon command, the top of the charging and data processing base opens, the drone flies out and performs its data collection task, after which it flies back and lands on the base. The processed data are sent to the office of the large agricultural company for further use and analysis through Internet. One or more independent, autonomous drones can be operated separately and they can be instructed to perform data collection and data processing tasks at any time, even on a daily basis (Accesswire, 2022).

Infrared camera recordings are very beneficial for monitoring plant populations. With their help, among other things, plant diseases can be detected in time, the vigour of germination can be judged, or the recordings make the yield estimate more grounded. Irrigation irregularities can also be easily detected with infrared camera recordings. During the movement of the drone, a mechanism constantly adjusts the position of its camera so that the recording is perpendicular to the surface (ortho recording). On request, a picture from a different angle can be produced at any times. The use of drones in carrying out various agricultural technological operations, mainly material application, is already starting to go beyond the experimental phase. In addition to the significant advantages and opportunities provided by monitoring, there are also limitations. The measurement and data collection technology used does not allow viewing under the leaf or canopy. Drones are often supplemented with other microbots. The mobile microbots developed and manufactured for agricultural use are equipped with wheels, so they can also perform surveying and monitoring work in the area under the leaf or canopy. Robots equipped with a robotic arm can also perform other tasks. Such a task can be, for example, the installation and collection of wireless network units (Mote), as well as the collection of soil or plant samples.

The method of precision crop production has been widely recognised and applied, the size of the crop area, the intensity and efficiency of cultivation fundamentally affect production costs and economic efficiency. With the spread of mass production of technical devices, it is expected that the price of measuring devices, instruments and machines will decrease, which will contribute to the spread of farming methods that take quality and environmental conditions into account (Rodrigez et al., 2012).

3.3. Logistics processes

The use of drones in the field of logistics and transportation can be a solution for improving environmental protection effects or alleviating labour shortages and by avoiding traffic within a given range, drones are able to deliver packages with a weight corresponding to their capacity in a shorter time, and can even easily deliver their shipment to locations that are difficult to access, all in a contactless manner, and moreover, more cost-effectively (Francuz & Bányai, 2021). The use of drones can also have beneficial effects from an environmental protection point of view, the energy consumption of vehicles and the emission of harmful substances can be reduced (Füzesi et al., 2018).

The research of Restás (2021) points out that the use of drones can also play an important role in the health sector, for example small packages - medicines, bandages, etc. – residential or institutional home delivery, or disinfection of public areas by drone spraying. Part of the transport of blood products and laboratory samples can also be solved with the help of drones (Trencsányi, 2019). Füzesi et al. (2018) emphasized that ready-made food delivery can be carried out using drones. Several companies have already used pilot systems in the last mile delivery of goods, in which they successfully tested the application possibilities of drones in their work processes. Most of these are shipping companies, such as Amazon, which successfully tested home delivery of packages weighing a maximum of 2.25 kg, or DHL, which was able to deliver medicine to Ukerewe Island in Tanzania in 4 kg packages. However, the tests of Daimler are also worth mentioning, where using a hybrid version, trucks and drones worked together to

deliver packages weighing a maximum of 2 kg. Based on the application, a table was created (Table 2) in order to summarise the concepts by region, nature of package, weight, mass and range of the drone (Bóna & Sárdi, 2021).

