Thoughts and Figures on Quality Measurements

- ***Introduction***
  - ***Different factors influencing quality***
- ***Quality measure as performance predictor***
  - ***Comparison of NFIQ with proprietary quality measure***
  - ***Comment on NFIQ***
- ***Quality measure as a selection tool***
  - ***Select fingers to put on the card for 1:1 after a 10-finger enrolment***
  - ***Select a best image in a stream ("auto capture")***
- ***Quality measure as a analysis tool***
  - ***Correlation of different biometrics***
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- ***Conclusion***

Different Factors Influencing Quality

(defined as a matcher performance predictor)

- ***Biometric sample degradation / occlusion***
  - ***Fingers :*** *scars, burns..*
  - ***Iris :*** *specific diseases, lenses, glasses*
  - ***Face:*** *glasses, hair, beard, …*
- ***Acquisition Device quality***
  - *Resolution, MTF, signal-to-noise ratio, …* ***(As in IQS app F/G for fingerprints)***
- ***Acquisition environment***
  - ***Finger :*** *external light, temperature, dryness/humidity, …*
  - ***Face:*** *Ambient light (IR)*
  - ***Iris :*** *Ambient light (visible), background of the scene*
- ***User/device interaction***
  - ***Finger:*** *Finger positioning on platen*
  - ***Face:*** *Orientation of the head, mimics*
  - ***Iris:*** *Positioning in the capture volume,*

⇒ ***There is <u>more</u> behind quality defined as a matcher performance predictor than just a measure of damaged finger or of the quality of the acquisition device.***

In particular, <u>user/device interaction is critical</u> (“ergonomics”)

Quality Measure as Performance Predictor :

Comparison of NFIQ and Proprietary Quality

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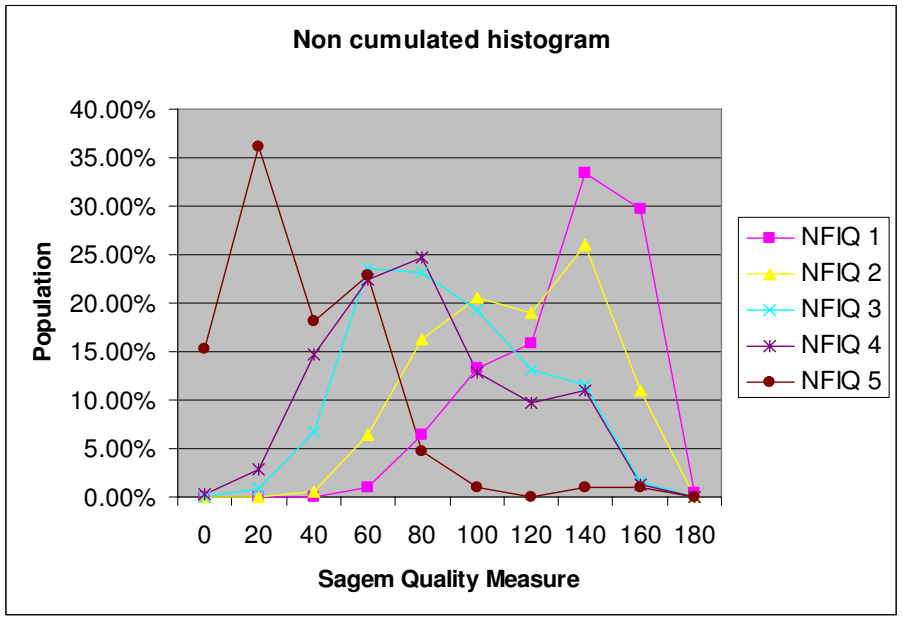
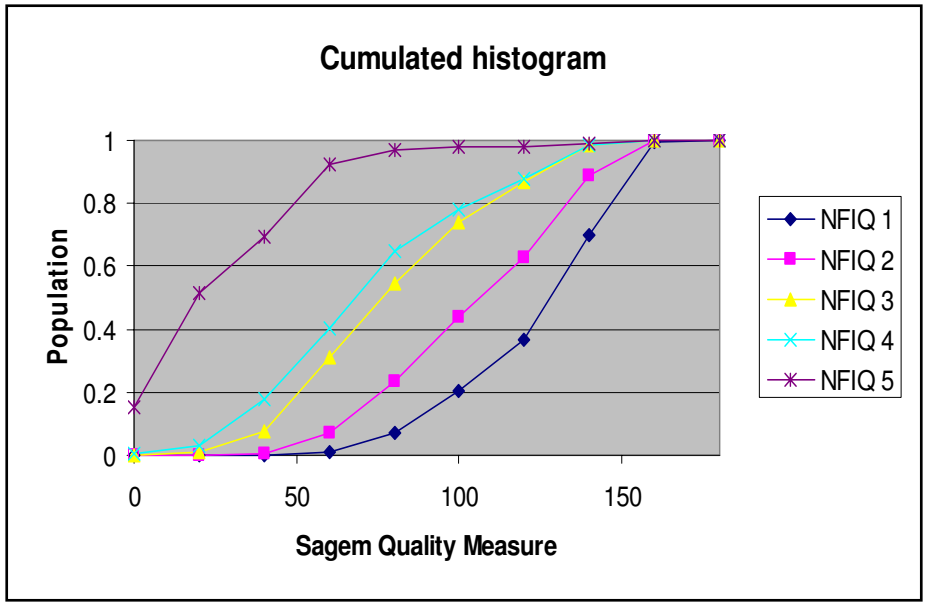
Correlation Between NFIQ and Proprietary Quality

