Usability, Interoperability and Biometrics Quality

- **Introduction**

- **Quality of the source**

- **Quality of the acquisition**

- **Quality of the template extraction**

- **Conclusion**

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NIST Biometric Quality
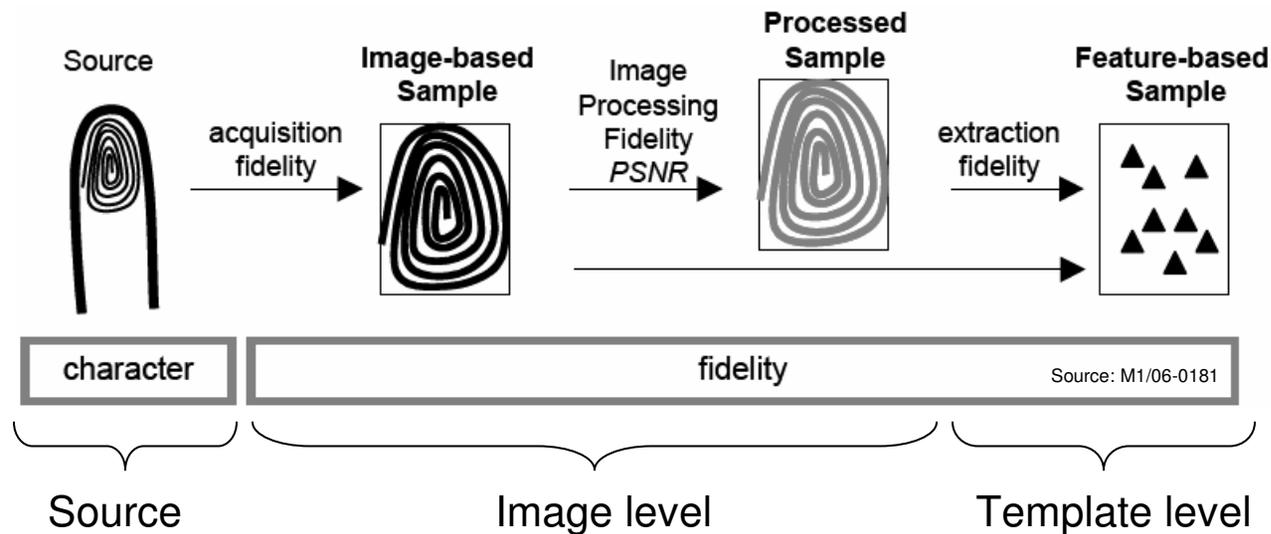
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Use of quality measure

- Quality measure is used for many tasks in a biometric system
  - Auto-capture:
    - trigger acquisition process to capture optimal quality data
  - Accept enrolment:
    - Reject bad quality data _asks for recapture
  - Update enrolment data:
    - Replace reference data with higher quality
  - Characterize a database / a population.
    - Useful to predict performances
  - Monitor a system _statistics
    - Detect problems in procedures, materials, training, …
  - Conditional processing
    - ex: adapt process/algorithm to cope with bad quality data.
  - Etc …

- Quality measures are meant to provide information or trigger action
  - Must be interpretable
  - "Relative Quality" / "Absolute quality"

- "Absolute" quality measures are particularly useful when/where
  - Several technology suppliers are involved (interoperability)
  - Image data is not available or difficult to access

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Different Factors Influencing Biometrics Quality

Source — Image level — Template level

- Q_Total "=" Q_Source . $Q\_Acquisition$. $Q\_Extraction$

- Simplistic formula, but shows that:
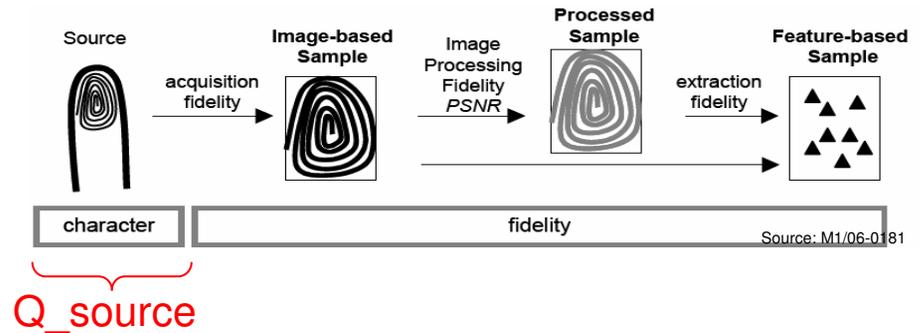   - $Q\_Total < Q\_Source$;
    - $Q\_Total < Q\_Acquisition$;
    - $Q\_Total < Q\_Extraction$

⇒ Each component is critical to get good quality image or template
⇒ Each component has to compensate for the other's weaknesses

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Different Factors Influencing Biometrics Quality

Q_source

Source: M1/06-0181

Q_Source:

- **Population characteristics:**
  - *scars, beards, lenses, occlusions, …*
 - *Can not be changed !*

The Serenity Prayer:
« God grant me the serenity
to accept the things I cannot change;
courage to change the things I can;
and wisdom to know the difference .»

