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## TRANSFER OF 3D SCANNING TECHNOLOGIES INTO THE PRACTICE OF CRIMINAL PROCEEDINGS

**Introduction.** *Everyday, hundreds ideas of innovative technologies are developed, and thousands innovative products and services are implemented. The practice of criminal proceedings does not stand aside these processes. In recent years, foreign specialists have been increasingly focusing on 3D scanning technologies and the potential of their use in investigations.*

**Problem Statement.** *The problem of 3D technologies in the criminalistic practice has not been sufficiently developed in Ukrainian science, and the idea of using 3D technologies for fixing evidence, as well as tracing the evidence and corpus delicti is only at the initial stage of development. In the future, focus on active implementation of 3D scanning technologies in forensic activities is expected to increase.*

**Purpose.** *On the basis of generalization of international experience, a systematic review of the advantages of using 3D scanning technologies in criminal proceedings has been carried out, and the prospects for the transfer of these innovations to the criminalistic practice in Ukraine have been outlined.*

**Materials and Methods.** *Comparative analysis, formal and logical methods.*

**Results.** *The use of 3D scanning technologies is a unique way of fixing the information about a criminal offense, which provides access to the virtual image of the crime scene for all participants of the criminal process. An investigator, a prosecutor, a judge, and a juror can visualize the crime scene using 3D model. The advantages of this process are universality, portability, agility, ease of use, efficiency, safety, multi-functionality, and cost effectiveness.*

**Conclusions.** *The world practice of police services has proved the expediency of using laser scanning while investigating criminal offenses. Ukraine is also expected to make a progress in the technological support of police and expert services, insofar as effective counteraction to modern crimes without innovations is an impossible mission.*

*Key words:* innovation, 3D scanning, reconstruction, virtual model, criminal proceedings, crime scene, and police.

The Law of Ukraine No. 40-IV of 04.07.2002 On Innovation Activity defines the concept of “innovations”, by which the legislator suggests newly created (applied) and (or) improved competitive technologies, products or services, as well as organizational and tech-

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nical decisions of the production, administrative, commercial or other nature that significantly improve the structure and quality of production and (or) social sphere [1]. Everyday, hundreds ideas of innovative technologies are developed, and thousands innovative products and services are implemented. The practice of criminal proceedings does not stand aside these processes. In recent years the specialists of scientific and research institutions, expert services and law enforcement agencies have been increasingly focusing on 3D scanning technologies and their potential use during pre-trial investigations, as well as presentation of evidence in the courtroom.

The problem of 3D technologies in criminalistic activity, in particular scanning of the crime scene is not sufficiently developed in Ukrainian science. This conclusion can be drawn from a few publications in professional editions (S. Danets, A. Neporada, A. Tereshkevych, R. Shekhavtsov) and the lack of thorough monographic interdisciplinary research. In Ukraine, the idea of using 3D technologies for fixing evidence, as well as tracing the evidence and corpus delicti is only at the initial stage of development. Instead, in some countries (the USA, Poland, Italy, Australia, Turkey, and many others) such innovations have been actively introduced into the practical activity of bodies, authorized to conduct pre-trial investigation or carry our examinations. This research is a continuation of *Innovative Technologies of 3D Scanning in Criminalistic Activity* publication, the task of which was to intensify a discussion of researchers and practitioners in Ukrainian criminalistic science about the prospects for the introduction of 3D technologies [2].

The objective of this research is to implement, on the basis of generalization of international experience, a systematic review of the advantages of using 3D scanning technologies in criminal proceedings, as well as outline the prospects of the transfer of these innovations in Ukraine.

It is known that the success of the whole investigation depends, to a great extent, on the quality of fixing the evidence at the crime scene. The

application of conventional tactical methods of criminalistic tactics and techniques without the use of innovational technologies cannot meet the ever-increasing demands for the level of accuracy, details and efficiency of documenting the data at the crime scene. The laser 3D scanner makes it possible not only to fix criminologically relevant information thoroughly, accurately, effectively and with a high quality, but also to significantly reduce the procedural expenses of the forces and means, since it enables creating a 3D copy of the scanned object, which can be reviewed and explored, with the help of a special software, and even printed using a 3D printer [3]. Due to the use of 3D innovations in police activities at the crime scene, the transfer of these technologies into the area of criminal proceedings began.

The international community is keen on exploring the possibilities of 3D technologies, whereas the scanner manufactures convince of their advantages that include the following elements:

**1. Universality.** The laser 3D scanner can be used in any room, in any part of the open space, in any light and in the inspection of any crime scene. The American police services involved in the investigation of traffic accidents and crimes related to the use of firearms, and carrying out the forensic mapping of a place of murder, explosion or arson, have the most common practice of using 3D scanners at the crime scenes [4]. In Europe such technologies are tested in the investigation of explosions, the activities of organized groups and terrorism [5]. An essential advantage of 3D scanning in comparison with photos or video is the lack of high lighting requirements, since the latest generation of scanners can visualize a scanned crime scene or a single less visible trace, regardless of the quality of artificial light or daylight. At the same time, it should be noted that foreign experts advise not to use 3D scanners at less informative scenes, with significantly limited zone of a crime scene and trace information. In such investigative situations it is enough to use the usual tactical methods of fixing the information and it will correspond to the principle of resource savings.

