

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*



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Push towards zero error biometrics



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Quality problem: “The Last 1%”

Or maybe “The Last 0.1% or 10%”

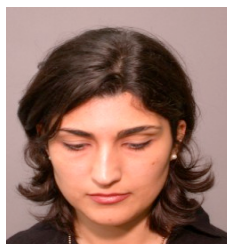
» Fraction of samples that should not be sent to the matcher

- 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



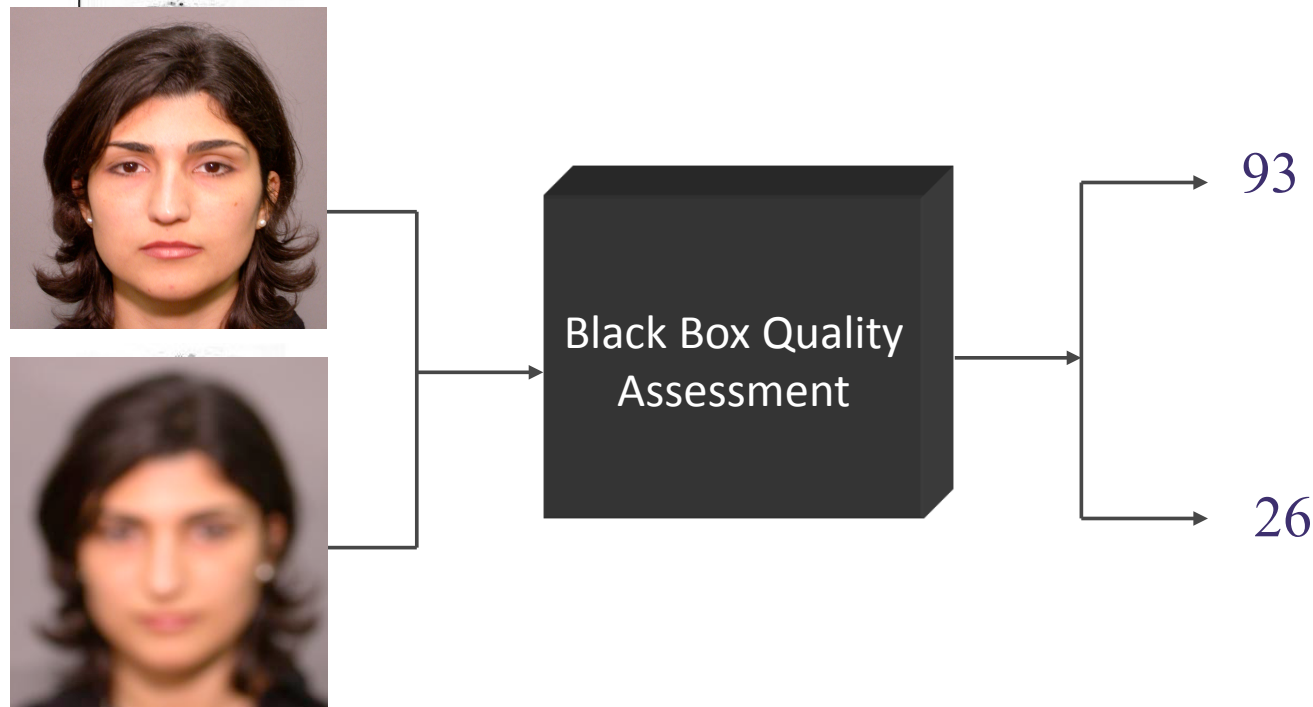
environment, e.g. imaging, e.g. focus
shadows



Quality :: Predictive of performance



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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.

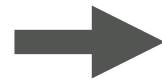
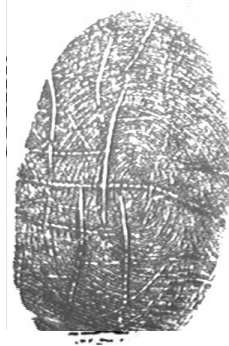


Breaking the myths of biometric quality

- 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



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.

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



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- » 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)
- » 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

NFIQ Lite.



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