Mobile high-resolution 3D-Scanner and 3D data analysis for forensic evidence

Sprawozdania

Informacje na temat projektu

3D-FORENSICS

Identyfikator umowy o grant: 312307

Strona internetowa projektu

Projekt został zamknięty

Data rozpoczęcia
1 Maja 2013

Data zakończenia
31 Sierpnia 2015

Finansowanie w ramach
Specific Programme "Cooperation": Security

Koszt całkowity
€ 1 770 435,00

Wkład UE
€ 1 420 262,00

Koordynowany przez
FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV
Germany

Final Report Summary - 3D-FORENSICS (Mobile high-resolution 3D-Scanner and 3D data analysis for forensic evidence)

Executive Summary:
A major part of the daily work for the police and other forensic service providers is the recording and analysis of trace evidence left at crime scenes. Two important types of trace evidence are footwear and tyre track impressions. This evidence can be used to both inform investigations and as a basis for expert

opinion evidence in criminal proceedings. It is evidence towards identifying the criminal(s) at crime scenes. The most common operational methods to record such traces are through plaster casting (3D evidence) and photography (2D evidence). Both methods have a number of disadvantages, just to name a few: plaster casting requires a considerable amount of time and destroys the trace; and photography provides no depth information. This can lead to the evidence, particularly the 3D evidence, not being collected and therefore not being available to inform criminal investigations or to support criminal prosecutions.

3D-Forensics has developed a prototype mobile high resolution 3D-scanner and 3D data analysis software for forensic evidence to record and analyse footwear and tyre impressions as well as profiles left at crime scenes in 3D and colour with optical scanning technology. The scanner is designed as a handheld device which can be used outdoors with battery power. The scans provide highly resolved 3D point clouds and colour images are taken simultaneously with an attachable high resolution camera. The colour images are mapped onto the 3D point cloud. The integrated 3D measurement and colour data can then be analysed with a set of software tools to investigate characteristics of the footwear and tyre impressions. The software has been designed to allow an analysis of the new 3D data in a way in which forensic experts are used to working with traditional techniques. Class characteristics such as size and model are determined by the user respectively measuring the impression in the fully co-ordinated 3D data and by comparing the impression with images from manufacturers' or other sole or tread databases. Individual identification characteristics such as holes and tears in footwear impressions can be compared against scans of suspects' shoes or the actual shoes. A full set of annotation tools enable experts to record their analysis. The raw data is never changed and all analysis steps can be undone so analysis can be undertaken by multiple experts. A workflow and methods have been implemented to ensure the integrity of the data.

The system was successfully tested in relevant environments i.e. similar to crime scenes and offices which lead the consortium to the conclusion that it has reached the Technology Readiness Level (TRL) 6. Disadvantages of common operational methods are overcome by the 3D-Forensics system. An implementation project has been developed to take the prototype through to market launch. In the final steps the system would be technically improved regarding operational behaviour, robustness, stability, user-friendliness and simplicity; and operational implementation supported through further end-user testing and validation activities in relevant accredited processes.

The system offers to support the solving of more crime and at a lower cost, which would be a further deterrent to criminal activity.

The project duration was 28 months from May 2013 until August 2015. The following partners participated in the 3D-Forensics project: Fraunhofer IOF, The National Police of The Netherlands DelftTech BV, Lucas Instruments GmbH, Enclustra GmbH, Gexcel Srl., and Crabbe Consulting Ltd.

Project Context and Objectives:
Project context
Footwear and tyre impressions are one of the most frequent trace types at both Serious Crimes (SC) with dead or seriously injured people and also High Volume Crimes (HVC) such as burglary and car crime. Accordingly, footwear and tyre impressions left at crime scenes are important evidence for both criminal investigations and criminal prosecutions. The most common operational methods to record such traces

are through plaster casting (3D evidence) and photography (2D evidence). Both methods have a number of disadvantages, just to name a few: plaster casting requires a considerable amount of time and destroys the trace; and photography provides no depth information. This can lead to the evidence, particularly the 3D evidence in HVCs, not being collected and/or not being analysed and therefore not being available to inform criminal investigations or to support criminal prosecutions.

