Zen and the Art
of
Facial Image Quality

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Overview

What is Quality? – Definition(s), Utility and Relevance to Biometrics

What is Image Quality?

Biometric Matching: Face vs. Fingerprints

Measuring "Facial" Image Quality

Recommendations

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What is Quality?

Merriam-Webster: a degree or grade of excellence or worth

Philip Crosby: conformance to requirements

ISO 9000: degree to which a set of inherent characteristics fulfills requirements

What is Quality?

Merriam-Webster: a degree or grade of excellence or worth

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ISO 9000: degree to which a set of inherent characteristics fulfills requirements

- ultimately undefinable - value judgement that emerges from the relationship between observer and the object being observed

- *can be* definable in the proper context

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What is Image Quality?

Humans evolved to make use of image data for daily living

- as a stimulus for behavioral responses

- as input data for generating conceptual representations

⟶ our perception of the world is less complete and continuous than we think and our awareness based on more *a priori* information than is obvious to us

Subjectivity of term "quality" is problematic for image analysis

- ambiguous performance criteria are the gremlins of image analysis

- usually manifest themselves in unpredictable or unintended behavior

Meaning of the term ultimately depends on the application – how is it used and for what purpose?

- motivation for NFIQ – reasonable…for fingerprints

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Biometric Matching:
# Face vs. Fingerprints

Step 1: Image Acquisition

- definition of "face" has been extended (inadvertently) to include many different instantiations of human face appearances

- perception is that quality analysis, face recognition should be possible to some degree

- a quality metric for "facial" images (above) might be expected and desired, but not for a comparable variation in finger images – we don't even try to classify these types of finger images

Biometric Matching:
Face vs. Fingerprints

- by definition, a fingerprint is an impression made by direct contact of the finger with a solid surface
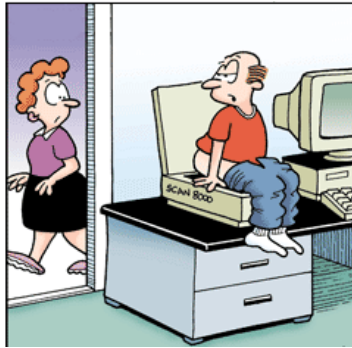
- ~~unknown scale~~
- ~~unknown illumination~~
- ~~unknown focus~~
- ~~unknown age~~
- ~~resolution~~
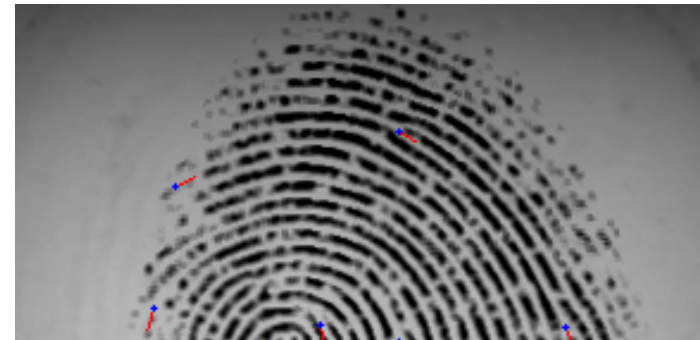- unknown pose
- unknown deformation
- occlusion
- noise

- context of fingerprint quality much more constrained

- multiple, relatively robust, relatively stable features for matching – very unlike face images
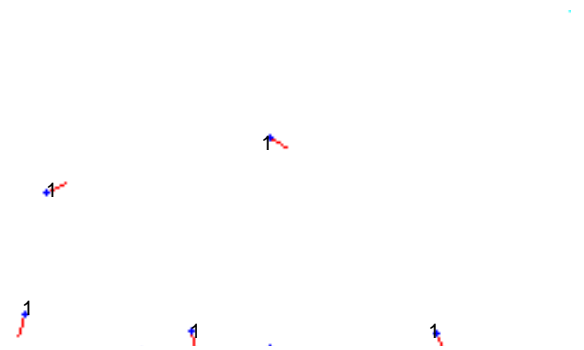
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Biometric Matching: Fingerprints

