

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*
 - *Impact on fusion*
- **Conclusion**



Different Factors Influencing Quality

(defined as a matcher performance predictor)

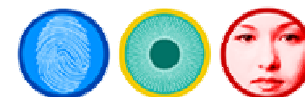
- **Biometric sample degradation / occlusion**
 - **Fingers** : scars, burns..
 - **Iris** : specific diseases, lenses, glasses
 - **Face**: glasses, hair, beard, ...

 - **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 more 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, user/device interaction is critical (“ergonomics”)



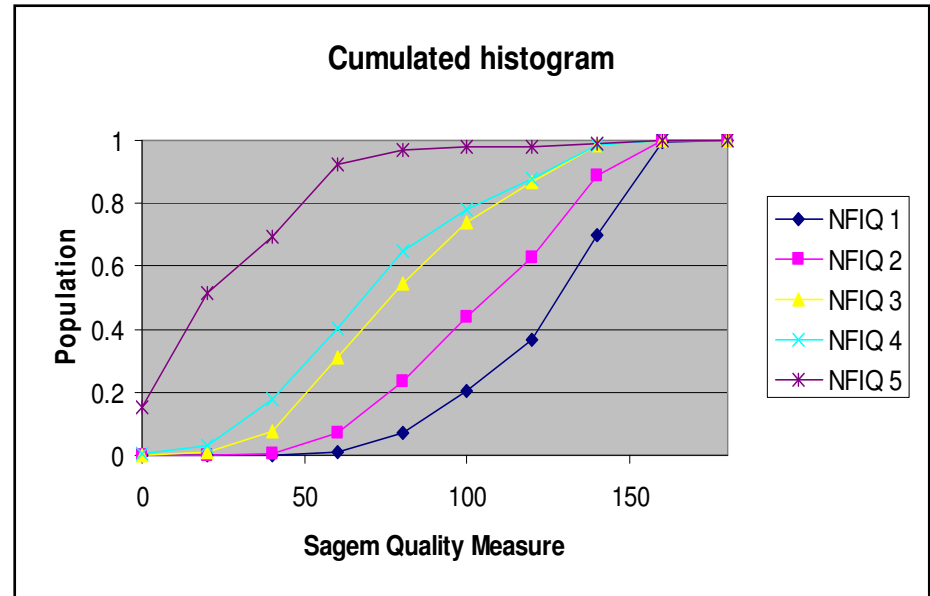
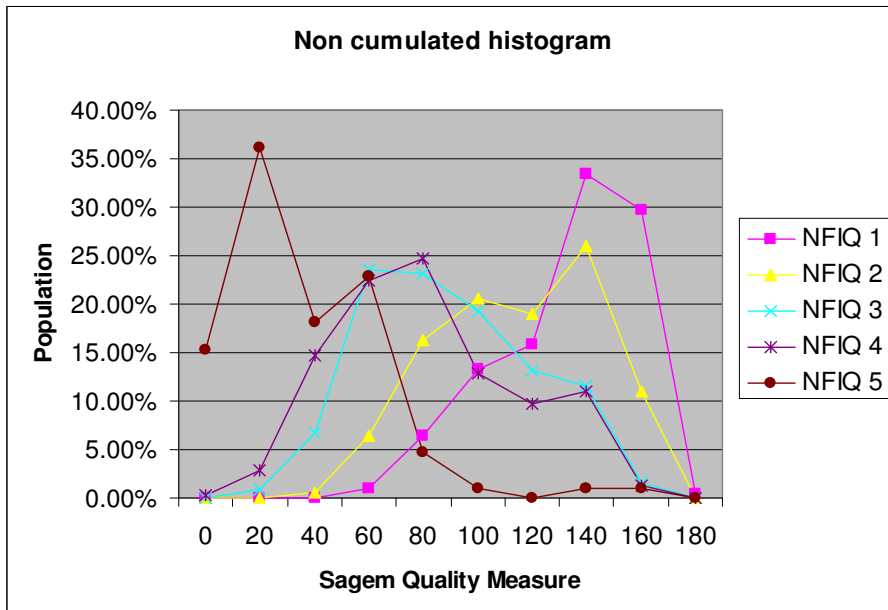
Quality Measure as Performance Predictor :

