Iris recognition from low resolution photographs

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Supervisor: Zeno Geradts, FNWI
Introduction: Iris recognition

Pioneer: John Daugman

Useful because:

- Epigenetic trait
- Template aging problem
- Speed
- Ubiquity
Introduction: Algorithm

Detect iris using Hough transform

Mask for missing portions of the iris

Unroll using “rubber sheet model”

Create iris code using Gabor wavelets

Compare iris code with hamming distance

Introduction: Low resolution

Iris Recognition with a Database of Iris Images Obtained in Visible Light Using Smartphone Camera
Mateusz Trokielewicz, Ewelina Bartuzi, Kasia Michowska, Tosia Andrzejewska, Monika Selegrat

Reconstruction of Smartphone Images for Low Resolution Iris Recognition
Fernando Alonso-Fernandez, Reuben A. Farrugia, Josef Bigun
Research question

How does iris recognition perform when presented with near-infrared photographs taken at a distance compared to visible light images taken at a distance?

- How accurately can irises be identified in photographs taken in the visible light spectrum?
- How does distance to the camera affect the accuracy of iris identification in photographs taken in the visible light spectrum?
- How accurately can irises be identified in photographs taken in the near-infrared spectrum?
- How does distance to the camera affect the accuracy of iris identification in photographs taken in the near-infrared spectrum?
Methodology: experiments

Matlab open source implementation of first Daugman algorithm

All experiments are done on a dataset of photographs and photos taken of my own irises.
Awkward moments
Methodology: experiments

Matlab open source implementation of first Daugman algorithm

All experiments are done on a dataset of photographs and photos taken of my own irises.

- Establish a baseline for both visible light and near-infrared light
- Take photo’s at a distance / simulate distance by blurring dataset photos
- Do this for both spectrums
- Run tests on new photos and compare results.
Methodology: Dataset

Warsaw Biobase Smartphone Iris v1

- Iphone 5S
- Visible light
- 68 persons
- 2 sessions
- Both left and right eye
- Varying number of photographs per session, per eye
Methodology: Camera

Trust spotlight pro

- Manual focus
- 1.3 megapixel
- Supposedly easy to take out IR-filter
## Results: missing values

### Missing values and usable values for each experiment

<table>
<thead>
<tr>
<th></th>
<th>Exp 1</th>
<th>Exp 2</th>
<th>Exp 3</th>
<th>Exp 4</th>
<th>Exp 5</th>
<th>Exp 6</th>
<th>Exp 7</th>
<th>Exp 8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Failed</strong></td>
<td>0</td>
<td>283</td>
<td>10</td>
<td>510</td>
<td>1</td>
<td>125</td>
<td>58</td>
<td>266</td>
</tr>
<tr>
<td><strong>measurements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Total</strong></td>
<td>20</td>
<td>1400</td>
<td>100</td>
<td>1400</td>
<td>20</td>
<td>700</td>
<td>100</td>
<td>700</td>
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<tr>
<td><strong>comparisons</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Usable</strong></td>
<td>20</td>
<td>1183</td>
<td>90</td>
<td>890</td>
<td>19</td>
<td>575</td>
<td>42</td>
<td>444</td>
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<tr>
<td><strong>measurements</strong></td>
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<td></td>
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</tbody>
</table>
Results: self close-ups

Averages of comparisons between self photographs

<table>
<thead>
<tr>
<th></th>
<th>Visible light</th>
<th>Near infrared light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left eye</td>
<td>0.391</td>
<td>0.349</td>
</tr>
<tr>
<td>Right eye</td>
<td>0.450</td>
<td>0.409</td>
</tr>
</tbody>
</table>
Results:

Averages of comparisons between photographs of the same iris

| Averages:       | 0.283 | 0.299 | 0.268 | 0.291 |
## Results:

Averages of self-photographs compared with self-photographs taken at a distance

<table>
<thead>
<tr>
<th></th>
<th>10cm</th>
<th>20cm</th>
<th>30cm</th>
<th>40cm</th>
<th>50cm</th>
<th>60cm</th>
<th>70cm</th>
<th>80cm</th>
<th>90cm</th>
<th>100cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left eye visible light</td>
<td>0.433</td>
<td>0.457</td>
<td>0.424</td>
<td>0.450</td>
<td>0.420</td>
<td>0.430</td>
<td>0.469</td>
<td>0.429</td>
<td>0.478</td>
<td></td>
</tr>
<tr>
<td>Left eye IR light</td>
<td>0.428</td>
<td>0.404</td>
<td>0.429</td>
<td>0.439</td>
<td>0.389</td>
<td>0.404</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right eye visible light</td>
<td>0.427</td>
<td>0.422</td>
<td>0.410</td>
<td>0.455</td>
<td>0.420</td>
<td>0.432</td>
<td>0.440</td>
<td>0.463</td>
<td>0.455</td>
<td></td>
</tr>
<tr>
<td>Right eye infrared light</td>
<td>0.426</td>
<td>0.428</td>
<td>0.415</td>
<td>0.429</td>
<td>0.466</td>
<td>0.387</td>
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</tr>
</tbody>
</table>
## Results:

Averages of iris photograph comparison with iris photographs that are blurred to simulate distance

<table>
<thead>
<tr>
<th></th>
<th>Original</th>
<th>2x blur</th>
<th>4x blur</th>
<th>8x blur</th>
<th>16x blur</th>
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</thead>
<tbody>
<tr>
<td>Left eye visible light</td>
<td>0.259</td>
<td>0.276</td>
<td>0.277</td>
<td>0.315</td>
<td>0.404</td>
</tr>
<tr>
<td>Left eye IR light</td>
<td>0.251</td>
<td>0.264</td>
<td>0.294</td>
<td>0.273</td>
<td>0.316</td>
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<tr>
<td>Right eye visible light</td>
<td>0.297</td>
<td>0.314</td>
<td>0.293</td>
<td>0.310</td>
<td>0.362</td>
</tr>
<tr>
<td>Right eye infrared light</td>
<td>0.286</td>
<td>0.299</td>
<td>0.281</td>
<td>0.289</td>
<td>0.285</td>
</tr>
</tbody>
</table>
Results:

Absolute values of left irises compared to iris photographs blurred to simulate distance.
Results:

Absolute values of right irises compared to iris photographs blurred to simulate distance
Discussion

- Self-photographs likely indicates an image too poor for identification
- Red light does seem to offer slight improvement in recognition
- Specular reflection likely plays a larger role in real life scenarios
- Dataset was taken from specific demographic

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Conclusion

Very low quality sensors are not suitable for iris recognition

A smartphone camera can do iris recognition at a moderate distance

Iris recognition can be done in visible light

Red light improves matching accuracy slightly

No conclusions can be drawn about the difference between gaussian blur and real physical distance
Future work

Ruling out identity instead of verifying identity

More ideal dataset

Exact research on the best wavelength for iris recognition

Converting iriscode back to an iris
Thank you for your attention