Comparative Image Quality of Multispectral Fingerprint Images

Robert K. Rowe, Ph.D.
CTO & VP

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Topics

- Background
  - Multispectral hardware
  - Physiology
- Image quality
  - Qualitative study
  - Quantitative study

  - Notes:
    - Comparisons are made to conventional optical imaging (TIR)
    - These studies are small; intended as motivational rather than definitive

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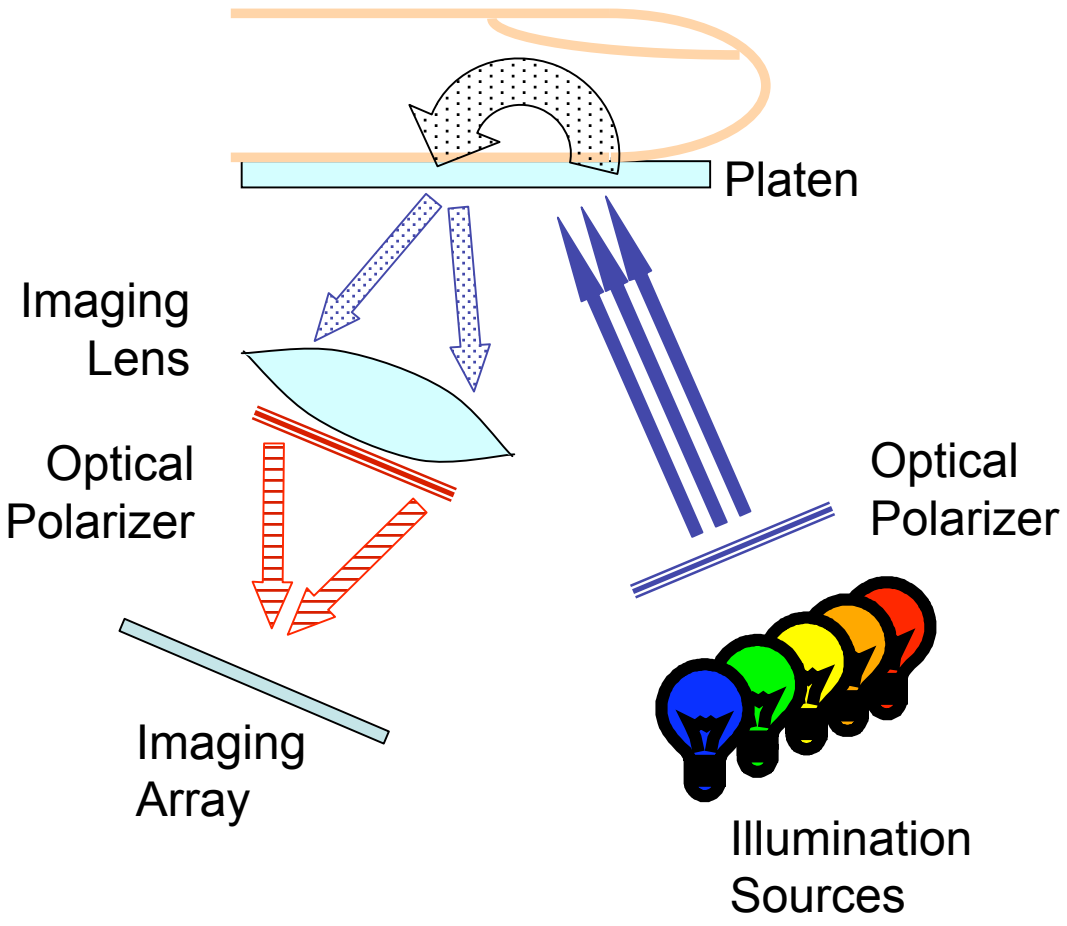
Multispectral Imager (MSI)

- Arrange optics to image skin surface and subsurface
- Collect a quick series of <u>different</u> images
  - multiple illumination colors
  - different polarization conditions



