UDC 343.985
DOI: 10.56215/04221204.61

Unmanned aerial vehicle as a forensic technical tool and object of forensic research

Ihor Yefimenko*
PhD in Law
National Academy of Internal Affairs
03035, 1 Solomianska Sq., Kyiv, Ukraine
https://orcid.org/0000-0002-6684-7760

Abstract
The relevance of this study was conditioned upon the scientific originality and practical significance of the use of unmanned aerial vehicles in the detection, investigation, and prevention of criminal offences. The purpose of this study was to investigate topical issues of using UAVs in two aspects – as a technical forensic tool and as a tool and means of committing a criminal offence. The research methodology included a set of general scientific and special methods that allow assuming and concluding on the specific features of using a UAV in the detection, investigation, and prevention of criminal offences. Thus, this study was based on a diagnostic method for cognition of social and legal phenomena and concepts in their development and interdependence. Along with this, general and special research methods were used, namely comparative legal, system-structural, statistical, logical, and other modern methods of scientific cognition. The theoretical framework of this study included studies of scientists and practitioners in the field of criminal procedure and forensics. The regulatory framework of the study included the norms and provisions of current regulations and their practical implementation in the law enforcement sphere. The study examined topical issues related to the UAV as a modern technical forensic tool and object of forensic research. The paper considered certain aspects and features of the use of UAVs in the detection, investigation, and prevention of criminal offences. To this end, various aspects of the use of UAVs as modern technical forensic tools were comprehensively analysed, distinguishing theoretical foundations of application, statutory regulation, organizational, technological, and scientific-methodological support. The features of using UAVs as a tool and means of committing criminal offences were determined. The study investigated typical traces left as a result of using UAVs, features of their logging and seizure. Considering investigative situations, the sequence, and specifics of conducting an inspection and seizure of a UAV and its elements at the initial stage of the investigation were determined, as well as an indicative list of issues for their expert investigation was provided. The significance of the results and practical value of this paper is that it highlights the specific features of using a UAV as a technical forensic tool and object of forensic research, formulates scientific and methodological recommendations for the use of unmanned aerial systems in the investigation, solving, and prevention of criminal offences. The study also defines the areas for improving Ukrainian legislation to regulate legal relations in the field of criminal justice on the use of unmanned aerial systems by law enforcement agencies

Keywords:
unmanned system; drone; unmanned aviation; criminal offence; law enforcement agencies

Article's History:
Received: 09.09.2022
Revised: 09.11.2022
Accepted: 07.12.2022

Suggest Citation:
Yefimenko, I. (2022). Unmanned aerial vehicle as a forensic technical tool and object of forensic research . *Law Journal of the National Academy of Internal Affairs*, 12(4), 61-71.

*Corresponding author

Introduction

Over the past few decades, human has conquered more natural forces than in the entire previous history of humankind. Presently, the use of modern information and digital technologies is no longer considered something fictional. Moreover, due to their accessibility and technical capabilities, they have found their wide application not only in the military sphere, but also in law enforcement activities (Kharchenko *et al*., 2005; Zhilin, 2011; Bakutin, 2020). This circumstance substantially influenced the transformation of forensic science and gave an impetus to the digitalization of modern criminalistics, saturating it with electronic-digital devices, tools, systems, and electronic communication exchange between them. Currently, the scientific literature uses the term "digital criminalistics" increasingly often. Emphasizing its revolutionary importance, scientists and practitioners define its further development as one of the priority areas for improving forensic knowledge (Kolodina & Fedorova, 2022).

The practical implementation of information and digital technologies in forensic activities is the introduction of unmanned aerial vehicles (UAVs, drones) into the work of law enforcement agencies (Bilous, 2016; Bakutin, 2020).

From a forensic standpoint, a drone can be considered an aircraft without a pilot, crew, or passengers on board, equipped with an engine that lifts it into the air due to aerodynamic forces, works both in automatic mode and through remote control, and which can be equipped with special technical and forensic means of aerial and non-aerial influence, video and photo equipment, as well as other devices and equipment for reconnaissance and monitoring of airspace, terrain, and aquatic environment.

Therewith, the rapid development of information and telecommunication systems has not bypassed crime. Existing as a social phenomenon, crime has successfully mastered the achievements of technological advance, adapting them into its activities. Thus, for instance, according to leading international organizations, even today the losses caused by criminal offences in the use of the latest information and telecommunications systems can be compared with the income from illegal trafficking of narcotic drugs and weapons. Moreover, many torts in this area stay hidden, which characterizes their high latency (Korshenko, 2020; Computer crimes in the USA, 2022).

The analysis of scientific literature and law enforcement practice suggests that UAVs enable the commission of a considerable large number of criminal acts related to espionage, terrorist activities, collaborationism, smuggling, human life and health, obtaining illegal benefits, trafficking of drugs and psychotropic substances, illegal arms trafficking, illegal obtaining of restricted information, disruption of aircraft traffic, security of critical infrastructure facilities and, as a result, national security in general (Blaguta & Movchan, 2020).

Such a wide range of applications of drones in criminal activities is primarily explained by many individual characteristics that allow using drones as tools and means for committing criminal offences. These features include the technical capabilities of the UAV, which, along with its small size, low visibility, relatively low price and availability, allow one to do the following:

– perform air delivery of items to protected ground objects.

– equip drones with diverse types of weapons and high-precision electronic devices.

– perform automatic (autonomous) piloting that does not require long-term special training.

– engage in large-scale acts that can cause considerable damage, destruction, and casualties (Kanchenko, 2015; Holotov *et al*., 2017).

