Engineering in Criminal Probation. 3D Scan of the Body with the Help of Virtopsy Software

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ABSTRACT: Over time, engineering has played an important role in the development of the society we have today. Technology has been and will be the science that has given mankind an increase in quality of life, strong economic growth, strong military influence, a chance at life in treating incurable diseases that threatened and threaten the population and last but not least engineering in the field of justice brought justice. The implementation of engineering in the technological modalities of forensic research through imaging and radiological diagnosis, meant an innovative solution for criminologists. Thus, for investigations where a corpse is always found at the crime scene, the forensic probation must be carefully analyzed by specialists, and it cannot be brought to a favorable result without a technology that allows this. If we look in this context at the classic methods of determining the cause and time of death, we see that once at the morgue of the IML, specialists resort to surgical means namely autopsy of the corpse by dissection and subsequent finding the result, by suturing and grooming. This classic process takes time, and for criminal investigation bodies can bring serious negative effects, such as a new crime or even the escape of the criminal. So here we can understand the need for engineering and so nowadays specialists can boast of the new ***Virtopsy*** software. This software is designed as a CT that with the help of 3D scanning of the body, can determine not only the time and cause of death, but also blunt objects possibly inside the body. Interestingly, this software, thanks to scanning, radiological diagnosis and imaging, reaches the possibility of calculating the depth of the wound, the technological properties of the knife, the knife, for example, in the case of a stabbing, the technology of bullets in the case of shooting, and many other material and technological properties of weapons or objects that caused death. ***Virtopsy*** is therefore the software that sheds light on murder cases, this software is again a living proof of the importance of engineering in this field as well.

KEYWORDS: engineering, forensic research, Virtopsy, investigations, 3D scanning, technology

Introduction

Over time, engineering has played an important role in the development of the society we have today. Technology has been and will be the science that has given mankind an increase in the quality of life, a strong economic growth, a strong military influence, a chance at life in treating incurable diseases that threatened and threaten the population and last but not least the judicial engineering of brought justice. The implementation of engineering in the technological modalities of forensic research through imaging and radiological diagnosis, meant an innovative solution for forensic scientists.

In order to better understand this aspect related to the adaptation of technology in the forensic field, a definition in this sense would be: *"Forensics is the science that develops technical and scientific means and methods, as well as tactical procedures for discovery, fixation, lifting, examination and interpretation, judicial evidence, carrying out expertise and technical-scientific findings, in order to prevent and discover crimes, identify the perpetrators and administer the evidence necessary to find out the truth in the judicial process."* (Romanian Police - National Institute of Forensics - politiaromana.ro). Therefore, reference is made to conducting on-site research, examination of laboratory evidence, conducting technical-scientific findings and forensic expertise, as well as fundamental and applied scientific research, these being the main structural branches related to forensics.

Particularizing the branches of forensics, it will be analyzed in the following, aspects related to the functioning of each, as follows:

(a) *On-the-spot investigation*: this is usually the beginning of a criminal investigation into the act. The technical-scientific investigations of the place where the crime was committed or of some related surroundings are part of the fundamental process of the subsequent performance of all findings or expertise. We cannot discuss a field research without the necessary equipment, this is about special dusts and fingerprint brushes, various devices that use UV light to identify bloodstains that are not visible to the naked eye, collection bags various suspicious objects, different chemical pencils that can cause the reaction of chemical agents, and the list goes on, all for the purpose of taking evidence that will later be used against the perpetrator.

(b) *Examination of evidence in the laboratory*: Another important aspect that contributes to the investigators' path to the resolution of the case is the examination in the laboratory of various objects found at the crime scene and especially on the victim's body. Related to this aspect, here we carefully analyze the finest and smallest details, which cannot be analyzed otherwise, so we are talking about different human secretions, hair, DNA, fingerprints, blood, chemicals, and the list goes on. This branch is a vital one in the criminal prosecution process, as it provides a high percentage of criminal identification. But none of the above could have been possible without the technical and scientific engineering not intervening and developing modern equipment, so we can boast today with high-performance laboratories in thousands of police institutions.