- **Procedures**
  - *Instructions*
    - *"open your eyes", use creams, remove glasses, use uniform background, …*
  - *Training of operators*
  - *Some level of procedures are necessary, but often not user friendly …*

How can a universal quality measure help ?

- *Trigger specific action within a procedure*
- *Monitoring effect of actions*

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## Different Factors Influencing Biometrics Quality
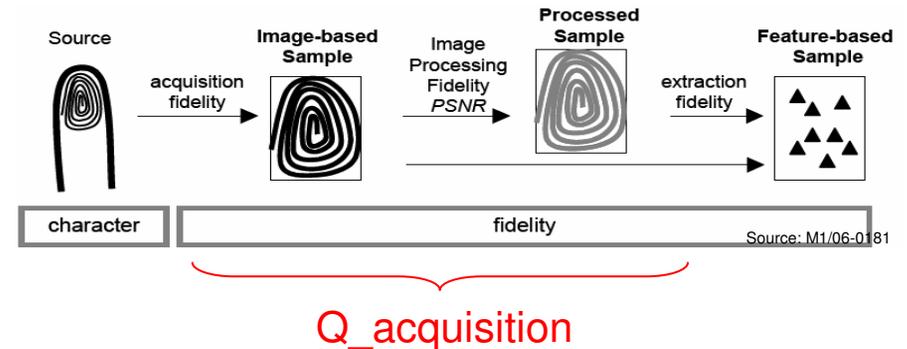
Q_acquisition

For a given source,

Q_Acquisition = Q_Sensor . Q_Capture Process

- Q_Sensor
  - Fidelity of the sensor is necessary
    - Can the sensor reliably and accurately capture the information available ?
    - Field of View, Blur, resolution, distortion, SNR, …
    - ⇒ "IQS"-like certifications are necessary
  - Also need to measure and quantify:
    - Fidelity | source:
      - The sensor need to be able to acquire "bad quality" sources
      - Scars, dry fingers, reflections, glasses, …
    - Fidelity | environment
      - Depending on the application, the sensor must be robust to environment (lighting, T°, humidity …)

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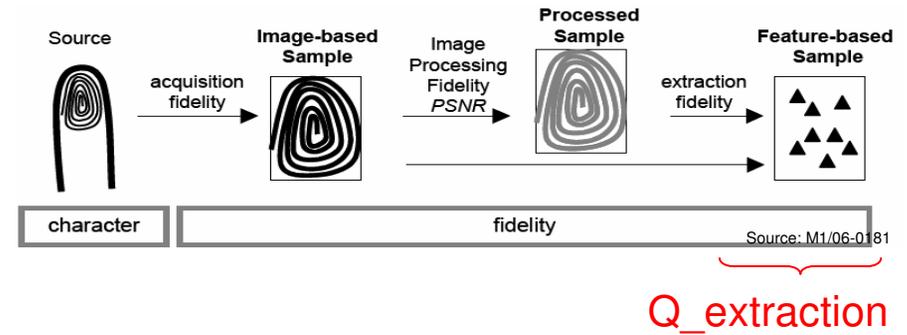# Different Factors Influencing Biometrics Quality