- ***Distribution of proprietary quality mark on each NFIQ quality levels***





- ***The cumulated histogram shows a good correlation between the 2 measures***
- ***The non cumulated histogram shows an overlap between the NFIQ classes***

⇒ ***NFIQ and proprietary quality measurements correlate well; however, there are some differences.***

⇒ ***Study in more detail the effectiveness of the two measurements***

NFIQ as a Sagem Performance Predictor Effectiveness

- ***FRR in each "NFIQ bin"***

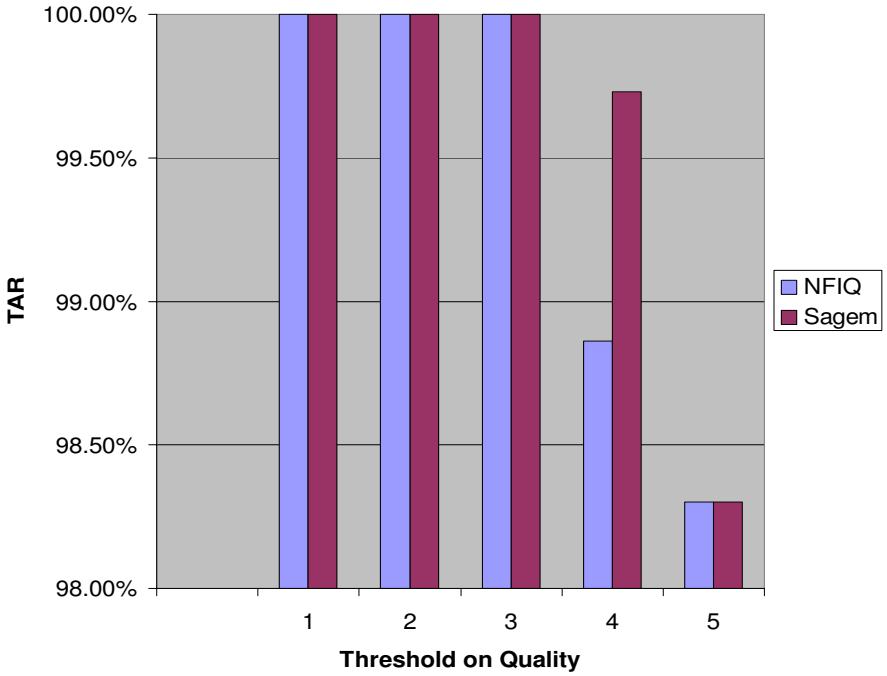
NFIQ	FRR
1	0.00%
2	0.00%
3	0.00%
4	1.39%
5	3.11%

