COGENT SYSTEMS

BEYOND COMPARISON™

"Image Quality On Purpose"

Presented to:
NIST Image Quality Workshop
November 7-8, 2007

Agenda

COGENT SYSTEMS

- Image Quality Assessments For Different Purposes
- Fingerprint Image Quality Case Study & Analysis
- Photograph Image Quality Case Study & Analysis
- Summary
- Contact Information

Cogent Fingerprint Image Quality Scoring Scale

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1	2	3	4	5	6	7	8-127

Good

- Calibration of Capture Device*
- Even Grayscale Distribution
- Few Low Confidence Minutiae Points
- Large Useful Image Area
- Low Noise Level of Useful Image Area
- Core Position/Core Confidence
  (Used For Quality, Not Matching)

Average

Poor

- Calibration of Capture Device
- Un-Even Grayscale Distribution
- Many Low Confidence Minutiae Points
- Small Useful Image Area
- Noise Level of Useful Image Area
- Low Core Confidence
  (Used For Quality, Not Matching)

Image Quality Score Has Direct Relationship to Matching Accuracy

Image Quality Evaluation Layers

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Evaluation Layer 1

Signal Analysis

Digital Image Quality
Grayscale Based on Device Calibration

Evaluation Layer 2

Fingerprint Content

Fingerprint Feature Data

Evaluation Layer 3

Minutia Reliability

Deleted, False or Low Quality Minutiae

Multiple Image Quality Evaluation Layers Improves Score Reliability

Fingerprint Image Quality – Improved Matching Algorithms

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- Key Premise: Matching Accuracy (2Print/10Print) Starts With Fingerprint Image Quality
- Image Quality Measurement is a *Good Predictor* of Matching Accuracy
- Use Of Advanced Matching Algorithms (Galaxy+) as Replacement or In Conjunction With Feedback Improves Matching Accuracy of Poor Quality Prints

Good ***Average*** ***Poor***

Cogent Quality Score	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8-Q127
Feedback Single Finger TAR	99%	99%	98%	98%	94%	88%	82%	54%

Cogent Quality Score	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8-Q127
Galaxy+ Single Finger TAR	99%	99%	99%	99%	98%	98%	96%	82% Galaxy+

Advanced Matching Algorithms Increase Ability to Match Poor Quality Prints

Four Finger Slap Capture For Segmentation

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- Slap Orientation
- Ability to Rotate +/- 90 Degrees Critical for Slap Segmentation Algorithm.
- If Orientation +/- 10 Degrees No Rotation Necessary.