3D-Forensics focussed on the recording and analysis of footwear and tyre impressions left at crime scenes in answer to the limitations of present techniques. It developed a prototype mobile high resolution 3D-scanner and 3D data analysis for forensic evidence to record and analyse footwear and tyre impressions as well as profiles left at crime scenes in 3D and colour with optical scanning technology.
The project was in response to a funding within the specific goals to support the commercial competitiveness of Small and Medium Enterprises (SMEs) and to deliver advanced contemporary forensic methods and equipment.

Objectives
The specific overall objectives were:
1) Development of a mobile high-resolution 3D scanning system for forensic evidence recovery at crime scenes.
2) Development of 3D data analysis and processing software tools to provide results which may be used in the investigation and prosecution of crime.
3) Test and evaluation of the 3D Scanning system with processing and analysis software by members of the forensic community.
4) To supplement the expertise of an SME based consortium with further end user and applied research knowledge for efficient and effective development of a new product.

Project Results:
The main results identified in the project which can be exploited are:

- Prototype Mobile high resolution 3D-scanner and 3D data analysis for forensic evidence
The purpose of the scanner and data analysis is to provide a state of the art method to record and analyse footwear and tyre impressions as well as profiles left at crime scenes in 3D and colour with optical scanning technology. The primary users will be forensic police departments and forensic service providers. It consists of all the results described below. The 3D-scanner and the dedicated analysis software prototype were developed with focus on the needs of forensic experts, especially for the investigation of footwear and tyre traces. It overcomes the limitations of traditional methodologies such as photography and plaster casting. The developed 3D-Forensics system is in our opinion leading in terms of resolution and accuracy compared to other mobile, handheld 3D scanning devices.

- System parameter requirements for a mobile high resolution 3D-scanner and 3D data analysis for forensic evidence
This result consists in a better understanding of the requirements which products would need to satisfy in order to have the potential to be commercially successful for the application to record and analyse footwear and tyre impressions as well as profiles left at crime scenes described. We were fortunate to have had the frank input from active police officers and other experts working with forensic evidence and

specifically footwear and tyre impressions on a daily basis as well as experts on the technology being implemented in the application described. In addition, organisational and legal rules connected with forensic evidence were input to the project.

- High resolution, handheld 3D Scanner with focus on forensic evidence recovery
The purpose of the “High resolution, handheld 3D Scanner with focus on forensic evidence recovery” is to collect 3D (point cloud) data of footwear and tyre impressions at crime scenes. The data is input into the “3D data analysis software” described below. 3D-Forensics’ 3D data capturing methodology is based on measuring the deformations of fringe patterns projected onto the impressions. Several millions of 3D-points are measured in one scan within a fraction of a second. The 3D scanning system consists basically of a projector to illuminate an impression with fringe patterns, two cameras acquiring images of the illuminated impression from slightly different angles and a processing unit to calculate the 3D point cloud out of the camera images. The scanner provides highly resolved 3D point clouds and colour images are taken simultaneously with an attachable high resolution camera. The colour images are mapped onto the 3D point cloud.

- New technique, procedure or equipment to reduce errors / artefacts caused by motion during handheld 3D scanning with stereo camera fringe projection scanners
The purpose of the “New technique, procedure or equipment to reduce errors / artefacts caused by motion during handheld 3D scanning with stereo camera fringe projection scanners” is to increase the accuracy of the data collected with the 3D scanner.

- New scientific approaches to speed up data acquisition and processing of stereo camera 3D sensors with projection unit
The purpose of the “New scientific approaches to speed up data acquisition and processing of stereo camera 3D sensors with projection unit” is to increase the speed of data acquisition and processing with the 3D scanning.

- Combination of handheld fringe projection 3D scanner with photo apparatus for colour acquisition
The purpose of the “Combination of handheld fringe projection 3D scanner with photo apparatus for colour acquisition” is to enable a 2D colour image to be overlaid onto the 3D image to aid police officer in their investigation and analysis. It also enable 2D images of footwear and tyre prints to be collected where no 3D impression is available e.g. on a hard surface such as a pavement.