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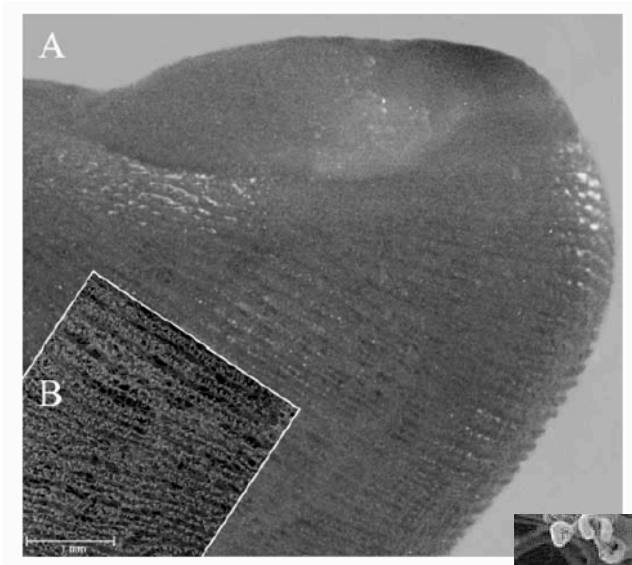
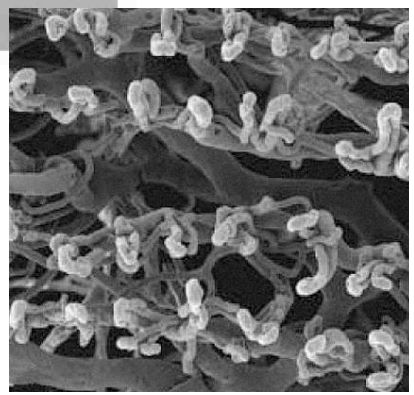
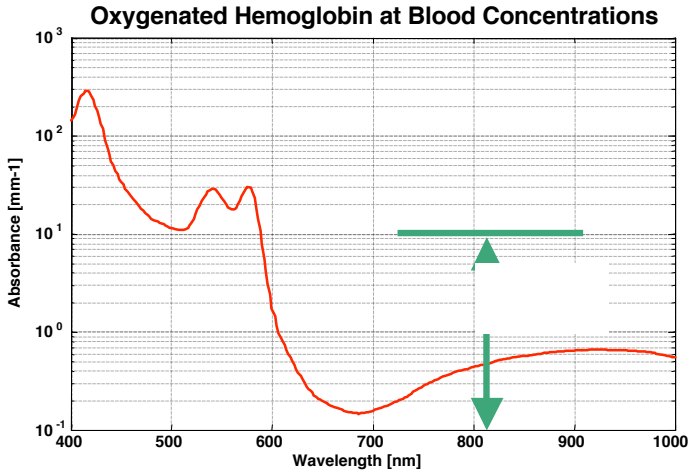
Multispectral Sensor
Relevant Fingertip Physiology







Optical absorption due to blood
(Note: semi logarithm scale)

The blood vessels and other skin structures provide an internal fingerprint pattern

From S. Sangiorgi et al., "Microvascularization of the human digit as studied by corrosion casting," J. Anat. 204, 123 – 131 (2004)