Ability of Segmentation Algorithm to Rotate Is a Key Attribute

Segmented Right Slap

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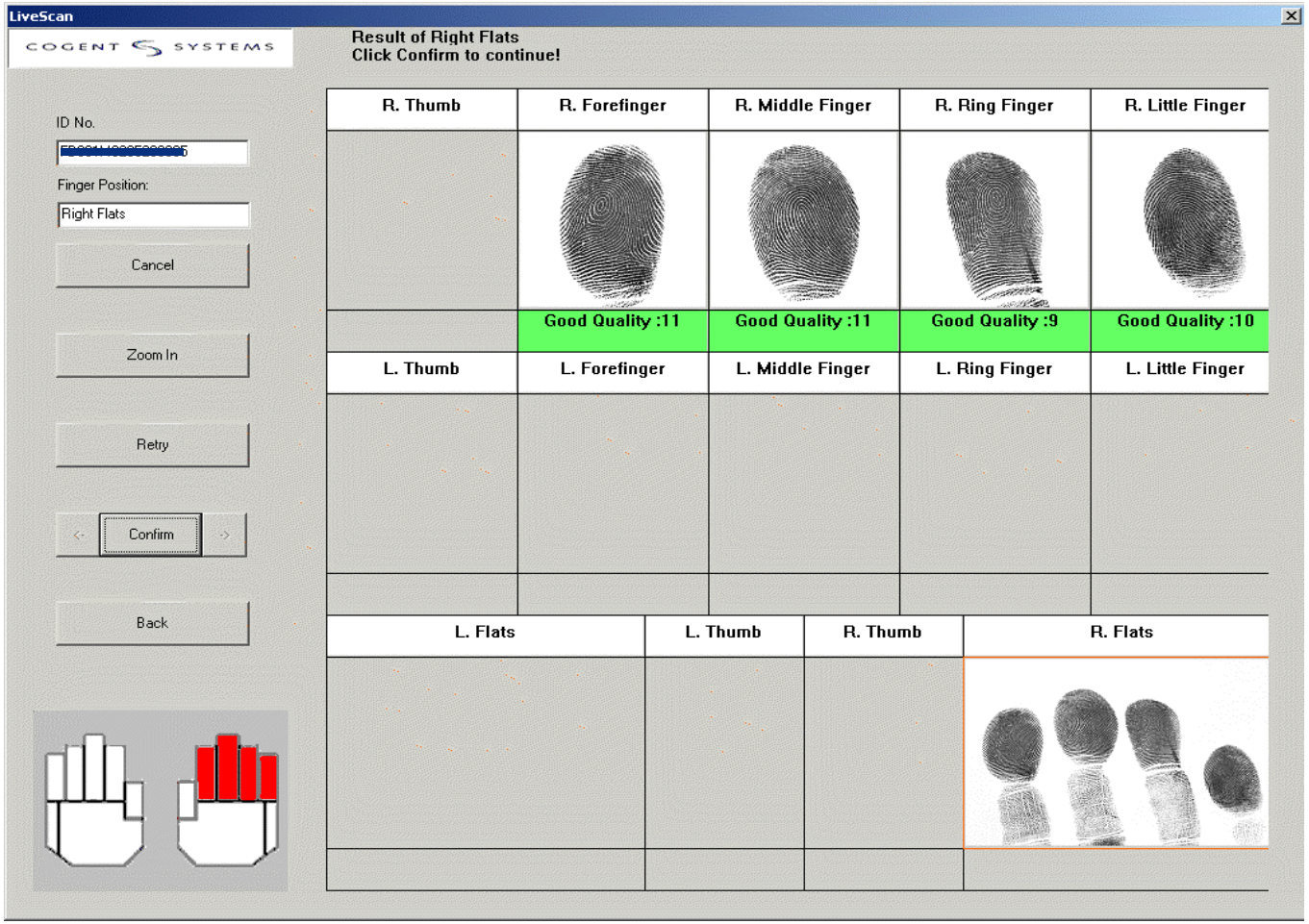
- Segmentation Confidence Scoring
- Key Metric For Image Quality