- ***Good Prediction effectiveness***
  - *No FRR for Quality 1,2,3 (more than 80% of the images)*
  - *FRR increases as the quality increases*
  - *Confirms the finding of NIST NFIQ report.*

Comparison of NFIQ and Proprietary Quality

- *In order to compare the prediction effectiveness, we "mapped" Sagem quality measure on NFIQ.*

- *This is done by quantifying our quality measure in 5 classes in a way to have the same population in the 5 Sagem classes as in the 5 NFIQ classes*



- ***Better separation of FRR with proprietary quality (less FRR in bin #4)***

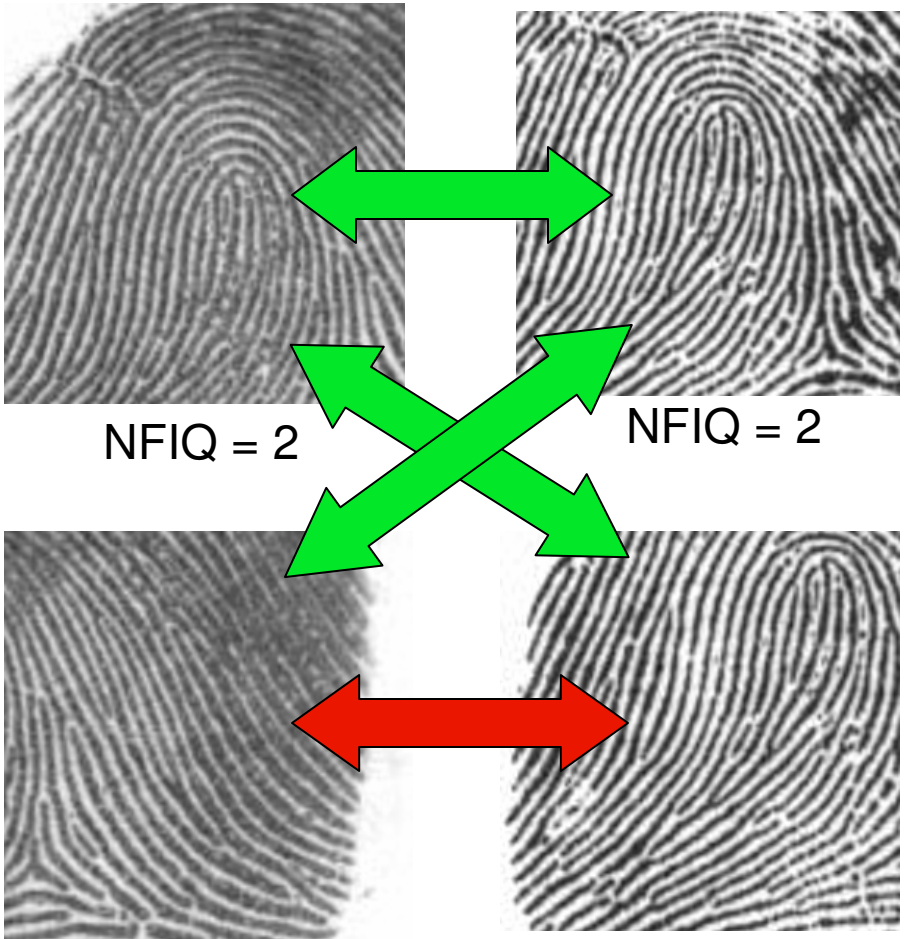
=> <u>Both quality measures are useful</u> :

- ***NFIQ as an generic performance predictor***
- ***Sagem measurement is preferred when Sagem matcher is used***

