Biometrics Quality: Technologies, Benefits and Challenges

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Introduction

- Biometric data quality is a key factor in the performance of identification systems

- Key issues regarding quality
  - Cost
  - Capture time
  - Feature extraction capability (algorithmic)
  - Physical size
  - Number of instances (e.g., number of fingers, multiple images)
  - Performance (accuracy, speed, etc.)

- Discuss
  - Impact of image quality based on actual large scale government and commercial programs
  - R&D efforts to address the system issues associated with image quality as part of the overall identification process
    - Quality Factor
    - Improve Data Quality
    - Dealing with Poor Quality
Fingerprint identification - Most widely used and most accurate biometric

- Example: European Union EuroDac System (provided by Cogent, in operation since January 2003)
  - “Lights-out” identification for people seeking asylum for all European Member States
  - No failure to enroll – all levels of image quality are accepted
  - Proven true accuracy rate of 99.9% with 0% false acceptance rate
  - 100% search penetration – no filtering or binning to limit search
  - Multi-finger search --- using best “quality” fingers or all “poor quality” fingers available from 10 fingers captured
Quality - Issues & Challenges

- **Practical Issues**
  - A solution could be limited by budget, operational environment constraints
  - Less than 10 fingers (application dependent)
  - Quality associated with the physical capture process (operator errors)

- **Challenge**
  - How to maximize identification performance with varying levels of biometric quality
    - Maximize algorithmic performance to compensate for poor image quality
Quality is Multi-Dimensional

- The quality of digital image --- *capture device*
- The quality of biometric sample --- *capture process*
- The quality of biometric feature data --- *algorithmic capability*
## Improving Performance for Poor Quality Images

<table>
<thead>
<tr>
<th>Quality Class</th>
<th>Quality Score</th>
<th>True Accept Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOD</td>
<td>1</td>
<td>99%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>99%</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>98%</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>98%</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>5</td>
<td>94%</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>88%</td>
</tr>
<tr>
<td>POOR</td>
<td>7</td>
<td>82%</td>
</tr>
<tr>
<td></td>
<td>8-127</td>
<td>54%</td>
</tr>
</tbody>
</table>

Based on 2 finger search

- For quality > 5
  - Multiple independent algorithms
  - Additional feature sets

**Texture - “3rd Level Feature Data”**

Based on NIST evaluations
Quality 8 images increased to 85% TAR from 54%
Texture Feature Example - Latent
Improved Performance with Galaxy+ Matcher

Original Match Score ---- No-hit
Galaxy+ Match Score --- Hit
Multiple Biometrics: Additional Feature Sets

Minutiae Matching for Fingerprints

Multi Matchers for Fingerprint

Image Matching for Third Level Details

Multi-biometrics Fusion

Minutiae Matcher

Galaxy Matcher

Final Stage Matcher

Fusion

LTD Matcher (Image Matching)

Facial Matcher

Multi Biometric Fusion

Final Result

Enquiry Minutiae, Enhanced Feature,

Minutiae Database

Enhanced feature

Feedback Matcher

Enhanced feature

Database Image

Facial Image

IRIS Matcher

IRIS Data
Fusion with Multiple Biometrics

Score level fusion

- Best tradeoff between ease of implementation and power, universally available.
- Many score fusion formulas
- A reliable usage model is using one strong biometrics that will be most suitable for the application as the ‘primary’ biometrics and have a second biometrics included for flexibility, risk migration and potential improvement.

Fused score: \( s(x) = \log L_A(x) + \log L_B(x) + \ldots \)
Conclusions

- A biometric system has to be resilient in processing all levels of quality and providing high performance.

- Quality is multi-dimensional and an identification system must adequately address all aspects:
  - The quality of digital image — *capture device*
  - The quality of biometric sample — *capture process*
  - The quality of biometric feature data — *algorithmic capability*

**Key challenge for biometric systems**

*Maximizing identification performance with varying levels of biometric quality*
Thank you!