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# International experience of forensic support for crime investigation

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## Abstract

In the conditions of scientific and technical progress, updating of legislation and law enforcement practice, technical and forensic support for the investigation of criminal offenses in the activities of investigative and expert units acquires special importance, requiring the complexity of research, including, taking into account the experience of foreign countries, which thanks to innovations in the fight against crime is gradually moving away from traditional (conservative) methods and methods of detecting, collecting and fixing traces of criminal offenses, and the situation in which law enforcement agencies have been working for more than half a century is quite close to the one that has developed today in connection with the armed military aggression against Ukraine. The latest technologies in the investigation of criminal offenses were considered and the ways of implementation of the best foreign practices in the activity of investigative and expert units of Ukraine were proposed. Attention is drawn to the application of artificial intelligence as a systematized set of information technologies, aimed at performing sufficiently complex forensic tasks. The feasibility of using the method of Forensic intelligence in Ukraine as a means of obtaining orienting and evidentiary information, which consists in combining disparate pieces of information (forensic materials) during the investigation of multi-episode (serial) criminal offenses in order to obtain a complete picture of repeated acts, is scientifically argued and establishing connections between places of criminal offenses committed by the same criminal or group of persons based on VideoAnalytics. The work of the "The Next Step" program, which allows you to compare shoe prints from different places of the commission of a criminal offense based on external features based on the geolocation of the scene, is considered. The adoption of foreign experience in the part of involving a forensic expert in the inspection of the scene of the incident with the authorization to conduct such an investigative (search) action in individual cases without the presence of an investigator, and upon completion of which to draw up an inspection protocol or an expert opinion, with further referral to the authorized entity, is substantiated (investigator) in order to reduce the burden on pretrial investigation bodies of Ukraine

## Keywords:

forensics; technology; special knowledge; investigative (research) action; forensic expert activity; inspection of the scene of the incident; unmanned aerial vehicle; artificial intelligence; forensic intelligence; DNA

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## Introduction

Rapid, complete and impartial pre-trial investigation of criminal offences is impossible without comprehensive and targeted technical and forensic support. The reform of the law enforcement system (separation of expert units from the National Police system) has led to an increase in the workload of the pre-trial investigation bodies of the National Police (the number of registered proceedings increased from 443,700 in 2012 to 1.9 million in 2021) [1; 2] and forensic institutions (for example, in 2021 alone the expert service of the Ministry of Internal Affairs of Ukraine conducted more than 300,000 forensic examinations and 44,000 inspections on forensic records). In such circumstances, effective technical and forensic support of pre-trial investigation bodies and expert units is recognised as one of the main priorities, determining the efficiency and integrity of the investigation of criminal offences.

The theoretical framework of the study was based on the studies conducted by prominent scientists, such as: A.A. Areshonkov [3], O.M. Striltsiv, O.S. Tarasenko [4], S.S. Cherniavskiy [5], Yu.M. Chornous [6], A.M. Al-Samman, T. Al-Hadhrami, A. Al Shami, & F. Alnajjar [7], J. Blaschke [8], P. Gonzalo [9] and others. The contribution of scientists to forensic science is certainly significant, but in the conditions of scientific and technological progress, radical changes in legislation and law enforcement practice, technical and forensic support for the investigation of criminal offences is of particular importance and requires a separate comprehensive study. In this context, it is essential to learn from the experience of international countries that, by applying innovations in anti-crime efforts, are gradually moving away from conventional (conservative) ways and methods of detecting, collecting and recording traces of criminal offences.

The scientific novelty of the results obtained is that the article, based on the study of the practice of law enforcement agencies, considers the relevant issues of technical and forensic support for the investigation of criminal offences in the context of the current state of Ukrainian and international criminal procedure legislation, investigative and expert practice.

*The purpose of the article* is to form a scientifically grounded basis for the technical and forensic support of the investigation of criminal offences in accordance with international investigative and expert practice.