Comment on NFIQ: Common Area Issues

- ***Performance depends on:***
  - ***Quality of information***
    - ***Ridge clarity***
  - ***Quantity of information***
    - ***Surface***
    - ***Number of minutiae***
  - ***Reproducibility of information***
    - ***Probability to see the same information in both samples***
    - ***Core has to be well centered***

- ***In order to improve effectiveness:***
  - ***<u>Reproducibility</u> has to be taken into account***
  - ***Large surface and high number of minutiae increase the reproducibility***
  - ***But it is not sufficient especially***
    - ***With smaller sensors (capacitive)***
    - ***Especially for non habituated users***



Quality Measure as Selection Tool

Select the best finger to put on a card for 1:1 after a 10-finger enrolment (ex : ID systems, PIV)

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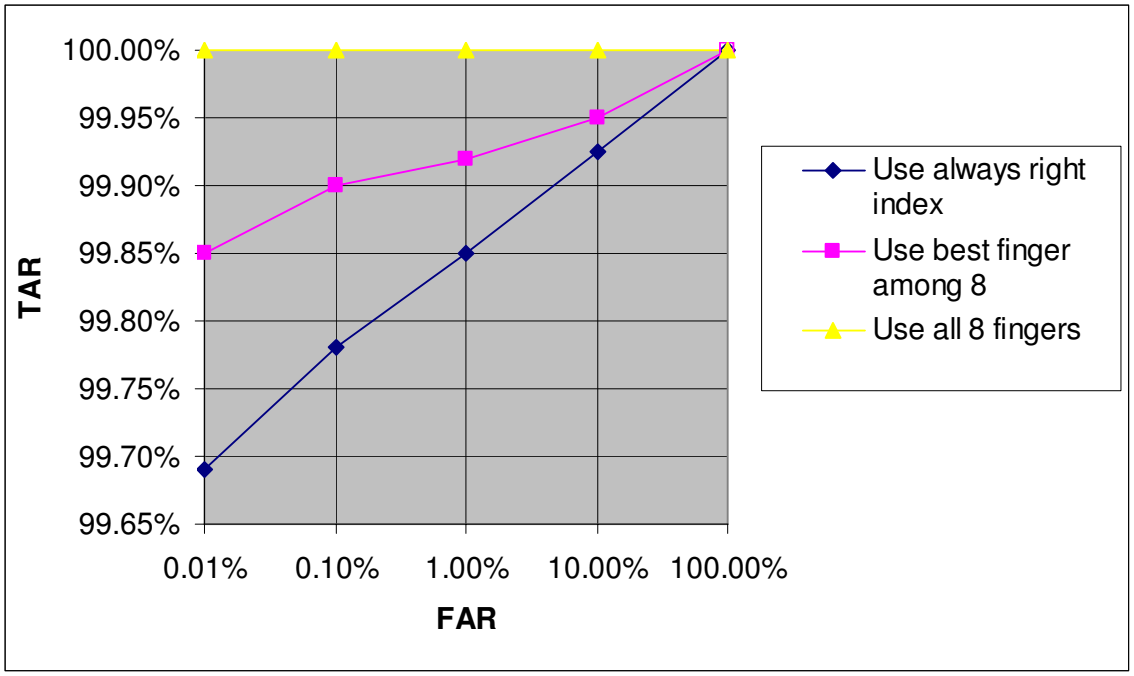
Using Quality Measure to Choose the Best Finger



- ***If only one finger has to be kept, choosing the best finger by using a quality measurement gives significantly better results than always taking the same finger***
- ***Of course, it is always better to use several or <u>all</u> the fingers available***

Quality Measure as Selection Tool

Select the best biometrics in a stream ("auto capture")

