Motivation and Use Cases for NFIQ 2.0

on behalf of
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Fingerprint Applications

- Official documents with fingerprints
  - European ePassports
  - European Residence Permits
  - Identity Cards (partially)

- European Visa Information System (VIS)
  - Tenprints from all Schengen (short-time) Visa applicants
    - Data stored for 5 years
    - Target size up to 100 Mio. records
    - Biometric verification at Schengen border checks has started

- Criminal AFIS

- Future RTP programs might use fingerprints
Challenges for Operators

- Problems
  - Technical
    - Heterogenous environments
    - Different software vendors and versions
    - Interoperability issues
  - System design
    - At enrolment stage, typically the biometric verification or identification system vendor is unknown
    - Large scale identification scenarios (AFIS) have high quality requirements
Challenges in fingerprint biometrics deployment (2)

- **Timing considerations**
  - Timing constraints are the biggest driver in the design of an enrolment and verification process
  - For many instances, quality correlates directly with time
    - Not only technical, but also organizational, e.g. user guidance
  - Time is expensive
    - Officers are expensive
    - Room is expensive
  - Which quality is required by the system?
    - How much time (on average) do I need to reach the desired level?
Stages of possible quality control

- **Scanner level**
  - Hardware built-in auto capture
  - Hard to tweak to a specific application scenario

- **Capture software level**
  - Beyond the vendor SDK
  - Run things like NFIQ, vendor software kits, other QA algorithms
  - Implement target system specific thresholds

- **Process level**
  - A background system rejects the fingerprints
  - Trigger recapture only when necessary
    - Avoid this as often as possible because of timing considerations, especially when round trips to central systems are involved
There’s no universal understanding of a term like **fingerprint of sufficient quality**
- Sufficient for which application?
- Quality requirements differ a lot for different applications (e.g. obviously between 1:1 and 1:n)
- But there’s quality in the standards.
  - An algorithm should produce a value in [0, 100].
  - Some do so... most don’t
  - But still scores are not calibrated to an accepted base line.
  - And there is no consensus of thresholds for specific applications

OK, let’s try … **NFIQ2.0**
Motivation for NFIQ2.0 Framework

- Modular approach for NFIQ2.0 development is desired
  - to be flexible regarding the implementation
  - to have a common basis of functionality needed for NFIQ2.0 development which might then be extended by exchange of certain modules
  - because project team is distributed and located all over the world
  - because only certain project partners have access to certain fingerprint databases
  - because work can be shared and re-used by others
  - to simplify the development process
Architecture of NFIQ2.0 Framework

NFIQ 2.0 Development Tools
- extractQualityFeatures()
- calculateUtility()
- startTraining()
- ...

NFIQ 2.0
- checkQuality()

NFIQ 2.0 light
...

Input/Output Interface
- Fingerprint images
- Quality features
- Comparison scores
- Utility values

Quality Feature Extraction Module
- Feature extraction

Utility Estimation Module
- Utility computation
- Fusion & binning

Machine Learning Module
- Prediction
- Training

Framework

Input/Output Module

Image Format Converter

Database

Filesystem

Quality feature x

Utility x

MLP
Context - I


Definitions

- **quality**: "the degree to which a biometric sample fulfils specified requirements for a targeted application"
- **quality score**: "a quantitative expression of quality"
- **utility**: "the observed performance of a biometric sample or set of samples in one or more biometric systems"

Biometric data quality blocks

- **Quality score**
  - 0: lowest quality
  - 100: highest quality
  - 255: failed attempt to assign a quality score

<table>
<thead>
<tr>
<th>description</th>
<th>size</th>
<th>valid values</th>
<th>notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Quality Blocks</td>
<td>1 byte</td>
<td>[0,255]</td>
<td>This field is followed by the number of 5-byte Quality Blocks reflected by its value. A value of zero (0) means that no attempt was made to assign a quality score. In this case, no Quality Blocks are present.</td>
</tr>
<tr>
<td>Quality Score</td>
<td>1 byte</td>
<td>[0,100]</td>
<td>0: lowest 100: highest 255: failed attempt to assign a quality score</td>
</tr>
<tr>
<td>Quality Algorithm Vendor ID</td>
<td>2 bytes</td>
<td>[1,65535]</td>
<td>Quality Algorithm Vendor ID shall be registered with IBIA as a CBEFF biometric organization. Refer to CBEFF vendor ID registry procedures in ISO/IEC 19785-2.</td>
</tr>
<tr>
<td>Quality Algorithm ID</td>
<td>2 bytes</td>
<td>[1,65535]</td>
<td>Quality Algorithm ID may be optionally registered with IBIA as a CBEFF Product Code. Refer to CBEFF product registry</td>
</tr>
</tbody>
</table>
Context - II

- Linked to ISO/IEC rev 29794-4:201x
  "Information technology - Biometrics sample quality Part 4: Finger image data"

- Quality feature classes
  - Global features
  - Local features (blockwise)

- Expected return of research investment
  - Revision of ISO/IEC IS 29794-4:201x
  - Upgrade to an IS (International Standard)
Problem statement (2\textsuperscript{nd} try)

- There’s no common language to establish an interoperable definition of \textit{fingerprint of sufficient quality} for a specific application scenario
  - When developing an application scenario, define a common understanding of the required image quality
  - We need the language for doing this
  - And we need a baseline tool for doing this
Expectations for the future

- NFIQ2.0 will be good enough to be used as baseline tool for defining fingerprint of sufficient quality
- NFIQ2.0 will be the calibration base for vendor QA tools
  - Vendor QA tools will not go away, but – at least – for large scale applications will be comparable (statistically, not on a by-image-basis) to NFIQ2.0
  - Vendor QA tools should not have a need to augment NFIQ2.0 itself, but it should be sufficient for a vendor to define a specific threshold for a specific application
- NFIQ2.0 will be used in all major fingerprint-based biometrics systems.
- NFIQ2.0-lite will provide feedback on mobile devices
- Of course, the term of fingerprint quality will not be stable, but the biometric community will have a way to adapt, refine, reformulate it according to the evolution of fingerprint technology
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