Comparison of NFIQ and Proprietary Quality



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”***

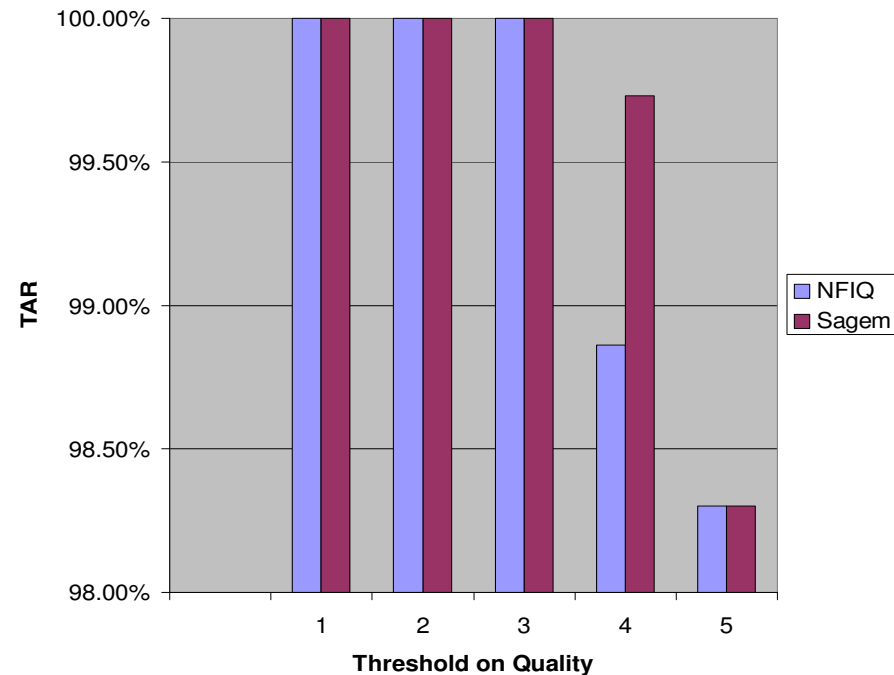
NFIQ	FRR
1	0.00%
2	0.00%
3	0.00%
4	1.39%
5	3.11%

- ***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)*

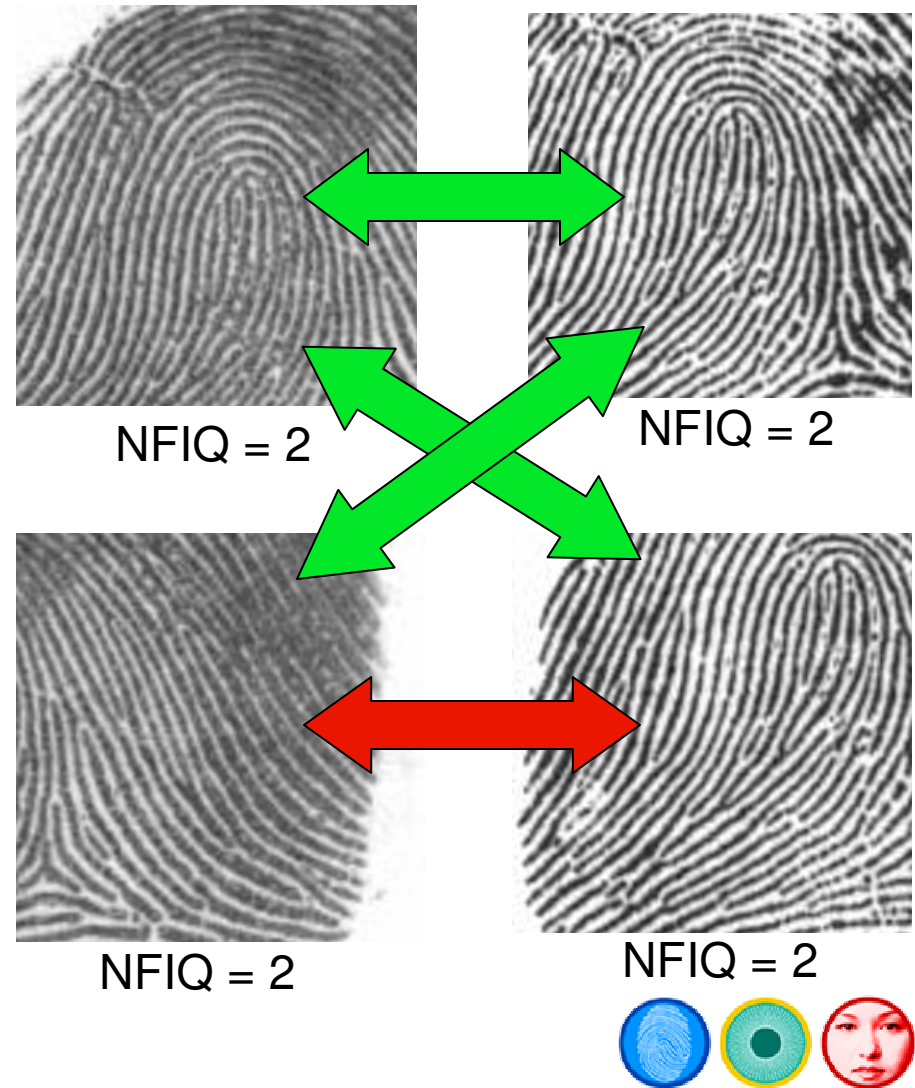
=> Both quality measures are useful :