(c) *Forensic expertise and technical-scientific finding*: the concept of forensic expertise has a wider openness resulting in the need for different types of expertise, such as archaeological forensic or anthropological expertise, forensic expertise of weapons and ancient objects, forensic expertise, numismatics forensics, and the list goes on, all of which belong to the term „forensic science." This forensic expertise is defined by several specialists as *"a probation procedure provided by law, consisting of a scientific research activity of judicial material evidence, performed by persons with thorough knowledge of strict specialty and which aims to identify persons, phenomena, objects and substances in a causal link with the unlawful act, the establishment of their properties or any changes in their form, content and structure and the mechanism of those changes"*. (I.N.E.C.; Stancu 1997, 54; Mircea 1999, 312). Therefore, I am of the opinion that forensic expertise as an activity has a probative purpose and a complex scientific character.

(d) *Fundamental and applied scientific research*: specialists in the field of Forensics and Forensic Medicine have investigated in the specialized works, traces of blood, semen, saliva and hair, created by the human body considering that they are the most important evidence, because they are present in large numbers at the scene of a crime. All biological traces, present in everyday life, related to the victim, offender, or crime scene, are equally important, whether they are human or nonhuman in nature, and a biological trace rarely found in the criminal space, but present in jurisprudence, can have a special importance for the investigation, opening new ways of solving the case, this practically defines the notion of scientific research of Forensics (Cioacă 2018).

In other words, the forensic scientist has branches that together, step by step, lead to the solution of criminal cases. In conclusion, an important aspect is the technological evolution, which becomes more and stronger, thus influencing the society and the field of criminal investigation. That is why I preferred to analyze in this article a software that leads this field in another dimension, it is the third dimension called the virtual dimension.

More precisely, for the investigations where a corpse is always found at the crime scene, the forensic probation must be carefully analyzed by specialists, and this cannot be brought to a favorable result without a technology that allows this. If we look in this context at the classic methods of determining the cause and time of death, we see that once at the

morgue of the IML (IML – (abbreviation) – Institute of Forensic Medicine), specialists use surgical means namely autopsy of the body by dissection and subsequent finding the result, by suturing and grooming. This process takes time, and for the criminal investigation bodies it can bring serious negative effects, such as a new crime, if we are talking about a serial killer, or even the escape of the murderer. So here we can understand the need for engineering and so nowadays specialists can boast of the new software ***Virtopsy***.

Innovative "virtopsy" technology in analyzing the corpse found at the crime scene

For starters, forensic medicine is based on the documentation, analysis and elucidation of scientific medical discoveries with activity in the living and among the dead where the main objectives are to determine the cause of death, how he was killed if we talk about a crime, the assessment of the injuries suffered and the forensic reconstruction of various criminal cases. However, there are two areas in which technology has not reached them, being forensic genetics and toxicology, but in the other areas it has been carefully incorporated as part of the working day, forensic pathological documentation still has as a fundamental technical part autopsy and protocols that have been around for a very long time.

From the point of view of the classic tools used by forensic doctors that help to identify the so-called truth, we mention the scalpel, the verbal description, the conventional two-dimensional photography. The idea of forensics imaging has long appeared, and the application of this method to the non-destructive documentation of forensic discoveries has managed to encourage the implementation of a new generation of technologies, so nowadays, classical imaging is far surpassed by technology in continuous development. The old textbooks of forensic radiology did not touch on the subject of the possibility of implementing technology in this field, we mention here the computerized technology of tomography and the technology of magnetic resonance imaging. Unfortunately, it seems that diagnostic imaging in forensic probation is underused because its huge development potential has not yet been recognized.

Historically speaking, in 1977 the first application of the computer tomograph appeared through forensic technology, which determined the description of the lesion model made after a shot in the head. Because at that time the quality and resolution were not so good, only a few pathological studies could be presented for the first time as evidence in court. The appearance of three-dimensional data was possible in 1989, but nevertheless there was no increase in the interest rate of criminologists. Over time, numerous researches by specialists have not led to a result of systematic examinations of the whole body, trying to determine the diseases and injuries suffered by the victim, using the combination of computed tomography and magnetic resonance imaging.

