Chapter 2

Perspectives for the use of drones in security issues: advantages and shortcomings

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Abstract: In the last ten years, unmanned aerial vehicles have gained immense popularity, especially in the most developed countries of the world. The scope of the use of drones is quite extensive, hence it opens a wide variety of possibilities for non-regulated acts. Due to rapid development of technologies and lack of legislations, drones pose a threat for private life and civilian health safety. This article analyzes the scope of the use of drones with their advantages and disadvantages, as well as the prospects for the development of drone industry. This article seeks to answer questions concerning where and how drones could be used in civilian spheres, and what are the main threats and measures to counter the illegal use of drones.

Keywords: UAV, Unmanned Aerial Vehicle, drone, detection, security, threats, measures, network, monitoring, surveillance, system, devices, control, safety, potential, technology.

Introduction

The industrial revolutions that have taken place in recent history have led to rapid scientific and technological progress in all areas of human activity, particularly in the development and use of the aircraft. Moreover, the contemporary speed of development of technologies along with the globalization process undoubtedly leads to an uncontrollable increase of security issues. The growing number of uses for drones can be both a security threat and an effective method of dealing with a range of security issues.

The first drones were primarily used for tactical purposes, as was the case for the first cell phones. The use of unmanned aerial vehicles as a weapon

goes back to the siege of Venice in 1849, when explosive balloons were launched into the city by Austrian armies. The true origins of military drones, however, are usually linked to the development of remote-controlled aircrafts used after World War I as anti-aircraft targets[41].

Unmanned Aerial Vehicle (UAV) – an aircraft without a crew on board, can have varying degrees of autonomy – from remotely controlled to fully automatic, as well as have differences in design, purpose, and many other parameters. From an etymological point of view, an unmanned aerial vehicle is a collective term that encompasses all types of aircrafts that cover a distance in the air without the direct participation of a person (pilot). Moreover, takeoff and landing, determination of the flight trajectory, including its duration, and other impacts on the aircraft by means of special devices (remote controls) is also indirect use of the UAV[42].

Each drone is developed for specific purposes, so there are several types of them: unmanned aircraft, unmanned helicopters, unmanned balloons. They are also subdivided into types depending on the size: micro, mini, medium, and heavy. And according to the features of the control, they are divided into controlled, automatic, and uncontrolled. Despite the existing structural differences and modifications, it should be noted that all of the above devices are types of UAVs, so it would be advisable to consider them in a general context[43].

The dominant industry in the development of unmanned aerial vehicles has been, and remains, the military. Today, almost all developed countries of the world are developing military unmanned aerial vehicles. This is due to the fact that UAVs are more mobile than a reconnaissance detachment, are slow-moving and imperceptible to the enemy, are capable of covering an area of a large radius, can stay in the air for more than 40 hours, and transmit information in real-time. One of the main motivations for the

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[41] Cyprian Kozera. Military Use of Unmanned Aerial Vehicles – A Historical Study. Safety & Defense. (2018) 4. 17–21. doi: 10.37105/sd.4.

[42] Kardasz P, Doskocz J, Hejduk M, Wiejkut P, Zarzycki H (2016) Drones and Possibilities of Their Using. J Civil Environ Eng 6: 233. doi:10.4172/2165-784X.1000233.

[43] Riham Altawy and Amr M. Youssef. 2016. Security, privacy, and safety aspects of civilian drones: A survey. ACM Trans. Cyber-Phys. Syst. 1, 2, Article 7 (November 2016), DOI: http://dx.doi.org/10.1145/3001836.

delivery of UAVs is that the vehicle has no crew. Even if the enemy noticed the drone and managed to hit the target, the pilot will not be hurt.

Drones show their effectiveness not only on the battlefields but also serve civilian purposes. There have been many issues with the ubiquitous usage of drones today, ranging from safe flights, legal regulations for use in public areas, privacy and family life, terrorist threats, and far more. Because of the absences of legislations and regulations, drones can be conveniently used for illicit activities, such as both surveillance and unlawful monitoring[44].