Segmentation Confidence Scoring Used In Addition to Image Quality

Segmented Slap – Poor Quality/Segmentation Identification

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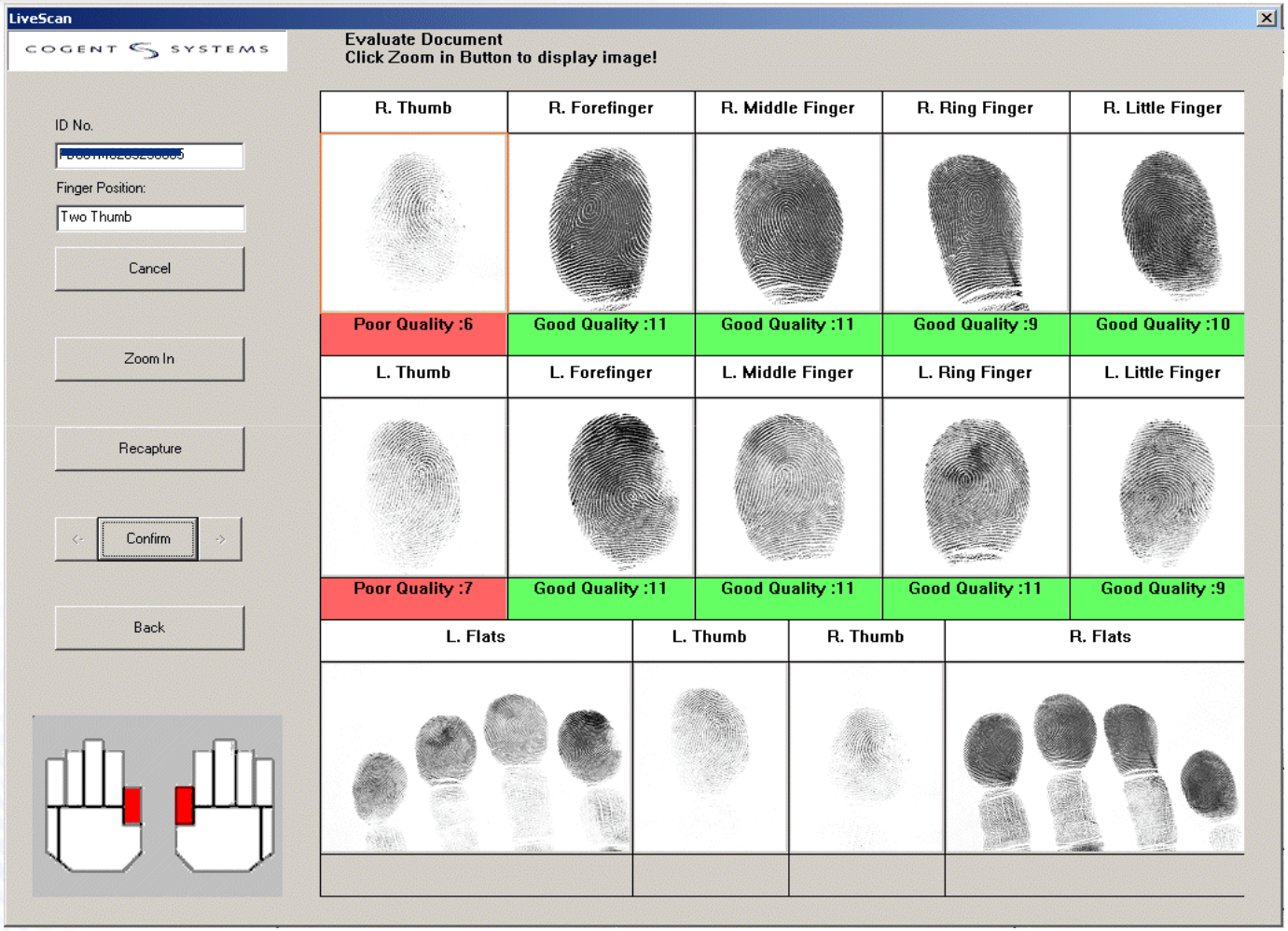

Segmentation Confidence Scoring Used In Addition to Image Quality

Typical Good Quality Digital Fingerprint

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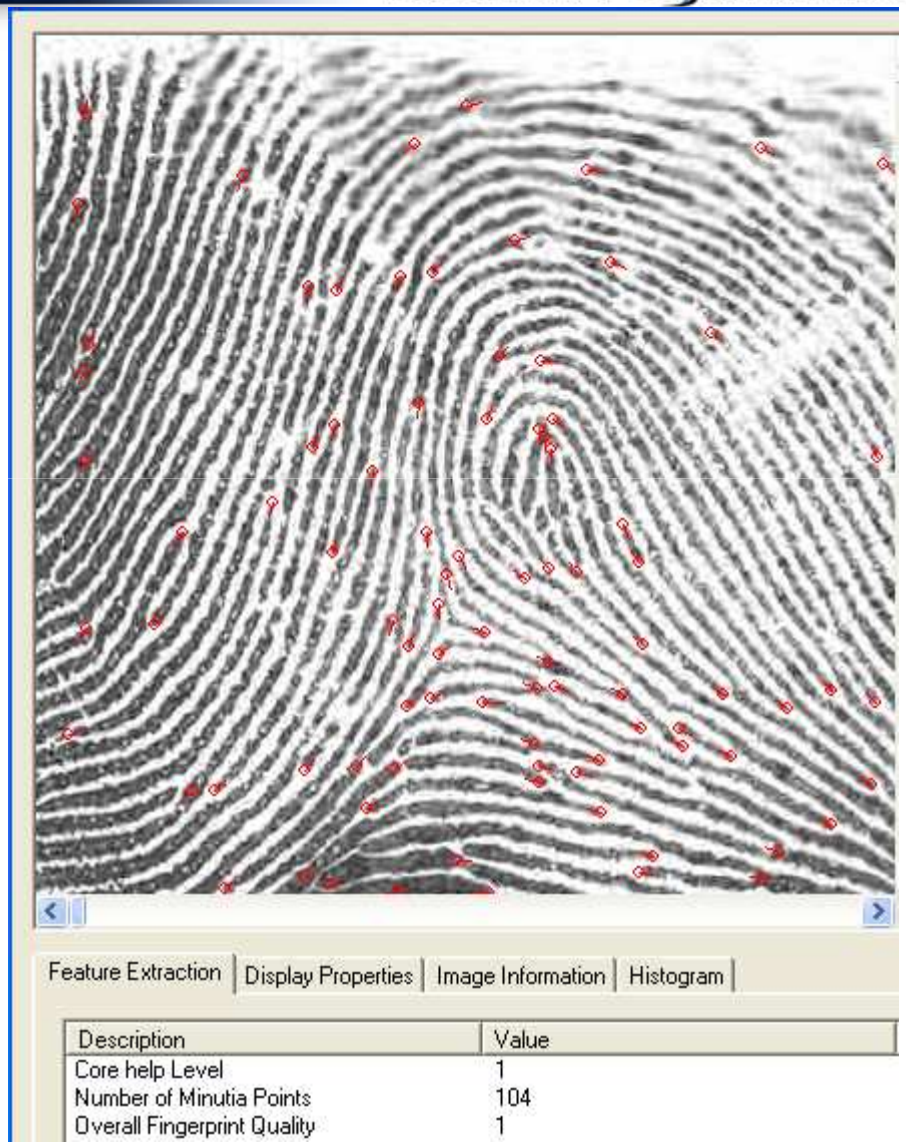
- Good Quality Fingerprint
  - Quality = 1 (Very Good)
  - Minutia Count = 104
  - Even Grayscale Distribution
  - Proper Capture Device Calibration
  - Evenly Rolled Fingerprint