Notably, unlike military doctrine, in legal science, the discussion of problematic issues related to the use of UAVs as a technical forensic tool and object of forensic research is relatively a new area of scientific research. However, some of their aspects, specifically those related to the use of drones in the activities of police, were covered in the studies of Ye. Bakutin (2020), V. Bilous (2016), R. Blahuta (2020), V. Holotov *et al*., (2017), M. Kobets (2017), Ye. Kuzmenko (2016), A. Movchan & M. Movchan (2020), S. Moslenko & S. Zelenskyi (2020), K. Sporyshev *et al*., (2018), etc. Admittedly, the scientific and theoretical developments of these authors are important for solving the problem of using UAVs by law enforcement agencies in the performance of their tasks, but they do not fully solve the complex issues concerning the specific features of using UAVs as a technical forensic tool and object of forensic research. Thus, for instance, most of these studies contemplate the role of the legal principles for conducting aviation operations using UAVs in criminal justice (Holotov *et al*., 2016; Movchan, & Movchan, 2016; Moslenko & Zelenskyi, 2020), as well as the main areas for improving the legislative regulation of the use of UAVs in police activities (Kuzmenko, 2016; Kobets, 2017; Bakutin, 2020). Therewith, some authors consider the UAV as one of the means of establishing objective truth in criminal proceedings (Moslenko & Zelenskyi, 2020), which, according to the author of this study, requires clarification. Firstly, in the conditions of the adversarial principle and the presumption of innocence, the use of such a philosophical category as "objective truth" is not entirely appropriate, and there is always the possibility of judicial errors. Secondly, those means of proof included in the criminal procedure, cannot fully ensure the objective institution discussed in the philosophical literature. Furthermore, using induction as one of the Aristotelian methods of cognition in criminal proceedings, it is not possible to obtain true knowledge. That is, if the activities of law enforcement agencies were aimed at establishing the objective truth, then in such circumstances justice would lose its significance.

In turn, the author of this study proposes to consider UAVs in two aspects: as a technical forensic tool and as an object for forensic research. Since UAVs allow obtaining not only evidentiary information that is vital to solve, investigate and prevent of criminal offences, but also enable the commission of a considerably large number of torts prescribed by the law on criminal liability. In this regard, this study will reveal the specific features of using UAVs as a technical forensic tool and object of forensic research in greater detail. For this, the tasks of this study were formulated as follows:

– to determine the features and technical capabilities of using UAVs in law enforcement, forensic, and criminal activities.

– to identify general and special forensic tasks of using UAVs as a technical forensic tool, as well as to describe the specifics of conducting an investigative inspection using UAVs on the example of eccentric, sector-wise, linear (frontal), and nodal inspection methods.

– to identify the main typical traces that can be left at the scene of an accident as a result of illegal use of UAVs, as well as to determine the features of their logging (recording) and seizure.

– to identify typical investigative situations at the initial stage of the investigation where the UAV was used as a tool and means for committing a criminal offence.

– to consider the general specifics of the tactics of conducting an investigative inspection of a UAV detected at the scene from a structural perspective.

– to formulate and justify proposals regarding the improvement of the current legislation in the part related to the use of UAVs when solving, investigating, and preventing criminal offences, as well as to formulate topical issues for further research.

Thus, the purpose of this study was to develop theoretical provisions that cover the specific features of using UAVs as a technical forensic tool and object of forensic research.

Materials and Methods

The regulatory framework of this study included laws and sub-legislative acts, the norms and provisions of which govern certain issues of the use of UAVs, namely: the Air Code of Ukraine No. 3393-VI dated 15.05.2011[1], Criminal Procedural Code of Ukraine No. 4651-VI dated 13.04.2012[2], Criminal Code of Ukraine No. 2341-III dated 05.04.2001[3], Code of Ukraine on Administrative Offences as amended on 26.05.2022[4], Rules for the use of flights by unmanned aviation complexes of the State Aviation of Ukraine, approved by Order of the Ministry of Defence of Ukraine No. 661 dated 08.12.2016[5], Instructions on the use of technical devices and means that have the functions of photo and film shooting, video recording, photo and film recording equipment, video recording by police bodies, approved by the Order of the Ministry of Internal Affairs of Ukraine No. 1026 dated 18.12.2018[6].

The theoretical framework of this study included the studies of scientists and practitioners in the fields of criminal procedure and forensics, who investigated individual issues related to the subject under study, namely the use of UAVs in police activities; features of introduction of unmanned aerial technologies into forensic practice; legal grounds and problematic issues of legal regulation of the use of drones in the activities of law enforcement agencies, etc.

This study was based on a diagnostic method for cognition of social and legal phenomena and concepts in their development and interdependence. This method was used to investigate regulations, analytical materials, concepts, and opinions of authors regarding certain issues included in the subject of this study.

Along with this, theoretical and empirical research methods were employed. For instance, the descriptive analytical and dogmatic methods were used to analyse the interpretations of legal categories, formulations of definitions, clarifications of the terminology, formulations of proposals for improving the current legislation on the subject under study. Comparative legal and formal legal methods were used to analyse regulations governing the activities and powers of police bodies and divisions, as well as certain issues concerning the use of UAVs in the airspace of Ukraine. Using the modelling method, conclusions were formulated, as well as proposals for improving the current legislation.

Results and Discussion

An unmanned aerial vehicle as a technical forensic tool. Due to its versatility, the use of UAVs in law enforcement and forensic expertise provides an opportunity to effectively implement the tasks set at relatively low financial costs, which previously required the use of not only a considerable number of personnel, but also general aviation[7]. Furthermore, the use of drones eliminates the risks of accidents involving participants in

[1]Law of Ukraine No. 3393-VI "On Air Code of Ukraine". (May, 2011). Retrieved from https://zakon.rada.gov.ua/laws/show/3393-17#Text.
[2]Criminal Code of Ukraine: Law of Ukraine No. 4651-VI. (April, 2012). Retrieved from https://zakon.rada.gov.ua/laws/show/4651.
[3]Criminal Code of Ukraine: Law of Ukraine No. 2341-III. (May, 2001). Retrieved from https://zakon.rada.gov.ua/laws/show/2341-14#Text.
[4]Code of Ukraine on Administrative Offences. (May, 2022). Retrieved from https://zakon.rada.gov.ua/laws/show/80731-10#Text.
[5]Order of the Ministry of Defense of Ukraine "On the Approval of the Rules for the Use of Flights of Unmanned Aircraft Complexes of the State Aviation of Ukraine" No. 661. (December, 2016). Retrieved from https://zakon.rada.gov.ua/laws/show/z0031-17#Text.
[6]Order of the Ministry of Internal Affairs of Ukraine No. 1026 "On the Approval of the Instructions on the Use of Technical Devices and Means that Have the Functions of Photo and Film Shooting, Video Recording, Photo and Film Recording Equipment, Video Recording by Police Bodies". (December, 2018). Retrieved from https://zakon.rada.gov.ua/laws/show/z0028-19.
[7]Criminal Code of Ukraine: Law of Ukraine No. 4651-VI. (April, 2012), op. cit.

