Digital crime scene reconstruction - the evolution of the digital documentation to the integral and virtual analysis

G. Sasse[1,2], B. Sauter[2,3], HP. Bieri[4], U. Lüthy[2]

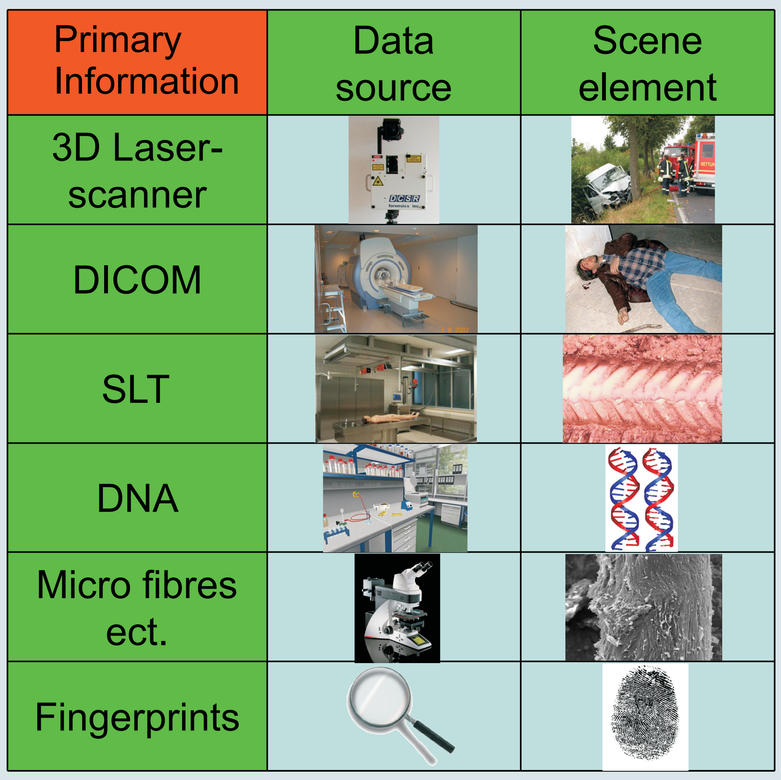
Kantonsspital Aarau[1] Switzerland, Institute for Digital Crime Scene Reconstruction DCSR forensics, Inc.[2] USA, Swiss Society for Medical Informatics[3], Switzerland, Staatsanwaltschaft Basel-Stadt Kriminalkommissariat [4], Switzerland