**2. Portability.** All modern kits for scanning in the field conditions are highly portable, as it is usually a small special suitcase that includes a scanner, special bullets, tripod and other necessary hardware components, as well as a laptop with special software. Recently, the technologies have been further improved, and the manufactures offer handheld scanners with special tablets for achieving the same result as a scanner with a tripod and computer (for example, the Faro® Freestyle 3D Scanner). Ensuring the performance of the same functions, such manual equipment is relatively cheaper than standard scanners (the cost of the Faro® Freestyle 3D Scanner is approximately \$ 7 – 10,000) [6].

**3. Accuracy.** One of the first points in the list of advantages, taken into account by both domestic and foreign experts, is the accuracy of documenting information in graphical form. As already noted, the essence of 3D technologies is the formation of a cloud of millions of points of a certain real environment (for example, the crime scene), which ensures the creation of its virtual model, available for review and investigation by law enforcement agencies. The clouds of points can be used for obtaining an accurate, realistic computer graphic 3D model with a wide range of applications (investigation of crimes, accidents, fires, etc.) [7]. According to American colleagues, the result is not animation or simulation, but a realistic picture, large-scale modelling, able to provide the presence of investigators at the crime scene and see the situation as seen by the offender [2]. Similarly, the Italian researchers have pointed out that virtual models enable looking at the crime scene from different positions, getting the experience of perceiving the scene in the eyes of the victim or the eyes of the offender, and recreating the dynamics of the event [9]. Different scanners may have different technical features (specification), but in any case this tool is more effective than a verbal description in the protocol or a static photograph.

But the court may always have doubts about the reliability of the scanning results. An interes-

ting incident happened in the state of Georgia (the USA). In one of the criminal proceedings David Dustin, as an expert in 3D scanning, scanned the courtroom a few days before his presentation of the virtual murder scene to the jury. On the day of the hearing D. Dustin first presented a scan of the courtroom, so that the jury would personally be convinced that the accuracy of documenting information with the help of such innovation is incredibly high, and the evidence recorded in this way is reliable. Only then, the expert moved directly to his conclusions in the case [10].

High accuracy creates the ability to visualize less visible objects, make their negative image, which in the future allows identification or classification examinations. In the absence of such innovation, a certain category of evidence becomes inaccessible for use at the stage of investigation or trial.

**4. Ease of use.** The technology of 3D scanning is not too complicated for the user and after special trainings the inspector-criminalist or the investigator can master it and apply it effectively. The preparatory stage involves placing the scanner by the indicators of a build-in levelling so that it does not deviate in relation to the requirements of special sensors, and setting of orientations (for example, for Faro® 3D scanners – setting of white spheres, which later allow combining individual scans of individual areas). Then all the received scans are merged into the one whole. It should be noted that scanning and information processing after scanning can be performed by both a specialist who carried out scanning, and various independent experts at any place and time. So an important for-argument of 3D technology is that the scanning process can be carried out only by one person, which reduces the number of police officers involved in the review of the crime scene [2, 11]. Modern 3D scanners are considered “*user-friendly*”, which allows their use by individuals without thorough training. It is worth noting that the processing of 3D scanning data still requires hard work of a spe-

cialist. The step-by-step instruction provides perfect knowledge of all system options, the choice of which depends on the tasks [12].

The transfer of 3D technologies enables changing the approach to recording procedural actions at the crime scene. The need for a detailed protocol with a detailed verbal description of the objects may generally lose its importance. The protocol will become a prototype of a reference with information about time, place, participants of the procedural action, applied technologies and supplements.

**5. Agility.** For a detailed verbal description of a standard living space in a usual way, one needs 1.5 to 3 hours, while 3D scanner will create the photorealistic model in a few minutes. According to one of the studies, a small crime scene can be scanned within 10 minutes, and multi-room premises a little longer, but it still takes minutes [14]. The American experts spent 30 minutes on making a 3D photorealistic model of a woman's murder scene (4 scans of the crime scene were made, and each of them was made within 6 minutes). Of course, then there was the processing of the scanned material with the help of special software, but the scanning made it possible to quickly fix the evidence information and allow the other investigators to work at the crime scene [8]. The similar results of scanning time are provided by Polish colleagues [2, 5].