Fingerprint Quality – Smeared Print

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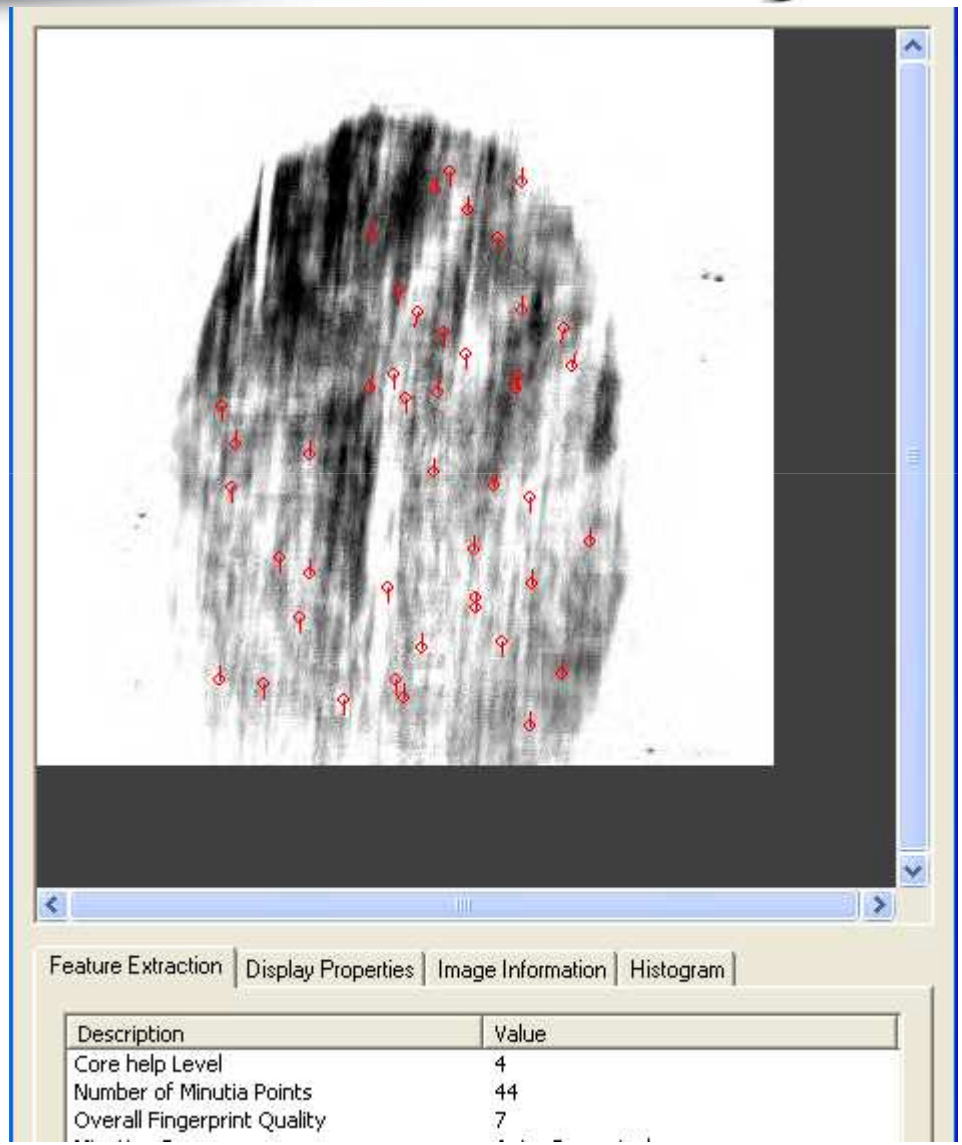
- Smeared Fingerprint
  - Quality = 7 (Average)
  - Minutia Count = 44
- Solution:
  - Smear Detection Algorithm
  - SDA Used In Capture Application to Prompt For re-Capture of Print



