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Recovery of forensic traces with use of state-of-the-art. imaging techniques – system for marking, tracing and maintaining chain of custody

Summary

The article describes the possibility of using modern techniques for crime scene imaging and a perspective of creating a system for denominating, tracing and maintaining the chain of custody of evidence. In particular, it presents the possibility of reproducing a crime scene based on recorded images and measurements performed with use of special markings. The Authors describe the chain of custody over the evidence and automation of procedures thanks to use of RFID tags.

Key words: 3D technology, scanning, chain of custody, eRCDŚ system, RCTK, aerial photographs, RFID tag

Crime scene examination, finding and recovery of material useful in further proceedings is the crucial element influencing the entire investigation (Kaczmarek, 2015). It is one of the pre-court procedures and involves detailed inspection of place, person, objects or corpse carried out both by means of human senses and with use of technical means, in order to clarify the character and circumstances of an incident and determining its perpetrator (Koźmiński i in., 2015).

The follow-up of detecting a trace at a crime scene obviously involves technical and legal securing to enable its examination in the laboratory and further use in pre-court procedure. An important element of evidence processing is maintaining continuous chain of custody guaranteeing control of possible changes and demonstration of observance of those rules. It is particularly important for reconstruction of the course of the incident, whereof the original location of a trace constitutes the foundation and leads to adopting likely investigative versions.

At the further stage of proceedings the most important part is demonstrating, by means of the evidence, the link between the suspect and the case but also ensuring unchanged state of the exhibits and traces throughout the proceedings. Such documentation has to exclude the risk of unauthorized

access and the activities that may lead to tampering the evidence.

Taking the above into consideration the Project Team commenced the work on solutions enabling full control of the evidence with introducing automation of some activities.

The designed system is the first one, in which the functionality of describing and recording the evidence will be integral with the functionality of acquiring

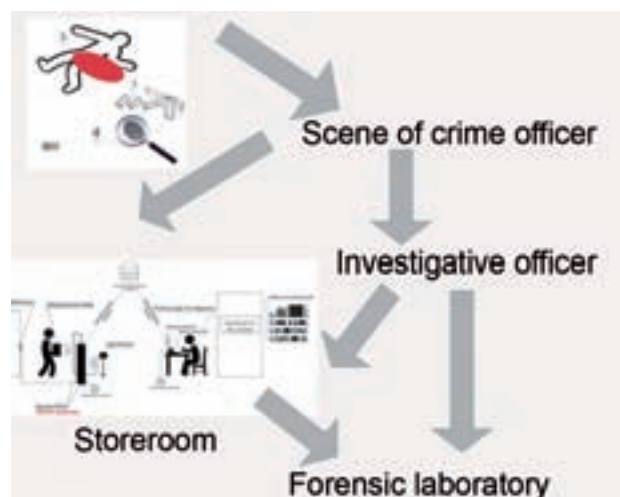


Fig. 1. Chain of custody.

information on the original location at the crime scene. In addition to that the system is to include extensive tools enabling acquisition of information on geolocation of a trace based on various data referring to crime scene. The methods used at present are limited to application of measuring tapes, odometers and manual laser rangefinders. Obtained measurements are recorded in crime scene examination protocol and used in creating a scene sketch comprising agreed upon topographic marks. Scene of crime officers more and more often use also tachometers, i.e. optical instruments for obtaining 3D spatial measurements by means of an incorporated encoder, providing the angle of the instrument to the initially identified position (Piotrowski, 2016). These instruments are still operated manually. In the planned system the acquisition of data will be possible both by traditional techniques and with use of more advanced solutions like tachometers, RTK GNSS system receivers, flying platforms (drones), laser scanner or structural light scanner, as well as from external sources, such as ortophotomaps or vector maps.

A major step forward in the forensic technologies is connected with the possibility of using for crime examination earth 3D scanning. This technology is presently used around the world mainly in such areas, as construction and architecture, industrial engineering, geodesy, protection of historical sites and archeology. It has been also used in forensic science more and more successfully since 2010 (Koźmiński et al., 2010). Due to the fact that digital methods of 3D imaging have created new, and much better than conventional methods, possibilities of concluding and formulating opinions in pathology and forensic medicine (Maksymowicz, Tunkowski, 2018) this tool could not be excluded in the assumptions of the created system.

Another tool used more and often for documenting large areas is the technique of taking aerial photos with use of small drones equipped with high resolution cameras. Using a set for imaging a crime scene from air during the examination has a lot of advantages. First of all, it gives the possibility of photographing crime scene from a completely new, broader perspective, that is from a considerable height (Klepczyński, 2017). Such a device may be used in open space but also in the areas limited with trees, buildings and other infrastructure.

