



Operational Elements of Fingerprint Image Quality

Biometric Quality Workshop

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Topics covered:

A product development & solution delivery meeting specific customer needs, point of view.

- **What is it?**
- **Where did it start and Why?**
- **What is possible? Capabilities;**
- **What is next? Concluding Thoughts.**

What is Fingerprint Image Quality?

It is primarily the “sample Image” signal strength.

A measure of signal to noise ratio.

Signal being the fingerprint friction ridge characteristics;

Noise being other stuff, or lack of presence of signal elopements

Not the predictive performance measure;

Not the data quality associated with signals;

Notes:

- Performance and data integrity (having correct metadata associated with a biometric sample image) are critical measures for an operational system however we must look at each of these measures **separately**, find the causes and effects for the most optimum system design and operation.
- There shall be no confusion in this definition since it is simple statement of fact from **Digital Signal Processing Text Books**.

Where did it start and Why?

- **Law Enforcement and Forensic Science of capturing the fingerprints for the purpose of individualization and identification.**
 - Ten-print 14-set of ink impressions capture
 - Is it over-inked?
 - Is it under-inked?
 - Do we have the right finger sequence – roll to slap comparison?
- **Introduction of biometrics identification and verification to civilian application;**
 - Welfare fraud prevention
 - One person, one vote
 - One person, one ID
 - How do we insure “quality” captured prints in a regular civilian office operation?

What is possible? Capabilities; The quality Control Points in Biometric Data Capture:

- 1. The first parameter is the condition of the person fingers friction ridge skin and other physiological state of the fingers.**

These conditions range from cuts, bruises, and skin disease or exposure to harsh environmental chemicals or the manual laborer that destroys the friction ridges to persons with bandaged or amputee fingers.

Depending on the severity of the condition the image quality control software will give the proper quality score to the print. In severe case the finger will be flagged as an FTE. Lack of fingers will be properly flagged in the fingerprint data record.

What is possible? Capabilities; The quality Control Points in Biometric Data Capture:

2. The second element is the device used to capture the fingerprint image data.

Many fingerprint image/data capture devices have no standards and no compliance testing defined and established for image quality, device reliability, consistency, degradation of sensing elements, acceptable tolerances or operational readiness verification (ORV) tests.

Operational Readiness Verification software and targets to check the reliable and to the spec, operation of the scanner is a must have for enrollment and verification sites.

What is possible? Capabilities; The quality Control Points in Biometric Data Capture:

3. Next is the method and steps used to take the fingerprint image.

This is related to man-machine interface, the ergonomics and the training of the operators following the fingerprint capture guidelines.

The parameters involved range from proper placement of the finger on the scanner or proper roll of the finger, to proper pressure and cleanness of the capture surface to making sure right finger sequence is taken and there is not duplicates.

What is possible? Capabilities; The quality Control Points in Biometric Data Capture:

4. **And finally, the last item impacting the fingerprint image quality is the methodology used for transmission and storage of the images in the system.**

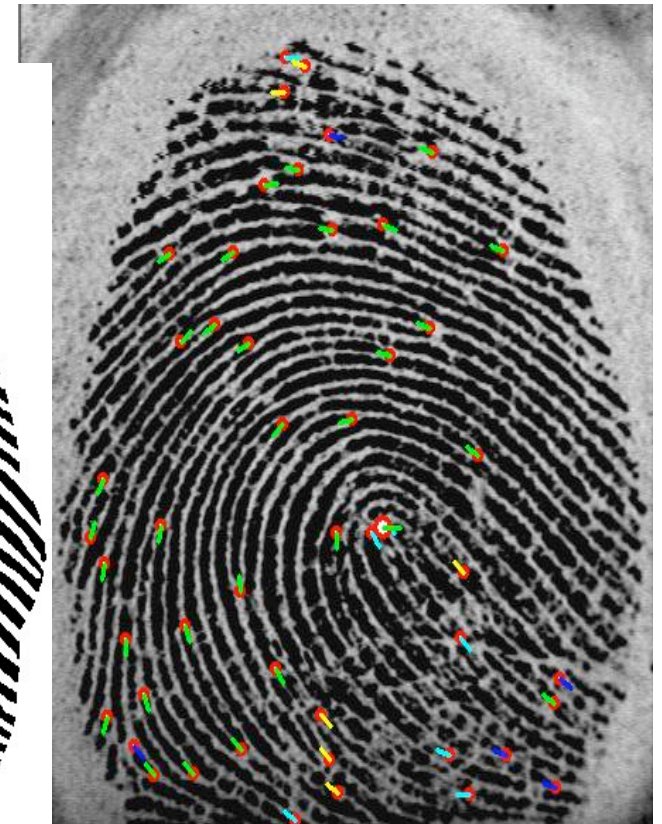
This relates to the image data manipulation, storage format and in particular the image compression techniques used. with the current image exchange standards, this is a solved problem. We must make sure compliant compression SDK's are used and the compression ratio is set right.

What is possible? Capabilities; So what does the “signal” Image Quality measure do for us?

- **Image Quality based processing and feature extraction;**
 - Lower quality → use iterative image enhancement
- **Image Quality based matching;**
 - Lower quality → use more features
 - Lower quality → apply different matching techniques.
 - 10-print or 20-print data samples → use best finger quality matching techniques
- **Manage performance using the image quality measure.**
 - Database statistics
 - Image quality based thresholding for best TAR/FAR performance.