**6. Safety.** Two aspects should be considered here. First, all 3D scanners are safe for use by police officers and experts. They undergo special certification, to not perform harmful radiation, and do not cause negative consequences for the life and health of the person who works with them. Secondly, the American colleagues point out that quite often these technologies, on the contrary, contribute to the safety of individuals, in particular in situations connected with documenting the traffic accidents. The experts note that the duration of the work of the police officers, who fixed the information at the scene by the traditional means of criminalistic technology and tactics, increased, which meant a longer stay of

the police officers in the area of dangerous traffic, where repeated accidents could happen, leading to injuries or even deaths of the police officers in the course of their duties. The scene scanning that is carried out at a higher speed and without loss of quality thus reduces the risk of such events and increases the safety of law enforcement workers [13, 14].

**7. Multi-functionality.** 3D scanning technology is not limited to 360° visualization of the crime scene. It is moving graphics with which one can continue to work and which can be used to solve other issues:

- ◆ to rotate the objects, which allows seeing the situation at different angles and in different projections;
- ◆ to accurately carry out the necessary measurements and determine the distances between the objects as well as their size;
- ◆ to study little-visible trace evidence (for example, the trace of shoes on brittle sand, when there is no possibility of producing highly-quality plaster casts and there is relatively low efficiency of photographing the trace, even with preliminary processing with special color sprays), as well as produce their 3D models, then negative copies and identifications;
- ◆ to produce 3D schemes and plans of the crime scene, digital photos of the crime scene and some other necessary annexes to the protocols on digital data mediums;
- ◆ to reconstruct the mechanism of committing a crime by studying the mechanism of the appearance of ballistic traces, the mechanism of blood trace formation, the mechanism of traffic accidents, etc.;
- ◆ to create 3D models of a mutilated face of an unidentified corpse of a person and conduct future anthroposcopic studies;
- ◆ to integrate the data and analyze the situation in the presence and in the absence of individual objects (for example, when the crime scene is scanned with a corpse, after moving it, one can inspect the corpse's place and re-scan it). Then, two scans can be imposed on each other and

the situation can be visualized before and after the dynamic stage of the review).

In addition, 3D technologies are used to study the traces of injuries on the human body as a result of bites, as well as study the bone fractures under the influence of mechanical factors. The American scientists even print 3D models of such bones in order to match them with potential instruments and thus achieve a high level of credibility of the conclusions of expert studies. The experimental studies of identifying the entire piece by its parts by printing with the help of a special 3D printer a broken bone of one corpse, the parts of which were found in different places, have already been carried out [15].

Scientific development in this area is going on. In the future work of detectives, the 3D technology of the reconstruction of the crime scene will become even more interactive [12].

**8. Cost effectiveness.** This is the last point in the list of advantages, but one of the key ones, because the combination of all the above advantages allows obtaining the desired result in a better way than the conventional means of criminalistic technology and tactics, with significantly lower resources costs. Undoubtedly, it is first necessary to invest heavily in the development and introduction of such technologies directly into the practical activity of expert services and police bodies: to purchase equipment and software; to form service centers; to provide certification of technical means; to organize a program of advanced training of workers and special trainings, during which it will be possible to master the order of using 3D technologies in specific conditions (fire, explosion, air crash, murder, use of firearms, accidents, etc.); to provide the ability to create 3D annexes to protocols recorded on data mediums and the possibility of their presentation in the court.

Indeed, in the literature one can find opinions that the obstacle to the massive use of 3D scanning technologies is, as a rule, a significant cost of devices, which is over \$ 100,000 [6]. But today there are already less expensive alternative de-

vices that can be implemented in the police departments without devastating local budgets.

However, investment will yield good results over the time: operational work of law enforcement agencies at the crime scene; qualitative fixing of traces and evidence, which will increase the possibilities for expert research. In turn, it will contribute to the effective execution of criminal proceedings, and, in a more global sense, will increase the public's trust in the entire law enforcement and judicial system. As S.V. Danets states, innovation facilitates the work of the criminological inspector involved in carrying out the review, since it is not necessary to measure the distance between objects and compile the scheme, as the program does everything for you quickly and accurately [3].

To conclude, one should mention another important aspect that the countries of the law system of *common law* pay a considerable attention to. This is a reaction to the so-called "CSI-effect", triggered by the demonstration in the television series of the unique capabilities of the *forensic science*. This state of affairs has led to the fact that the jurors considerably increase the requirements and expectations for the presentation of the evidence base. Often, they do not understand that the fantastic possibilities of quick and accurate identification demonstrated in films differ significantly from the routine work of the police services and experts. Therefore, practitioners do not hide the optimism that the innovative 3D scanning technologies in some sense are the response to such a challenge [13, 14, 16]. Specialists can move judges and jurors to the crime scene by means of 3D visualization, and this has a positive effect on the perception and understanding of cause and effect relationship, and assessment of evidence.

