3D-Forensics / FTI

Mobile high-resolution 3D-Scanner and 3D data analysis for Footwear and Tire Track Evidence

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Lucas instruments GmbH
GEXCEL Srl
DelftTech BV
Fraunhofer IOF

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Projects 3D-Forensics and 3D-Forensics/FTI

- Development and Introduction of optical 3D scanning to secure and analyse footwear / tyre impression traces

**3D-Forensics**
- FP7 – “Advancing contemporary forensic methods and equipment”
- 01/05/2013 – 31/08/2015
- Partners: 7
- Objective: Prototype (TRL6)

**3D-Forensics/FTI**
- Horizon2020 – “Fast Track to Innovation”
- 01/07/2016 – 31/12/2018
- Partners: 5 (+7 associated end users)
- Objective: Advanced Prototype / Product
## Participants 3D-Forensics and 3D-Forensics/FTI

<table>
<thead>
<tr>
<th>Participant organisation name</th>
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<tbody>
<tr>
<td>Fraunhofer Institute for Applied Optics and Precision Engineering</td>
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<tr>
<td>Crabbe Consulting Ltd</td>
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<td>Crime Scene Unit Zeeland – West-Brabant</td>
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<td>DelftTech BV</td>
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<td>LUCAS Instruments GmbH</td>
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<td>Enclustra GmbH</td>
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<td>Gexcel SRL</td>
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**Public End User**

- Politie

**Companies developing and supplying hardware and software**

- RTO and research consultant

**Company with crime scene forensic expertise**

- DelftTech BV
Agenda

- Problem / Motivation

- Development of the 3D-Forensics system
  - 3D scanner
  - 3D analysis software

- Introduction of the 3D-Forensics system
**Problem: Typical traces at Crime Scenes**

Diversity of traces at crime scenes in a certain period of time in the region Zeeland (NL)

<table>
<thead>
<tr>
<th>Trace type</th>
<th>Frequency %</th>
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<tbody>
<tr>
<td>Biological</td>
<td>10.38</td>
</tr>
<tr>
<td>Dactyloscopical</td>
<td>2.26</td>
</tr>
<tr>
<td>Gloves</td>
<td>5.54</td>
</tr>
<tr>
<td>Clothing</td>
<td>0.04</td>
</tr>
<tr>
<td>Microscopic traces (fibers / glass / …)</td>
<td>28.22</td>
</tr>
<tr>
<td>Digital Recordings</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>Footwear and tyre traces</strong></td>
<td><strong>22.91</strong></td>
</tr>
<tr>
<td>Toolmarks</td>
<td>30.48</td>
</tr>
</tbody>
</table>

- Footwear and tyre impressions are common traces at crime scenes (because the criminals cannot “fly“)
- They can be used to identify suspects and convict criminals
- They have a great importance to identify links between crime scenes or suspects ➤ Forensic Intelligence
Motivation: Plaster casting vs 3D scanning

- Footwear and tyre impressions are typically recorded by **plaster casting** (if time and circumstances allow it) or simple photography (but which captures only limited information value).

- **Optical 3D scanning** can improve the securing and investigation of impression traces ► **Stereo-based pattern projection** (structured light)

![Optical 3D scan of an impression](image-url)

![Visualisation of a scanned shoe print in R3 Forensics software](image-url)
## Motivation: Plaster casting vs 3D scanning

### Classic – Plaster casting
- Time up to 1.5 hours on scene
- Influence of weather
- Choose priority of technique
- Multiple processes at the impression
- Dirty
- Transport (fragile)
- Storage of evidence
- Selection because of amount of work
- All work done by expert

### 3D-Forensics - 3D scan
- Time (several seconds) on scene
- Almost no influence of weather
- More evidence because of easiness = more identifications
- Non destructive
- Clean
- Digital storage
- Pre-selection evidence
- Evidence can be sent digitally and even printed by 3D printer
Agenda

