Focussing the Beam - A New Laser Illumination Based Data Set Providing Insights to Finger-Vein Recognition

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Finger Vein Authentication

- Pattern formed by the blood vessels inside the finger has become an emerging biometric trait
- Blood vessels are underneath the skin and only visible in near-infrared light
- Vein pattern is resistant to (direct) forgery, liveness detection is easy
- Neither sensitive to finger surface conditions nor to abrasion
- Commercial scanners: palmar images using light transmission

Problem

- Only a few finger vein data sets publicly available
- No publicly available dorsal finger vein data set
- No fully open source finger vein scanner design available
PLUS OpenVein - Open Source Finger Vein Scanner

- NIR LED (left) and laser module based version (right)
- Acquires three fingers simultaneously (speed-up + prevent finger rotation)
- Light transmission and reflected light + dorsal and palmar
- Automated illuminator intensity control to achieve optimal image contrast
- Based on a flexible and modular design, details will be made open source soon
Advantages of Laser Modules over LEDs

- Less bright areas along the finger outlines
- Contrast remains high even if the distance between the illuminator and the finger is increased
- Advantages in contactless operation (see next presentation)
  - Multi-perspective finger-vein scanner based on laser modules [7]
PLUSVein-FV3 Data Set

- First publicly available dorsal finger vein data set
- 60 subjects, 35 male, 25 female, from 18 to 79 years old
- 6 fingers per subject $\rightarrow$ 360 individual fingers
- 5 dorsal images per finger, 1 session $\rightarrow$ 1800 images per scanner
- 2 scanners $\rightarrow$ 3600 images in total
- Image size: $420 \times 1024$ pixels, visible finger size: $200 \times 750$ pixels
- Has been extended by a palmar subset (same subjects) [2] $\rightarrow$ 7200 images
- Available for research purposes at: http://www.wavelab.at/sources/PLUSVein-FV3
Figure: Data set example images, laser (top) and LED (bottom)
Test Set-Up and Recognition Performance

- ROI extraction, pre-processing (CLAHE [10], HFE [9], CGF [8])
- Tested 4 different schemes: MC [6], PC [1], SIFT [3] and GF [4]
- Followed the test protocol of the FVC2004 [5] to determine EER, FMR1000 and ZeroFMR

<table>
<thead>
<tr>
<th></th>
<th>MC</th>
<th>PC</th>
<th>SIFT</th>
<th>GF</th>
</tr>
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<tbody>
<tr>
<td><strong>laser</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>EER</td>
<td>0.028</td>
<td>0.331</td>
<td>0.111</td>
<td>0.523</td>
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<tr>
<td>EER</td>
<td>0.028</td>
<td>0.028</td>
<td>0.117</td>
<td>0.336</td>
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<tr>
<td>FMR1000</td>
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<td>0.139</td>
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<tr>
<td>ZeroFMR</td>
<td>0.083</td>
<td><strong>0.056</strong></td>
<td>0.361</td>
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</table>

Table: Baseline performance results (in percentage terms, the best results per illumination type are highlighted **bold**)

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### Cross-Sensor and Sex Subgroup Specific Results

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>EER</td>
<td>0.288</td>
<td>2.775</td>
<td>2.86</td>
<td>1.353</td>
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<tr>
<td>FMR1000</td>
<td>0.478</td>
<td>5.078</td>
<td>5.622</td>
<td>3.522</td>
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<tr>
<td>ZeroFMR</td>
<td>1.267</td>
<td>6.522</td>
<td>7.689</td>
<td>8.144</td>
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</table>

**Table:** Cross-sensor (LED vs. laser) comparison performance results

<table>
<thead>
<tr>
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<th>male</th>
<th>female</th>
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<tbody>
<tr>
<td></td>
<td>MC</td>
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<td>nr. of subjects</td>
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<tr>
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<td></td>
<td>FMR1000</td>
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<tr>
<td>LED</td>
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<tr>
<td></td>
<td>FMR1000</td>
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<td></td>
<td>ZeroFMR</td>
<td>0.95</td>
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**Table:** Sex subgroup specific results
Conclusion and Future Work

- Established a new, publicly available, dorsal and palmar finger vein data set
  - Available for research purposes at: 
    http://www.wavelab.at/sources/PLUSVein-FV3
  - Simple finger vein recognition schemes achieve a decent performance on our data set
- Captured with our self-designed modular, multi-purpose finger vein scanner
  - All design details will be made publicly available soon
  - Advantages of laser modules over LEDs in contactless operation

Future Work

- Extend the data set (about 100 subjects by the end of 2018)
- Open source our finger vein scanner design
- Test more recent finger vein recognition schemes
Thank you!


Naoto Miura, Akio Nagasaka, and Takafumi Miyatake.
Extraction of finger-vein patterns using maximum curvature points in image profiles.

Bernhard Prommegger, Christof Kauba, and Andreas Uhl.
Multi-Perspective Finger-Vein Biometrics.

Jing Zhang and Jinfeng Yang.
Finger-vein image enhancement based on combination of gray-level grouping and circular gabor filter.

Jianjun Zhao, Hogliang Tian, Weixing Xu, and Xin Li.
A new approach to hand vein image enhancement.

K. Zuiderveld.
Contrast limited adaptive histogram equalization.