3D acquisition of forensic evidence presents crime scene analysts with new perspectives

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If you are into TV crime series, you have probably noticed how the likes of traces on bodies or shoe prints often help detectives to shorten their list of suspects. Such forensic evidence also plays a key role in real investigations, but state-of-the-art techniques have their limitations. Technology developed under the 3D-FORENSICS project will help greatly improve the precision of these analyses thanks to the use of 3D laser scanning technology.

Since 2003, the number of crimes recorded in the EU has constantly been decreasing. But while the capturing and analysis of forensic evidence—from fingerprints to ballistics and serology—has been instrumental in this trend, these methods still have some shortcomings. There are, for instance, doubts about the unique character of an individual's fingerprints or the criteria to declare a match in hair and fibre analysis. Then, the methods used to gather forensic evidence sometimes lack accuracy and it can be difficult to guarantee their integrity from the crime scene to the court.

Of all these problems, the last two were the focus of the 3D-FORENSICS (Mobile high-resolution 3D-Scanner and 3D data analysis for forensic evidence) project, which aims to increase the accuracy, flexibility and resolution of 3D-reconstruction—a promising forensic approach to the reconstruction and analysis of evidence.

Since May 2013, the seven-strong consortium, led by Fraunhofer and comprising five SMEs, has been developing three prototypes of 3D-

scanning systems along with new data analysis software. The system, which promises to make data acquisition more detailed and relieve experts from data processing by hand, aims to help the EU increase its rate of crime solving, which is still somewhere in the 70 % range.

Dr. Peter Kühmstedt, coordinator of 3D-FORENSICS, details some of the project's outcomes and his hope for the commercialisation of the newly-developed prototypes in the near future.

The share of unsolved crimes remains worrying in Europe. How do you explain it?

I think Europe was strongly affected by the debt crisis in recent years. Many states reduced their budgets for fighting crime, especially for High Volume Crimes (HVC), such as burglary and car crime. The investigation teams have limited resources for such cases. In my opinion, this issue seems to be one cause for crimes remaining unsolved, but there are no doubt many other reasons.

How can 3D-reconstruction of evidence help improve these statistics?

Optical 3D scanning technology has made much progress over the last 20 years. Typical applications are in the areas of industrial process control, architecture and cultural heritage.

The main objective of our project is the application of 3D technology to collect and analyse specific types of traces from crime scenes, namely footwear and tyre impressions. Statistics in the Netherlands show that footwear and tyre impressions are a common trace at HVCs. The techniques to capture these traces are typically photography or plaster casting but both techniques have their disadvantages: for instance

photographs contain no information on depth and plaster casting is very time-consuming. These disadvantages can lead to Crime Scene Investigators (CSIs) deciding not to collect these kinds of traces. Our technological approach is designed to overcome such disadvantages.

Optical 3D-scanning enables quick and contactless capturing of impression traces with detailed information. The analysis of digital 3D-data instead of plaster casts will ease the work of forensic experts and will enable increased linking of data from different crime scenes.

What is new about 3D-FORENSICS' approach to this 3D-reconstruction?

3D laser scanning technology is already used by some police and private forensic experts e.g. to record complete crime scenes, but it requires specialist knowledge and the systems have not been designed for the collection of footwear and tyre impressions. Our complete system, including 3D-scanner and analysis software, is the first system specifically designed for the application at HVCs. It is designed to be used in the complete investigation and prosecution process fulfilling all legal requirements. If we achieve our goals there is potential that plaster casting for footwear and tyre impression is completely replaced.

Our 3D scanning technology is based on the principle of fringe pattern projection. This approach is enabling us to build a compact 3D-scanner that is easy to use. Compared to present state-of-the-art laser scanners it captures a 3D scene in a smaller field of view, approximately the size of a shoe sole with a resolution better than 0.2 mm. The resolution enables the visualisation of tiny identifying marks, such as small scratches which can be used to match impressions to a suspect's shoes. In addition, the analysis software mimics the present forensic analysis process for footwear and tyre impressions. It is simple to use and includes tools to

determine class characteristics, such as shoe type and size and individual characteristics such as scratches.

Evidence is not easy to gather and maintain up to the point where a case goes to court. How does your technology help guarantee their validity and integrity?

We are lucky that our project team not only involves technologists but also forensic end users. In the beginning of our project we defined the requirements, such as transparency and the prevention of data manipulation, to ensure that evidence collected and analysed with the system will be admissible in court. The design and development which followed complied with these requirements. By way of example, the raw scan data is never irreversibly modified during the analysis process: each analysis step is logged and can be undone and redone.

However special functionalities in the system are only one way of ensuring admissibility in court. The second, perhaps more important part, is to convince the forensic experts. If the experts are convinced by the system and trust the results, they will not hesitate to seek to use them in court. Validation within an accredited forensic process is not within the parameters of the project, but this would be a further step during commercialisation.

How are the prototype trials going so far?

In April 2015 we completed three prototypes of the 3D-scanner as well as the prototype software, including all the necessary tools for data analysis. The first tests in the laboratory are finished and showed very promising results. We have now progressed to field testing in simulated crime scene environments. Different representative undergrounds such

as sand, clay and snow are being used. During the testing we are also comparing the results with classical methods such as plaster casting to document the advantages of our technique. The progression from laboratory to field conditions is often a hard step but we are keen to prove our system in the field environment in the time remaining in this project.

What are the remaining tasks for your team before project completion?

Our project has an overall duration of 28 months and ends in August 2015. In the first two years we defined the end user requirements, designed and developed the system and built-up the prototypes. In the remaining time we will concentrate on field testing and evaluation. The main objective is to prove functionality in the field environment.

What are your plans for commercialisation and when can it be expected?

The results of 3D-FORENSICS are prototypes of a system to capture, analyse and investigate footwear and tyre impressions from crime scenes. As soon as the functionality and utility of the prototype are proven, an extra step is needed to take the system from prototype status to a commercial product. The remaining project time will also be used to identify technical aspects which could be improved for commercialisation. In parallel the consortium has also been developing an exploitation strategy and is presently considering the different funding options in order to proceed with the steps towards commercialisation. The goal is to engineer a product in 2016 and to have it on the market in 2017.

More information: For further information, please visit 3D-

FORENSICS: www.3d-forensics.de/

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