Another important factor in terms of conventional autopsy is presented by society, which often rejects the forensic method. Being in a multicultural society, based on religious principles and ancestral traditions, many families resort to rejecting the conventional autopsy of the deceased relative, and this rather important and worrying aspect for jurisprudence, led to the implementation of non-invasive imaging documentation, and then where appropriate, guided minimally invasive tissue sampling in relation to angiography that addresses its vascularity. It was necessary to implement imaging, a method implemented in the early 1990s, after a powerful and terrifying homicide in Switzerland, in which case a comparison of the victim's skull with the deadly weapon could be analyzed, resulting in analysts a degree of certainty high, and so in 2000 it was requested to implement independent observer imaging of the surface of the corpse on the outside which could be correlated with the independent imaging of the surface of the corpse on the inside.

So analyzing these aspects we can understand why engineering has left its mark in forensic science so the need for imaging documentation at a high technological level led to

the emergence of the new ***Virtopsy*** software. This software was designed to be compatible with a CT (CT – (abbreviation) – Computer Tomograf), that with the help of 3D scanning of the corpse, can determine not only the time and cause of death, but also blunt objects possibly inside the body. Interestingly, this software, thanks to scanning, radiological diagnosis and imaging, reaches the possibilities of calculating the depth of the wound, the technological properties of the killer weapon, the knife, for example, in the case of a stabbing, the technology of bullets in the case of shooting, and many other material and technological properties of weapons or objects that caused death. If we ask ourselves how it works, then we can say that by manipulating the data set with volume playback instruments (VR), the virtual autopsy method appears, which can be used anytime and anywhere.

Compared to the advantages of this technological concept, no forensic discovery with its help has been disturbed, as they appear in conventional autopsy techniques. Virtopsy is thus a concept of approach that systematically compares the results of radiological scanning and surface with those obtained from conventional autopsy technique. We must thus focus on the fact that the forensic investigation of the circumstances and the corpse is based more on the assessment of the injuries suffered according to their vitality, which can lead to the forensic reconstruction of the incident.

Clinical trials using *Virtopsy* software

The experiments of this software were appreciated and admitted by the *Local Department of Justice* and *the Ethics Committee* of the University of Bern, which included 120 forensic cases involving people whose age at death ranged from 22 weeks from birth, up to 94 years. Each body was wrapped in two forensic bags with no other objects that could contaminate the radiology equipment and protect the identity of the deceased during the clinical scan. In other words, the functionality of the new ***Virtopsy*** concept and its advantages and disadvantages were analyzed on each device and medical method. These devices and medical methods include computer tomography, magnetic resonance imaging, photogrammetry based on 3D optical scanning, logistics, cross-section correlation with traditional autopsy results, and the list goes on.

(a) *Multisection and microcomputer tomography*: in this case, the whole body was scanned with a 1 or 1.25 mm collimation on a four or six detector line scanner. Up to 1200 axial images resulted, with a 1.25 mm thick section and a 0.7 mm increase in the soft and bone tissue nuclei. In special cases, bone tissue samples were examined on a micro-CT system. This scanner can imagine a 3D volume with a resolution of 10 to 100 μm. The system thus allows the examination of samples with diameters between 4 and 40 mm.