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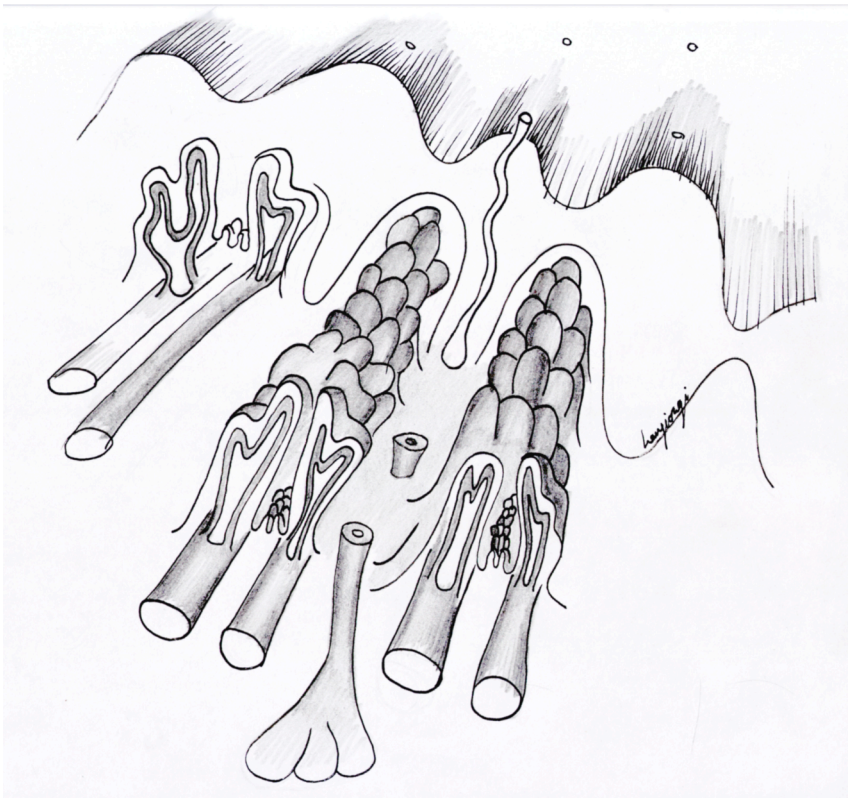
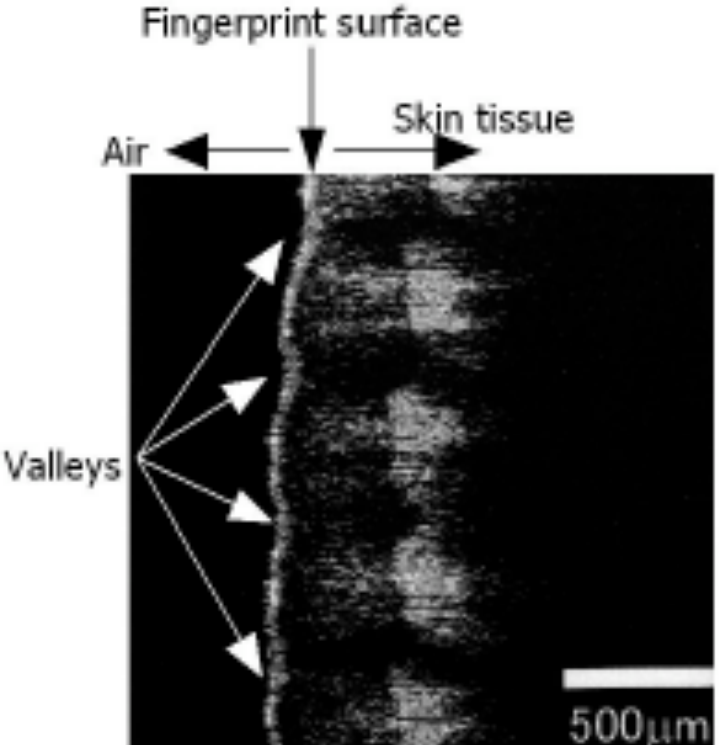
Further Physiological Details



Simone Sangiorgi, personal communication



A. Shirastsuki*, et al, Novel optical fingerprint sensor utilizing optical characteristics of skin tissue under fingerprints, Proc SPIE 5686, 2005

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Current Multispectral Configurations

Dual-Technology Sensor
for Civil Applications
(with Cross Match)