An example of that may be the possibility of taking pictures of inaccessible river bank, river current, excavations, fire sites, areas difficult to photograph due to their specific nature (Rusek, 2016). Using a drone for documenting a catastrophe site or road accidents should become a widespread practice in near future. Panoramic photography techniques as well as their appropriate digital processing do not being such effects as recording the scene from various perspective, including from a large height above.



Fig. 2. Device for air photography with a high resolution camera (4K).



Fig. 3. Photograph taken at straight angle at height of 40 m.

A close attention should be paid to the innovative functionality under development in the area of automatic processing of crime scene photographs based on using encoded photogrammetric markers. The solution is to ensure effective positioning of photographs from crime scene and automation of determining location of a marked trace. The original location of traces will be determined in 3D space in a local reference frame adopted for crime scene examination. In the cases where the input data are limited and when the third coordinate of trace location (height) is not significant (e.g. it will result from terrain configuration), only plane (2D) coordinates will be acquired and recorded.

The system will consist of a mobile unit used at the crime scene (with no requirement of communication with Police IT system), which will enable determining the location of the trace, introducing relevant information and printing evidence description form to be placed on the packaging of exhibits. The form will contain graphically encoded information, selected data in a form comprehensive to human eye and warning symbols related to possible threat that the material may pose. Information about the recovered material will be, in future, transferred to electronic crime scene



Fig. 4. Tachometer at crime scene.



Fig. 5. 3D laser scanning.



Fig. 6. Points cloud from 3D scan.



Fig. 7. Ortophotomap made from a drone flying above.

examination protocol made at the scene (at present such a solution is not functional due to formal and legal reasons). Upon returning from the crime scene the information on the recovered traces will be scanned and entered into the Electronic Record of Investigative Activities, the central index functioning within the Police with the purpose of recording procedures executed by police officers within:

1. investigations in progress – Electronic Record of Investigations (e-RCDS);
2. verifying proceedings in progress – Electronic Record of Verifying Proceedings (e-RPS);
3. exhibits recovered in case investigations – Electronic Book of Exhibits (e-KDRz);
4. issued decisions to summon expert witness – Electronic Record of decisions to admit evidence in form of expert witness opinion (e-RPB);
5. scene of crime activities (recovered traces and exhibits at scenes of criminal incidents) – Electronic Index of Scene of Criminal Incidents (e-RCTK) (Białęcki, 2016).

The information processed in such a manner and introduced into the system will be accessible on every stage of the preparatory proceedings. This is supposed to minimise the risk of errors and, at the same time, guarantee security of the trace or exhibit. In order to provide necessary functionality it will be necessary to modify the methodology of scene of crime examination and technical recovery of forensic traces in order to adapt it to the possibilities of the system and take into account respective legal regulations.

From the moment of finding and recording the position of an exhibit or mark will be traced by the system. Additionally, it is possible to implement an application recording change of trace location. The application will also verify whether a trace is submitted to the appropriate storeroom and detect any attempt to release an exhibit that should not leave the deposit. Traces will be automatically identified based on graphic (qr) codes in evidence forms.

Implementation of unique *Radio-frequency identification (RFID)* codes for the purpose of identification



Fig. 8. Data transferred to the application for making a sketch.



Fig. 9. Arrangement and detection of markers in a situation photograph.

and describing recovered traces is to grant an increased control over the mentioned procedures and their full automation. Such tags are electronic chips equipped with antennas and comprising certain information, in this case: a unique ID, which clearly denominates given evidence. The system, extended in this way will comprise automatic workstations arranged as electronic gateways for controlling the flow of evidence. Denominated evidence be passing through the system will be recorded automatically without the need of underrating any actions by the staff member. The workstations will be able to signal all inconsistencies by means of visual and sound alarm. Because the prices of electronic security measures are steadily decreasing there is a good chance that such a solution will become a standard in near future.

Summary

The use of state-of-the-art techniques to document crime scenes and appropriate securing form the crucial condition of effective forensic analysis. At the same time, proper documenting of all stages of the forensic circulation allows minimising the risk of contamination, and the electronic form together with information that will already be included in the system, significantly improves the work of law enforcement authorities. An important element of the developed solution is the integration of various systems, aiming



Fig. 10. Application of RFID tag.

at mutual availability of information and elimination of duplication of effort.

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Sources of Figures:

Figures 1–3: authors

Figures 4–9: CYBID

Figure 10: authors

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