Biometric Quality
The last 1% Biometric Quality Assessment for Error Suppression

Next Generation NFIQ
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Team Members

» NIST (US)
» BSI (Germany)
» BKA (Germany)
» Fraunhofer IGD
» Hochschule Darmstadt / CASED
» secunet Security Networks AG
» ...and the whole biometrics community
Push towards zero error biometrics

Quality problem: “The Last 1%”
Or maybe “The Last 0.1% or 10%”

» Fraction of samples that should not be sent to the matcher
  - mostly feedback based on only one instance (representation)
  - providing constructive feedback only possible if cause of poor quality is known

character, e.g. scar  behavior  environment, e.g. imaging, e.g. focus shadows
A biometric quality assessment method derives a numerical quality value from an input biometric sample. The quality value is related to the biometric error rates that are likely to be realized when the sample is matched.
Breaking the myths of biometric quality

- Quality is not about human perception
  - It is about why recognition algorithms fail
    - Scientific research to quantify
      - the effect of image covariates on recognition error (FNMR and FMR)
      - Whether, to what degree and for which covariates constancy (or sameness) matters.

- Quality *does not* come in pairs
  - comparison scores come in pairs!!
    - Quality algorithm is not needed if the pair of images to be compared are available -- use a matching algorithm
    - Most of the time (e.g., enrollment) only one instance (representation/view/..) is available
      - This is one of the reasons why the quality problem is challenging
    - A very poor quality sample almost always causes recognition failure, regardless of quality of the other image
NIST Fingerprint Image Quality (NFIQ 1.0)

- NIST developed NFIQ in 2004
  - Open source, publicly available
- Key innovation: quality as a rank statistic for performance
- NFIQ is a machine learning algorithm
  - Exploratory variables: image properties (minutiae, ridge clarity)
  - Response variable: separation of genuine and impostor comparison
NFIQ 1.0 – test of time

- Novel definition of biometric quality
  - performance related
  - accepted by the community

Interoperability
  - uniform interpretation
  - tuned to a class of matcher

Open source
Extensively examined
  - by NIST and others
  - tools for quality summarization, slap, ...

Aging
  - recognition technology has advanced since 2004.

Efficiency
  - ~300 msec per image - not fast enough for real time
  - takes 4 times for 4-finger slap

Not enough levels
  - Still statistically significant

Insensitive to partial prints
2 years ago ...

» Workshop on March 6, 2010 (IBPC 2010)
» Several options for NFIQ 2.0 were discussed
» The community overwhelmingly recommended a new, open source, generalized version of NFIQ to be developed in consultation and collaboration with users and industry.
  » Same technical approach, but better, bigger, faster, etc.
NFIQ 2.0 wish-list as of March 2010

- Generalized vanilla flavor
- More levels, particularly for poorer quality
- Determination of whether it is a fingerprint image or not
- Improve feature vector
  - A vector of quality scores?
- Faster to meet requirements of mobile application (< 15 msec)
- Calibration
- Slap quality
  - Not just aggregate of the 4 fingers
  - How to handle missing fingers
- Technical guidance for setting quality threshold
- Less dependencies of makefiles / libraries + better documentation
After the March 2010 workshop ...
NFIQ 2.0 Team

» NIST and BSI teamed up to develop the new and improved open source NIST Finger Image Quality.

» Invited research organizations and industry members to provide specific support in the development of NFIQ 2.0.

» Suggestions/comments to nfiq2 DOT development AT nist DOT gov

» Website

http://www.nist.gov/itl/iad/ig/development_nfiq_2.cfm

Call for participation

» http://biometrics.nist.gov/cs_links/quality/NFIQ_2

NFIQ_2_call_for_participation_v0.0.pdf

» Submission of comparison subsystems (i.e. matchers) whose comparison scores will be used for training of NFIQ 2.0

- 9 participants (major fingerprint recognition technology providers)

» Submission of fingerprint images demonstrating NFIQ 1.0 anomaly
NFIQ 2.0 wish-list as of March 2010

Components as of March 2012

- Generalized vanilla flavor
- More levels, particularly for poorer quality
- Determination of whether it is a fingerprint image or not
  - Determination of altered fingerprint?
- Improve feature vector
  - A standardized vector of quality scores?
- Faster to meet requirements of mobile application (<15 msec)
  
  NFIQ Lite.

- Calibration
  - And mapping to NFIQ 1.0
- Slap quality
  - Not just aggregate of the 4 fingers
  - How to handle missing fingers
- Technical guidance for setting quality threshold
  - Enrollment and verification
- Less dependencies of makefiles / libraries + better documentation
Out of scope of NFIQ 2.0
i.e., When NOT to use NFIQ 2.0

- Latent fingerprints -- while same approach works, it is a very different problem than finger image
- 1000 ppi (not enough images around)
- Images captured by non-optical sensors
Design principles / Development fields

- **Feature extraction**
  - Selection of features (Measure appropriate image characteristics that convey information for comparison algorithms)
  - Number of features
  - Implementation issues :: speed / robustness / etc.

- **Machine learning**
  - Selection of training data (balanced mixed of easy / moderate / difficult)
  - Selection of utility function (response variable)
  - Techniques (SVM, Regression tree, MLP, etc.)
  - Training parameters

- **NFIQ 2.0**
  - Fingerprint or not? Altered fingerprint or not?
  - „Lite“ version
  - Vanilla flavor + Several algorithmic flavours
  - Modular design
Current Status

✓ Framework design complete
✓ Framework implementation complete
✓ Feature selection based on their influence on recognition performance and computational efficiency
✓ Feature evaluation by correlation and ERC curves (Error-Reject-Characteristics)
✓ Steps towards machine learning procedure
  ✓ Definition of response variable based on comparison scores
  ✓ Training set selection

We like to hear your thoughts /comments / suggestions
Match 2012 workshop agenda

13:00 Elham Tabassi, NIST, NFIQ 2.0 project overview
13:20 Oliver Bausinger, Motivation and use cases for NFIQ 2.0
13:35 Michael Schwaiger, Framework, architecture, modularization
13:55 Christoph Busch, Technical overview of features
14:05 Martin Olsen, Candidate features, computation and visualization
15:15 Break
15:45 Johannes Markle, Quality feature evaluation, preliminary results
16:15 Timo Ruhland, AFIS quality requirements and implementation
16:30 Soweon Yoon, Inclusion of mutilated fingerprint detection
16:50 Elham Tabassi, discussion on what’s next.
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www.nist.gov/itl/iad/ig/development_nfiq_2.cfm

nfiq2 DOT development AT nist DOT gov