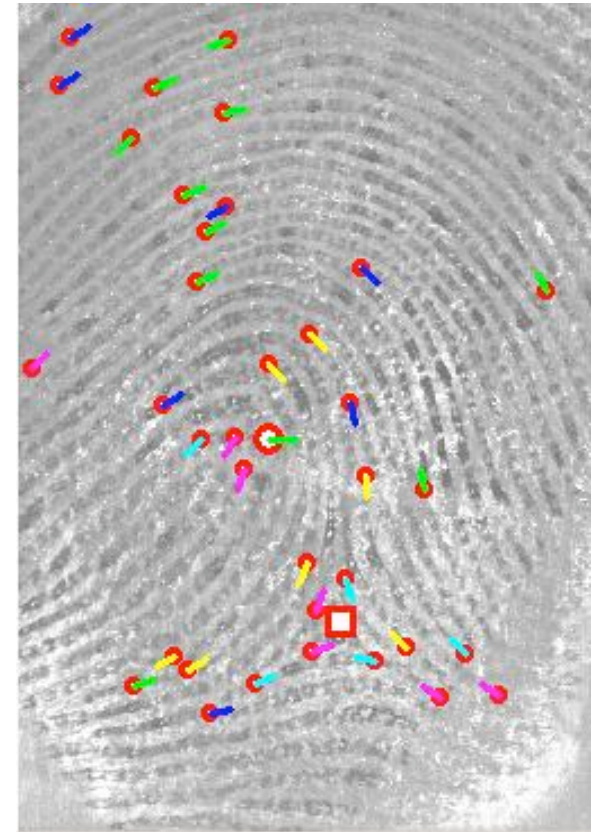
Good signal presence → Normal Image Enhancement Algorithms

The color of minugia tail show its quality : green represents best quality, blue, pink, yellow, light blue, and red colors represent the quality from high to low respectively



Low contrast Image → Improved Image Enhancement Algorithms

The color of minugia tail show its quality : green represents best quality, blue, pink, yellow, light blue, and red colors represent the quality from high to low respectively



Over-inked or extra pressure → Improved Image Enhancement Algorithms

The color of minutia tail show its quality : green represents best quality, blue, pink, yellow, light blue, and red colors represent the quality from high to low respectively



Do we have enough signal to match this?

Latent Case : 777200100007

Respondent Case : 777056761603

Latent vs. LCF

Display Minutiae

Ident

Statistical Ident

Non Ident

Save To Charting

Finger: ? Print: 1

Finger: 8

Position	ID	Matcher Score
1	777056761603	4768
2	6784545	4336
3	6824218	4117
4	6695563	4070
5	6818324	4023

Help Charting Cancel < Prev Next > Finish

Complete work on current case and submit

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Use more extensive matching → Use of Expert Matching

- Search print has 6 minutiae
- The EM score was 4768 from a cold search on background database of 1 million fingers

1. 7705676	4768
2. 6787545	4336
3. 6824218	4117
4. 6818236	4023

Concluding Thoughts.

- **Identity Management Using Biometrics is a Global Economic Mega-trend;**
 - A Mega-trend is a direction or sequence of events with momentum and durability that is slow to establish but, when adopted by the Market, stay with us for a longtime.
 - **“Identification using biometrics will become an increasingly accepted and integral part of our lives”;**
Dr. Fred Preston, UK PITO
- **Civil ID, non-law enforcement application will be the driver for the deployment of biometric Identification:**
 - Automated biometric signal content quality measures is a must have;
 - The measures used **MUST NOT** violate the basic forensic science foundations.

Concluding Thoughts.

- **EU VIS-BMS (Visa Information System – Biometrics Matching Subsystem) requires an **open source User Software Kits** from the vendor to be distributed to the Member States for their VIS roll out to maintain uniform Quality Control for the biometric sample data captured through out the world and at point of entries.**
- **We have the opportunity to lead this effort here via our major initiatives, VISIT, and IAFIS to turn this into an international standard – think interoperability, quality control gate on the level of signal quality of biometric samples – allowing defined and standard quality measure, for biometric data exchange, helping us in our global fight against the criminals/frauds.**

What is next?

- Being the measure of “Signal” or intrinsic features of fingerprint, there is **NOTHING propriety** about the image quality measures and methods of measurements.
- **NFIQ is an excellent starting point. Need to take it to the next level:**
 - Turn into a true fingerprint signal content measure
 - Like any other open-source software, be maintained and managed with full configuration management and SW engineering practices.
 - Variations for fast image quality, real-time live-scan capture feedback, or small signature for entry mobile devices, etc. need to be released and maintained.



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one of the pioneers and industry leading authority in the field of Fingerprint Biometric Identification with over 26 years of management and R&D experience in industry and academics.

Currently he is in charge of the business development strategy, partnership and technology acquisition for the Motorola Biometrics business unit.

In the last 14 years, Dr. Bavarian led the development of two Automated Fingerprint Identification Systems, products generations with over 100 large scale deployments.

Prior to Motorola, Dr. Bavarian was a professor in the Department of Electrical and Computer Engineering at the University of California, Irvine for eight years, where he conducted original research and published 100 technical papers and received several awards for outstanding research and distinguished teaching.

Dr. Behnam Bavarian received his Ph.D. in Electrical and Computer Engineering from The Ohio State University, Columbus Ohio.

