Approaches to Face Image Capture at US-VISIT Ports of Entry

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Agenda

- US-VISIT background
- Potential face recognition applications in US-VISIT
- Air *port of entry* (POE) operational environment
- Preliminary air POE face image quality assessment
- Image Quality Improvement and Face Recognition Study – description, constraints, and approach
- Usability considerations

US-VISIT Vision and Background

- *Advancing the security of the United States and worldwide travel through information sharing and biometric solutions for identity management*
- Biometrics captured at US-VISIT primary inspection
  - Fingerprints
    - Two flat index fingerprints, evolving to 10 slap prints in late 2008; pilot begins 11/07
    - Automated matching with manual match verification
  - Facial image
    - Human verifiable traveler history
    - Currently no automated face recognition

Applications for Face Recognition

- Compare live photo with visa and/or past photos for visitors who are not (fully) fingerprinted
- Compare live photo with e-Passport photo for first time Visa Waiver Program visitors
  - FBI 10-Print check performed post-enrollment; only watchlist check in real time
- Increase verification confidence through decision level or score level fusion
- Detect aliased (duplicate) records or fraud
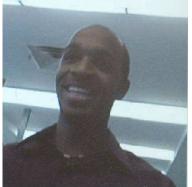- Search face-only watchlists

Air Port of Entry (POE) Environment

- Key factors for face recognition
  - Pose angle
  - Interocular pixel resolution
  - Illumination
  - Background

Air POE Face Image Quality Assessment
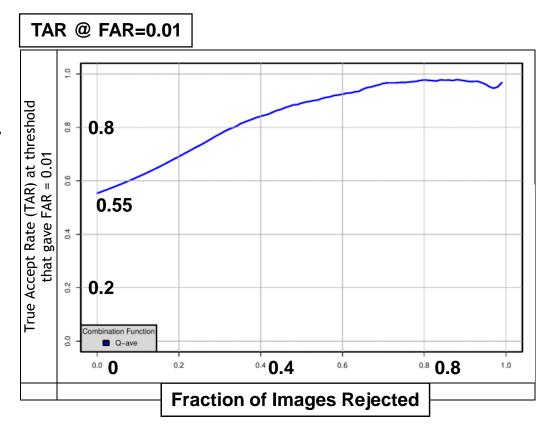## (ref. P. Grother, NIST)

- Limited evaluation of ~1.5M POE facial images circa 2004
  - Images 240x240 color JPEG
  - Manual inspection of several thousand images
    - ~70% of images with pose angle >10°
    - Small but significant percentage of faces were cropped
    - Some blur
  - Automated inspection with FR engine
    - 95% of images interocular distance in 25-75 pixel range
    - Finds face correctly ~90%
    - 14% of images deemed unsuitable for FR (FTA)
  - Primary problem poor geometry: pose>size>crop>distortion

Estimating the Effect of "Quality in the Loop" (ref. P. Grother, NIST)

- Apply quality metric tool to images
  - Reject all search images below quality threshold "Q"
  - Plot TAR vs. rejection fraction for increasing "Q"
  - TAR & FAR improve
- Maximum improvement achieved when camera limitation is reached

TAR @ FAR=0.01

True Accept Rate (TAR) at threshold that gave FAR = 0.01

0.8

0.55

0.2

Combination Function
Q–ave

0 **0.4** **0.8**

Fraction of Images Rejected

US-VISIT Image Quality Improvement and FR Study – Concept Exploration

- Investigate hardware (camera) and software (face finding and image quality assessment) approaches to facilitate acquiring images that conform to DHS adopted standard, INCITS 385
  - Use higher quality camera (lens, resolution, auto-exposure, auto-focus, high dynamic range, pan-tilt-zoom (PTZ))
    - High resolution permits zooming to required head size
  - Compute quality metric(s) of a still image and request recapture if unacceptable
  - Compute quality metric(s) for a series of video frames; select frame that (best) meets quality requirements
- Investigate officer/subject usability of image capture sensor
- Study recently initiated — to be completed late summer 2008