## Materials and Methods

The article applies a systematic approach and various research methods: **dialectical** – to characterise the technical and forensic support of the investigation of criminal offences; **system analysis** – for a comprehensive generalisation of the latest technologies included in the subject of research, in particular the use of unmanned aerial vehicles (UAVs), forensic intelligence, automatic fingerprint identification system (AFIS), the Next Step

programme, etc.; **system-structural** – to determine the content and structure of the article; **dogmatic** and **formal-legal** methods contributed to the clarification of the conceptual and categorical apparatus; **comparative law** – to establish the specifics of the work of Ukrainian forensic institutions, as well as the specifics of the use of technical and forensic research in a number of international countries; **forecast** – during the implementation of best international practices, **structural** and **functional** – to establish the main methods of detecting, removing and fixing traces of a criminal offense during the inspection of the scene of an accident; **modeling** – when forming proposals and recommendations for implementing the best international practices in the activities of investigative and expert units, as well as the capabilities of intelligent technologies and the method of forensic intelligence in the investigation of criminal offences; **statistical** – when confirming conclusions with statistics, materials of criminal proceedings, Investigative, prosecutor's and judicial practice.

These methods were used at all stages of the study, which include: defining a scientific problem, setting the goal and objectives of the study; detailing the directions for improving the technical and forensic support for conducting an inspection of the scene; providing suggestions for improving the use of intellectual technologies in the investigation of criminal offences; determining the characteristics of the use of criminal intelligence methods in the investigation of criminal offences; outlining promising areas for the development of forensic science in Ukraine and the world.

The empirical basis of the study is systematised data of state statistical reporting on the work of Ukrainian and international law enforcement agencies for 2012-2021; summary data of the study of criminal proceedings, expert opinions (for the period 2014-2021); analytical summaries of the National Police of Ukraine, the Office of the Prosecutor General, a number of international law enforcement agencies (England, Israel, Germany, the United States of America); results of many years of study of investigative and forensic practice.

## Results and Discussion

Countering crime in modern conditions requires advanced, comprehensive research [3], and the activity of the investigator at the initial stage of the pre-trial investigation is a single, interconnected system of investigative (search) actions aimed at identifying, recording, seizing, packaging and investigating traces of a criminal offence, which largely determine the success or “failure” of the next stage of the investigation. As stated in Art. 214 of the Criminal Procedure Code (CPC) of Ukraine: “Investigator, detective, prosecutor shall immediately, but not later than 24 hours after the submission of the application, notification of a criminal offence or after his/her independent discovery from any source of circumstances

that may indicate the commission of a criminal offence, submit the relevant information into the Unified Register of Pre-trial Investigations (URPTI), initiate an investigation and provide the applicant with an extract from the above register within 24 hours from the moment of submission of such information"<sup>1</sup>. Therefore, the use of technical and forensic means after registering the data in the URPTI is objective and the most significant. There are certain patterns in the detection of a wide range of traces of criminal offences, which allow for targeted search and collection of evidence.

According to Art. 237 of the CPC of Ukraine, inspection is an investigative (search) action carried out to detect traces of a criminal offence and other material evidence, clarify the circumstances of a criminal offence, as well as other circumstances relevant to criminal proceedings<sup>2</sup>. One of the most common types of inspections (during which the largest amount of trace information is usually collected) is the inspection of the scene. The examination of the scene requires the use of various technical and forensic means and tactical techniques for detection, fixation, seizure, packaging, transportation, storage, expert examination of trace information, etc. For example, in modern conditions, when examining the scene of an incident, it is necessary to use such technical and forensic means to detect and remove traces:

- physical traces – laser scanners, fibrogastroscopy, infrared photography, georadar “OKO”, “Grot”;
- electronic “digital” traces (tablet Cellebrite UFED Touch 2; MSABXR; hardware “chip-off” for removing information from the memory chips of mobile devices; “Mobile Criminalist”; Magnet AXIOM; Belkasoft Evidence Centre; hardware record blockers – Tableau T35U; Wiebitech Forensic Ultra Dockv 5;
- recording of physical data – unmanned aerial vehicles (UAVs), FARO Laser Scanner Focus3D, Google Earth and others [3].

Nowadays, one of the requirements for such an investigative (search) action is to photograph the entire territory, including aerial views. For such an inspection, it is necessary to use a wide range of unmanned aerial vehicles, the so-called drones (UAVs), different in capabilities and characteristics. They are able to capture videos and images in real time, transfer them to a remote server for storage and further use. UAV is a small controlled aircraft that can be operated remotely [7].

The use of UAVs in the forensic mapping process will not only increase the accuracy of the data collected but will also be a way to improve the presentation of this data more professionally and accurately. Presentation of a three-dimensional image in the courtroom during the trial will allow showing the picture of the scene more accurately, and clearly present all the material evidence recorded at the scene. These steps will bring forensics to a new level.

