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3D MODELING AS FORENSIC METHOD – SCOPE,
LIMITS AND RELIABILITY. LITHUANIAN PRACTICES

The article introduces a new 3D simulation method developed and validated by the Forensic Science Centre of Lithuania, the purpose of which is to automate crime scene investigation and facilitate the performance of expert examination by ensuring the recording of appropriate, reliable and high-quality data and to ensure a clearer visualisation of the case situation. The authors of the article present not only the possibilities and the mechanism of application of the method, but also discuss its compliance with the to international and national standards and data protection requirements applicable for methods of expert investigation.

Keywords: forensic examination, forensic examination method, validation of the forensic method, 3D modelling, data protection.

Introduction. Constantly developing and newly emerging technologies and technological solutions make a significant impact not only on the changes of social and economic societal relations, but also on the development of solutions in criminal justice, especially where an emphasis of scientific evidence is made in the criminal procedure and proving process. Scientific evidence may be

defined as data derived from the application of special knowledge based on in-depth knowledge of an area of science such as arts or crafts, other than law, applied by a specialist or expert. In addition to other procedural and expert duties, specialists and experts have a duty to improve their qualifications, develop their competencies and carry out applied research, so that the forensic methods used in expert practice were in line with scientific and technological innovations. Usually, such innovations are most widely developed and implemented in the practice of forensic institutions. In Lithuania, for example, such requirements are defined at the statutory level, i.e., Article 6 (3) of the Law of the Republic of Lithuania on Forensic Examination provides that "Forensic examination institutions have the right to approve the new types of forensic examinations and to grant the qualification of a forensic expert to the examiner by setting up a qualification commission composed of researchers of the relevant branch of science and experts in the corresponding field". However, innovation is also subject to additional requirements in order to avoid errors in the process of investigating and handling cases. Thus, Article 12 (2) (1) of the aforementioned Law states that a forensic expert must carry out forensic examinations and other expert examinations in accordance with their competence, using scientifically approved, generally recognized, and reliable or accredited examination methods.

The aim of this article is to discuss the reliability of 3D modelling as one of the newer and more promising forensic methods, based on the example of the methodology developed by the Forensic Science Centre of Lithuania.

Methods of forensic examination. The word method (Greek-methods) means a path or a way for research. A method is a path or movement from uncertainty to knowledge, the way to achieve a set goal in practice, and a theoretical way for cognition. The forensic examination method depends on the expert's professional knowledge, the subject of the forensic examination, and the object of the investigation.

The objectives and the goals of forensic examination are achieved by forensic experts by means of reference to certain methods. Experts are independent in choosing the appropriate investigative methods in accordance with the tasks to be dealt with in a particular situation. For example, Article 11 (2) (1) of the Law Forensic Examination, which describes the rights of a forensic expert, states that a forensic expert has the right to independently choose the investigative methods to be applied. However, as it has been already mentioned in the introduction, when choosing investigative ways and methods, the expert must take into account their reliability and suitability for the investigative task.

When examining the institute of reliability and appropriateness of the method, it is necessary to distinguish between scientific methods as a scientific discipline and forensic methods as an applied field of expertise. Scientific methods are designed to study mass phenomena and their regularities, whereas applied forensic methods, although having a scientific nature (based on scientific and technical solutions), are suitable to study individual-specific objects. Scientific and expert methods must meet the criteria of validity and reliability in terms of results, safety, efficiency, cost-effectiveness, etc. While methods of social sciences typically establish regularities of certain processes, phenomena, etc. as

certain tendencies (individual elements of the whole may even contradict the prevailing tendency), methods of specific forensic examination are aimed at establishing the undoubted unambiguous truth. In addition, forensic examination methods must comply with the criterion of admissibility.

The forensic encyclopaedia describes the method as a system of collecting data (facts) necessary for the expert to deal with a set task by means of logical and/or instrumental operations. Operations constituting a specific method are the application of regularities of practical knowledge about the objective reality in order to acquire new knowledge [1].