Fingerprint Quality – Light Print

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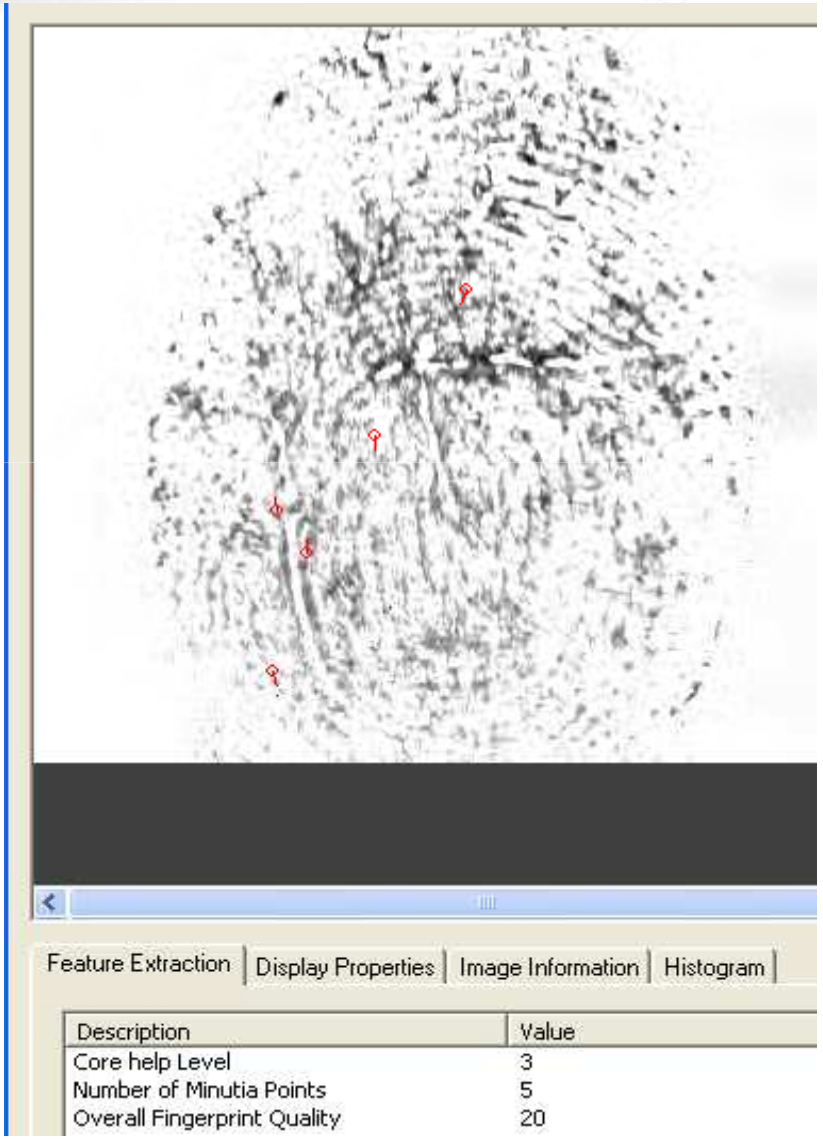
- Light Contrast Fingerprint
  - Quality = 20 (Very Poor)
  - Minutia Count = 5
  - Poor Grayscale Distribution
- Solution:
  - Ensure Capture Device Is Properly Calibrated
    - Normal Distribution is 128 (88-168) on 0-255 Scale.