The widespread proliferation of drones has created threats to intrusions and citizens' privacy. It should be noted that international documents have recognized the right of citizens to inviolability of private life as a fundamental concept. The Universal Declaration of Human Rights states that no one may be subjected to "arbitrary or unlawful interference with an individual's privacy, family, home or correspondence, and of unlawful attacks on his honour and reputation"[45].

Drones are increasingly being used to promote public safety by offering affordable, easy-to-operate, yet analytically advanced remote sensing solutions that resolve the technological challenges of public safety, including search and rescue, response to hazardous situations, extinguishing of construction and forest fires, remote location distribution of medicines, and much more.

The global market for unmanned aerial vehicles is showing significant growth with great prospects in the near future. The main factors contributing to the growth of this market include the increase in the military budgets in a number of countries, as well as the expansion of the use of UAVs in the commercial sector. However, the lack of specific legal regulations is the main constraint on the growth of the UAV market during the forecast

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[44] Riham Altawy and Amr M. Youssef. 2016. Security, privacy, and safety aspects of civilian drones: A survey. ACM Trans. Cyber-Phys. Syst. 1, 2, Article 7 (November 2016), 25 pages. DOI: http://dx.doi.org/10.1145/3001836.

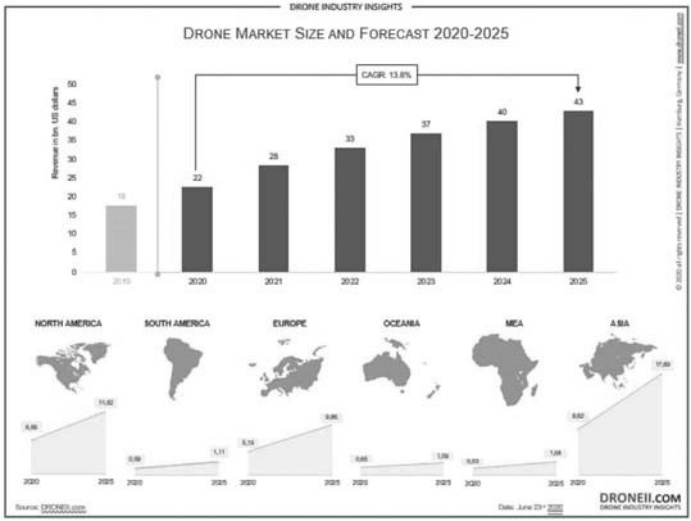
[45] "Universal declaration of human rights," 217(III) International Bill of Human Rights, 1948. (International Covenants on Human Rights, art. 17) https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_217(III).pdf.

period. As technology advances, drones are becoming more ubiquitous and affordable, leading to a debate in which their benefits are weighed against the new ethical and legal challenges they are creating.

Given the affordability and growing technical capabilities of drones, a wide range of illegal activities should be expected with their use. It can be banal industrial espionage using high-resolution cameras installed on drones, listening equipment, or equipment for hacking wireless networks, it can be unauthorized delivering objects inside the perimeter or transporting them outside, it can even be a targeted attack on sensitive nodes of the object using the very drone or explosives delivered on it[46].

The remotely controlled unmanned aerial vehicles considered in this article, have significantly decreased in size, equipped with modern microelectronic control devices, navigation, video surveillance, and miniature electric motors, have turned from a hobby into a device for mass use for household and other human needs.

Figure 1: Future Forecast for Drone Market Worldwide



[46] Winkler, Stephanie, Sherali Zeadally, and Katrine Evans. "Privacy and Civilian Drone Use: The Need for Further Regulation." Ieee Security & Privacy 16, no. 5 (2018): 72–80. https://doi.org/10.1109/MSP.2018.3761721.