Step 2: Feature Extraction/Template Generation

minutiae extraction

template generation
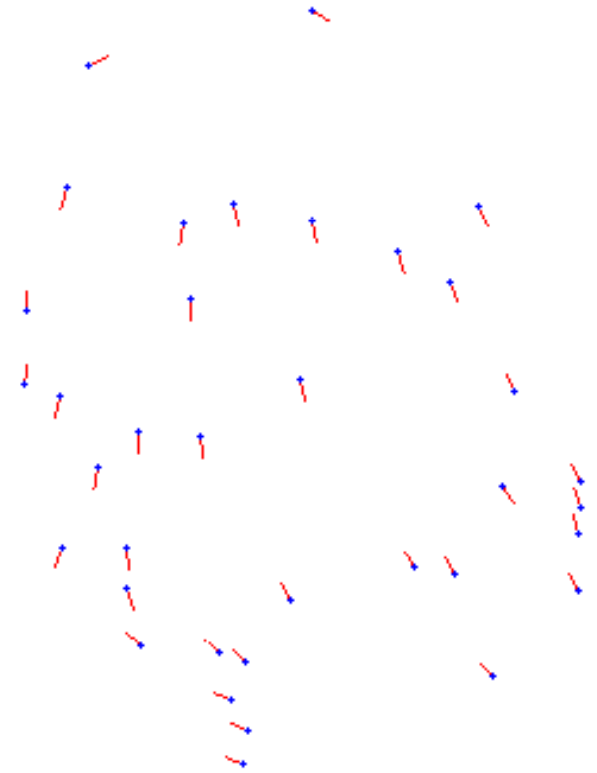
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Biometric Matching: Fingerprints

Step 2: Feature Extraction/Template Generation

Biometric Matching: Fingerprints

**Step 2:** Feature Extraction/Template Generation

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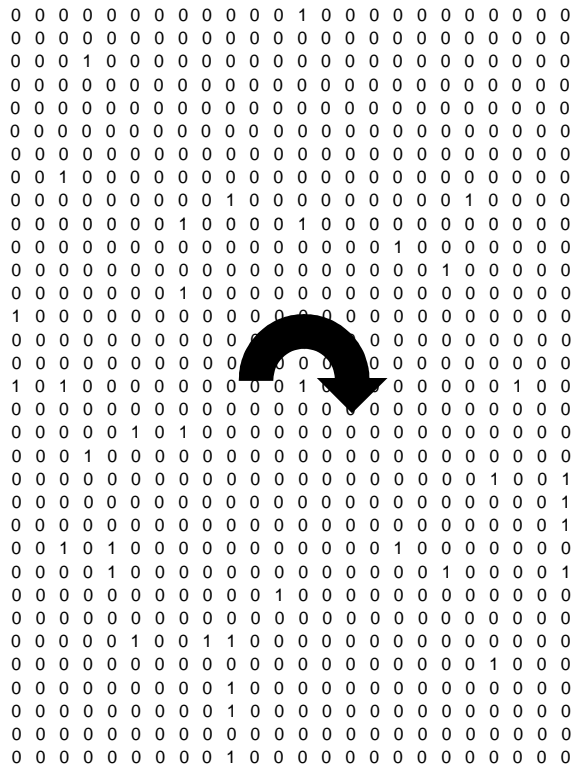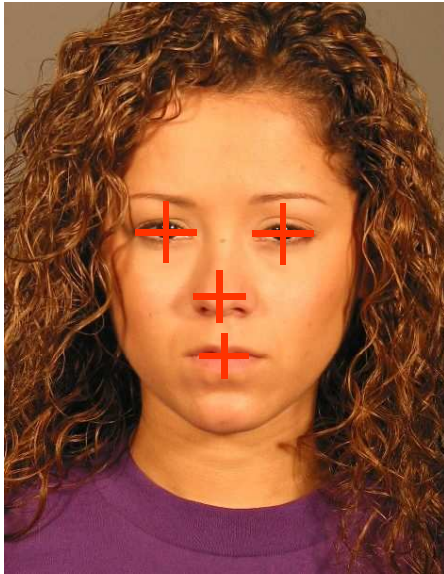
Biometric Matching: Fingerprints

Step 2: Feature Extraction/Template Generation

- rotate and apply "convolution" kernel to unknown images
- magnitude of maximum response determines match