According to the authors, the use of UAVs in law enforcement and forensics, in particular, can bring it to a new level of development. The compact size, mobility and high resolution of real-time video images means that large areas can be explored in a short period of time. The use of UAVs can minimise the “contamination” of the scene itself with foreign traces, and also map and study a specific place before visiting it. Installation of various sensors and devices, including thermal (infrared) video cameras on the UAV will allow observing what cannot be seen with the naked eye. Invisible thermal radiation is reflected by objects regardless of visibility conditions and time of day.

Thus, exploring the area using thermal video cameras can make it easier for criminologists to find certain objects at the scene, or people in a large or hard-to-reach area.

One of the promising areas of drone use may be forensic anthropology. Currently, the use of drones to search for human remains is still at an early stage of development. The US Department of Justice has allocated a grant to the Forensic Anthropology Center of Texas State University (FACTS) to study the possibility of using drones as tools for the detection and identification of human remains [9]. To search for human remains, they plan to use drones with the following useful devices and modifications: infrared imaging, hyperspectral visualisation, multispectral visualisation, advanced light filters. The ultimate goal of the project is to create standardised procedures for the use of drones to search for human remains so that law enforcement agencies have a quick and relatively easy-to-use solution in such cases [8]. UAV photography also helps identify recent soil disturbances and shifts and even locate some burials. This will be very useful in such cases as the detection of mass graves (for example, today in the conditions of military operations on the territory of Ukraine, the use of UAVs may be relevant in the context of finding human corpses and various unidentified graves, etc.). Aerial photography gives the investigator a different view of the scene and is often more useful than conventional photography from the ground level [10]. Another area of application of UAVs can be not only the detection of fires in the open area but also the conduct of fire-technical expertise and the establishment of the origin of the fire, record, and collection of material evidence [9].

Using the laser scanners mounted on the UAV, it is possible to effectively capture the scene and combine all the data to create a complete picture of it in three-dimensional space (3D), which can be used at any time. Presentation of a three-dimensional image in the courtroom during the trial will allow showing the picture of the scene more accurately and present all the material evidence recorded at the scene more clearly. These steps will bring forensics to a new level.

<sup>1</sup>Criminal Procedure Code of Ukraine. (2012, April). Retrieved from <http://zakon3.rada.gov.ua/laws/show/4651-17>

<sup>2</sup>*Ibidem*, 2012.

Besides, it is highly relevant to use data stored on digital devices by experts, with its further use as evidence in court [11-13].

Forensic science traditionally involves the detection, collection, analysis, and interpretation of finger marks, toe marks, shoe marks, and deoxyribonucleic acid (DNA) to effectively perform the tasks of criminal proceedings.

For the rational use of forensic data during the pre-trial investigation and the provision of additional intelligence information, the introduction of the Forensic intelligence method has recently been launched in the practical activities of law enforcement agencies. This new direction in criminalistics is based on the processing and use of forensic data (forensic databases, serial methods, forensic data from the scene, etc.), a means of obtaining orientation and evidentiary information that is collected and analysed by forensic units. Its main principles are the use of forensic data to identify the relationship between them (for example, an investigator can link crime A to crime B based on a unique burglary method and further link crime B to crime C based on a similar set of shoe prints). Through the recording and analysis of forensic data, the investigator can get a more holistic view of these crimes, establish the relationship between crimes and link criminals to crimes [14].

One of the first stages of using forensic data for intelligence purposes in the Israeli police was the use of the automatic fingerprint identification system (AFIS) to solve serial criminal offences against property (burglaries) [14]. A correlation was found between unsolved criminal offences committed during the year through the detection of latent fingerprints and palm prints from the same source, prints left at the scenes of criminal offences were linked to more than 20 cases. The data collected on the basis of AFIS identification showed that it was the same person. Based on the data obtained, the behaviour of the perpetrator was analysed and he was detained at the scene of the criminal offence during an attempt to break into the apartment [15].