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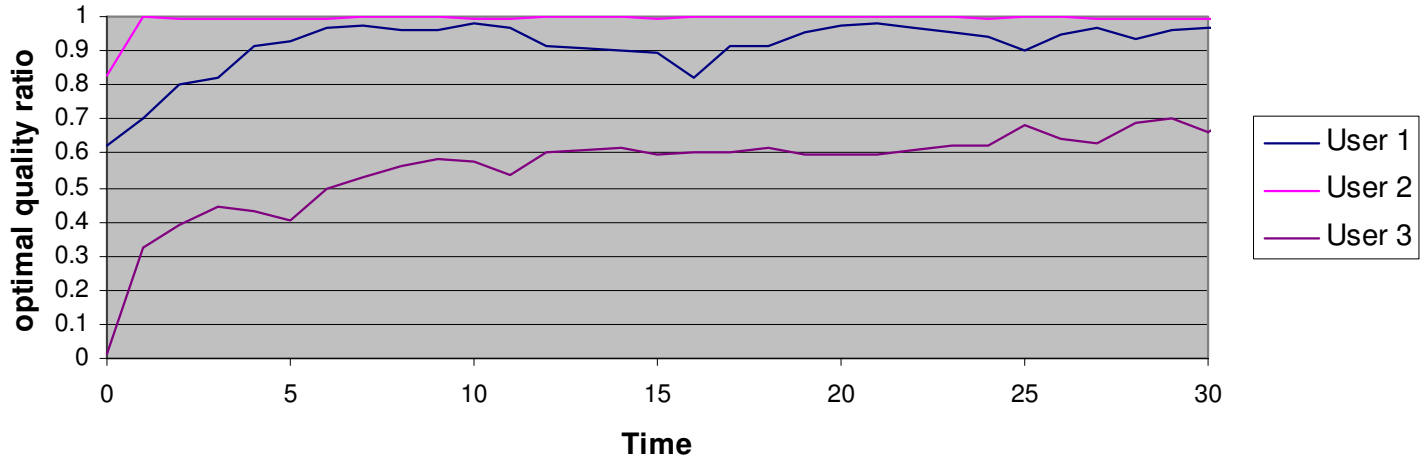
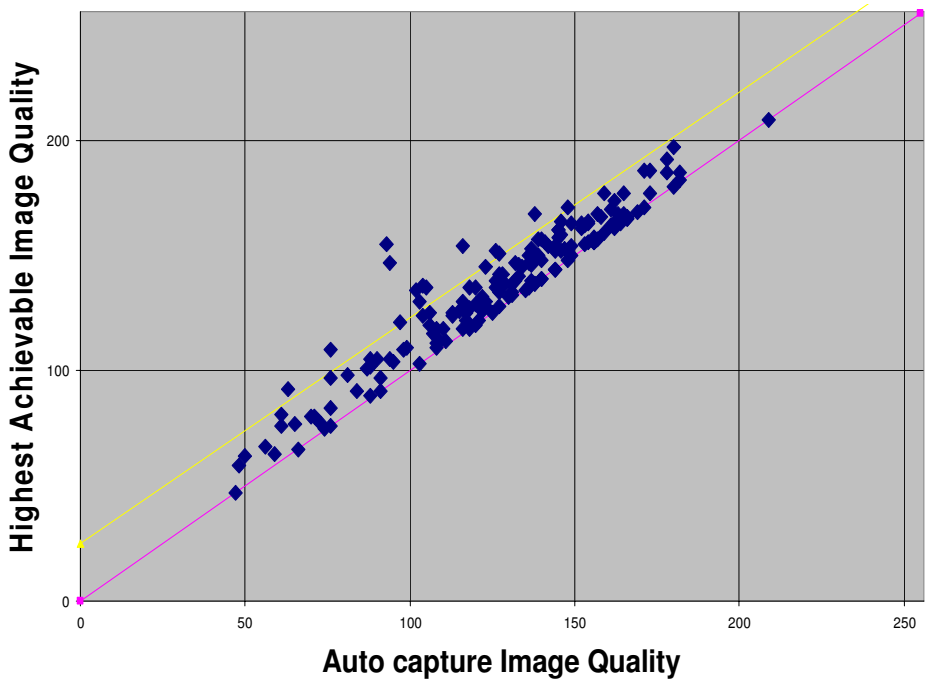
Quality as a Selection Tool : the Challenge of Auto Capture