Forensic methods are based on:

– methods of fundamental sciences;

– the nature and characteristics of forensic objects;

– practical experience in dealing with various algorithmic or heuristic forensic tasks.

Methods may be applied in the forensic examination if they meet certain established criteria, the key to which are reliability and relevance to the set task. Specific requirements for methods are the following:

1) they cannot cause damage or alter the object under investigation. Where a meeting of such requirement is impossible, the forensic institution must acquire a corresponding authorization from the institution that ordered the examination. It should be noted that this criterion is not applicable where micro-quantities (of fibres, etc.) are examined. In such cases, the ordering institution must clearly understand that the microscopic amounts of substances submitted for examination will be used up and will not be available for re-examination;

2) the effectiveness of such methods must be scientifically validated;

3) the results yielded by the methods must be obvious and clear not only to specialists but also to all parties involved in criminal proceedings;

4) the methods used must exclude any restrictions on human rights and freedoms and must not degrade the dignity of people.

The modern forensic theory distinguishes three groups of methods that are used for forensic examination, namely: [2].

– methods discussed in the standards (standardized methods);

– methods adopted by the forensic institution (methods of fundamental sciences modified and adapted for forensic examination);

– methods developed and validated by the forensic institution.

Methods used in forensic examinations are also subject to requirements laid down in ISO standard 17025 (the standard is one of those that must be implemented and complied with by a forensic institution in order to be accredited). The requirements are:

– the method must meet the needs of the customer and must be suitable for the set task;

– the method must be validated;

– the forensic expert must prove their ability to apply the method in practice.

Thus, forensic examination methods are subject to high standards in terms of quality, reliability, reproducibility, and legality.

3D modelling as a method for performing a procedural and forensic examination activities. Traditional methods already include image analysis, widely used in the identification of vehicles, weapons, etc. or subjects captured in photos submitted for investigation in terms of discovering what objects are captured, reconstructing chronologies, highlighting images for further research, finding out if the submitted video record is continuous and demultiplexing multiplexed videos. Rapidly developing technologies and the growing demand by the client induces the need for new, sometimes unconventional, investigative methods allowing to deal with a broader range of issues. One of such methods is the visualization of the crime scene and 3D modelling.

Practical case investigations, especially where large-scale areas have to be inspected and photographed (e.g., traffic accidents, fires, acts of terrorism, technogenic accidents), often take massive human resources and extended periods of time. The period of time spent to collect evidence at the crime scene so that to ensure the success and efficiency of the further investigation is critical and directly affects the quality of the collected data. The human factor is also an important element, especially if the works on the scene are carried out manually, e.g., a simple error made in the inspection report, which is usually filled in at the scene as a draft version to be transferred to the final form, may render the further investigation impossible. The quantitative and qualitative scope of the collected data has a direct impact on the quality and reliability of the conclusions made by the forensic expert. In order to reduce the impact of the discussed factors on data collection, it was necessary to address the issue of automating the full or partial crime scene investigation by means of the latest technologies. Experts of the Forensic Science Centre of Lithuania, implementing a long-term 3D simulation and visualization strategy, have come up with a hypothesis that automation should be based on the use of a quadcopter (drone) and/or a 3D scanner. A series of experiments aimed at identifying the specific parameters to be recorded, the precision required to make an accurate record of the crime scene, the data necessary for visualization, and a reliable output, which could be used in further expert investigations, including investigations in traffic accidents, traceology, etc., has been carried out. Then, on the basis of the obtained data, it was necessary to determine the technical parameters of the equipment that meet the set requirements with the view of the complexity (or rather the ease of use) of the equipment. As the result of the aforementioned works, the method of data collection based on the use of a quadcopter (drone) was chosen.