Also, as the analysis of the practice of the police of the state of Israel shows, most criminals who commit burglaries use gloves and masks to avoid leaving their fingerprints and to avoid being recorded by security cameras. However, in many cases, it is possible to find matching footprints. The footprints can be used to connect not only a specific offender with a specific place of a criminal offence but also, if a series of footprints are found in several places, to connect them with each other. Recognising the importance of applying and using the information obtained during the seizure of footprints, the Israeli police are developing a system for comparing and matching images of footprints obtained during the inspection of the scene between the footprints in the data collection to identify the relationship between the scenes of criminal offences [16]. In this regard, the programme "The Next Step" [16] has been developed and implemented in the work of the expert service of the

Israeli police, which allows comparing footprints from different places of criminal offences by external signs (i.e., by the pattern of footprints), focusing on the geolocation of the scene (comparison comes from closer to each other to more distant places) and provides investigators with additional data for the investigation (for example, data on serial crimes, allows detecting the same footprint left at several seemingly unrelated events, even if the footprints are found in different cities or districts), and increases the database of shoe prints from crime scenes. Each new image of a footprint obtained during the inspection of the scene should be entered into this data collection and compared against all available images to identify matches, even in the absence of a specific suspect. When a match is detected, a forensic specialist will conduct a preliminary analysis of the data, such as the place and time of the criminal offence, and the method of commission, after which the processed initial data is transferred to the intelligence department for further processing and analysis [16].

For effective identification of a criminal using genetic information, it is necessary to create unified national databases of DNA profiles, including:

- DNA profiles isolated from biological traces and removed from the scene;
- constantly updated operational and investigative database of DNA profiles of detainees, suspects and convicts [17].

At the same time, attention should be paid to the issues of legal regulation of replenishment and use of the database, and protection of human genetic information stored in it. One of the most exemplary and at the same time the largest database of DNA profiles in terms of population is the British NDNAD (UK National Criminal Intelligence DNA Database) [17], which was created in 1995 and contains information about any person detained or arrested by the police on suspicion of committing a crime, before being charged. The samples remained in the database and were not subject to seizure, even if the case against the person was later terminated due to lack of evidence [17]. The database of DNA profiles is also used to identify unidentified corpses found at the scene of crime, disasters or hostilities, as well as to identify the person (if the person's identity is not established), to establish the DNA profile of the victim from biological objects, to link it to the crime scene, or filter out biological traces. The victim, whose DNA profile was not previously in the database, can submit a sample on a voluntary basis or by court order (this DNA profile is not entered into the database, but only checked for matches). It is important that all forensic experts are mandatorily registered in the DNA database to be able to weed out their biological traces and to exclude the mistaken entry of their DNA profiles left at crime scenes into the database. After completing their service, officers have the opportunity to submit a request to remove their DNA profile from the general police database.

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In cases where samples of biological materials were seized during the examination of the scene of a particularly serious crime and a DNA profile was identified, but no match was found in the database, it is possible to conduct a so-called "family" search: the database searches for sequences of DNA fragments that repeat (short tandem repeats – STR), which are statistically as close as possible to the DNA profile from biological samples seized during the examination of the scene, and if such sequences are found, an additional search for the Y chromosome is carried out among them, which may allow narrowing the circle of suspects to close relatives on the paternal line [18]. Such an examination can provide investigators with additional intelligence and narrow down the circle of suspects.

The study of the practice of pre-trial investigation bodies of Ukraine showed that investigators rarely use technical and forensic means, relying on the help of specialists. Such a subject of pre-trial investigation is entrusted with almost all the responsibilities for the use of technical and forensic means and methods, which is due to the lack of practical skills of 71% of investigators in technical and forensic means during the ISA [3]. Here, it would be advisable to adopt the experience of the Israeli police, where, firstly, the investigator or investigative team does not immediately respond to any reports of a criminal nature (patrol police officers are sent first), and secondly, to interact with the investigative authorities and assist in the investigation of criminal offences, in particular at the scene, an expert forensic unit was established, which is part of the investigative department<sup>1</sup>. Direct interaction between the investigator and the forensic expert is carried out by involving the latter in the inspection of the scene and granting him the authority to conduct such an ISA in some cases without the presence of the investigator (for example, burglaries), which helps to reduce the workload of

investigators. The tasks of the expert include: establishing the circumstances of the incident to detect the offence; identifying the suspect, collecting evidence; detecting, recording and extracting traces of a criminal offence; providing recommendations to the investigator in charge of the case on the transfer of material evidence to the relevant forensic laboratories [18].

One of the main prerequisites of a successful examination of the scene is to preserve the site in its original form until the arrival of a forensic expert. That is, the police officers who arrived first at the scene (usually patrol police officers) must ensure its safety. From the moment the first police officer arrives at the scene and until the professional authorities have completed their examination of the scene and collected evidence (or until otherwise instructed by the person in charge of the investigation), it is essential to ensure that there are as few unauthorised persons at the scene as possible.