- ***"Auto capture" is an algorithm to automatically detect the best image in a stream***
  - ***An efficient "auto capture" algorithm has to detect***
    - *the best quality image (accuracy)*
    - *as quickly as possible (response time, ergonomics)*
  - ***A good "Auto capture" algorithm will improve***
    - *Capture speed and ergonomics*
    - *But also makes the quality of the captured data less dependent on the user or operator*
  - ***Quality measure is used to optimize the choice of best image***
    - *Trade off between acquisition time and quality of the captured sample*
    - *Need to have a real time quality measure*
    - *Best possible quality for a person unknown*

Quality as a Selection Tool: the Challenge of Auto Capture for Slaps Scanners



- *X axis is quality of the image chosen by the auto capture.*
- *Y axis is the best reachable quality in the sequence (chose a posteriori)*

- ***Slaps segmentation and quality assessment on each finger cannot be done in real time (30 frames/sec)***
  - *Need to have a simplified, real time quality assessment to trigger the acquisition*
- ***Real time quality assessment and a posteriori quality assessment concur*** *(less than 10% difference compared to the optimal value)*

Quality Measure as Tool for Analyses

Multi Biometrics - Fusion

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Workshop

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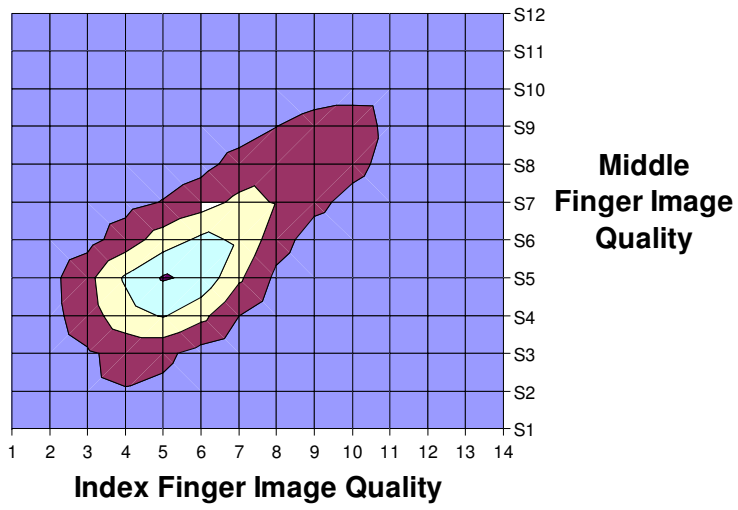
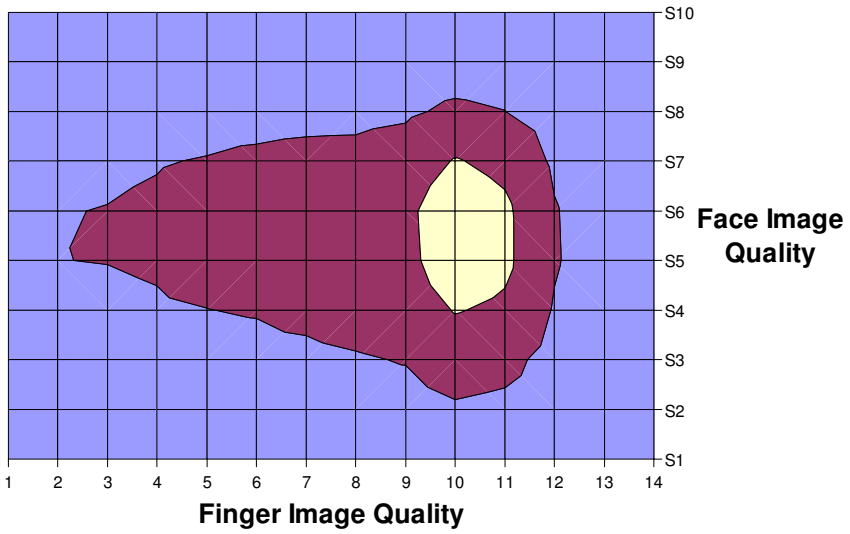
Correlation Between Biometrics