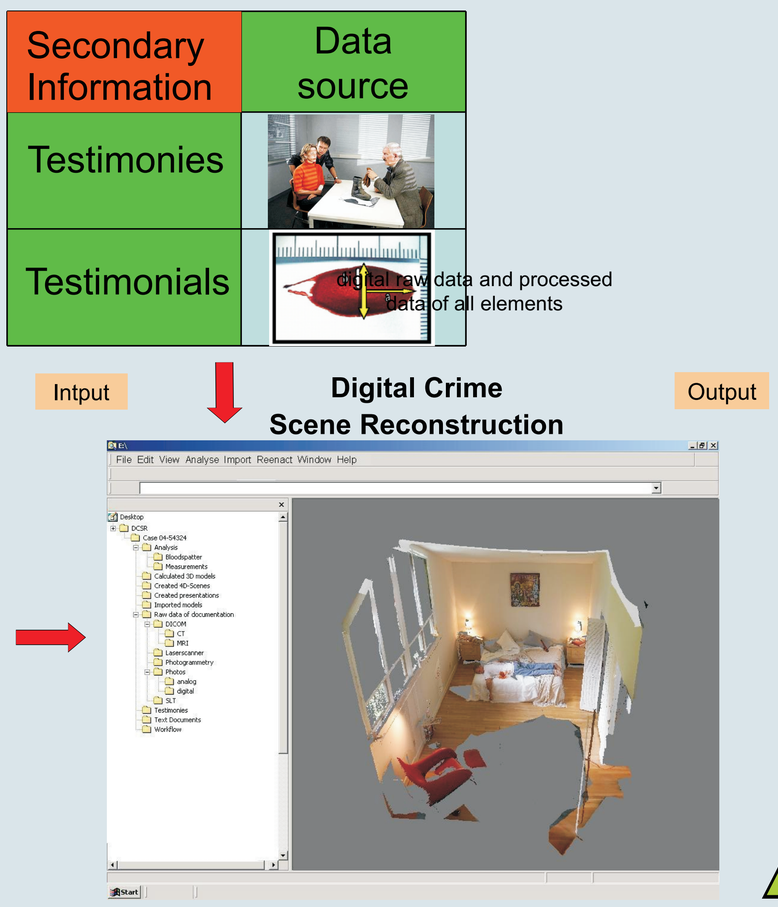
Abstract

One of the first actions in the process of solving a crime is the documentation of the crime scene. Up to now, no method existed which could document a crime scene extensively, quickly, easily and without causing artefacts. The 3D-Laser scanning method closed this gap and shows the broad benefit for digital material. With this method, the fast and almost complete documentation of a crime scene has already become possible today. In these virtual models blood tracks can be traced back and many more further options are possible. In addition to the actual documentation, own digital notices and annotations with f.e. referrals to secured and safekept objects can be generated and administered. In these models trajectories of projectiles can be visualized and calculated. Further on, simplified 3D models are suitable for the visualization of plausible variations of the suspected course of event in 4 dimensions. In the same model, statements of witnesses can be checked on falsity or synthesis dynamically. The further development of these methods and their possibilities are virtually unlimited, merely the capacity of the data for high-dissolving three-dimensional presentation is the current limiting factor. The fields of application of these new procedures are altogether convincing, innovative and forward-looking - the digital revolution in solving crimes.

Introduction

The modern documentation of a crime scene was initiated by taking photos. They can preserve the impression of this crime scene, and therefore this approach is standard, worldwide. More recent methods like photogrammetry are usually bound to computer systems and are therefore rather exceptionel. In cases of high importance, however, photogrammetry is standard too. But mostly data are only kept and not evaluated because this is very time-consuming. Methods, which preferentially are computer-based, were developed and introduced recently. These techniques use digitally saved data which are converted to three-dimensional virtual models. We have studied the integration-potentials of these methodes.





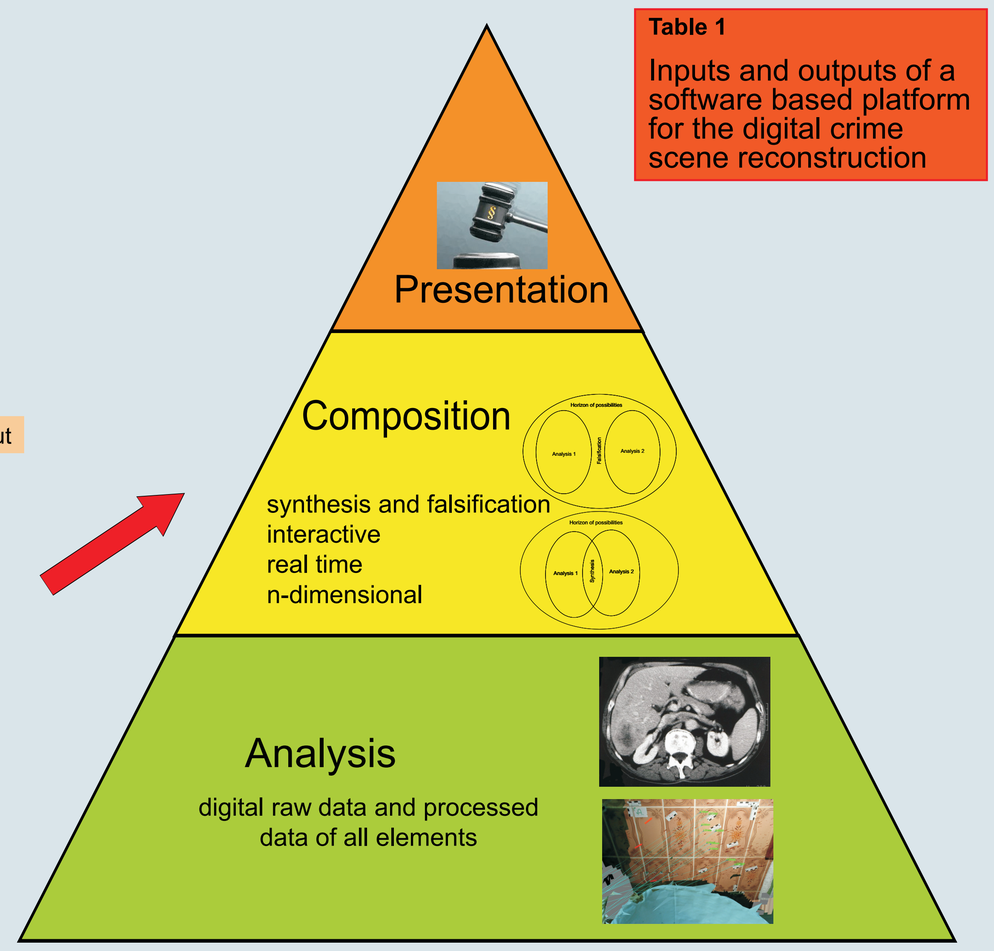


Table 1

Inputs and outputs of a software based platform for the digital crime scene reconstruction