Implementation Constraints

- Initial focus on air POEs
- Limited CBP officer involvement
- Overall POE inspection time cannot be increased
- No changes to POE facilities
- No supplemental illumination
- No compromise to officer safety or line of sight
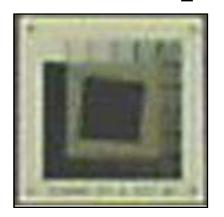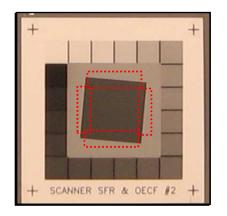- Solution must be cost effective

Study Approach

- Select a representative camera from each of several classes – current webcam (baseline), upgraded webcam, digital point-and-shoot, quality video/PTZ
  - Assess cameras using test targets to identify candidates for live image capture (scenario analysis)
- Select several quality metric software tools and identify candidates for testing on evaluation images
- Integrate selected cameras into software test harness; capture photos and video streams from volunteer population; run image quality software *post-capture* to assess impact on image selection
- Determine "best" hardware/software combination; integrate to run *real time* to capture images of volunteers and assess potential impact on image selection
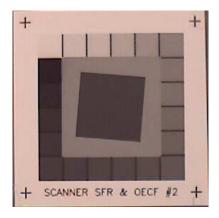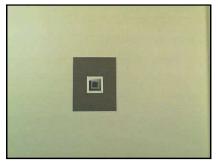
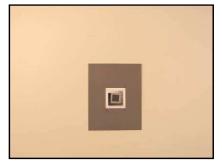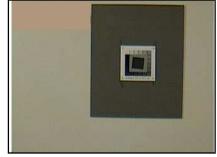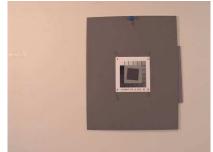# Assessing Camera Resolution Using the ISO 16067 Spatial Frequency Response Target

Webcam
(640x480)

Point & Shoot Digital
(2592x1944 still,
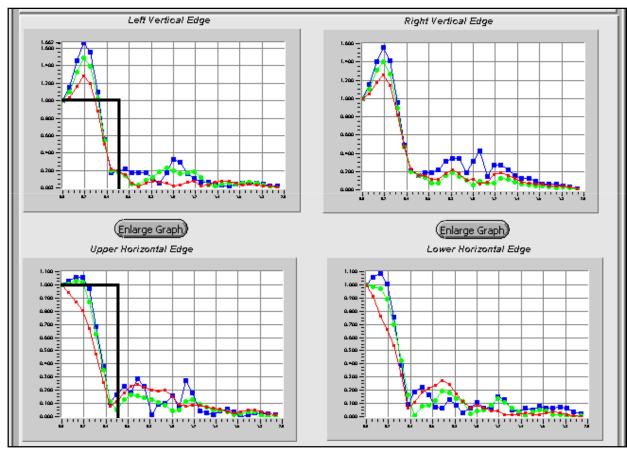640x480 video)

Wide Dynamic Range
Video (320x240)

Hi-res Video
(1600x1200)

Measured MTF for Point-and-Shoot Digital Camera

- MTF or SFR = relative contrast at given spatial frequency

- Ideal response would have high MTF below Nyquist frequency and low response above it

- Horizontal edge response should be similar to vertical edge response

  – Some cameras boost horizontal (vertical edge) SFR

Color Profiling with Little CMS Chart

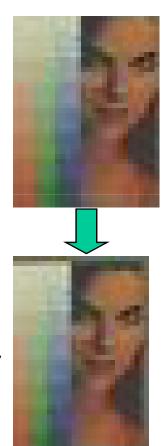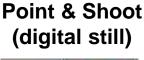**IT8.7/2**

Little CMS

http://littlecms.com/

"Liberal open source license"

	Webcam	Hi-res Video	Point & Shoot (digital still)
Original			
After color profiling			

Analysis of Face Image Quality Assessment Products

- Provision of desired metrics
- Value ranges
- Histograms (thresholdable)
- Eye detection accuracy
- Correlation with human perception
- Correlation with FR performance

Simulated Demonstration of "Quality in the Loop" for Image Selection (Webcam)