Upon completion of the inspection of the scene of a criminal offence, the forensic expert must draw up a report of the inspection or an expert opinion that refutes or confirms the involvement of any person or object of a criminal offence with its subsequent submission to the authorised entity for investigation, and, if necessary, to the court. Thus, they should be familiar with legal acts (Instructions, Decrees, etc.) and have appropriate training to appear and testify in court [19].

## Conclusions

The basis of technical and forensic support is technical and forensic means, which should be divided into: 1) means of detection, inspection and preliminary examination of objects that contain or may contain forensic information (used during the ISA); 2) means of verification of objects according to forensic records; 3) expert analysis (used by experts in the course of forensic examinations).

As part of the application of intelligent technologies in the investigation of criminal offences, it is necessary to pay attention to the use of artificial intelligence as a systematic set of information technologies aimed at performing rather complex forensic tasks (identification of suspects, prediction of deviant behaviour, investigation at the scene of a criminal offence, tracking money flows, protection against fake news, etc.) Such tools are practically relevant in the work of law enforcement agencies.

In international practice, Forensic intelligence is used as a means of obtaining orienting and evidentiary information with the correct intellectual processing of all forensic information (methods, traces, time parameters, video surveillance materials, etc.) by combining its disparate parts during the investigation of multi-episodic (serial) crimes to complete the pattern of repeated acts and establish links between the places committed by the same criminal or group of persons based on

<sup>1</sup>Criminal Identification Division (Forensic Science Division) Instruction – Appointment and Positions, Order No. 02.04.03 dated 15.08.2017. *Israel Police*. Retrieved from [https://www.police.gov.il/menifa/01.02.04.03\\_2.pdf](https://www.police.gov.il/menifa/01.02.04.03_2.pdf)

VideoAnalytics, it is possible to establish the potential circle of suspects three times faster, and to reduce the entire unsolved array by almost half. From this perspective, the implementation of the “The Next Step” programme,

which provides investigators with additional data for the investigation and completes the forensic database of shoe prints from crime scenes, is very relevant in the Ukrainian practice of investigating criminal offences.

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# Міжнародний досвід техніко-криміналістичного забезпечення розслідування кримінальних правопорушень

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## Анотація

В умовах науково-технічного прогресу, оновлення законодавства й правозастосовної практики техніко-криміналістичне забезпечення розслідування кримінальних правопорушень у діяльності слідчих й експертних підрозділів набуває особливого значення, потребуючи комплексного дослідження, зокрема врахування досвіду міжнародних країн, який, завдяки інноваціям у боротьбі зі злочинністю, поступово відходить від традиційних (консервативних) способів і методів виявлення, збору й фіксації слідів кримінальних правопорушень. Водночас обстановка, у якій вже понад півстоліття працюють правоохоронні органи, досить близька до тієї, що склалася сьогодні у зв'язку зі збройною військовою агресією проти України. Розглянуто новітні технології в розслідуванні кримінальних правопорушень і запропоновано шляхи імплементації кращих міжнародних практик у діяльність слідчих та експертних підрозділів України. Акцентовано на застосуванні штучного інтелекту як систематизованої сукупності інформаційних технологій, спрямованої на виконання достатньо складних криміналістичних задач. Науково аргументовано доцільність застосування методу криміналістичної розвідки (Forensic intelligence) в Україні як засобу отримання орієнтувальної та доказової інформації, що полягає в об'єднанні розрізаних частин інформації (криміналістичних матеріалів) під час розслідування багатоєпізодних (серійних) кримінальних правопорушень з метою отримання повної картини повторюваних діянь і встановлення зв'язків між місцями кримінальних правопорушень, учинених одним і тим самим злочинцем чи групою осіб на підставі Video Analytics. Розглянуто роботу програми «The Next Step», яка дозволяє порівнювати сліди взуття з різних місць учинення кримінального правопорушення за зовнішніми ознаками орієнтуючись на геолокацію місця події. Обґрунтовано переймання міжнародного досвіду щодо залучення експерта-криміналіста до огляду місця події з наданням повноважень проводити таку слідчу (розшукову) дію в окремих випадках без присутності слідчого та складання по завершенню протоколу огляду або експертного висновку з подальшим направленням до уповноваженого суб'єкта (слідчого) з метою зниження навантаження на органи досудового розслідування України

## Ключові слова:

криміналістика; техніка; спеціальні знання; слідча (розшукова) дія; судово-експертна діяльність; огляд місця події; безпілотний літальний апарат; штучний інтелект; криміналістична розвідка; ДНК