As virtual platform serving for all the above mentioned elements, the crime scene first is captured with a 3D-laserscanner. The data are imported and colour pictures with high resolution of the areas of interests are mapped together. The 3D-model of the crime scene is the basis of all next steps: annotations can be put to any point on the model - to explain, what are the facts or to link them with additional information. High accuracy-models of for instance the weapon(s) are imported and can be studied in context with the model or separately. DICOM data can be imported and placed into the body of a victim. The whole model of surface and anatomy of the victim and all available information are documented. This serves as the basis for the analytical processes of forensic specialists. Blood spatter analysis can be done by measuring the spatters using the validated formulas. Trajectories of projectiles can be visualized. Range of vision and positions of involved persons can be studied dynamically. Physical behaviour of dynamic elements can be studied applying natural laws.

A workflow-engine controls the status of accomplishment of different tasks of the specialists, exchanges information between them and shares the knowledge in the case.

Discussion

The draft (table 1) of the needed software application with database might be visionary - but it is not. All elements of the software are available. We put them together in pieces as a proof of concept and we found that it is a matter of knowledge of forensic science, medical informatics, 3D-applications and physics. The hardware needed consists of a 3D-laserscanner, a CT/MRI to generate the DICOM data and a device for high accuracy capturing safe kept material, which we found is to be the best practice. The other devices, to get the data of fingerprints, DNA, micro fibres and so on, mostly also have digital outputs - however, there are also unstructured formats. There are standards proposed by the scientific working group on digital evidence (SWGDE) but there is still a lack of standards of interfaces between devices that produce such digital evidence.

The concept of the integrated software, however, leads to a nearly complete digital platform where a broad variety of further analysis is possible. As a base, static analytical measurements such as blood spatter analysis are possible as well as dynamical

Material and Methods

Material

As material, we chosed the digitally available documentation of a criminal case, which we categorise in visible and investigative elements. Investigative elements are diveded in pretended facts and evidence based facts.

Visible elements are all things of a crime scene, the human eye is able to see or that can be seen with aid. These elements are digital images and 3D-models of the crime scene, bodies, safe kept material and imported models of previously not damaged objects such as models of cars, airplanes, etc. Other elements, that can be made visible by investigative forensic processes are for instance: DICOM pictures, DNA results, microfibres, fingerprints, documented temperature, etc.

The pretended facts consist of testimonies of witnesses and offenders, whereas evidence based facts are opinions of experts and obvious effects of natural laws.

Method

As method we chosed the integration of the above material using the principles of knowledge management which is regarded to be a key element for efficacy, effectiveness and quality in complex topics where many specialists work together.

Results

Methods of knowledge management lead to the integration of all available data, information and knowledge on one platform. Most of the information and knowledge in a criminal case nowadays is available digitally. Software which integrates these elements is needed. Regarding the sensitive data, this platform must be secure and accessed via access control. In order to see, edit and save data, there must be a database which stores everything. Knowledge management also demands sharing of information and knowledge, which is done by a process oriented engine.

Axis of room/space and time are integrated and enable the investigators to re-enact the crime scene.

forensic analysis such as the movements of victims, witnesses and offenders in the criminal act. On this level also traffic accidents can be reconstructed. If there is a need of physical proof of (pretended) behaviour of an element or a person in the crime scene or accident, a re-enactment can be recalculated by means of the evidence of physical rules. Due to hardware limitations nowadays interactive re-enactments must be done with models where polygons and textures have been reduced whereas a rendered output like a moving picture can be calculated in the original resolution. This dynamic composition can be done with only one element or the whole crime scene.

On the next level, the analyses are put together to a composition where the cycle of synthesis and falsification with the analytical methods and all other findings begins. With these methods, the dynamic acts can be reduced to the most plausible ones. The different stored actions - whether they are plausible or not - can be shown at the next level of presentation on court, interactivly for witnesses or wherever they are needed. With suitable technology such as shutter glasses, the scenes can be experienced in real three dimensional perception.

The software and the database must be validated by scientific work; each module, hardware device and interface has to be evaluated by scientific procedures. As an example of the validation of such a module, we are doing research on statistical blood spatter analysis with available software for a 3D-laserscanner.

An interactive and integrated platform makes sure that digital evidence is handled along SWGDE-standards and keeps its accepted evidence on court. A login authorizes investigators to process the available data following rules to be defined. It also links all specialists and their work together which is the base of quality improvement in the inter- and trans-disciplinary work. Thus, the evolution of IT-based virtual forensic investigation goes on.

Conclusion

The future of integrated forensic documentation, analysis and presentation systems will have axes in four dimensions. It will store all data and the processing of the cases in standardized formats which have to be defined.

Contact
georg.sasse@dcsr.com
Benno.sauter@dcsr.com