- Problem / Motivation

- Development of the 3D-Forensics system
  - 3D scanner
  - 3D analysis software

- Introduction of the 3D-Forensics system
### 3D-scanner: Prototype

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Highly resolved 3D and color</td>
<td>Simple to use: 1 trace in one shot</td>
</tr>
<tr>
<td>Application outdoors mobile, handheld</td>
<td>Compact, battery driven</td>
</tr>
<tr>
<td>Equipment for bright sunlight</td>
<td>Easy to transport</td>
</tr>
</tbody>
</table>

© 3D-Forensics/FTI consortium
3D-scanner: Prototype specifications

Confidential – not in Public version for wider release
3D-scanner: Prototype capabilities

- Details are important individual characteristics of shoes
3D-Forensics system: „from crime scene to court”

- Traditional securing and analysis procedure

- New 3D scan based procedure mimics the traditional procedure
3D analysis software: R3 Forensic Prototype

- **R3 Forensic**: Simple user interface – different shadings - colour
3D analysis software: R3 Forensic Prototype

**R3 Forensic:** Simple user interface – different shadings - colour
3D analysis software: R3 Forensic Prototype

- Two-stage process

**Phase 1**
Import / Preprocessing

- Preprocessing, Stitching & Registration
- Meshing + Colour mapping

**Phase 2**
Analysis
3D analysis software: R3 Forensic Prototype

- Preprocessing and simple stitching of single scans
3D analysis software: R3 Forensic Prototype

Class characteristics, like type and size
3D analysis software: R3 Forensic Prototype

Individual characteristics

Import of pre-defined identification characteristics
3D analysis software: R3 Forensic Prototype

Comparison of datasets
Agenda

- Problem / Motivation

- Development of the 3D-Forensics system
  - 3D scanner
  - 3D analysis software

- Introduction of the 3D-Forensics system
Introduction of the 3D-Forensics system

(1) **Familiarisation testing**
   Initial introductory training by 7 end users

(2) **Pilot testing**
   System demonstration in small operational area and in a controlled manner to identify the operational benefits and any further improvements
   ▶ receive feedback and suggestions for technical improvements to be implemented in the advanced prototype (TRL9)

(3) **Round robin testing**
   Performance verification, reproducibility tests by different users

(4) **Validation** (in an accredited process)
**System testing: Loan of prototypes**

- Testing of typical materials / objects
- Evaluation of usability
- Varying scan settings / environments
- Evaluation of software tools

![Tyre trace in R3 Forensic](image)

- Handheld
- Tripod
- Shadow box

![Clay Soil Mortar Sand](image)

![3D scan in snow](image)
System testing: Evaluation of data

- Evaluation of data quality
- Comparison to other techniques

Photo | Plaster cast | 3D-Scan | Resolution specimen
Round robin test and Validation

- Feedback from first testing phase is used to improve the prototypes
- **Round robin test** is then a first step to demonstrate the **validity of the 3D-Forensics system**:
  - Different users scan the same traces
  - Different users analyse and compare the same 3D datasets
- **Validation** means:
  - Create a **body of evidence** (data and its analysis) to convince criminal justice systems
  - Prepare a **comprehensive documentation** about the usability of the overall 3D-Forensics system for the application on footwear and tyre impressions from crime scene to court
  - Develop **quality control procedures** for end users
Round robin test and Validation

Important frameworks for validation:

- Criminal law (incl. procedure)
- Standards
  - ISO/IEC 17020:2012, Conformity assessment - Requirements for the operation of various types of bodies performing inspection
  - ISO/IEC 17025:2005, General requirements for the competence of testing and calibration laboratories
  - ....
Summary

- The projects 3D-Forensics and 3D-Forensics/FTI pursue the **Development** and **Introduction** of a new method to capture and analyse footwear and tyre impressions by **optical 3D scanning**
  - „from crime scene to court“

Next steps:

- **2017/18 >>** Technical improvement to reach an advanced prototype
- **2018 >>** Round robin testing on a set of traces and datasets
  - Validation in an accredited process
- **2018/19 >>** Product launch
Thanks for the invitation and your attention!

More information about 3D-Forensics?

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More information about 3D scanning?

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