There are several spheres of human life where drones could be integrated:

A. Medicine
German non-profit group Definetz has proposed the use of drones for the emergency delivery of defibrillators and other medical supplies in cases where it is impossible to wait for the arrival of a medical team[47]. So, for example, in the event of an attack of myocardial infarction or cardiac arrest, the count goes on for minutes, and the first aid provided on time will save the patient's life. In the medical field, drones can be used to deliver medical supplies to remote rural areas.

B. Filming
In cinematography, video filming from a bird's eye view creates new perspectives and opportunities for improvisation in creativity that were not possible before. Drones are already being used for on-the-spot reporting and sporting events. Another area of their application is the creation of documentaries about wildlife[48].

C. Agriculture
In agriculture, using drones, information is collected on the state of the cultivated areas, the degree of maturity of plants, the need for irrigation is assessed, and spot treatment of foci of diseases is carried out[49]. Prompt detection of plant diseases allows you to make a more accurate decision on their treatment and monitoring the situation.

D. Oil and gas industry
Standard approaches to monitoring oil and gas pipelines are complemented by drone surveillance. Signals from sensors for monitoring

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[47] Mackle, C., Bond, R., Torney, H., Mcbride, R., Mclaughlin, J., Finlay, D., Biglarbeigi, P., Brisk, R., Harvey, A., & Mceneaney, D. A Data-Driven Simulator for the Strategic Positioning of Aerial Ambulance Drones Reaching Out-of-Hospital Cardiac Arrests: A Genetic Algorithmic Approach. IEEE journal of translational engineering in health and medicine, 8, 1900410. 2020, https://doi.org/10.1109/JTEHM.2020.2987008.

[48] K. Collins "Behind the mind-boggling shots captured by BBC drones," 2014. https://www.wired.co.uk/article/bbc-drone-journalism.

[49] Tripicchio, Paolo & Satler, Massimo & Dabisias, Giacomo & Ruffaldi, Emanuele & Avizzano, Carlo. (2015). Towards Smart Farming and Sustainable Agriculture with Drones. International Conference on Intelligent Environments, Prague, 2015, pp. 140–143, doi: 10.1109/IE.2015.29.

and detecting leaks are used to identify the current state of pipelines and assess the environmental situation[50]. High-quality real-time images allow you to quickly detect oil spills and identify unauthorized activities in protected areas.

E. Emergencies
Drones are used in rescue operations by emergency services to find lost people where access without special equipment is limited, for example, in mountainous areas[51]. Drones can also quickly deliver life-saving appliances, food, and water to disaster sites, to fire, or earthquake areas.

F. Environmental Monitoring and Civil Science
Drones are used to study the melting of polar ice, with their help they determine the migration routes of animals, detect unauthorized dumps, fight poachers, identify cases of violation of environmental legislation, determine the level of pollution, as well as the impact of various pollutants on the global environmental situation[52]. A very promising concept in this direction is the concept of citizen science, which is understood as conducting scientific research with the involvement of a wide range of volunteers (citizen scientists). It is proposed to use a network of drones of citizens-scientists for integrated observations in different geographical areas. An important component in the drone network is the coordination of their actions and the transmission of images to a single monitoring center, which is necessary for the effectiveness of observations and ensuring the accuracy of research in cases of single drone failures.

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[50] T. Kh. Fataliyev, Sh.A. Mehdiyev, "Analysis and new approaches to the solution of problems of operation of oil and gas complex as a cyber-physical system," International Journal of Information Technology and Computer Science (IJITCS), 2018, Vol.10, No.11, pp. 67–76, doi: 10.5815/ijitcs.2018.11.07.

[51] S. Waharte, N. Trigoni, "Supporting search and rescue operations with UAVs," International Conference on Emerging Security Technologies, 2010, pp. 142–147, doi: 10.1109/EST.2010.31.

[52] Ivosevic, Bojana & Han, Yong-Gu & Cho, Youngho & Kwon, Ohseok, "The use of conservation drones in ecology and wildlife research," Ecology and Environment, 2015, Vol.38, No.1, pp. 113–188, doi: 10.5141/ecoenv.2015.012.