- *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:**
 - Reproducibility 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

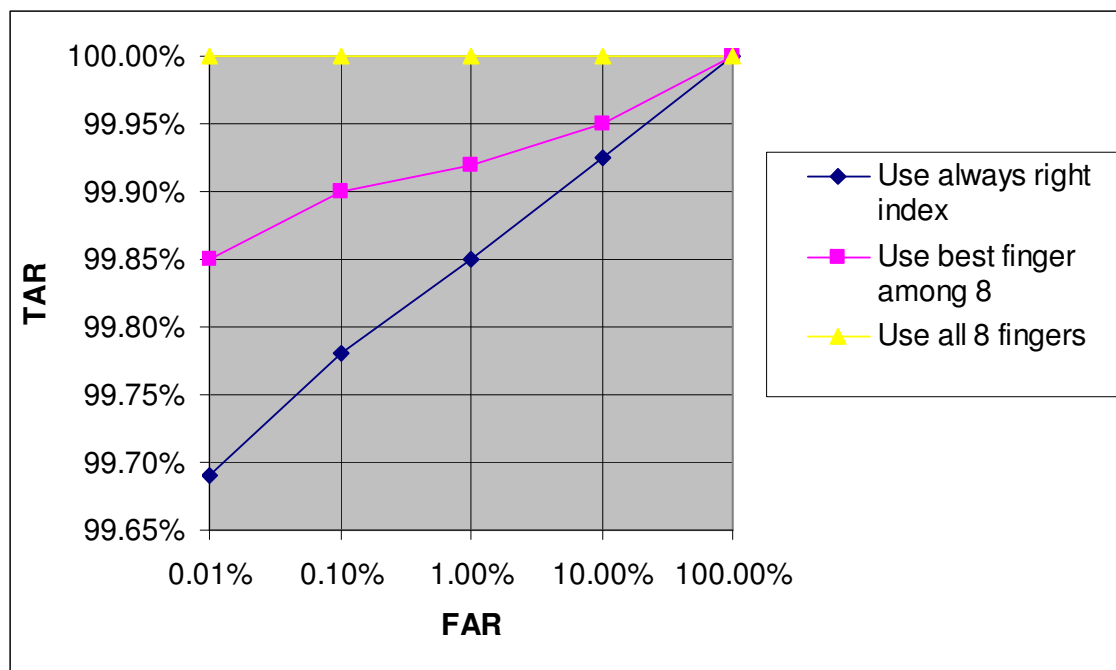


Quality Measure as Selection Tool

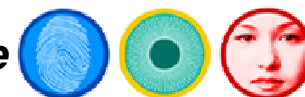
***Select the best finger to put on a card for 1:1
after a 10-finger enrolment
(ex : ID systems, PIV)***



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 all the fingers available***