Fingerprint Quality – Dark Print

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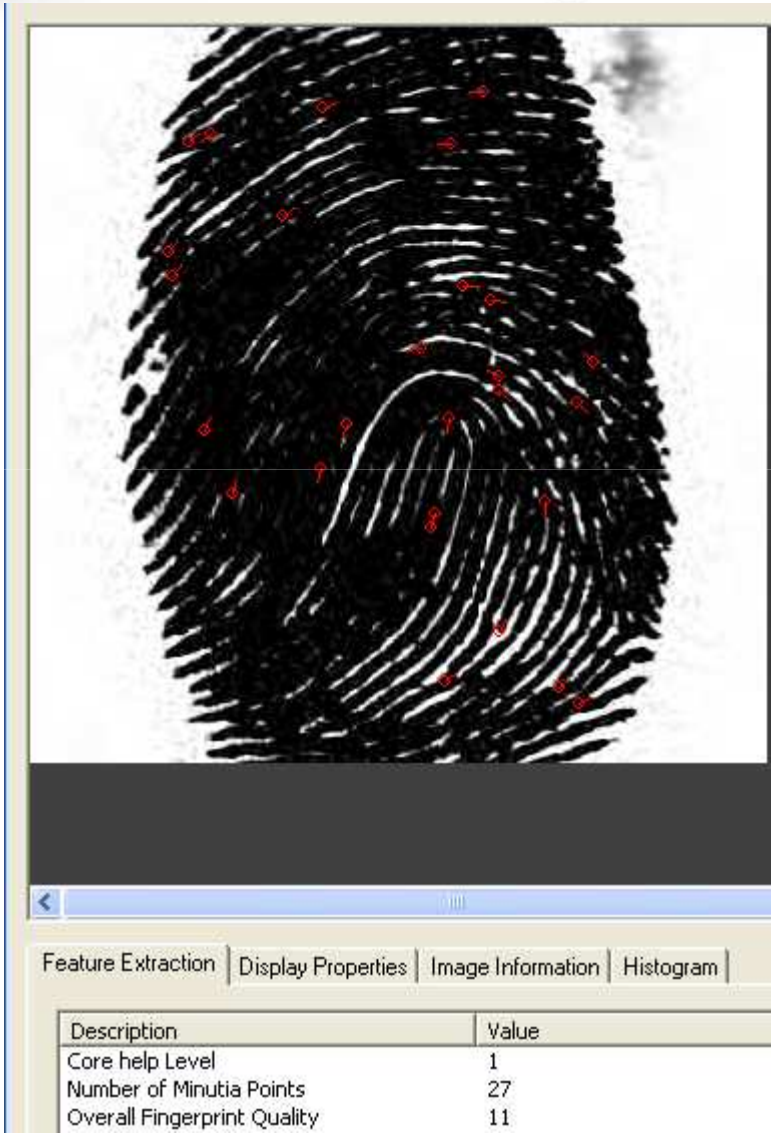
- Dark Contrast Fingerprint
  - Quality = 11 (Very Poor)
  - Minutia Count = 27
  - Poor Grayscale Distribution
- Solution:
  - Ensure Capture Device Is Properly Calibrated
    - Normal Distribution is 128 (88-168) on 0-255 Scale.
  - Ensure Too Much Finger Pressure Not Applied to Platen



Client Application – Centering Algorithm

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- Core Centering Versus Geometric Centering Algorithm
  - Two Primary Fingerprint Centering Algorithms
  - Core Centering
    - Identifies Core Center of The Print and Centers Image
    - Core NOT Used by Cogent For Matching. Only for Image Centering
  - Geometric Centering
    - Utilizes x,y Coordinates of the Print Image and Centers Image
- Recommendation :
  - Core Centering Algorithm Should Be Used to Obtain More Useful Image Area than Geometrics Centering Algorithm
  - Core Centered Fingerprints Provide Higher Quality Scores

Geometric Centered Quality- 12

Core Centered Quality- 6

Photograph Image Quality Assessment

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- UK-Visas Application
  - Biometrics Capture & Matching System Used In >140 Countries
  - Captures 10Print Slaps, Biographic Data & Digital Photo
- UK-Visas Program Case Study For Photograph Quality
- Photograph Quality is Pre-Cursor For Face Recognition
  - Uniform Lighting
  - Frontal View
  - Head Length/Width Ratio
  - Eyes Open