The method comprises several simple technical operations that only take a brief instruction and require no special expert knowledge. In order to perform an inspection, a quadcopter operator must first choose at least two points of reference and measure the distance between them (see Figure 1). The distances between the reference points will be used to determine possible errors in the size and proportions of the acquired image (3D model).

Fig. 1. Shows a photo of the terrain taken by a quadcopter with reference points, indicated by blue arrows on the left of the photograph, and the measured distances between the points, indicated on the right of the photograph

A quadcopter, controlled by a specialized mobile application, uses a special algorithm also known as the selected quadcopter flying mission, to capture the scene. The terminology of the forensic science describes the mission as an objective method of visual inspection of the crime scene, which can be carried out in three ways – concentric, where the motion is in a narrowing spiral, eccentric where the motion is in an expanding spiral and linear where the motion is in a straight line. The latter may be further subdivided into – thin network inspections, thick network inspections, and areal inspections. The choice of one or another method in forensic science depends on [3]:

– characteristics of the site;

– the size of the surveyed area;

– the presence of pieces of evidence of a crime, the location, and quantity of the pieces of evidence;

– the availability of human resources;

– the professional experience of the expert in charge.

Thus, as we can see in the presentation of the technology, its application simplifies the implementation of the first three elements, as the software allows the choice of the most optimal way of inspection and eliminates the last two elements, namely, the number, qualifications, and competencies of experts in charge.

The mode of the missions (inspection), depending on the need and the circumstances of the event, is selected in the menu of the mobile application (see Fig. 2)

Fig. 2. The menu of the mobile applications of the mission

As it can be seen in the figure describing the missions (inspection modes), several options are available: the first three, shown on the left, are mixed areal and linear modes, the fourth is the concentric mode and the last one is reserved for a free flight inspection mode. As it has been mentioned, missions must be selected depending on the site map or satellite image (4G is recommended). Also, the area of the flight zone to be captured must be set (see Appendix 1). 3).
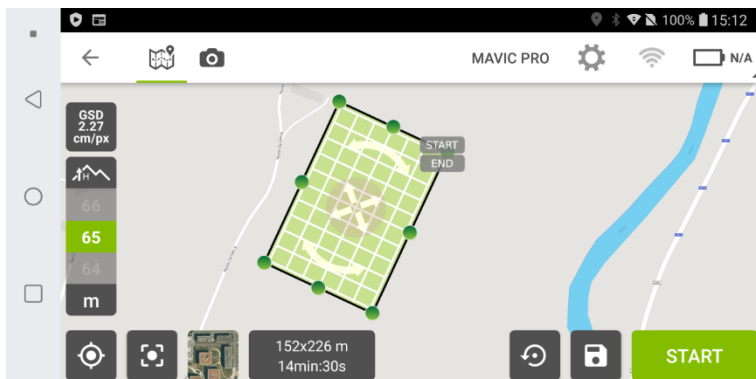

Fig. 3. Flight zone selection

When the mission is selected and the flight area is set, the data are automatically sent to the quadcopter that executes the planned mission from takeoff to landing without direct operator control. Thus, a specially trained quadcopter operator can collect data from the site and pass it to a forensic expert for further processing. Hence, the data collected by the quadcopter is passed to an expert institution for processing, where the forensic expert uploads it to a computer and special software forms an orthographic image or a 3D model of the site, i.e., the software simply combines the data (measurements, visual data, GPS data) captured in separate images and their metadata into a single whole. Thus, the primary result of the use of this equipment is an orthographic image (or a 3D model), which can be used independently or transferred to a specialized agency for further analysis. For example, an expert holding an orthographic image, or a 3D model of a traffic accident can upload it to the forensic examination software and model the event under "real" conditions using data, measurements, and distances captured by the Quadro scope, clean of human interference or interpretations.