Source: M1/06-0181
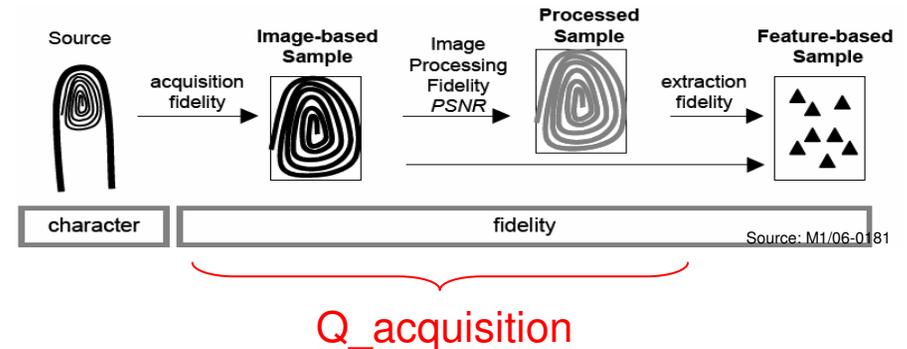
Q_acquisition

For a given source,

Q_Acquisition = Q_Sensor . Q_Capture_Process

- Q_Capture_Process
  - Acquisition loop
    - Capture the best possible image during a capture session
    => Real time "quality" measure can help triggering the acquisition
  - Ergonomics / Feedback (usability):
    - Acquisition must be easy and universal
      - Language and culture barrier.
      - Feed back must be real time and intuitive.
    - Feed back must also imply corrective behavior that would improve the quality
      - Necessitates more than "good/bad" or "better/worst"
      - Example: UK Iris (over 120K users, over 500K border crossing)
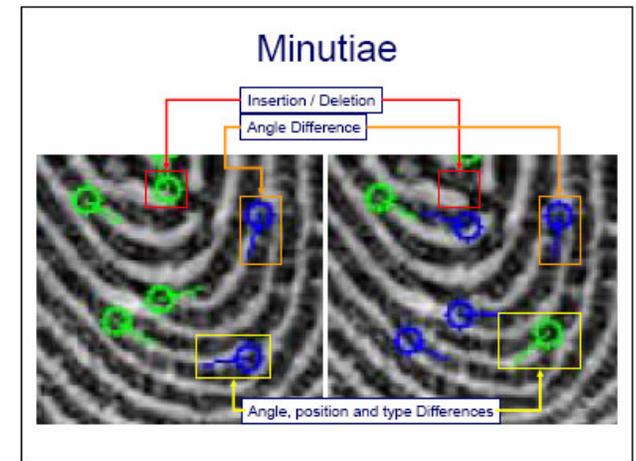   => Not sure that a quality measure can really help here

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Different Factors Influencing Biometrics Quality

Source: M1/06-0181

Q_extraction

For a given image,
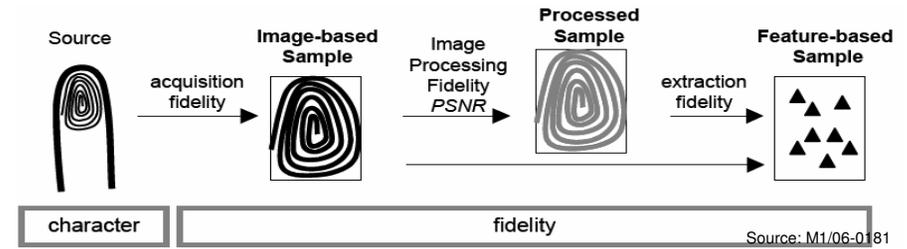## Q_extraction is affected by

- **Quality of feature extractor**
  - *Minutiae extraction is done for automated search by AFIS*
  - *Extraction depends on quality of feature extractor*

- **Compliance with standards**
  - *Rules for minutiae placement are defined in standards*

- **But: standards do not completely address today**
  - *Confidence issues*
    - *How certain are we there's a minutiae there*
  - *Precision issues*
    - *What is the tolerance in position and angle*

Only for fingerprint today (No template standard exists today for face and iris)

- *Today each feature extractor / matcher makes its own assessments*
- ⇒ *Features extractors and matchers are somehow inter-dependent today*
  - *This impacts negatively interoperability (cf Minex)*

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Different Factors Influencing Biometrics Quality

Source: M1/06-0181

Q_extraction

- **Confidence issue:**
  - *Some matchers are designed to cope with many false minutiae*
  - *Some are designed to really trust each minutia in the record*
    - *=>Some feature extractors will "take more risks" and keep more minutiae*
    - *=>Because different matcher have different needs,*
      - *it is not desirable to impose rules on "level of risk"*
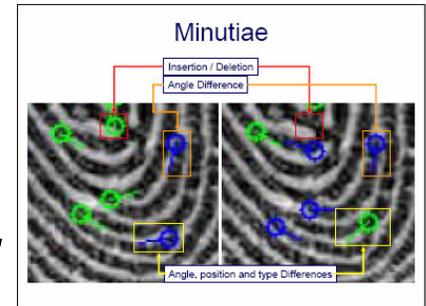
Minutiae

- **Calibrated local quality measure can help mitigate that:**
  - *Goal: assign to each minutiae an interpretable quality score*
  - *Such a calibrated local quality can be used by Matchers to a posteriori prune the templates according to their robustness to false minutiae*
  - *For example: Minutiae_qual = P (True_minutiae)*
    - *Need for an annotated dataset (ground truth minutiae) is made available*
    - *A publicly available calibration tool will facilitate (and accelerate) interoperability*

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Conclusion

- ## *Sensor Quality :*
    - *"Fidelity" certification (IQS, WSQ) are necessary for image interoperability*
        - *Similar framework for face and iris would help*
    - *"Acquisition loop" and "Usability" are also critical to sensor quality*

- ## *Image Quality*
    - *NFIQ approach very useful , necessary for interoperability*
        - *But need to taking into account finger placement*
        - *Real time universal measure nice to have but not necessary*
    - *Similar open source measure for face and iris would help*

- ## *Minutia Quality*
    - *Definition of quality at minutiae level is necessary to increase interoperability*
    - *Need to enable minutiae pruning according to matching algorithm*

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