The introduction of 3D scanning technologies in criminal proceedings has prospects in Ukraine as well. Thus, in 2011 a test application of 3D scanner was carried out in the practical police unit in Kharkiv Oblast. According to S.V. Danets' research, the laser scanning capabilities were tested during the inspection of the scene of an acci-

dent with a laser scanner *LeicaScanStation 2* (Switzerland). The same testing of the laser scanning of the accident scene, but using the laser scanner *FARO® LaserScannerFocus3D 120* (the USA) was conducted on the basis of the “criminalistic ground” of the State Scientific and Research Expert Criminalistic Center of the Ministry of Internal Affairs of Ukraine [2, 3]. In the future, there should be an increase in the interest of the scientific community and specialists in the issue of the active introduction of 3D scanning technologies into criminalistic activity.

The conducted research gives grounds for the formulation of the following conclusions. First, the improvement of criminalistic technical means is the most common way of the transfer of innovations into the area of criminal proceedings. Today, along with 3D scanning technologies the innovative products in the field of biometrics, geoinformation technologies, automated workplaces, integrated databases, expert researches, in particular molecular genetic, dactyloscopic, ballistic, etc. are actively developed.

Secondly, the use of 3D scanning technologies is a new unique way of fixing the information about a criminal offense that allows “freezing” the crime scene as it was at the time of the review, and provides access to such a 3D image for all participants of the criminal proceedings. In other words, the investigator, the prosecutor, the investigation judge, the judge and the jury can move to the crime scene while browsing the 3D model without leaving their workplaces. The main advantages of using such an approach to information processing are universality, portability, speed,

ease of use, efficiency, safety, multi-functionality and cost effectiveness.

Thirdly, the research conducted in many countries proves the expediency of using laser scanning during the investigation of criminal offenses. Police and expert services in many counties of the United States, Poland, Italy Australia and some other countries are actively testing 3D scanners not only for visualization of the crime scene and field investigation, but also for expert trace, ballistic, anthroposcopic studies.

Ukraine should also be expected to make a progress in the technological development of criminalistic provision of police and expert services, since effective counteraction to modern crime without innovations will be a challenge impossible to implement. By this time, the practice of testing 3D scanners was extremely small and episodic. One of the reasons for that is the great cost of equipment and the lack of staff capable of systematically using such technologies in the practice of investigation. At the same time, it should be emphasized that no innovation will succeed if it is used in isolation from other important achievements of humanity. One cannot absolutize any technology. It is not necessary to completely ignore the traditional means of fixing information (for example, photo fixation or video), since during 3D scanning errors may also be allowed that negatively affects the course of the investigation [16]. Only a combination of previous experience and new opportunities in the world of innovations enables working out an effective prototype of “intellectual weapon” against crime.

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#### ТРАНСФЕР ТЕХНОЛОГІЙ 3D-СКАНУВАННЯ У СФЕРУ КРИМІНАЛЬНОГО ПРОВАДЖЕННЯ

**Вступ.** Щодня розробляються сотні ідей інноваційних технологій, впроваджуються тисячі інноваційних продуктів та послуг. Не залишалася осторонь цих процесів і сфера кримінального провадження. Останнім часом іноземні фахівці дедалі більше увагу приділяють технології 3D-сканування та потенційним можливостям її використання у ході розслідування.

**Проблематика.** Тема 3D-технологій у криміналістичній діяльності в українській науці розроблена недостатньо, а ідея використання 3D-технологій для фіксації доказової інформації, дослідження слідів та речових доказів перебуває тільки на початковій стадії розробки. В майбутньому зацікавленість до активного впровадження технологій 3D-сканування у криміналістичну діяльність буде тільки зростати.

**Мета.** Системний огляд переваг застосування технологій 3D-сканування у кримінальному провадженні на підставі узагальнення міжнародного досвіду, а також окреслення перспективи впровадження зазначених інновацій в Україні.

**Матеріали та методи.** Компаративний аналіз, формально-логічні методи.

**Результати.** Застосування технологій 3D-сканування — це унікальний спосіб фіксації інформації про кримінальне правопорушення, що забезпечує доступ до віртуального зображення місця події усім учасникам кримінального процесу. Слідчий, прокурор, слідчий суддя, суддя, присяжний можуть, переглядаючи 3D-модель унаочнити місце події. При цьому основними перевагами застосування такого підходу обробки інформації є: універсальність, портативність, швидкість, легкість у використанні, оперативність, безпечність, поліфункціональність та економічність.

**Висновки.** Світова практика роботи поліцейських служб доводить доцільність застосування лазерного сканування під час розслідування кримінальних правопорушень. В Україні також слід очікувати прорив у технологічному розвитку криміналістичного забезпечення діяльності поліції та експертних служб.

*Ключові слова:* інновація, 3D-сканування, реконструкція, віртуальна модель, кримінальне провадження, місце події, поліція.