- Results of investigation and construction of an ergonomic positioning and carrying system
The purpose of the “Results of investigation and construction of an ergonomic positioning and bearing system” is to enable easy handheld measurements taking into consideration the weight and dimensions of the 3D-sanner and photo apparatus together with their mass centres. Furthermore, it was the aim to provide a robust and electrically connected plug-in connector with high spatial reproducibility and with ease of use. Moreover, it was the purpose to ensure ergonomic positioning with all versions of mounted / not mounted devices (battery, photo camera, display, …)

- Results of investigation and construction of an light-weight housing according to system und user requirements

The purpose of the “Results of investigation and construction of an light-weight housing according to the end user requirement” is to enable secure, robust and ergonomic mounting of the system components in an housing by the minimal weight

- 3D data analysis software
The purpose of the “3D data analysis software” is to analyse the 3D (point cloud) data together with the 2D colour images obtained by the “High resolution, handheld 3D Scanner with focus on forensic evidence recovery” described above together with the “Combination of handheld fringe projection 3D scanner with photo apparatus for colour acquisition” also described above. The software has been designed to allow an analysis of the new 3D data in a way in which forensic experts are used to working with traditional techniques. Class characteristics such as size and model are determined by the user respectively measuring the impression in the fully co-ordinated 3D data and by comparing the impression with images from manufacturers’ or other sole or tread databases. Individual identification characteristics in footwear impressions such as holes and tears can be compared against scans of suspects’ shoes or the actual shoes. A full set of annotation tools enable experts to record their analysis. The raw data is never changed and all analysis steps can be undone so analysis can be undertaken by multiple experts. A workflow and methods have been implemented to ensure the integrity of the data.

- Electronics system for stereo camera 3D sensors with projection unit
The “Electronics system for stereo camera 3D sensors with projection unit” is an intermediate component between the processing unit (Host Computer) and the scanning setup, consisting of the one projector and two cameras in the “High resolution, handheld 3D Scanner with focus on forensic evidence recovery” described above. It guarantees a robust measurement process synchronizing image projection and acquisition; accurate projection of the fringe patterns and safe transfer of acquired image data.

- Mars EB1 Base Board
The “Mars EB1 Base Board’s” main purpose is to provide the application-specific infrastructure for the FPGA subsystem (see next section).

- 3D Scanner FPGA Firmware
The “3D Scanner FPGA Firmware’s” main purpose is to implement the low-level electronic system functionality using programmable logic on an Artix-7 FPGA.

- Results of evaluation of tests of the high resolution 3D-scanner and 3D data analysis for forensic evidence
This result consists in an evaluation of the performance of the technology developed in the project, particularly with regards to the requirements of end users. This knowledge will be input into the re-engineering and/or further development following the end of the project.

- 3D-Forensics as reference project
This result consists in being a member of a successful international collaborative research and technological development (RTD) project and specifically in the area of the Framework 7 programme, Security and Forensics.

Potential Impact:
The project has provided research and development results targeted towards the project objectives listed above.

The system was successfully tested in relevant environments i.e. similar to crime scenes and offices which lead the consortium to the conclusion that it has reached the Technology Readiness Level (TRL) 6. The developed 3D-Forensics system is in our opinion leading in terms of resolution and accuracy compared to other mobile, handheld 3D scanning devices. The system's software has been designed specifically for this application and the system's workflow and methods to ensure the integrity of data.

An implementation project has been developed to take the prototype through to market launch. In the final steps the system would be technically improved regarding operational behaviour, robustness, stability, user-friendliness and simplicity; and operational implementation supported through further end user testing and validation activities in relevant accredited processes.
There is no known forensic service provider that uses 3D technology for footwear and tyre trace impression recovery and analysis at present. Thus, the expected product has a high innovation potential and is commercially interesting and in our assessment to date viable. The system offers to support the solving of more crime and at a lower cost, which would be a further deterrent to criminal activity. The system with some modifications is also potentially interesting for other applications such as cultural heritage, medicine and industry.

More than 100 dissemination and communication activities were achieved during the project, targeting audiences around the world. Members of the consortium presented the project at more than 50 specialist workshops, conferences and exhibitions. The 3D-Forensics prototype system was also demonstrated directly to end-users at more than 10 events. Through these events, the 3D-Forensics project is confident that it managed to reach more than 50.000 within the target audiences. More than 400 direct contacts with the police and other forensic experts were made to introduce and keep them updated with the 3D-Forensics project. A core of these experts is committed to supporting the implementation project through testing and validation.

The project website as well as providing an overview of the project includes: project flyers, a gallery of images of the prototype, a video of the prototype, a link to view data from the prototype and peer reviewed articles on the system.

List of Websites:
http://www.3D-Forensics.eu/

Ostatnia aktualizacja: 31 Marca 2016

Permalink: https://cordis.europa.eu/project/id/312307/reporting/pl