Webcam   **Video from Digital Point and Shoot**

(15 fps)   **(30 fps)**
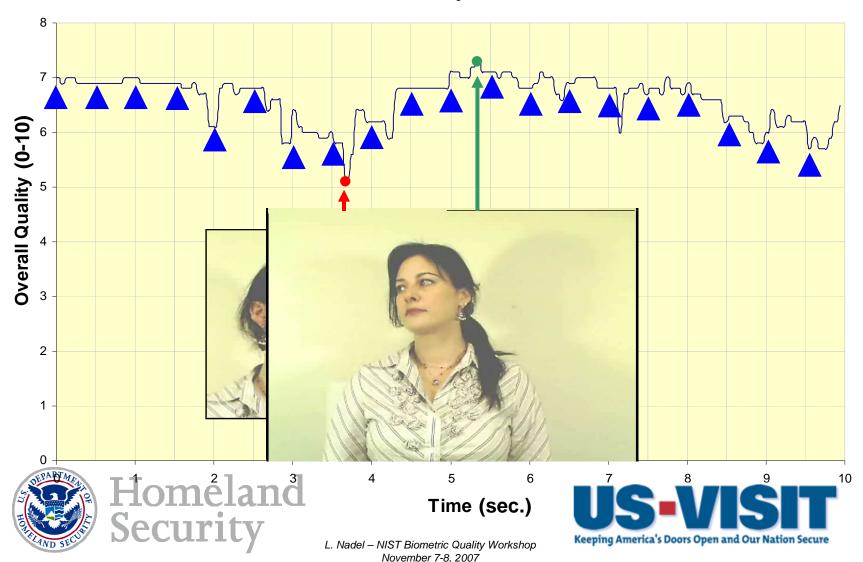
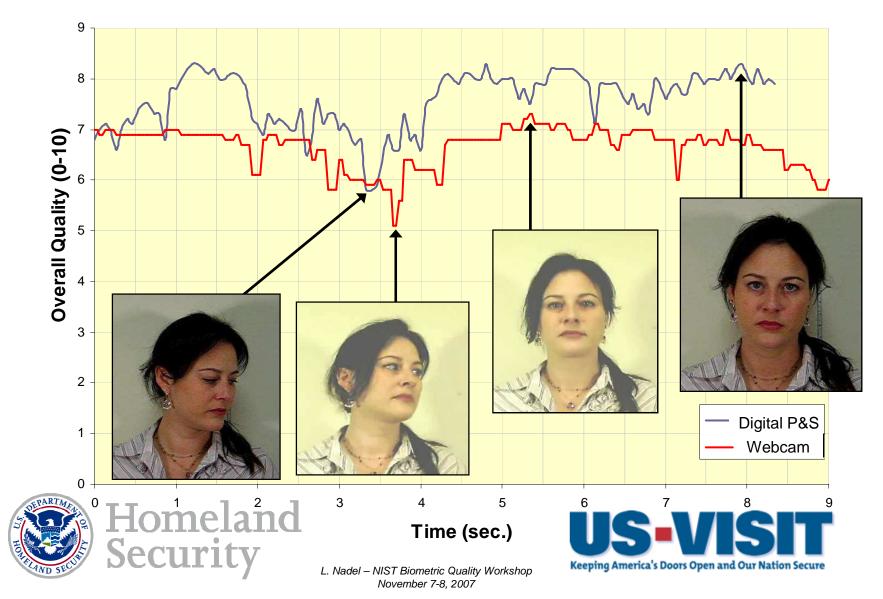## Sample video clips to be analyzed

Simulated Demonstration of "Quality in the Loop" for Image Selection (Webcam)

Overall Quality vs. Time

Comparative Quality of Webcam and Video From a Digital P&S Camera
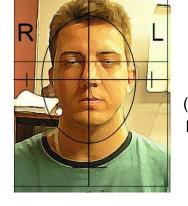
Face Capture Usability Considerations

- Traveler
  - Individual needs to know that picture is being taken
  - Image capture sensor should "look like a camera"
  - Limit individual's degrees of freedom, e.g., indicate where feet should be placed on floor
- CBP Officer
  - For officer placement of camera, show geometric overlay on video screen to indicate proper placement and size of image to be captured

(Illustration courtesy of
NIST Usability Group)

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