Biometric Quality

The last 1% Biometric Quality Assessment for Error Suppression

Next Generation NFIQ

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NIST / ITL / Image Group

Team Members

» NIST (US)

» BSI (Germany)

» BKA (Germany)

» Fraunhofer IGD

» Hochschule Darmstadt / CASED

» secunet Security Networks AG

» *...and the whole biometrics community*

Sponsors

Push towards zero error biometrics

Quality problem: "The Last 1%"

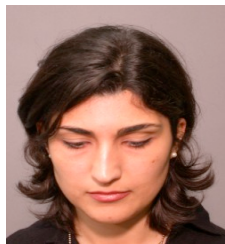Or maybe "The Last 0.1% or 10%"

» Fraction of samples that should not be sent to the matcher

– mostly feedback based on only one instance (representation)

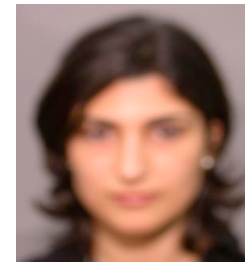– providing constructive feedback only possible if cause of poor quality is known

character, e.g. scar   behavior   environment, e.g. imaging, e.g. focus shadows

Quality :: Predictive of performance

93

Black Box Quality Assessment

26

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)
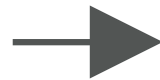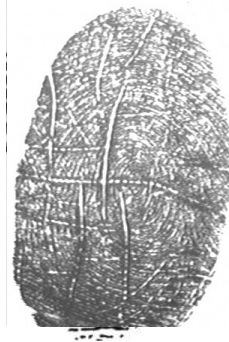
NFIQ $\rightarrow$ quality number $=5$

» 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

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2 years ago ...

» Workshop on March 6, 2010 (IBPC 2010)

» Several options for NFIQ 2.0 were discussed

  – http://biometrics.nist.gov/cs_links/ibpc2010/
    options_for_NFIQ2.0.pdf

» 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.

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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 ...

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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

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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

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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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NIST

www.nist.gov/itl/iad/ig/development_nfiq_2.cfm
nfiq2 DOT development AT nist DOT gov

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