The use of drones is not limited to these examples. You can also note archeology, construction, journalism, geodesy, volcanology, etc. This brief overview suggests that the use of drones is a very necessary and relevant area.

The number of active drones continues to grow steadily. It can be predicted unmistakably that as their number increases, there will be more threats to information and physical security, and privacy threats and invasions of privacy. Drones can be controlled either remotely or autonomously using onboard computers. In fact, a drone is a model of a cyber-physical system[53]. The physical elements on board of the drone use a network of sensors and actuators that communicate with the ground control system over a wireless link. Therefore, the drone system is vulnerable to attacks targeting cyber-physical elements, the interface between them, wireless communication, or even a combination of several components.

There are also publications that provide information on the technological possibilities of introducing hardware Trojans directly at the stage of microchip manufacturing[54]. Environmental factors (weather conditions, birds, etc.) can lead to the termination of the operation of drones: functional failure or inability to conduct video surveillance.

An important issue in the use of drones is their integration into the national airspace while ensuring a high level of physical security. It is difficult to imagine a situation when, on a cargo delivery mission or carrying out journalistic activities, a drone, due to a malfunction, will fall on crowded places, damage power lines, or interfere with airports and other important government agencies. Unfortunately, this happens. The use of drones poses the task of controlling the airspace and separating it from manned aircraft (airplanes and helicopters).

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[53] Riham Altawy and Amr M. Youssef. 2016. Security, privacy, and safety aspects of civilian drones: A survey. ACM Trans. Cyber-Phys. Syst. 1, 2, Article 7 (November 2016), 25 pages. DOI: http://dx.doi.org/10.1145/3001836.

[54] Villasenor, John. "The Hacker in Your Hardware." Scientific American 303, no. 2 (2010): 82–87. http://www.jstor.org/stable/26002135.

Countering threats

Measures to counter such threats today are conditionally divided into three categories:

The first category is preventive and prophylactic measures. This may include geolocation restrictions, which the designers have applied to drone applications. The device will turn in the opposite direction, against all the attempts of its pilot, approaching the boundary of the zone, which is 'firmwared' as a no-fly. The debate remains unanswered as to how drone manufacturers can incorporate all the objects they wish to defend from such a threat to the no-fly zone blacklist. Moreover, drone users are in a position to unlock flights over certain jurisdictions, with the exception of the most relevant ones from the point of view of state security. The security threat issue remains unanswered[55], however, information boards along the perimeters of secured objects can have a certain deterrence impact. In addition to the standard "Restricted zone," "Passage prohibited," "Using drones closer than... meters from the fence is prohibited" may be added to banners.

Drone security measures (remote detection of drones) at the most secure locations are **the second type**. In this field, the production of equipment operating on or incorporating various concepts is being actively carried out. Few international vendors have already launched very powerful drone detection systems to the market for both urban and open space environments.

There are several different approaches to drone detection today:

Acoustic drone detection. UAV acoustic detection systems are simple to install and run, do not need authorization for special services, and are equally successful both during the day and at night. Acoustic detection of drones can be sufficiently long-range and resistant to barriers such as plants, cables, and antennas. However, a high degree of background noise can create a problem

[55] Waddell, Kaveh. "The Invisible Fence That Keeps Drones Away From the President." https://www.theatlantic.com/technology/archive/2017/03/drones-invisible-fence-president/518361/.

for a system operating on this concept in an urban environment. For suburban services, however, these systems are more appropriate[56].

Optical drone detection. Unmanned aerial vehicle optical detection technology is conveniently incorporated into the current surveillance scheme of the site since it is a high-resolution camera. Specific software tunes them to aerial objectives of limited size and enables one to monitor a video of the drone's approach to the object. For dense urban environments, visual drone detection is ideally suited, since it has a relatively limited range and allows for any amount of noise. Its downside is that amateur-assembled drones frequently have shapes that are too distinctive from those found in the database of the network, and so they may not be recognized[57].