The advantages of the method compared to traditional methods of crime scene inspection are as follows:

– the speed of data collection: an area of 6000 sq. m can be photographed within 3 minutes on average;

– big volumes of data and measurements allow the expert to solve problems and to draw conclusions on issues that have not been addressed previously, for

example, previously used two-dimensional images did not allow full assessment of perspective and accurate identification of individual objects in the picture, a problem absent in 3D models;

– economy of human resources, excluding the possibility of error, a short 16-hour training course for the operator;

– the ability to watch and evaluate the site virtually in a 3D image.

Although the developed automated method of visual inspection of the crime scene is based on standard hardware and technological solutions, certain modifications make it adaptable to the needs of expert examination. The method has already been validated on the national level as it meets the requirements of international standards set for forensic investigation methods. However, conditions of application and use of the method make its approval difficult: it must be used for the investigation of identical cases in several independent laboratories. At the moment, there is no possibility to have identical recoveries of crime scenes in different states and there are no data about the number of forensic institutions using the method However, it is likely that the problem will be successfully addressed in the future.

The issue of protection of personal data in 3D modelling. As for the possibility of using 3D modelling in legal proceedings, it is important to address the issue of personal data as well since the investigations incorporate the processing of large amounts of data. Where the site is inspected from the sky (by a flying quadcopter), private personal data (appearance, vehicle model, license numbers, etc.) may be captured along with crime associated data and it is important to make sure provisions of legal regulations on personal data protection are not violated. The main instrument enforcing the international standard of personal data protection is the General Data Protection Regulation (GDPR) [4], which lays down the rules for the collection, processing, and storage of personal data of employees, customers, suppliers, or other persons and stipulates liability for the unauthorized collection, improper processing, etc. The regulation stipulates that the scope of application of the instrument is limited to the data of natural persons. However, the GDPR is not applicable to the processing of personal data by competent authorities for the purposes of prevention, investigation, identification of, or prosecution for criminal offenses and enforcement of criminal sanctions, including protection against and prevention of threats to public security. Also, Article 6 of GDPR lays down the terms and conditions for lawful processing of documents:

– where a legal obligation (imposed by EU or national legislation) must be performed;

– where the processing is necessary for the accomplishment of a task carried out in the interest of the public or in the exercise of official authority vested in the data administrator (as defined by EU or national law);

– The GDPR emphasizes that the concept of public interest is not explicitly defined in legal acts, however, the public interest is understood in the recommendations as a value important to the society to be enforced by public authorities (as well as bodies of public administration), disregard of which would lead to violation of rights and legitimate interests of many people. Criminal law and

criminal procedure are branches of public law where specialized agencies, such as the pre-trial investigation officer, the prosecutor, and the court, must perform functions ascribed to them by the state, such as the initiation, termination, and completion of criminal prosecution are formalized by courts and law enforcement bodies and by a court ruling adopted in accordance with valid legal acts.

Hence, the GDPR provides that the processing of personal data for the benefit of public interest is legitimate where:

– functions stipulated by legal acts are carried out for the benefit of public interest;

– functions stipulated by legal acts and assigned by public authorities are carried out.

– The aspiration for the public interest is the objective of public authorities in the first place but may also apply to any company or agency authorized to perform functions of public authorities or act for the benefit of the public interest.

– In such a case, the processing of personal data is inevitable. Where functions or acts for the benefit of public interest are viable without the use of personal data, the processing of personal data is deemed unlawful. Also, the principal task or function must be clearly justified by law.

– The company must be clearly aware of the specific legal action to be followed in their performance in order to prove the legitimacy of the processing of personal data.