such operations, which are accompanied by an explosion or fire hazard, injuries, or death of people. This means, for instance, neutralization of explosive objects or mine clearance of premises, pursuit of criminals, establishing their location, conducting various search and rescue operations (Bilous, 2016).

In this regard, the author of this paper agrees with the opinion of some scientists and practitioners who believe that the use of UAVs for forensic purposes should not be limited to merely examining the scene of an accident, it is much broader[1]. Thus, the modern development of information technologies allows equipping drones with special, digital equipment that can identify individuals who are wanted in the video stream, or those included in the relevant databases of law enforcement agencies, as active participants in mass riots, individuals involved in terrorist activities, organized crime and banditry, simulate their 3D images and store the information received in the relevant information resources. The use of such complexes can be especially effective during public events, sports competitions, protests, civil unrest, as well as in other places of mass gathering of people where it is technically impossible to install stationary surveillance systems (Blaguta & Movchan, 2020).

Another successful example of the adaptation of unmanned telecommunications systems in forensic activities is the use of UAVs during search activities to search for missing persons, especially when it comes to densely wooded areas, forests, mountainous areas, and other hard-to-reach or dangerous places.

One of the priority areas of using the capabilities of the unmanned aerial vehicle is to establish the facts of poaching, illegal mining, illegal felling, illegal planting of narcotic plants, and the detection and elimination of underground drug laboratories.

The technical capabilities of the UAV allow effectively implementing measures to prevent the commission of criminal offences by air patrolling objects of the main pipeline and railway transport. Features of this monitoring are the use of not only analogue, but also multichannel video recording in real time. This enables simultaneous observations in several spectral ranges (visible, infrared, radar, thermal imaging, etc.), thereby allowing to track objects both at night and in conditions of poor visibility (Korshenko, 2020).

Using aerial photography of the terrain, it is also possible to obtain orthophotomaps, digital models of the terrain and 3D images, and innovative software allows performing hyperspectral and multispectral imaging and laser scanning of the terrain, premises, structures, and other investigated objects.

Unmanned aerial systems became particularly popular during the Anti-Terrorist Operation and the Joint Forces Operation in the east of Ukraine. There, drones were used for operational purposes to identify and eliminate places of permanent and temporary deployment of militants, their checkpoints, storage places for weapons, ammunition and military equipment, reconnaissance and sabotage groups, unexploded ordnance, as well as installation and monitoring of customer devices, their interception, and geolocation (Kharchenko et al., 2005; Interdepartmental scientific and practical conference, 2021).

Presently, drones are widely used in patrolling residential areas and the state border. For instance, in 2021, according to the State Border Service, 60 drones of the Chinese company DJI Matrice 300 were purchased with a total cost of more than 50 million hryvnias, which are already successfully used today during the protection of the state border of Ukraine (2021).

UAVs also enable effective search and counter-intelligence activities for obtaining and implementing operational information, which is important to solve, investigate, and prevent criminal offences. The technical capabilities of drones, together with supplementary, special, optical devices with which they are equipped, not only prevent the risks of their unwanted detection, but also provide the opportunity to detect, inspect, investigate, control, record, and monitor various objects, terrain, and environment during law enforcement intelligence.

Thus, UAVs can be classified as separate, special forensic technical means capable of effectively performing measures to obtain forensic information essential for the investigation and prevention of criminal offences.

In this regard, the use of drones in law enforcement activities, according to their functional purpose, can be systematized into *general and special* forensic tasks. General forensic tasks include *procedural, intelligence, investigatory, and search and rescue* tasks. In turn, special forensic tasks can include:

– the use of drones in law enforcement intelligence, including the search for criminals hiding from pre-trial investigation and court bodies, conducting both overt and covert surveillance, examining premises, buildings, structures, terrain, vehicles, etc.;

– the use of drones to solve preventive tasks, including prevention of offences, recording offenders at the scene, stopping and preventing criminal attacks, photo and video recording (including in real time), certain circumstances of offences, their consequences, participants, tools and traces left by them, conducting operational and official activities to protect public order and public safety, etc.;

– the use of drones during the investigation and solving of certain types of criminal offences, including for technical forensic organization of the investigator's activities, the identification and preliminary examination of physical evidence, the search for people, animals, and things in hard-to-reach or dangerous places, the collection of samples and the removal of objects for further forensic investigation, ensuring the personal safety of

[1]Law of Ukraine No. 3393-VI. "On Air Code of Ukraine". (May, 2011). Retrieved from https://zakon.rada.gov.ua/laws/show/3393-17#Text.

participants in criminal proceedings, tracking and fixing the whereabouts of suspects, etc.

Considering the above, it is possible to conclude that the effectiveness of the use of UAVs as a technical and forensic tool can take place during the following activities:

– *survey* of large areas. It is most effective to carry out such an inspection during the search and recording of objects visible from the air left as a result of a plane crash, illegal felling, illegal sowing and cultivation of narcotic plants, as well as the identification of individuals hiding from the investigation and the court in a densely wooded area, etc.

– *survey* of the area in extreme conditions, e.g., during the investigation of socially dangerous acts, in conditions of threat to ecological safety, in the event of threats of snow avalanches, landslides, mudslides, rock falls, etc.