Radar drone detection. The use of Doppler radars[58] for detecting drones is associated with some legislative restrictions (dual-use equipment) and the rather high cost of such systems. However, the undeniable advantage is the variety. The drone can be identified a few kilometers away from the covered object, giving enough time for countermeasures to be taken. For radar drone detection systems, special configurations make them unresponsive to birds and manned aircraft.

Radio frequency drone detection. Another principle that addresses the issue of background noise, low visibility, and short range may be the identification of drones from signature radio signals. However, modern drones are not always radio-controlled, and their flight routes can be configured via GPS, so radio-frequency drone detection systems are not always successful[59].

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[56] Samuel Huber, Peter Wellig, Kurt Heutschi, "Determination of the detection threshold of human observers in acoustic drone detection," Proc. SPIE 11158, Target and Background Signatures V, 111580L (17 October 2019); doi: 10.1117/12.2533174.

[57] Seidaliyeva U, Akhmetov D, Ilipbayeva L, and Matson ET. "Real-Time and Accurate Drone Detection in a Video with a Static Background." Sensors (basel, Switzerland) 20, no. 14 (2020). https://doi.org/10.3390/s20143856.

[58] Doppler radar uses continuous rather than pulsed waves and measures the speed of a target from the change of frequency of the echo signal. Source: https://www.sciencedirect.com/topics/engineering/doppler-radar.

[59] "Drone Detection and Neutralization Technologies – Part I" https://www.cerbair.com/drone-detection-and-neutralization-technologies-parti-blog/.

Drone detection with multi-sensor systems. Via multiple channels at once, multi-sensor drone detectors will process the target signal: optical, thermal, acoustic, ultrasonic, radio frequency, and radar. This increases the identification probability and largely solves the question of false alarms, making multi-sensor drone detection systems very convenient for urban environments and quick deployment at any facility in a handheld version. At the moment, in the field of low-altitude airspace defense, such equipment seems to be the most successful[60].

The third category of measures is the neutralization of drones. Complexes that identify a target using radar, control it using a video and infrared camera, during which a focused radio interference beam disables the drone or intercepts the control of it, could conduct active countermeasure against unmanned aerial vehicles.

Today, by jamming the radio or GPS signal, the neutralization of drones will lead to an uncontrolled fall, which poses a serious threat to people and property beneath. Furthermore, the operation of the nearby interaction and navigation devices can be disrupted. This counteraction approach therefore has significant drawbacks[61]. A less technological approach: it is possible to neutralize low-flying drones using a pneumatic network, and to neutralize high-flying drones using an interceptor drone with a deployed network[62]. Promising developments are underway for mobile air cannons that shoot capsules with a net and a parachute: a drone caught in the net does not fall, but smoothly descends to the ground. However, at the proper stage, the regulatory basis for effectively combating such threats has not

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[60] Martin Laurenzis, Sebastien Hengy, Alexander Hommes, Frank Kloeppel, Alex Shoykhetbrod, Thomas Geibig, Winfried Johannes, Pierre Naz, Frank Christnacher, "Multi-sensor field trials for detection and tracking of multiple small unmanned aerial vehicles flying at low altitude," Proc. SPIE 10200, Signal Processing, Sensor/Information Fusion, and Target Recognition XXVI, 102001A (2 May 2017); https://doi.org/10.1117/12.2261930.

[61] P. Tedeschi, G. Oligeri and R. Di Pietro, "Leveraging Jamming to Help Drones Complete Their Mission," in IEEE Access, vol. 8, pp. 5049–5064, 2020, doi: 10.1109/ACCESS.2019.2963105. https://ieeexplore.ieee.org/document/8945330/citations#citations.