Multispectral Sensor for
Turnstile Entry into Theme Parks

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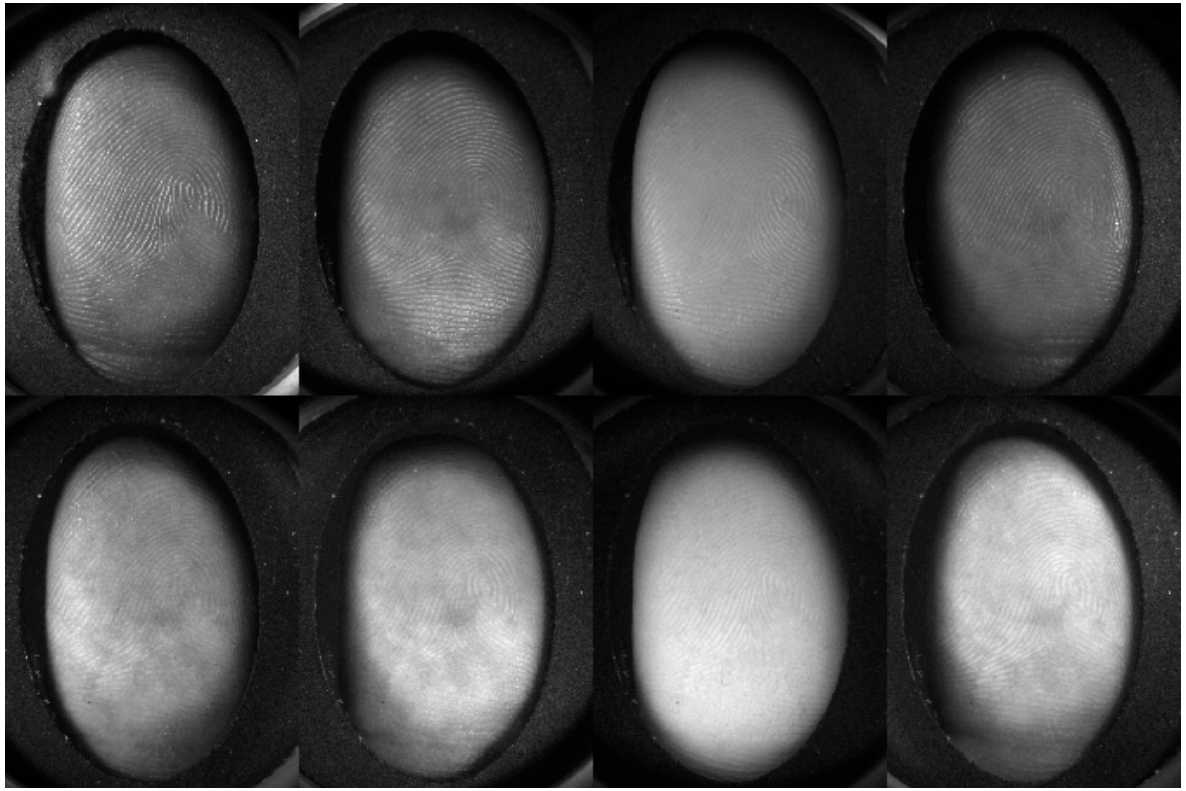
Typical Data
Individual Planes and Composite Image

470, 530, 617nm and white-light, random polarization



470, 530, 617nm and white-light, crossed polarization

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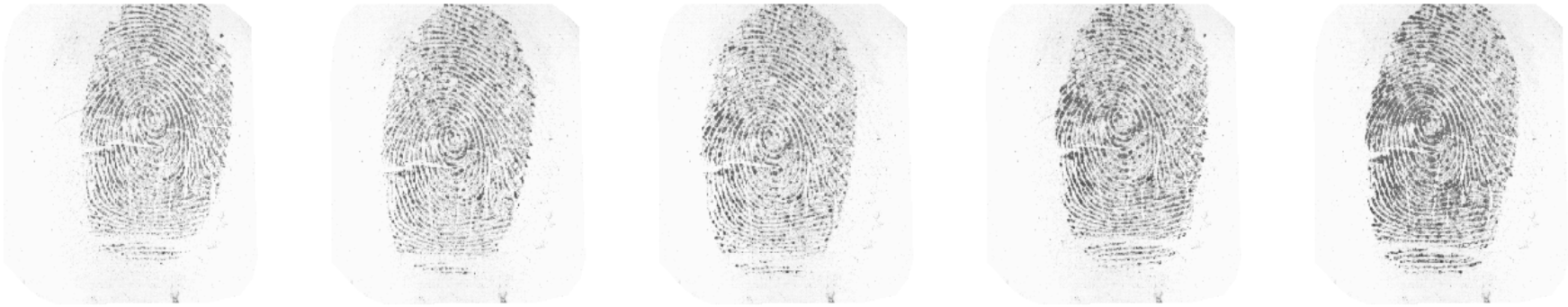
Performance studies