(b) *Magnetic resonance imaging and microscopy*: the head, thorax and abdomen were analyzed on a 1,5-T system but not only these parts were taken into account, we are also talking about other parts of the body of forensic interest, such as it would be the neck in case of strangulation, extremities in case of injuries, etc. These analyzes led to coronal, sagittal and axial images with different contrast weights. The MRI microscopic study procedure was performed at room temperature on a Bruker DMX (Cioacă 2018); spectrometer coupled to a wide-hole magnet operating at 9.4 T. Formalin-fixed eyeballs were washed in phosphate-buffered saline, dried relay and placed in -a 25 mm glass tube filled with Fluorinert before imaging. Three-dimensional anatomical images resulted in a T1 (msec repeat time / msec echo time = 200/8, number of acquired signals = 16, acquisition time = 9.5 hours); enhancement of the T1-weighted imaging sequence. After the image was completed, the eyeballs were cut in half and prepared for embedding paraffin. Histological sections 6 μm thick were cut and then stained with hematoxylin-eosin (H-E) to distinguish hemorrhage from eye tissue.

(c) Photogrammetry based on 3D optical scanning: the standard for documenting lesions in forensic medicine remains photography with accurate measurements. However, similar to conventional radiography, the photographic process displays a 3D wound in only two dimensions. With the TRITOP / ATOS II system, the 3D color-coded surface can be recorded by detecting the distortion of light strips projected on the surface. Therefore, the system can recalculate the 3D surface that caused the distortion. This system is usually used when high accuracy, close to 20 μm, is required. With this technology, it is possible to document from fine details such as skin lesions to the general report, the whole body.

(d) Identification: to begin with, any post-mortem investigation begins with the identity of the body to be clarified and proved; if the corpse can no longer be identified with the naked eye, showing serious damage, the post-mortem investigation has as one of its purposes the restoration of the identity of the unidentified body. Computer tomography with multiple detectors can be very helpful in this regard. Security in post-mortem identification is possible only on the basis of dental condition, DNA profiles or fingerprints. Usually, however, the method of recognition by DNA is not recommended because it requires time for analysis, and thus fingerprints and dental identification are more frequently used. With cranial CT data obtained in a corpse, it is possible to reconstruct any facial projection that may lead to the identification of the victim. A plus in computer-aided software analysis would be a shoulder, hip or knee stent - findings that are often already expected based on effective external inspection. This technological concept used in forensic CT has shown that mobile devices could be used to collect post-mortem data in cases of mass casualties, such as plane crashes or natural disasters. In such cases, the identification of bodies is the major issue to be addressed, and with the software implemented in the computer tomograph can have a huge impact in identifying disaster victims.

(e) Cause and manner of death: regardless of how the victim's right to life has been or has been extinguished, for example, natural causes, accidents, suicides, homicides, death can have a variety of causes. Some of the causes of death belong to certain organs, such as the brain, heart and lungs. Various systemic findings have concluded that this leads to death.

Referring to the most common organ in the cause of death, namely the brain, the typical traumas discovered in clinical radiology are equally well visualized in post-mortem imaging. Thus we understand that the increasing intracranial pressure as a result of trauma usually manifests itself at autopsy as a transtentorial hernia of the temporal lobe or a hernia of the cerebellum in the foramen magnum.

Referring to the second common organ in case of death, namely the heart, studies show that most natural deaths are caused by heart failure. Chronic heart disease, for example, cardiomyopathies can induce heart failure by sharply reducing the number of contractile fibers.

Conclusion

In conclusion, ***Virtopsy*** is therefore the software that sheds light on murder cases and not only, is this software again a living proof of the importance of engineering in this field as well. ***Virtopsy*** offers excellent tools for reconstructing crime and accidents, represented in 3D such as internal wounds, real colors of surface lesions and even full-scale models of entire crime scenes and events. ***Virtops'***s approach in the legal field brings to life the critical forensic evidence in an impartial and easy to understand way, suitable for presentation as evidence to legal professionals. However, the concept of ***Virtopsy*** has come to be implemented in medical automation, namely in robots.

So the Virtobot system is an automated system that performs a variety of tasks along with the CT scanner that was developed for innovation and medical technology. The mode of operation is as simple and well-understood as possible, so it allows the automatic

documentation of the high-resolution 3D surface, as well as the taking of CT-guided post-mortem tissue samples. And because engineers have always taken care of their technological art, its modular design facilitates the expansion of the system by adding functionality in the future (Virtopsy 2021).

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