Thus, processing of personal data in the course of criminal prosecution is subject to a lower standard, as criminal prosecution is conducted by specialized bodies tasked with a specialized function, i.e., investigation of crimes and administration of justice. For example, Article 109 of the Constitution of the Republic of Lithuania states that justice in the Republic of Lithuania shall be administered only by courts, while Article 118 provides that the pre-trial investigation shall be administered and conducted by a public prosecutor. Criminal prosecution is carried out in accordance with the procedure established by the Code of Criminal Procedure of the Republic of Lithuania, Article 2 of which stipulates that the prosecutor and pre-trial investigation bodies must take all possible measures ascribed to their competence by law in order to instigate an investigation and disclosure of the criminal offense within the shortest possible term as soon as they are reported of signs of a criminal offense. The achievement of the aforementioned objectives is impossible without collecting and processing personal data. All entities involved in the procedure for the performance of certain specific functions should be informed about confidentiality clauses, for example, court experts who, pursuant to Article 12 (2) (5) of the Law on forensic examination, have a duty to protect national, institutional, commercial and professional secrets and not to make public data of forensic examinations without the consent of the court or the judge who appointed the forensic examination, the prosecutor or an official of the pre-trial investigation body or a natural or legal person or other institution and their subdivisions who placed an order for the forensic examination.

Thus, the use of a quadcopter for the collection of personal data and the further processing of the collected data in the course of the aforementioned specialized functions meet the requirements set by the GDPR.

Conclusions. 1. With the development of technologies, new investigative methods are being introduced into the field of criminal investigations and forensic practice, the purpose of which is to automate the investigative processes as much as possible and eliminate the risk of human error, thus making the course of criminal proceedings and forensic examination more efficient. 3D modelling is one of the latest innovations that have been introduced in Lithuania.

2. Effects of 3D modelling are multifold as they include optimization of site inspection, improving the efficiency of forensic examinations, and clearer visualization of the event.

3. The method of 3D modelling has been validated in line with both the international and national requirements for forensic examination and the basic provisions laid down for the protection of personal data.

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3D МОДЕЛЮВАННЯ ЯК КРИМІНАЛІСТИЧНИЙ МЕТОД – ОБСЯГ, МЕЖІ ТА НАДІЙНІСТЬ. ЛИТОВСЬКА ПРАКТИКА

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В статті представлено новий метод тривимірного моделювання, розроблений та підтверджений Центром судових експертиз Литви, метою якого є автоматизація дослідження місця злочину та полегшення проведення експертизи шляхом забезпечення запису відповідних, надійних та якісних даних та для більш чіткої візуалізації ситуації у справі. Автори статті

висвітлюють не лише можливості та механізм застосування методу, а й обговорюють його відповідність міжнародним та національним стандартам та вимогам захисту даних, що застосовуються до методів експертного дослідження.

Ключові слова: судова експертиза, метод судової експертизи, валідація криміналістичного методу, 3D-моделювання, захист даних.

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HANDWRITING EXPERTISE IN THE FORENSIC SCIENCE CENTRE OF LITHUANIA: PRESENT ACTIONS AND FUTURE VISION

Recently, the number of expert investigations in handwriting evidence at the Lithuanian Forensic Examination Centre (LTEC) has significantly decreased. The decrease has been observed for several years already.

The present article analyses possible reasons for the decrease in the number of expert investigations in handwriting in LTEC and the importance of such investigation in the context of judicial research, court proceeding, and criminal investigations. Also, the article deals with the use of electronic signatures and associated security problems in the digital environment.

Key words: *handwriting examination, signature, digital signature, digitized signature, informativeness of signatures.*

Formulation of the problem. In recent years, the Lithuanian Forensic Examination Centre has seen a significant decrease in the number of requests for handwriting examinations (Table 1).

Presentation of the main material. The trends in handwriting investigations make it necessary to assess the present situation, raising concerns of handwriting experts, totalling nineteen in LTEC (in Vilnius, Klaipėda, and Šiauliai branches). A review of the data on handwriting investigations of the recent year allows making the following preliminary conclusions:

– The number of illegal documents of incorporation and financial transactions of businesses, sole traders, and enterprises has decreased significantly (by more than 60 percent according to LTEC statistics). Online registration and online submission of financial reports allow rapid tracking of illegal transactions and impede the establishment and operation of illegal business units;