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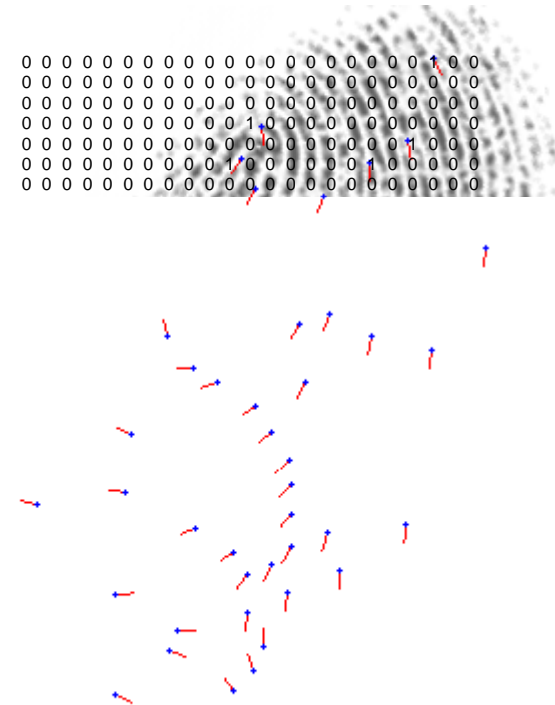
Biometric Matching:
Face

Fingerprints: multiple, relatively robust, relatively stable features for matching
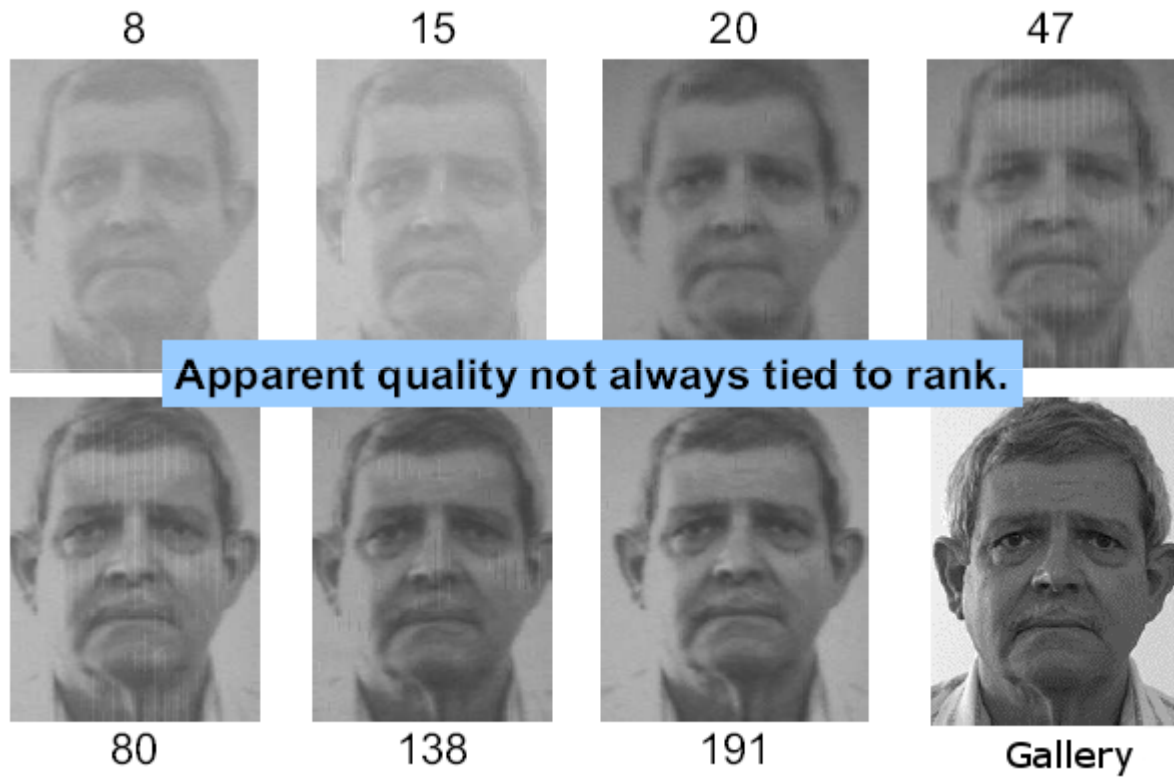

Face:

- no agreed-upon common feature set for "face" images

- maximum of 3 or 4 consistently reproducible features

- eye location is often critical – perturbation studies with various face recognition algorithms have shown a high sensitivity to eye location (Riopka & Boult, ACM Bioemetrics Workshop 2003) – c.f. minutiae