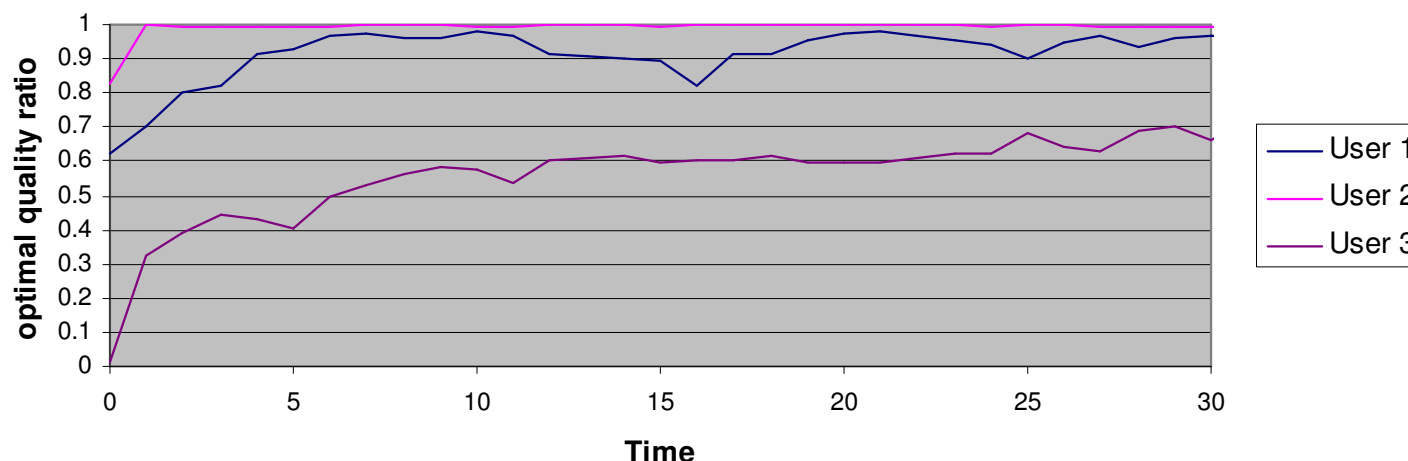


Quality Measure as Selection Tool

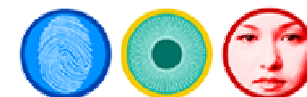
***Select the best biometrics in a stream
("auto capture")***



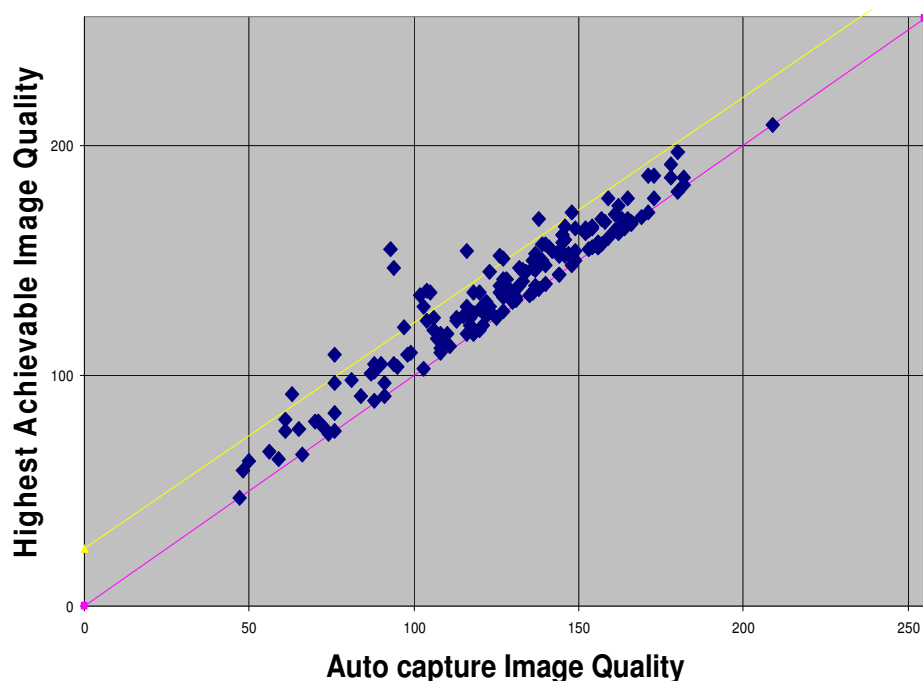
Quality as a Selection Tool : the Challenge of Auto Capture