Study #1

- Example images of several different imaging conditions
  - Normal
  - Wet skin
  - Dry skin
  - Light contact
- Comparison made to conventional images measured contemporaneously
  - Identix DFR-2100

Normal Conditions

Conventional Images, Mean NIST Quality Value = 3.2



Lumidigm Images, Mean NIST Quality Value = 2.0

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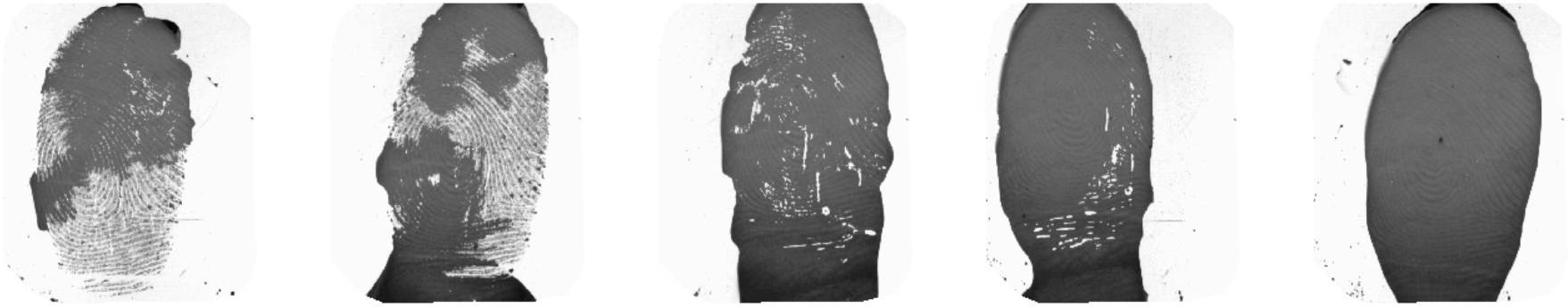
Water on the Platen

Conventional Images, Mean NIST Quality Value = 5.0



Lumidigm Images, Mean NIST Quality Value = 1.4

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Dried Skin
(With Acetone)

Conventional Images, Mean NIST Quality Value = 2.2

Lumidigm Images, Mean NIST Quality Value = 1.8

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Light Pressure

Conventional Images, Mean NIST Quality Value = 5.0

Lumidigm Images, Mean NIST Quality Value = 2.0

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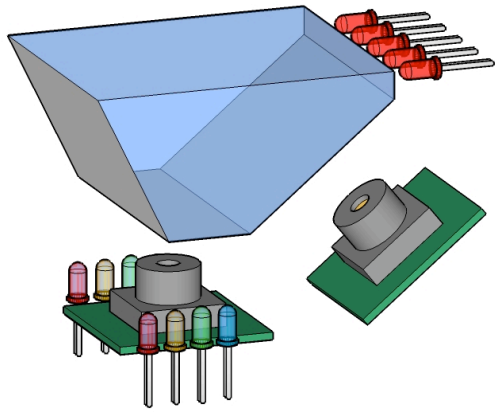
Study #2

- Examine the relative biometric performance of two fingerprint image modalities measured simultaneously
  - Conventional
  - Multispectral
- Examine the relative NIST quality metrics

Biometric Performance Comparison Methods

- Use a dataset collected with the Lumidigm/CrossMatch 2-Camera Prototype
- Dataset consists of
  - 45 people
  - 184 unique fingers
  - 685 samples
- Reduce the 6 MSI image planes into a single composite image

Prototype of Lumidigm / Cross Match two-camera sensor



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Biometric Performance Comparison Results

- For this study:
  - TIR images produced an equal-error rate (EER) of 10.6%
  - The corresponding MSI images produce an EER of 2.9%
- Unqualified, single-sample enrollment
- Full round-robin assessment
- Dry, desert environment

