Child Fingerprint Recognition

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Motivation and objective for the study on children fingerprints

- A reasonable minimum age for automated fingerprint recognition of children was discussed by European legislators around 2008 in the context of biometric passports and the Visa Information System.

- JRC has been tasked to conduct a study on the feasibility of fingerprint recognition of children under the age of 12.
Research Issues

1. Growth:
   Children grow and so do their fingers
   → Can older fingerprints still be recognised?

2. Structure size:
   Children have smaller fingerprints
   → Is typical image resolution sufficient?
Previous Studies

- **TNO** study on proper enrolment for e-passports, including children: 145 children, fingerprints obtained within short time frame (2004)

- **NJI/ Ultra-Scan** study on children fingerprints: 300 children, fingerprints with 2-3 years distance (2006-2009)

- **BKA/ Univ. Göttingen** study: 48 reoffending juveniles, fingerprints obtained at various ages, starting at ~12 years (2010)
The JRC Study

- Based on anonymised children fingerprints, acquired during issuance and renewal of passports
  - provided by courtesy of the Portuguese government
  - under application of the highest standards of security and data protection

- Characteristics:
  - Some 1600 children, scanned twice within 2 – 4.5 years (using 500-dpi single fingerprint scanners)
  - left and right index finger
  - age coverage: 0-11 years
Used Data
Summary of technical findings

- Fingerprints of kids **can be recognised** at up to 4.5 years distance.

- **Smaller size** of children fingerprints does not theoretically conflict with typical image resolution (500 dpi)

- Ultimate criteria: **Quality** of fingerprints **is decisive** and increases with age.
**First finding:**

**Growth surprisingly not an issue**

- All tested algorithms show the **same recognition rate regardless of the time** between the fingerprints (up to 4.5 years)
- Explanation: ability of the algorithms to deal with (limited) distortions.

*Tested algorithms: NIST + 2 commercial systems*
Matching scenario:

Set 1:
latest FPs per finger

Set 2:
oldest FPs per finger

Matching after ground-truthing
(reduction from 3264 to 2611 FP pairs)
Recognition rate of two matchers (@FAR=0,1%)
Age group according to oldest (i.e. first) fingerprint of a pair
Second finding:
Size only matters in relation to quality!

- Even smaller fingerprints could be recognized by the given image resolution (500 dpi).

- However, size conflicts with quality reducing factors!
Comparison of “genuine” scores above threshold of two versions of commercial matching algorithm (FAR@0.1%)
Third finding:

Quality comes with age!

- Condition of fingers influence quality (dryness, humidity, dirt and other substances) – for children and adults!

  - "good"
  - "bad"
  - "bad"

- Children fingerprints: Smaller dimension + bad quality = reduction of recognisability
Further technical findings:

- NFIQ lacks adoption to children case (because most used matchers for training do the same)

- Isotropic growth model seems good enough to serve for cases up to ~5 years of time difference

- Alternative scanner types should be considered for children
Isotropic growth model:

- Predicted by a previous study of BKA / Univ. of Göttingen
- Best alignment of landmarks shows good confirmation of prediction (~5-10% error)
Example: closest shape alignment for 50 months time distance
Example: 50 months time distance
Performance under various scalings
Alternative fingerprint acquisition devices?

- Multispectral scanner
- Touchless scanner
- CrossMatch’s new “Guardian”
<table>
<thead>
<tr>
<th></th>
<th>Traditional (Dermalog/TBS 2D/ Cross Match)</th>
<th>Multispectral (Lumidigm)*</th>
<th>Touchless (TBS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Best</strong></td>
<td>Strong recognition at NFIQ 1</td>
<td>Weak recognition though NFIQ was 1-2.</td>
<td>Strong recognition at NFIQ 1-3</td>
</tr>
<tr>
<td><strong>Humid</strong></td>
<td>Weak recognition with NFIQ at 4-5.</td>
<td>Weak recognition though NFIQ was 1-2.</td>
<td>Weak to strong recognition rate at NFIQ 3-4.</td>
</tr>
<tr>
<td><strong>Sugar</strong></td>
<td>Recognition mostly weak at NFIQ 3-5.</td>
<td>Weak recognition though NFIQ was 1-2.</td>
<td>Strong recognition at NFIQ 1-3</td>
</tr>
<tr>
<td><strong>Dirt</strong></td>
<td>Weak to strong recognition at NFIQ 4-5</td>
<td>Weak recognition rate low at NFIQ of mostly 1.</td>
<td>Strong recognition at NFIQ 1-2</td>
</tr>
</tbody>
</table>

**Qualitative results (6 test persons only, adults)**

Match against best Dermalog FP

* Lumidigm gets **strong recognition** against Lumidigm
Full Report available at:

Further investigations:

- Calibration of results against data from adults
- Complete age group coverage: 0 -25 years
- Further cooperation with vendors of fingerprint recognition systems
- Verification of recommendations in larger field trials
Thank you!

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