- **“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

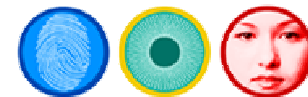


Quality as a Selection Tool: the Challenge of Auto Capture for Slaps Scanners



- 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)**



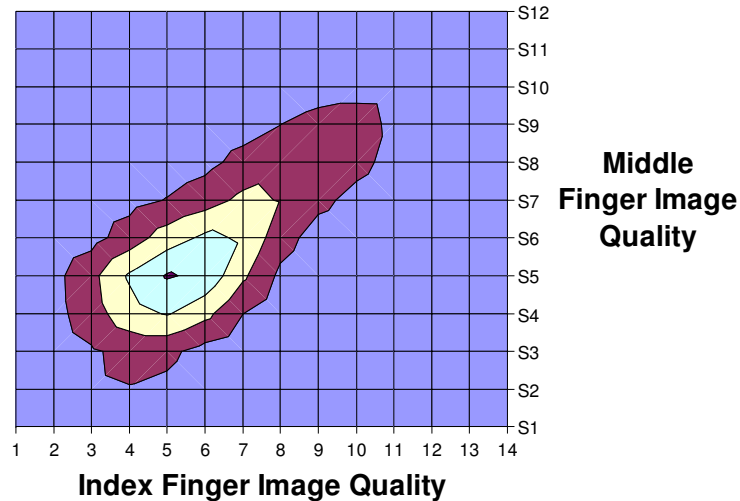
Quality Measure as Tool for Analyses

Multi Biometrics - Fusion

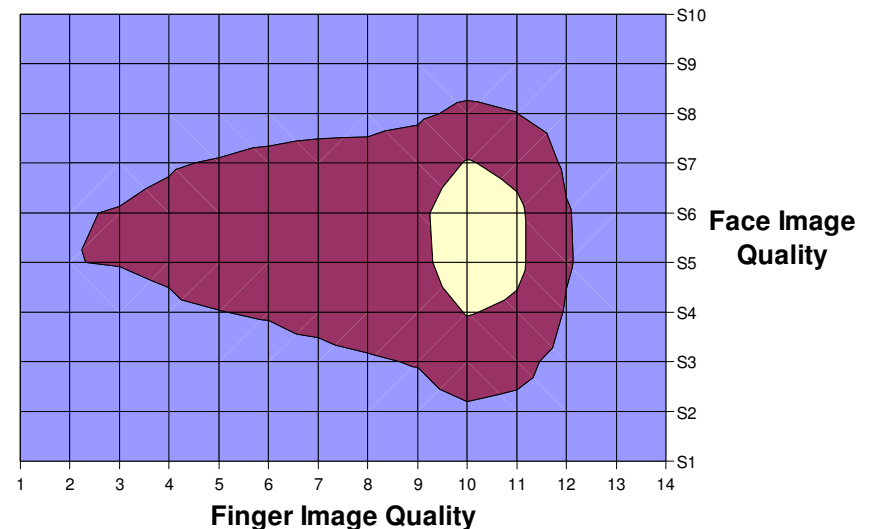


Correlation Between Biometrics

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



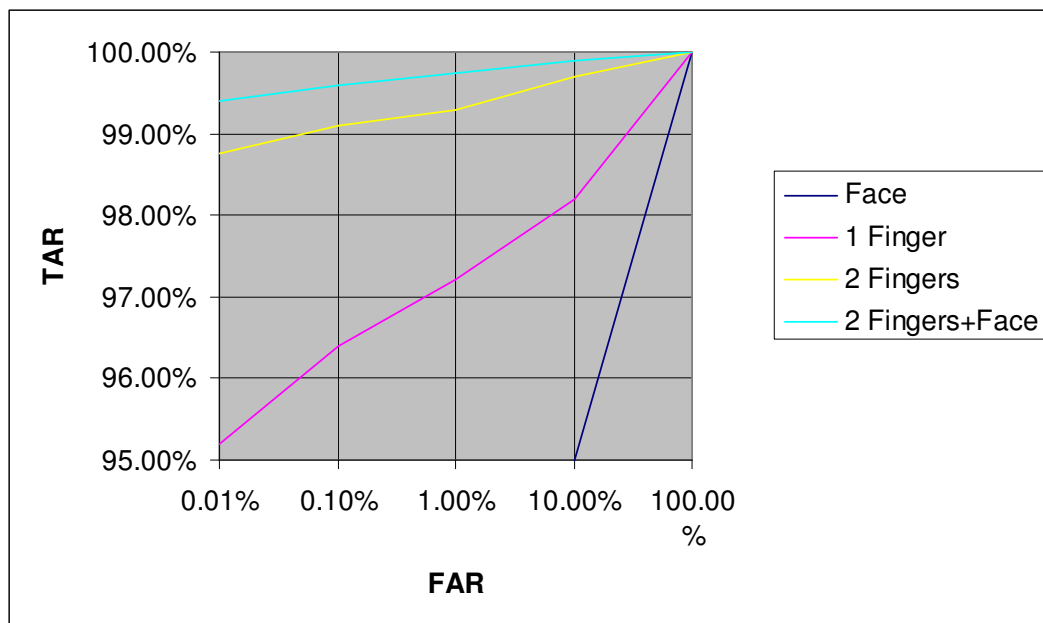
Correlation Face Image Quality / Finger Image Quality



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

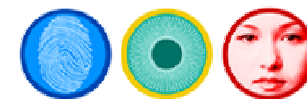


Correlation Between Different Biometrics: Impact on Fusion



- 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

- **Fusion of two fingerprints improves performance despite the fact that the two fingers are correlated, because fingerprint is a strong biometrics**
- **Fusion of fingerprints and face 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*