Table 2: Current application of drones in logistics

	System name	Concept, nature of package delivery	Drone mass	Drone capacity	Drone range
Delivery of food	Yonghui, China	Traditional (package delivery)	n.i.	5 kg	19 km
	Tesco, Oranmore, Ireland	Traditional (package drop)	n.i.	4 kg	n.i.
	AHA, Reykjavik, Iceland	Traditional (package drop)	10 kg	3 kg	10 km
	Walmart, Fayetteville, USA	Traditional (package drop)	n.i.	2,9 kg	n.i.
	Uber Eats, San Diego, USA	Combined with passenger cars	n.i.	n.i.	10 km
	Pizza Hut, Bnei Dror, Israel	Traditional	n.i.	n.i.	n.i.
Delivery of medicines and health products	DHL Paketkopter, Tanzania	Traditional (package delivery)	n.i.	4 kg	65 km
	UPS-CVS, USA	Traditional (package drop)	9,5 kg	4 kg	20 km
	Health Service Executive, Moneygall, Ireland	Traditional (package drop)	n.i.	4 kg	n.i.
	DHL Paketkopter, Norddeich-Just, Germany	Traditional (package delivery)	n.i.	1,2 kg	12 km
	DHL Paketkopter, Bonn, Germany	Traditional (package delivery)	n.i.	1,2 kg	1 km
	Walmart, USA	Traditional (package drop)	n.i.	n.i.	1,61 km
Mixed delivery of food and medicine	EASE Drones, USA	Traditional	10 kg	2,9 kg	10 km
	Google Project Wing, Christiansburg, USA	Traditional (package drop)	n.i.	1,3 kg	19,3 km
	Google Project Wing, Canberra, Australia	Traditional (package drop)	n.i.	1,5 kg	14 km
Delivery of small packages	UPS International	Traditional (package drop)	12 kg	6 kg	45 km
	DHL, Guangzhou, China	Combined with a parcel machine	n.i.	5 kg	8 km
	Amazon Prime Air, Cambridge, England	Traditional (package drop)	n.i.	2,25 kg	16 km
	Daimler, Vans&Drones, Zürich, Switzerland	Combined with trucks	9,5 kg	2 kg	20 km
	DHL Paketkopter, Reit im Winkl-Winklmoosalm	Combined with a parcel machine	n.i.	2 kg	8,3 km

Source: Füzesi et al. (2018)

4. Data protection and other issues

Even though drones and various UAV's are widely used on an international basis, the legal requirements highly vary by region and state, therefore, the acquisition of a permission could be difficult in some cases.

Several legal issues arise in connection with the use of drones, including a number of data protection issues that await a clear settlement. Although a comprehensive legislation has not yet been enacted in Hungary on the subject, the National Authority for Data Protection and Freedom of Information summarized in a recommendation the most important data protection aspects related to the use of drones for state, commercial and private purposes in 2014 (NAIH, 2014).

In general, the use of drones is not a data protection problem, but rather the data management carried out with accessories that can be mounted on drones. The main issue arises from the fact

that even the intended use can represent a very strong intrusion into the private sphere of the person, since the device is able to indiscriminately collect data on everything that comes into its view, a view that is unusual compared to the experience of using similar technologies. Although the use of drones is not primarily problematic from a data protection point of view, the use of complementary devices that are also suitable for recording personal data at the same time bears with a significant impact beyond specific data management as they can have an effect on the private sphere, since the perception of their presence alone can create a feeling of intrusion into the private sphere, therefore data management can even be implemented without the person concerned noticing or being aware of it (Haddal & Gertler, 2010).

Besides the privacy and data protection issues, the application of drones on a wider scale highly depend on a range of technological factors: the capacity is considered as the main hurdle. Even though users can already choose from a wide variety of devices, short battery life and inconstant location data still remain obstacles to be tackled. UAV's are heavily threatened by external forces such as extreme weather conditions, animals and other environmental factors. The weight of payload has been considered as an additional source of issue, however, there are already drones available that are able to carry more than 2 metric tonnes of supply in war zones, which means that based on the technological capabilities, it should not pose and issue.

However, it must be mentioned in connection with heavy payloads, that using drones for logistics in heavily populated areas raise questions regarding safety requirements (Ballve, 2015).

5. Conclusion

The application of drones can be already seen on an international basis, for a wide range of different purposes. Even though their military use still remains prevalent, they can be clearly seen to be applied in both residential and corporal purposes. The advantages have been recognised in various industries, however, there are several disadvantages and barriers users have to face.

The use of unmanned aerial vehicles also has its dangers and limitations. The biggest problem is the regulatory system, the lack of legal framework, its inaccuracy, its differences from country to country, and in some cases its obsolescence. Another extremely important source of danger is the issue of flight safety. Not all models have an object avoidance function, therefore, it can easily happen that the drones collide with something, collide with another aircraft, crash, causing damage to both the transport device and package, as well as to the environment (people, animals, plants, buildings, means of transport, etc.). In light of these, it is not surprising that their insurance is not smooth either, and controlling and professionally handling these flying robots is not an easy tasks. The limits of the use of drones include the finiteness of their capacity, the parameters of the packages (weight, size), and the distance to the destination. Last but not least, the issue of personal rights is also problematic for the models making the recording.

Even though there is a wide range of obstacles drone users face when it comes to their applications, based on the literature review, their use is prospected to become parts of our everyday life, once the main legal and technological hurdles can be resolved.

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