High Performance Low Complexity DCT-based Iris Recognition

Donald M Monro, Soumyadip Rakshit and Dexin Zhang

Electronic and Electrical Engineering, University of Bath
Bath BA2 7AY, United Kingdom
S.Rakshit@bath.ac.uk
Http://dmsun4.bath.ac.uk

NIST FRGC ICE Workshop 23 March 2006
Outline

• Data Collection
• Iris Recognition System
• Feature Extraction & Weighting
• Classifier Design
• Proposed Metric
• Results
• Ongoing & Future Work
Bath Iris Image Database

Currently 16,000 Images from 400 Subjects (800 Eyes)

Mid-2006 Target 32,000 Images from 800 Subjects (1600 Eyes)

http://www.bath.ac.uk/elec-eng/pages/sipg/irisweb
Non Ideal Images

Blinking, Out-of-focus, Motion Blur, Out of Line-of-sight
Iris Recognition System

Image Acquisition → Eye Image → Localization Normalization → Intensity Enhanced → Feature Extraction → Iris Code

Decision ← Match ← Classifier ← Enrolled Database

Smart Sensors Ltd
High performance iris recognition and matching
Feature Extraction

- Image divided in diagonal 8 x 12 patches [BMVA 04, ICIP 05]
- 50% overlap in both directions
- Windowed average over width
- Windowed 1D DCT of length 12 over length
- Adjacent DCTs differenced
- Zero Crossings form Feature Vector
• Blue and Brown Iris Structures differ.
• Positional weightings effective within ethnic groups but ineffective across groups.
• DCT Coefficient weighting is effective in choosing the most discriminating bits and reducing the Feature Vector Size.
• Most effective sub-feature bits 1, 2, 3.
• Final Feature Size = 2343 bits (300 bytes).
Masking

- Artifacts in iris images lead to erroneous code formation.
- Caused by specular reflections, hard contact lens, eyelids, eyelashes, etc.
- Non-iris regions masked to 0 graylevel in normalized image.
- Masked regions omitted during image equalization and coding.
Product-of-Sum Distance Classifier

\[
Dist = \frac{1}{K} \prod_{i=1}^{M} \left( \sum_{j=1}^{N} \left( \text{Feature } 1_{ij} \oplus \text{Feature } 2_{ij} \right) \right) \left( \sum_{j=1}^{N} \left( \text{Mask } 1_{ij} \square \text{Mask } 2_{ij} \right) \right)
\]

The Product of Sum of Hamming Distances (HD) between subfeature bits gives a metric with good separation of Matching and Non-Matching classes.

- Parameter Optimization by minimizing Equal Error Rate (EER).
- Theoretical EER predicted by measuring areas of equal overlapped regions.
Proposed Metric

A widely used metric for system performance - separation between Normalized Hamming Distance of Matching and Average of Non-Matching Irises.

Proposal - Compare the separation between Normalized Hamming Distance of Matching with Nearest Non-Matching Irises.
## Test Datasets

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Number of Classes</th>
<th>Enrol Images per class</th>
<th>Test Images per Class</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASIA</td>
<td>308</td>
<td>3</td>
<td>Rest</td>
<td>2156</td>
</tr>
<tr>
<td>Bath</td>
<td>150</td>
<td>3</td>
<td>Rest</td>
<td>2955</td>
</tr>
</tbody>
</table>
Results

Receiver Operating Characteristic Curves

EER = 2.6 x 10^{-4} and Falling

<table>
<thead>
<tr>
<th>Method</th>
<th>Feature Extraction (ms)</th>
<th>Matching (ms)</th>
<th>Total (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daugman</td>
<td>422</td>
<td>31</td>
<td>453</td>
</tr>
<tr>
<td>Tan</td>
<td>125</td>
<td>68</td>
<td>193</td>
</tr>
<tr>
<td>Monro</td>
<td>45</td>
<td>31</td>
<td>86</td>
</tr>
</tbody>
</table>
Ongoing & Future Work

- More Iris Image Collection
- Iris Quality Metrics
- Novel Localization methods
- Fast Searching and Matching
- Rotation Invariance
- Alternative Iris Transforms
- Iris Variation Simulation
- Liveness Detection
- Effect of Medical Conditions
- Spoofing Countermeasures
Acknowledgements

Professor Tieniu Tan
National Laboratory of Pattern Recognition (NLPR)
Chinese Academy of Sciences Institute of Automation (CASIA)

Industrial Sponsors: Smart Sensors Ltd. (UK)

Donald M Monro, Soumyadip Rakshit and Dexin Zhang
Electronic and Electrical Engineering, University of Bath
Bath BA2 7AY, United Kingdom
S.Rakshit@bath.ac.uk
Http://dmsun4.bath.ac.uk

NIST FRGC ICE Workshop 23 March 2006
Questions ?