Several Attributes Contribute to a High Quality Photograph Image

Photo Image Quality Assessment

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- Failed Quality Check
  - Eyes Closed
  - Uneven Lighting

Photo Image Quality Assessment – Case 2

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- **Failed Quality Check**
  - **Non Frontal View**
  - **Head Width/Height Ratio**

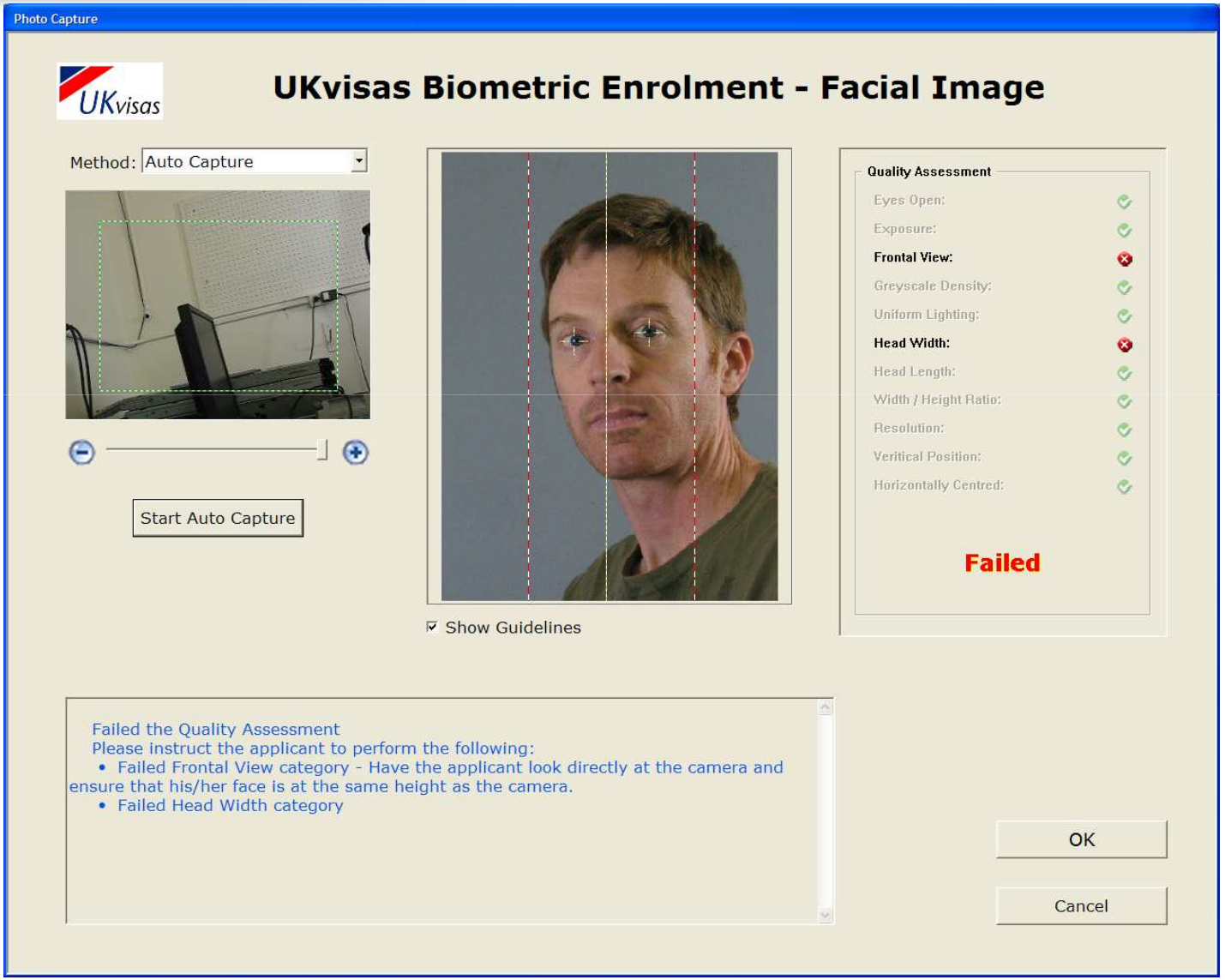

Photo Image Quality Assessment – Case 3

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- Passed Quality Check
  - Full Frontal View
  - Consistent Lighting
  - “Eye Contact”
  - Head Width/Height Ratio