– *monitoring* road signs and road users to detect and record violations of the traffic rules.

– *inspection* of the scene during the pre-trial investigation.

– *searching* for individuals hiding from investigative bodies and the court, as well as pursuing them on hot tracks.

The choice of particular tactics and methods of using UAVs in each of these cases depends not only on the number of drones involved, their technical capabilities, the size of the surveyed area, weather conditions and time of day, but also on the purpose and a set of tasks that need to be solved.

Thus, in case when it is necessary to detect the maximum possible number of traces and elements of an event, the centre of which is known and located in a relatively small plane, it is advisable to use the *eccentric survey method*, which lies in the rectangular movement of the drone with a gradual expansion of its flight angles.

Given the relatively small area of the surveyed area, during the eccentric method, as a rule, only one UAV is used with a relatively moderate wind speed, or its complete absence (no-wind conditions). Therewith, the centre of the survey is always its starting point (see Fig. 1).

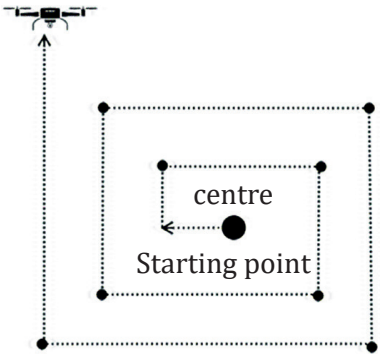

Figure 1. UAV movement during the use of the eccentric survey method

When the survey centre is known, and the region of the surveyed area has a rounded shape of a relatively small area, it is advisable to use *the sector-wise survey method*, where the starting point of its beginning is located at a distance outside its centre (see Fig. 2).

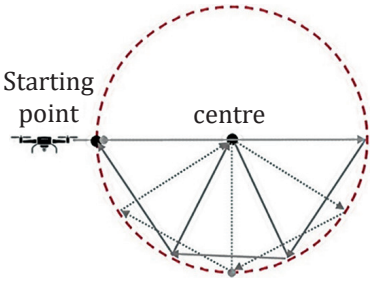

Figure 2. UAV movement during the use of the sector-wise survey method

When the investigator does not have a clearly defined centre, or it is not known, it is possible to apply the *concentric survey method*, which lies in surveying objects from the periphery along a narrowing spiral, to the imaginary centre of the scene (see Fig. 3).

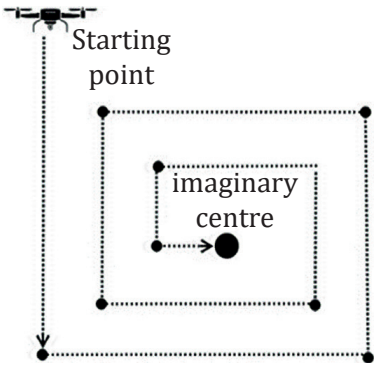

Figure 3. UAV movement during the use of the concentric survey method

When there is a need to survey large or extended areas, e.g., when there is information about illegal felling or illegal planting of narcotic plants, *a linear (frontal) or nodal inspection method may be applied*. In this case, the centre is irrelevant, and therefore these methods can be applied both in the presence of the survey centre and in its absence.

Furthermore, linear and nodal methods allow using two or more UAVs simultaneously, which affects the time, flexibility, and effectiveness of the survey (see Figs. 4 and 5).

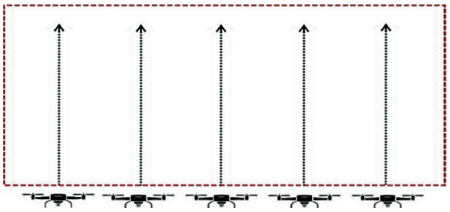

Figure 4. UAV movement during the use of the linear (frontal) survey method

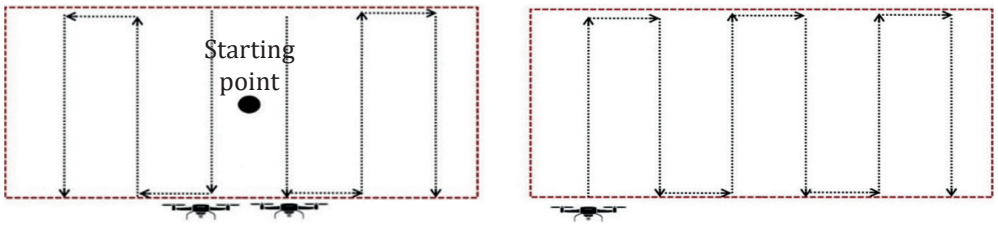

Figure 5. UAV movement during the use of the nodal survey method

When deciding on the choice of one of the listed survey methods, one also needs to consider the technical specifications of the UAV, namely:

– the presence of a system that allows separating the flight control of the UAV from the control of its camera.

– availability of supplementary technical equipment (added photo and video cameras, lighting sources, radio stations, other repeaters, sensors, and laser locators of various functional purposes, etc.).

– flight performance characteristics of the engine.

– the presence of a gyroscope, which is the main node responsible for the orientation of the drone in space.

– the availability of online data transmission capabilities in HD video format.

– the presence of the function of loss of communication with the operator and transition of the flight system to automatic operation mode with unassisted return of the UAV to the launch point along the marked trajectory.

– the availability of automatic tracking, using GPS (*Global Positioning System*) of the drone's flight path and returning it to the launch point, or performing a flight according to a predetermined program along a marked flight path.

In this context, there are only three space countries in the world (the USA, Japan, and China) that have the necessary number of satellites in orbit to create a full-fledged navigation system.

There are two such navigation systems in the United States. The first of which is open to public access, which allows its use for commercial purposes (it can be use it on civilians' gadgets), and the second GPS navigation system is closed and intended only for solving military and reconnaissance tasks. The military GPS, unlike the commercial one, is more precise. This system cannot be used in free access because it works through closed, coded communication channels, which are practically impossible to trace and intercept. The owner of an open navigation system is entitled to independently make adjustments and system errors to the GPS operation without notifying users.