Image Quality: needs to be indicative of how consistent and complete feature extraction is *likely to be* for a given image and identity
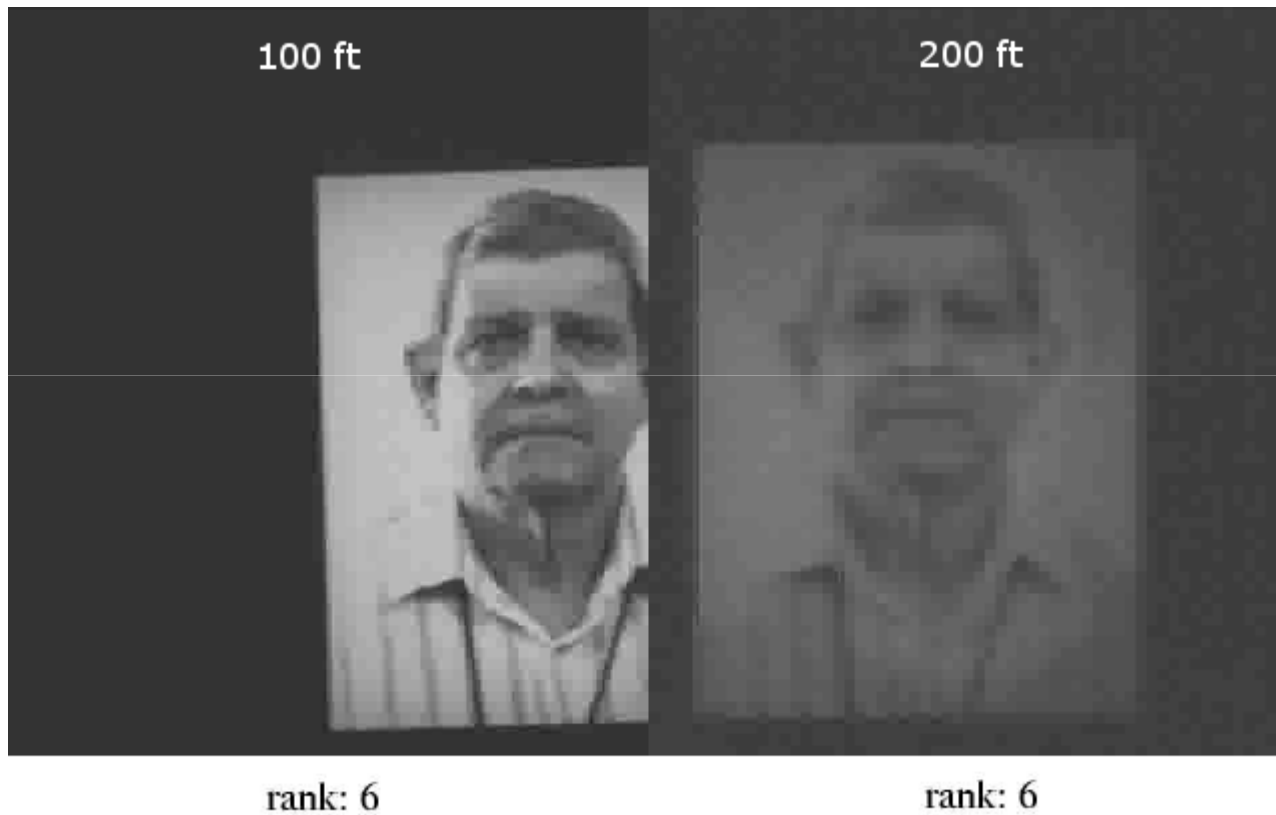
- for fingerprints, correlation between this criterion and matching performance is high, enabling NFIQ approach to work

- problem is no one has come up with a facial image representation (yet?) based on external visual appearance that has the same kind of robustness

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Apparent Facial Quality vs. Matcher Performance

8   15   20   47

Apparent quality not always tied to rank.

80   138   191   Gallery

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Apparent Facial Quality vs. Matcher Performance

T. Boult – Beyond Image Quality, 2006

Measuring Facial Image Quality

Pre-analysis: can be used as feedback to a system that tries to maximize the possibility of accurate biometric measurement

⟶ minimize the variance of non-biometric elements

⟶ e.g. filter facial images for "faceprints" – based on high level object detection and enforcements of specified constraints

- constrain the class of images to be considered for quality measurement

Analysis: can be used to guide image processing and analysis algorithms

- facial dynamic range, brightness, contrast, color balance, focus, facial texture detail, etc.

Post-analysis: can be used to temper the confidence of an identification or its contribution to a multi-biometric system

- matcher-agnostic approach: predicting failure for a given input image by analyzing similarity score distributions (see Riopka & Boult, AVBPA 2005)

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Thank you!

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