Correlation of Finger Image Quality of Index And Middle Fingers (Right Hand)

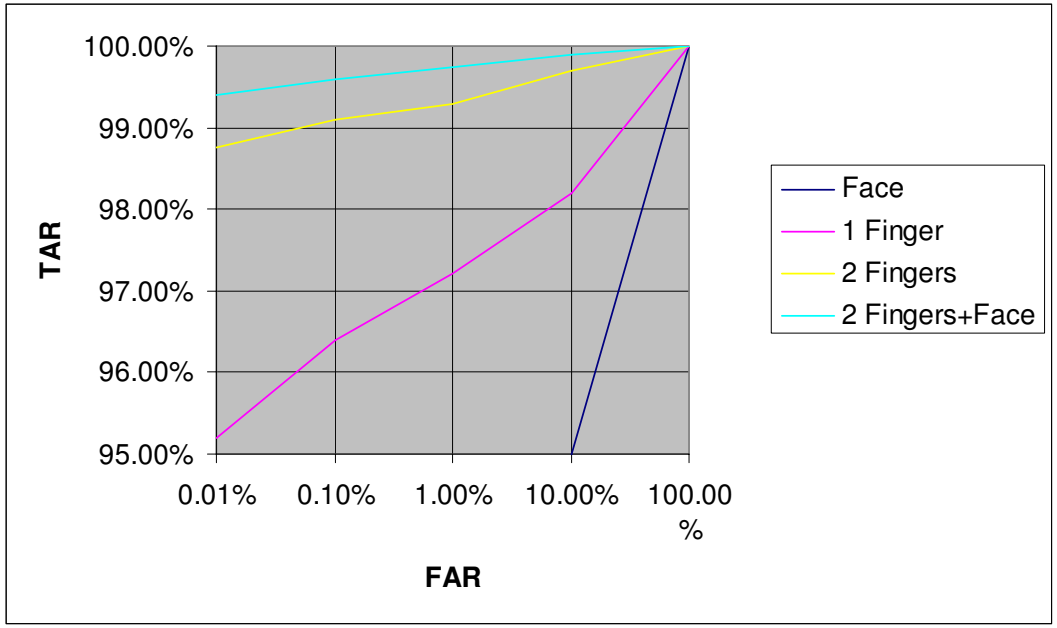


Correlation Face Image Quality / Finger Image Quality



- ***Qualities of fingers of same person are correlated, especially on the same hand***
- ***Hardly any correlation between quality of finger and face***

Correlation Between Different Biometrics: Impact on Fusion



- *On this operational database, performance of single biometrics (face alone or one finger alone) was poor.*
- *The main reason is bad procedures and lack of training of operators*

- ***<u>Fusion of two fingerprints</u> improves performance despite the fact that the two fingers are correlated, because fingerprint is a strong biometrics***
- ***<u>Fusion of fingerprints and face</u> improves performance despite the fact that face is a weaker biometrics, because of the non correlation***

Conclusion

- ***Effectiveness to predict matcher performance is a great definition for quality***
- ***With this definition, quality is more than just a measure of the quality of the biometrics or of the sensor used***
  - *in particular, user/sensor interaction is critical*
- ***NFIQ is a good predictor of Sagem matcher performance; however, Sagem quality measure is more efficient***
- ***Both quality measures are interesting***
  - *NFIQ as an generic performance predictor*
  - *Proprietary (Sagem) measurement is preferred when Sagem matcher is used*
  - *It makes sense to keep both, as planned for the ANSI/NIST update*
- ***Information on reproducibility should be added***
  - *Especially true with smaller sensor (e.g. capacitive) and non habituated users*
- ***It would be nice to have the same for face and iris***
  - *Proprietary measures exist*
  - *Global measure validated on several vendors would be useful*