Despite the space past, unfortunately Ukraine does not have its own navigation system, which forces Ukrainians to use the American GPS for public access.

An unmanned aerial vehicle as an object of forensic research. Investigating topical issues related to UAVs as a technical forensic tool, it is impossible to ignore the fact that criminal underworld could not but take advantage of the technological advance of humanity in the aviation industry.

Thus, according to the results of studying investigative and judicial practice, there has recently been a tendency for illegal use of UAVs over high-security facilities and critical infrastructure facilities. Specifically, drones are used to illegally transfer prohibited items, including phones and SIM cards, to places of deprivation of liberty. The communication tools obtained in this way are used by convicts to commit telephone fraud. This is confirmed by the results of statistical studies, which indicate that more than half of all illegal "call centres" are located in penitentiary institutions and pre-trial detention centres[1].

Therewith, only a few people are brought to real criminal responsibility for committing such acts. The consequence of this is that Article 307.2 of the Criminal Code of Ukraine prescribes liability only for the transfer of narcotic substances to places of deprivation of liberty[2]. As for the illegal transfer of phones, computers, and other prohibited items to individuals held in pre-trial detention centres and penitentiary institutions, this is the subject of an administrative offence under Article 188 of the Code of Ukraine on Administrative Offences[3].

The issue of unauthorized filming, which violates the right to inviolability of private and personal life of citizens, also requires special attention. Thus, using a UAV, it is possible to conduct an aerial survey of the private (personal) life of citizens, as well as property belonging to them, to further publish provocative photos and videos on the Internet, which can adversely affect the business reputation of an individual and/or humiliate their honour and dignity (Kobets, 2017).

During the illegal use of UAVs in the airspace, there is also a threat to people's lives and health. The possibility of accidents caused, for instance, by a UAV falling on passers-by, their vehicles, houses, and other property located within the perimeter of its flight is not excluded. Furthermore, the use of UAVs over critical infrastructure objects or within air routes can

[1]Order of the Ministry of Defence of Ukraine "On the Approval of the Rules for the Use of Flights of Unmanned Aircraft Complexes of the State Aviation of Ukraine" No. 661. (December, 2016). Retrieved from https://zakon.rada.gov.ua/laws/show/z0031-17#Text.
[2]Criminal Code of Ukraine: Law of Ukraine No. 2341-III. (May, 2001). Retrieved from https://zakon.rada.gov.ua/laws/show/2341-14#Text.
[3]Code of Ukraine on Administrative Offences. (May, 2022). Retrieved from https://zakon.rada.gov.ua/laws/show/80731-10#Text.

lead to particularly dire consequences, or even disasters. This primarily indicates that the UAV as an aircraft is a source of increased danger, since its unauthorized use by an incompetent person can lead to irreparable consequences for people, society, and the state as a whole.

Notably, in 2018, non-compliance with the rules for operating a drone over an airport in the UK led to the cancellation of hundreds of flights. To identify and stop the offence, not only police units were involved, but also the Royal Armed Forces. Since according to British legislation, the use of drones within a 1-kilometre radius from the perimeter of the airfield is prohibited (Kuzmenko, 2016).

This allows concluding that the illegal use of drones can lead to grave consequences, and therefore UAVs can be attributed not only to one of the means of technical and forensic support, but also to one of the objects of forensic research.

In this context, special attention should be paid to the typical traces left as a result of the use of UAVs, as well as their recording and seizure during procedural actions.

In the classical sense, all traces that can be left during the commission of a criminal offence, including by a drone, can be divided into three groups, namely:

– *material traces*, displayed in the form of damage or destruction of the hull (fuselage) of the drone itself, its individual parts, elements, devices, equipment, or video recordings or photographs with it, delivery and launch vehicles, etc.

– *perfect footprints*, reflected in the memory of eyewitnesses, victims, suspects, etc.

– *virtual (electronic-digital) traces*, displayed in the random-access memory of an unmanned device or on its information carriers.

This division allows identifying at least four investigative situations of surveying the scene of an accident at the initial stage of the investigation of a criminal offence, namely:

– direct detection of a drone at the scene, without cargo attached to it (prohibited items, objects, etc.);

– direct detection of a drone at the scene, with cargo attached to it.

– detection of only cargo at the scene, probably transported and dropped by a drone.

– detection of individual parts of elements and devices at the scene of an accident, as well as their fragments, which are probably components of the drone or cargo transported by it.

Without delving into the tactics of conducting an investigative survey in each of the listed cases separately, this study will only try to consider its general specifics structurally, which include the following:

– measures to protect the scene of an accident and resolving issues concerning the origin of objects found on the site, as well as their potential threat to human life and health and the environment (e.g., their pertinence to explosive or toxic devices, chemical or radioactive substances).

– actions to *register* the detected objects at the scene (directly of the UAV itself, its parts and fragments, the cargo transported and dropped by it, etc.), with the mandatory use of three types of recording (orientational, nodal, detailed (large-scale).

– *removal* and packaging of objects discovered at the scene, with early resolution of issues regarding the type of container to pack the removed objects in, its sealing capacity, and further storage location. Such packaging may include cardboard boxes, polymer containers, panels made of synthetic or natural fabric, including bags made of durable material (matting, burlap, leather, synthetic materials).

Special attention should be paid to traces of fingerprint, or biological (tracological) origin reflected on the identified objects. Such traces, as an example, can include traces of layering or peeling of paint, glue, fingerprints, as well as arbitrarily applied marks with various slogans, flags, emblems, symbols, and other identifying marks. All these traces require immediate recording and removal at the scene of the incident and subsequent referral for forensic examination with identification, diagnostic, situational, and other issues.

1. *Recording* the results of the inspection in the record of the scene of the incident, where data on the type of UAV, its serial number and markings, the condition of the body and its individual parts, the presence of other equipment, its condition, the presence and packaging of cargo attached to it, its contents, weight, type of attachment, etc. are subject to mandatory reporting.