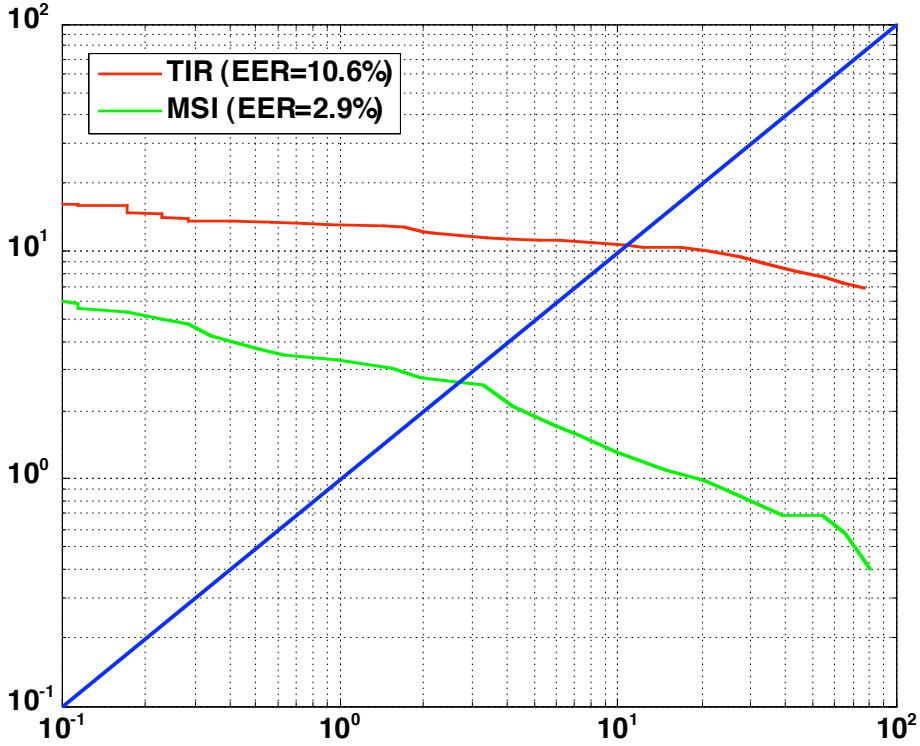

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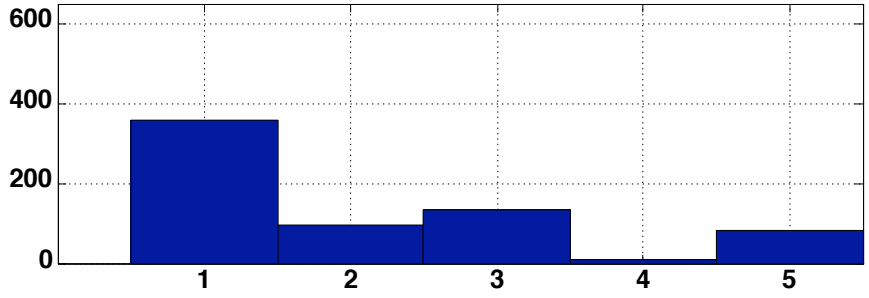
Image Quality Comparison Methods

- Apply the NIST quality algorithm (NFIQ) to each of the MSI and TIR images.
  - Values range from 1 ←→ 5, 1 is best, 5 is worst
- Accumulate and compare the respective histograms of image quality values

Image Quality Comparison Results

- TIR image quality shows a significant spread across the 5 quality categories
  - Mean = 2.06
- Corresponding MSI image quality is much more tightly clustered around the high quality category (1)
  - Mean = 1.25
- These results correspond well with the relative performance values
  - EER=10.6% vs. 2.9%



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Summary and Contact Details

- Multispectral imaging technology has been designed to provide higher quality images over a wider range of conditions than conventional fingerprint imaging methods
- Initial studies have demonstrated this benefit of multispectral imaging
- Further (and larger) studies are underway to better quantify the improvements

- Contact information:

Rob.Rowe@Lumidigm.com

505.272.7406

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