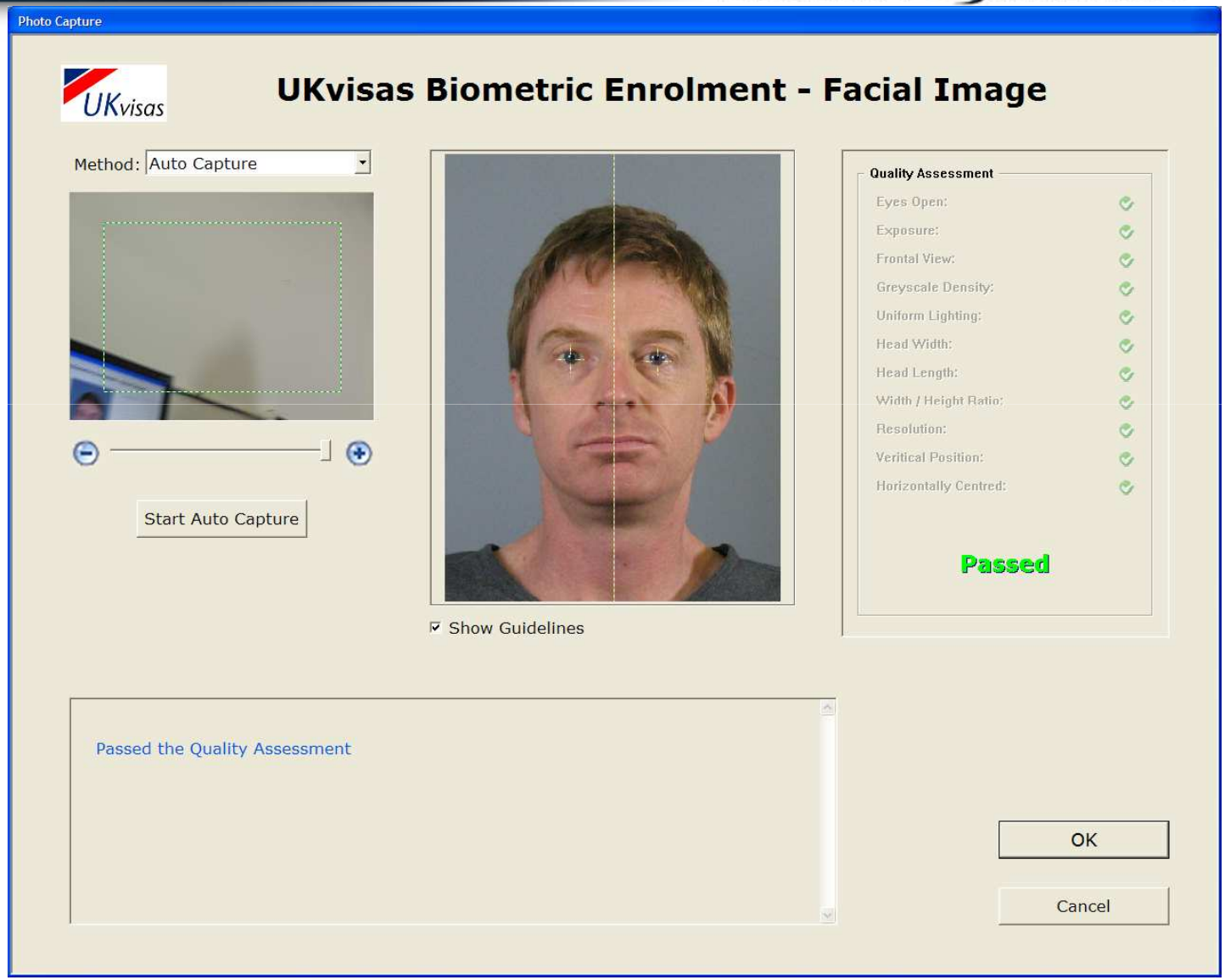

Image Quality Assessment Summary

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- Fingerprint Image Quality Considerations
  - Calibration of Capture Device
  - Grayscale Distribution
  - Segmentation Confidence
  - Centering Algorithm
- Photograph Image Quality Considerations
  - Lighting
  - Pose
  - “Eye Contact”

Image Quality Has Direct Relationship to Matching Accuracy

Cogent Contact Information

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