FORnsic Marks Search - KIRAS Project

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FORMS?

• FORMS objectives
  • (semi-)automatic search and retrieval of similar tool marks in criminal offenses
  • Allows for searching marks in a database to detect crime series or link crimes

• Partners
  • CogVis Software und Consulting GmbH
  • Vienna Centre for Societal Security – VICESSE
  • Bundeskriminalamt – Büro für Kriminaltechnik

• Details
  • 1.9.2015-31.08.2017
  • Funded by: FFG – KIRAS
FORMS?

Lock cylinder

Tool

Soft spot

Contact
Before

Soft spot

Breaks

After

Toolmarks

FORMS?
Examples
• Stats
  • ~ 300 Toolmarks (and growing)

<table>
<thead>
<tr>
<th>Marks/Tool</th>
<th>Tools</th>
<th>Images</th>
<th>Images/Total Images [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>63</td>
<td>63</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
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<td>12</td>
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</tr>
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<td>7</td>
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<td>2</td>
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<tr>
<td>Total</td>
<td>155</td>
<td>296</td>
<td>100</td>
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</tbody>
</table>
Procedure
Procedure › Standardized Image
Procedure ➤ Standardized Image
Procedure ➤ Standardized Image

FORensic Marks Search (FORMS) - SPTM Meeting 06.10.2016
Procedure ➔ Standardized Image
Procedure > TV „Enhance“
Procedure › Real Enhance
Procedure  › Annotate + Upload
Procedure ➔ Processing on Server
Procedure › Processing on Server

Deep Learning

more on this later...
Procedure › Browse Database
Procedure › Find Similarities
Procedure ▶ Compare Toolmarks
Methodology
Methodologie  Deep Learning

• Advantages
  • “Learned” Features
  • Flexible
  • Fast (GPU mandatory)
  • Robust

• Disadvantages
  • Data needed for training
  • “Blackbox”
Deep Learning  ▶ Google Image Search
Deep Learning ▶ Google Image Search

Query
Deep Learning ➔ Google Image Search

Query

“Statue of Liberty”
Deep Learning Embedding
Deep Learning › Embedding

Images → Embedding

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Deep Learning → Embedding

Images → Embedding

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Deep Learning ➤ Embedding

Images ➔ Embedding
Deep Learning ➔ Embedding

Images ➔ Embedding

FORensic Marks Search (FORMS) - SPTM Meeting 06.10.2016
Methodology › Ground Truth

• Regions of Interest (ROI)
  • Multiple marks / image
  • Extraction of ROI
  • Advantage: fast & easy
  • Disadvantage: only 300 images

• Polylines / patches
  • „Inverse“ comparison Microscope
  • Annotate matching Patches
  • Verification using magnification
  • Advantages: many patches / image
  • Disadvantages: time consuming, tool necessary
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Methodology

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THEORETICAL PERSPECTIVES

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Deep Learning Matching Patches
Methodology ▶ Polyline Matching
Methodology › Polyline Matching
Methodology 〉 Polyline Matching
Methodology › Polyline Matching
Results
Results  NFI Toolmark Database

• Properties
  • 50 Screwdrivers (tool)
  • 5 angles of attack
  • 3D profiles & depth data
  • 2D high-res images (> 400x4000)
  • 300 images in total

• Advantages
  • Baseline results available [1]
  • Influence of resolution measureable
  • Comparison of 2D/3D possible

Results  NFI Toolmark Datenbank

- Example:
  - Same tool
  - 15° vs. 30°
  - 2D image / 3D profile superimposed
Results ∘ NFI Toolmark Database

- **NFIT 15**
  - 15° test
  - 30°/45°/60°/75° train
  - MAP = 78%

- **NFIT 30**
  - 30° test
  - 15°/45°/60°/75° train
  - MAP = 95%
• Preliminary results
  • Trained with best sample images
  • Tested with small set of toolmarks (10) on different locks
  • MAP of about 90%

• @ Demo
Queries  

Ranked Results ➔ (same tool)
User Interface Demo
• Extend database  
  • Same tool different locks  
  • Varying (known) illumination  

• We need YOUR toolmark images!  

Requirements  
• Resolution > 200 pixel / mm  
• Multiple marks of same tool  
• Type of tool annotated  
• Scale annotated (or fixed)  

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Thank you!