2. *Transportation* of objects seized at the scene for their further forensic examination. In this context, to achieve forensic tasks, all detected parts and fragments of the drone and the cargo transported by it are subject to a mandatory expert forensic investigation. Such parts and fragments can be distinguished *as follows*:

1. Investigation of the device itself and its individual parts and body fragments. For this purpose, several forensic tasks must be solved, which lie in determining the method of manufacture of the drone discovered at the scene (industrial, hand-crafted, or modified), its name, model range, market value, availability in free sale, functional purpose, found in its design changes, conversions, other features, their purpose and designation.

2. Research of the control unit and navigation systems of the drone. In this regard, modern UAVs are equipped with full-fledged computer systems consisting not only of a processor, random access memory and installed operating systems, but also added control units and space radio navigation sensors.

Usually, the specified equipment contains forensically significant information that can be the subject of computer-technical expertise research, and provide answers to a number of questions related to:

– type of control unit and data about its computer system (model, parameters, tactical and technical characteristics, installed operating system, scope of application, etc.).

– Autopilot system data, including geolocation marks regarding the start of the flight, its route, end, and return location in case of loss of communication with the drone.

– a list of operator commands received by the drone control system.

– altitude, speed, time, coordinates, hover point, and other indicators of the drone's position in space during flight.

3. Research of added flash memory. An essential object of forensic research of the drone is its flash cards and memory cards of technical devices that it was equipped with. These objects contain archival information that can provide answers regarding the flight path, its duration, satellite navigation coordinates, photo and video images of the area, objects, things, and people that were recorded by the drone operator during the flight. All this data can be used to determine the owner of the UAV, its operator, as well as the main places, locations, and purposes of operating the drone.

4. Research of power supply units and power plant systems. The power plant system and power units may contain information about the engine manufacturer, model, type, fuel cell, electric battery, fuel brand, composition, quality, origin, etc. Using comprehensive technical and technological expertise, it is also possible to solve several issues related to the power, load capacity, speed, range, and other technical specifications of the drone.

5. Research of radio communication systems and remote-control channels. During the study of these systems, it is possible to determine the radio communication channel from which control commands were received, its security, user authentication protocol, control distance, etc.

6. Research of supplementary devices, equipment, weapons, and objects transported by the drone. The technical capabilities of the drone allow equipping it with supplementary electrical devices, various types of weapons, as well as mechanisms designed for fixing and transporting them. In this regard, it is necessary to figure out the purpose of the objects seized at the scene, their technical data and specifications. Thus, when providing an explosive device for expert research, it is necessary to determine its type, model, manufacturing method, composition, and power in TNT equivalent.

Conclusions

Based on the results of this study, it is possible to draw the following conclusions:

Despite the noted positive trends in the introduction of unmanned aviation in the activities of law enforcement agencies of Ukraine, a complex of problematic issues currently stays unresolved. Firstly, this refers to insufficient equipment of police bodies and units with unmanned aerial systems. Secondly, this refers to the lack of a centralized management system and proper regulation of issues concerning the involvement of operators in the use of UAVs in procedural and law enforcement intelligence for the solution, investigation, and prevention of criminal offences.

In this regard, the introduction of unmanned aerial systems in the activities of law enforcement agencies, along with their advantages, still requires considerable financial costs, and not only for the purchase of unmanned systems, but also for their maintenance and training of qualified operators. This circumstance has created conditions under which it is now almost impossible to properly equip police bodies and units with unmanned aerial systems.

Proceeding from this, for proper technical support of law enforcement agencies with modern unmanned aerial systems, they should be concentrated in the subordination of a specially created single unit in the National Police system, which would have a legal basis, provided an appropriate purpose, tasks, area, and place of use, to be involved in the implementation of tasks assigned to law enforcement agencies.

Therewith, the legal grounds and limits of the use of drones by law enforcement agencies in their activities are becoming important. They must be brought into line with the constitutional norms that define the rights and freedoms of human and citizen. This refers to the fact that if the use of a drone concerns the receipt or disclosure of confidential, official, or secret information (e.g., the right to the privacy of personal and family life), then the restriction of these rights can take place only by a corresponding court decision and in cases clearly defined by law. Otherwise, obtaining information with restricted access will be considered illegal, which as a result implies the occurrence of legal liability defined by law.

The rapid development of the implementation of the capabilities of UAVs in criminal activities forces, in the near future, to develop and adopt special sub-legislative acts and regulations that would govern the issue of the organization of interaction between the bodies and units of the National Police in the fight against enemy drones and the mechanism of combating criminal offences committed using UAVs.

A separate scientific study is required on the grounds and procedure for law enforcement agencies to apply technical developments in the fight against enemy drones, which can be divided into three groups, namely:

– gun-type anti-UAV systems (e.g., a launcher for disarming glider-type UAVs Sky Wall 100);

– systems for combating UAVs of the radio-electronic type (e.g., a device that works on radio-electronic radiation Drone Defender V2 from the American company Battelle).

– systems for combating UAVs of the laser type (e.g., the HELMD laser radiation system from the Boeing company, which is in service with the United States).

References

[1] About Computer Crime Research Center. (n.d.). Retrieved from https://www.crime-research.org/about/.

[2] Bakutin, E.S. (2020). Directions for improving the legislative regulation of the use of UAVs in the activities of the Ukrainian police. *State and Law*, 77, 314-327.

[3] Bilous, V.V. (2016). Peculiarities of introduction of unmanned aerial technologies, devices and systems into forensic practice. *National Law Journal: Theory and Practice*, 5, 170-175.

[4] Blaguta, R.I., & Movchan, A.V. (2020). *The latest technologies in the investigation of crimes: Current status and problems of use*. Lviv: Lviv. state Univ. of Internal Affairs.

[5] By the end of 2021, the DPSU should receive 36 more drones. (October, 2021). Retrieved from https://defence-ua.com/news/dpsu_do_kintsja_2021_roku_maje_otrimati_sche_36_bezpilotnikiv_video-5584.html.