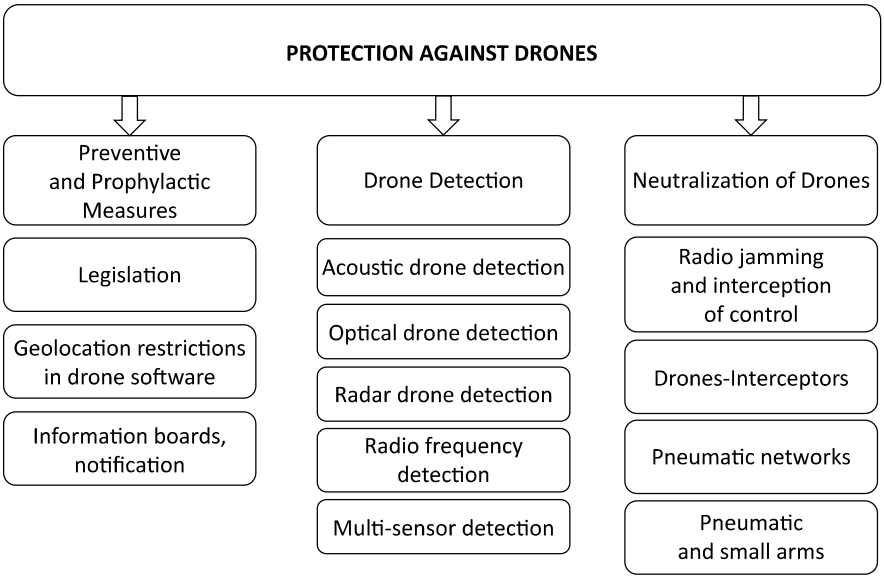
[62] Donovan Alexander, "Drone Hunters: 9 of the Most Effective Anti-Drone Technologies for Shooting Drones out of the Sky," Interesting Engineering, January 22, 2019, https://interestingengineering.com/drone-hunters-9-of-the-most-effective-anti-drone-technologies-for-shooting-drones-out-of-the-sky.

yet been established. Any consequence of a drone flying along the perimeter, for example, but not crossing it, can de jure be considered to cause malicious damage to private property. The use of pneumatic or small arms against property located even directly above the protected area could be considered illegal, since the airspace is not an object of private property. Such extravagant measures as the use of specially trained birds to prey drones (the program is being tested in the Netherlands) also cannot be considered seriously yet[63]. In the meantime, the drone operator may at any moment have a photo and video materials, the leakage of which is in every possible way the security service is trying to prevent. The problem is that the successful fulfillment of this task should mean not only "ground" and informational measures, but also "anti-aircraft" measures.

Technology is increasingly improving and complementing the field of low-altitude defense, though with some lag behind the origins of threats themselves. At this point, it is advisable to consider at least the possibility of adding new elements in the traditional object protection systems – drone detection devices, and to warn them of their approach. In any case, only in combination with drone detection equipment will potential systems of active countermeasures for drones be successful.

The use and purposes of civilian drones by individuals and their applications are very diverse and tend to expand. The development of drones is moving towards ensuring air traffic safety. However, in the sense of combating the risks of drone hijacking and illicit use by criminal and terrorist organizations, maintaining the information security of drones is now becoming a very urgent issue. Potential issues that may lead to unregulated drone usage and misuse must be expected by policymakers and authorities.

[63] Anna Holligan "Dutch police fight drones with eagles." https://www.bbc.com/news/world-europe-37342695



Since the widespread use of unmanned aerial vehicles is a relatively new phenomenon, neither national nor international legislation has managed to regulate their use. Of particular difficulty is the regulation of the right to use drones in armed conflicts and beyond, as well as the problem of responsibility for "collateral losses" among the civilian population and many other problems. Ensuring safety is a major concern when working with drones: to avoid mid-air collisions, UAVs must be capable of detecting potential collisions and maneuvering for safety, but in the event of system failures, potential impacts to the ground are another serious hazard, especially when using drones near large crowds.