[6] Holotov, V., Gunina, A., & Teleschuk, Yu. (2017). Analysis of the possibilities of using unmanned aerial vehicles in law enforcement agencies. *Modern Achievements of Geodesy Science and Production of Lviv Polytechnic University*, 1(33), 139-146.

[7] Interdepartmental scientific and practical conference. (2021). *Lessons of Russia's armed aggression against Ukraine – military strategic aspects": Materials of the scientific and practical conference* (pp. 296). Kyiv: National University of Defense of Ukraine named after Ivan Chernyakhovsky. doi: 10.26697/9786177089000.2017.347.

[8] Kanchenko, Ya.V. (2015). *Unmanned aerial vehicles for radiation reconnaissance and agricultural purpose*. Chornobyl (Kyiv region): Institute of NPP Safety Problems.

[9] Kharchenko, O.V., Kuleshyn, V.V., & Kotsurenko, Yu.V. (2005). Classification and directions of creation of unmanned aerial vehicles for military purposes. *Science and Defense*, 1, 57-60.

[10] Kobets, M.V. (2017). The concept and legal basis of the use of unmanned aerial vehicles in internal affairs bodies. *Actual problems of criminal law, process, criminology and investigative activity: Materials of the scientific and practical conference* (pp. 796-798). Khmelnytskyi: National Academy of the State Border Service of Ukraine named after B. Khmelnytskyi.

[11] Kolodina, A.S., & Fedorova, T.S. (2022). Digital forensics: Problems of theory and practice. *Kyiv Herald of Law*, 1, 176-180. doi: 10.32782/klj/2022.1.27.

[12] Korshenko, V.A. (2020). *Use of technical devices and technical means of photo and film shooting, video recording by police bodies and units. Analysis of foreign experience: Methodical materials for employees of the Ukrainian Armed Forces*. Kharkiv: National University of Internal Affairs. doi: 10.25313/2520-2308-2018-1-3486.

[13] Kuzmenko, E.V. (2016). Problems of legal regulation of the use of unmanned aerial vehicles in the law enforcement activities of the National Police of Ukraine. *Scientific Bulletin of the National Academy of Internal Affairs*, 4(101), 82-88.

[14] Moslenko, S.I., & Zelenskyi, S.M. (2020). Legal principles of aviation activity using UAVs in the field of criminal justice. *Scientific Bulletin of the Flight Academy. Economics, Management and Law*, 2, 154-161. doi: 10.33251/2707-8620-2020-2-154-161.

[15] Movchan, A.V., & Movchan, M.A. (2020). Use of UAVs in law enforcement agencies. *Social and Legal Sciences*, 3(9), 104-110.

[16] Pavlyuk, N.V. (2020). Scientific and technical support of investigative activity: Content and directions. *Theory and Practice of Jurisprudence*, 1(17), 1-13. doi: 10.21564/2225-6555.2020.17.206512.

[17] Sporyshev, K.O., Lunyov, O.Yu., & Matrosov, M.V. (2018). The procedure for planning the rational use of reconnaissance unmanned aerial vehicles during the execution of tasks to stop mass riots by the forces of the National Guard of Ukraine. *Scientific Notes of TNU named after V.I. Vernadskyi. Public Administration*, 6, 100-105.

[18] Yakymenko, I.Z. (2019). *Digital forensics: Computer lectures*. Ternopil: TNEU.

[19] Zhilin, E.I., Kolodiy, O.P., Rybiak, A.S., Lukovsky, O.Ya., & Lekah, A.A. (2011). Military unmanned aviation complexes of the "MINI" class in the Armed Forces of foreign countries. *Weapon Systems and Military Equipment*, 1(25), 14-20. doi: 10.34169/2414-0651.2017.1(13).44-49.

Список використаних джерел

[1] Про Центр дослідження комп'ютерних злочинів. URL: https://www.crime-research.org/about/.

[2] Бакутін Є. С. Напрями вдосконалення законодавчого регулювання використання БпЛА в діяльності поліції України. *Держава і право*. 2020. Вип. 77. С. 314–327.

[3] Білоус В. В. Особливості впровадження в криміналістичну практику безпілотних літальних технологій, апаратів і систем. *Теорія і практика*. 2016. № 5. С. 170–175.

[4] Благута Р. І., Мовчан А. В. Новітні технології у розслідуванні злочинів: сучасний стан і проблеми використання : монографія. Львів : Львів. держ. ун-т внутр. справ, 2020. 256 с.

[5] ДПСУ до кінця 2021 року має отримати ще 36 безпілотників. *Інформаційний ресурс Defense Express*. 2021 URL: https://defence-ua.com/news/dpsu_do_kintsja_2021_roku_maje_otrimati_sche_36_bezpilotnikiv_video-5584.html.

[6] Голотов В., Гуніна А., Телещук Ю. Аналіз можливостей застосування безпілотних літальних апаратів у правоохоронних органах. *Сучасні досягнення геодезії науки та виробництва НУ «Львівська політехніка»*. 2017. № 1 (33). С. 139–146.

[7] Міжвідомча науково-практична конференція: «Уроки збройної агресії Росії проти України – воєнностратегічні аспекти» : матеріали Міжнар. наук-практ. конф. (Київ, 29 квіт. 2021 р.). Київ : Нац. ун-т оборони України ім. І. Черняховського, 2021. 296 с. doi: https://doi.org/10.26697/9786177089000.2017.347.

[8] Безпілотні літальні апарати радіаційної розвідки і сільськогосподарського призначення : монографія / [В. Я. Канченко та ін.]. Чорнобиль : Ін-т проблем безпеки АЕС, 2015. 180 с.

[9] Харченко О. В., Кулешин В. В., Коцуренко Ю. В. Класифікація та тенденції створення безпілотних літальних апаратів військового призначення. *Наука і оборона*. 2005. № 1. С. 57–60.

[10] Кобець М. В. Поняття та правові підстави застосування безпілотних літальних апаратів у правоохоронних органах. *Актуальні проблеми кримінального права, процесу, криміналістики та оперативно-розшукової діяльності :* матеріали наук.-практ. конф. (Хмельницький, 3 берез. 2017 р.). Хмельницький : Нац. акад. держ. прикордон. служби України ім. Б. Хмельницького, 2017. С. 796–798.

[11] Колодіна А. С., Федорова Т. С. Цифрова криміналістика: проблеми теорії і практики. *Київський часопис права*. 2022. Вип. 1. С. 176–180. doi: 10.32782/klj/2022.1.27.

[12] Застосування органами та підрозділами поліції технічних приладів і технічних засобів фото- і кінозйомки, відеозапису. Аналіз закордонного досвіду : метод. матеріали / [В. А. Коршенко та ін.]. Харків : Нац. ун-т внутр. справ, 2020. 44 с. doi: https://doi.org/10.25313/2520-2308-2018-1-3486.

[13] Кузьменко Є. В. Проблеми правового регулювання застосування безпілотних літальних апаратів у правоохоронній діяльності Національної поліції України. *Науковий вісник Національної академії внутрішніх справ*. 2016. № 4 (101). С. 82–88.

[14] Мосленко С. І., Зеленський С. М. Правові засади проведення авіаційних робіт з використанням БпЛА у сфері кримінального правосуддя. *Науковий вісник Льотної академії*. 2020. Вип. 2. С. 154–161. (Серія «Економіка, менеджмент та право»). doi: https://doi.org/10.33251/2707-8620-2020-2-154-161.

[15] Мовчан А. В., Мовчан М. А. Використання БпЛА у діяльності правоохоронних органів. *Соціально-правові студії*. 2020. Т. 3. № 9. С. 104–110.

[16] Павлюк Н. В. Науково-технічне забезпечення слідчої діяльності: зміст та напрямки. *Теорія і практика правознавства*. 2020. Вип. 1 (17). С. 1–13. doi: 10.21564/2225-6555.2020.17.206512.

[17] Споришев К. О., Луньов О. Ю., Матросов М. В. Порядок планування раціонального застосування розвідувальних безпілотних літальних апаратів під час виконання завдань із припинення масових заворушень силами Національної гвардії України. *Вчені записки ТНУ ім. В. І. Вернадського*. 2018. № 6. С. 100–105. (Серія «Державне управління»).

[18] Цифрова криміналістика : консп. лекцій / уклад. І. З. Якименко. Тернопіль : ТНЕУ, 2019. 109 с. URL: http://dspace.tneu.edu.ua/handle/316497/36005

[19] Жилін Є. І., Колодій О. П., Риб'як А. С., Луковський О. Я., Леках А. А. Військові безпілотні авіаційні комплекси класу «MINI» в Збройних силах іноземних держав. *Системи озброєння і військова техніка*. 2011. № 1(25). С. 14–20. doi: 10.34169/2414-0651.2017.1(13).44-49.

Безпілотний літальний апарат як техніко-криміналістичний засіб та об'єкт криміналістичного дослідження

Ігор Миколайович Єфіменко
Кандидат юридичних наук
Національна академія внутрішніх справ
03035, пл. Солом'янська, 1, м. Київ, Україна
https://orcid.org/0000-0002-6684-7760

Анотація
Актуальність теми дослідження обумовлена науковою новизною та практичною значущістю використання безпілотних літальних апаратів під час розкриття, розслідування та попередження кримінальних правопорушень. Метою статті є дослідження актуальних питань використання безпілотного літального апарата у двох аспектах, по-перше, як техніко-криміналістичного засобу та, по-друге, як знаряддя й засіб учинення кримінального правопорушення. Методологія дослідження включає сукупність загальнонаукових і спеціальних методів, що дозволяють сформулювати припущення та сформулювати висновки щодо особливостей використання безпілотного літального апарата під час розкриття, розслідування та попередження кримінальних правопорушень. Так, основу дослідження становить діагностичний метод пізнання соціальних і правових явищ і понять у їх розвитку та взаємообумовленості. Використано загальні та спеціальні методи дослідження, зокрема порівняльно-правовий, системно-структурний, статистичний, логічний та інші сучасні методи наукового пізнання. Теоретичне підґрунтя дослідження становлять наукові праці вчених і практиків у галузі кримінального процесу та криміналістики. Нормативно-правовою базою слугують норми й положення чинних нормативно-правових актів, їх практична реалізація в правоохоронній сфері. У статті досліджено актуальні питання щодо безпілотного літального апарата як сучасного техніко-криміналістичного засобу й об'єкта криміналістичного дослідження. Розглянуто окремі аспекти й особливості використання цих апаратів під час розкриття, розслідування та попередження кримінальних правопорушень. З цією метою проведено комплексний аналіз різноманітних аспектів використання безпілотних літальних апаратів як сучасних техніко-криміналістичних засобів з виокремленням теоретичних засад застосування, нормативно-правового регулювання, організаційного, науково-технічного та науково-методичного забезпечення. Досліджено типові сліди, що залишаються внаслідок використання безпілотних літальних апаратів, схарактеризовано особливості їх протоколювання та вилучення. З урахуванням слідчих ситуацій визначено послідовність і специфіку проведення огляду та вилучення безпілотного літального апарата, його елементів на початковому етапі розслідування, а також наведено орієнтовний перелік питань для експертного дослідження. Значущість результатів і практична цінність статті полягає в тому, що в ній висвітлено особливості використання безпілотного літального апарата як техніко-криміналістичного засобу й об'єкта криміналістичного дослідження, сформульовано науково-методичні рекомендації щодо застосування безпілотних літальних комплексів під час розкриття, розслідування та попередження кримінальних правопорушень, а також визначено напрями вдосконалення українського законодавства з метою врегулювання правовідносин у сфері кримінальної юстиції з питань використання безпілотних літальних комплексів органами правопорядку

Ключові слова:
безпілотна система; дрон; безпілотна авіація; кримінальне правопорушення; правоохоронні органи