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
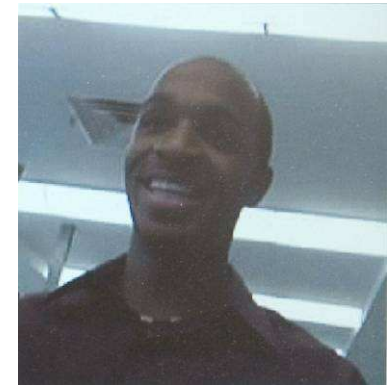- Detect aliased (duplicate) records or fraud
- Search face-only watchlists

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)
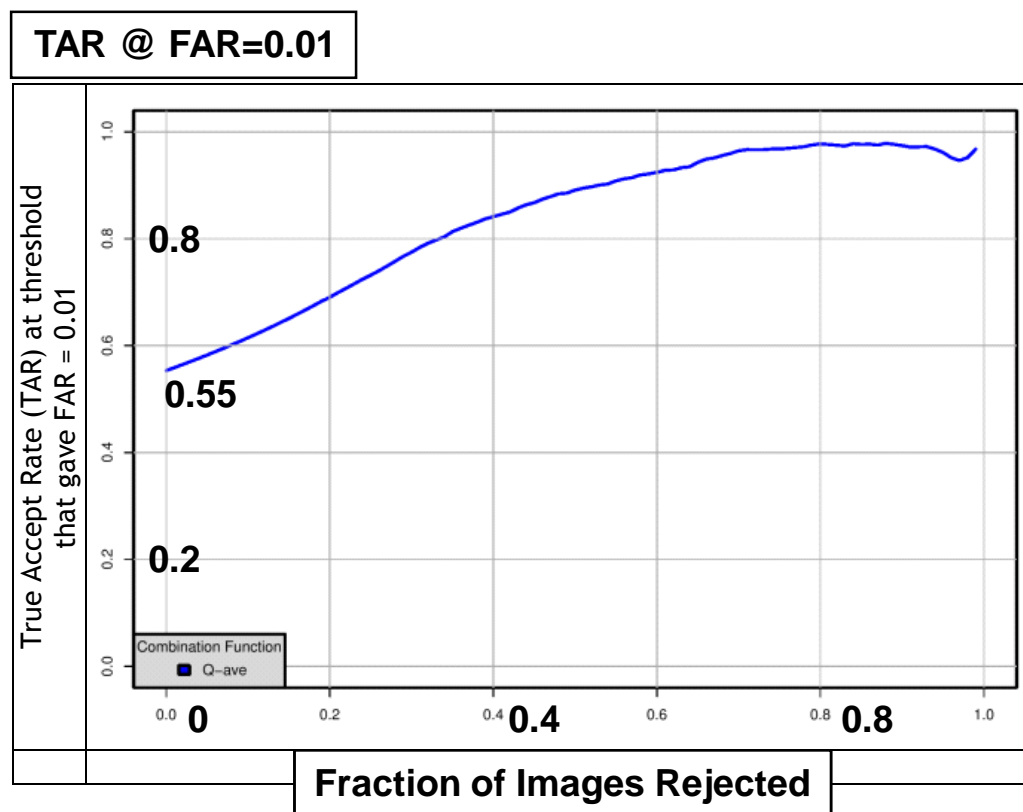 - Primary problem poor geometry: pose>size>crop>distortion

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

0.8

0.55

0.2

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

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
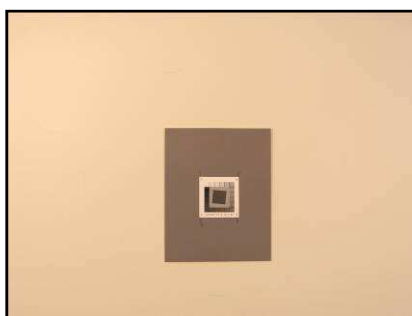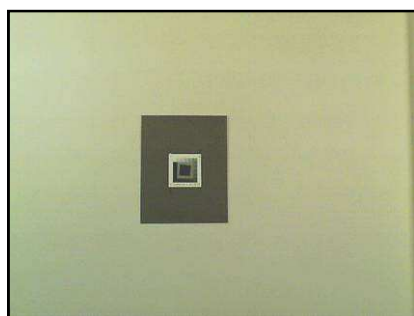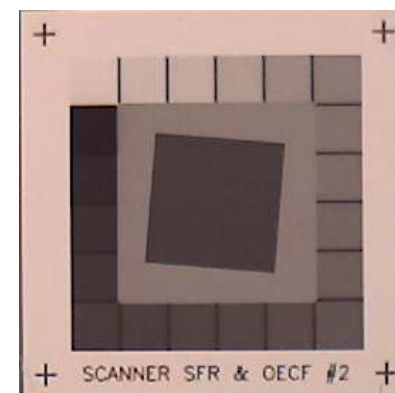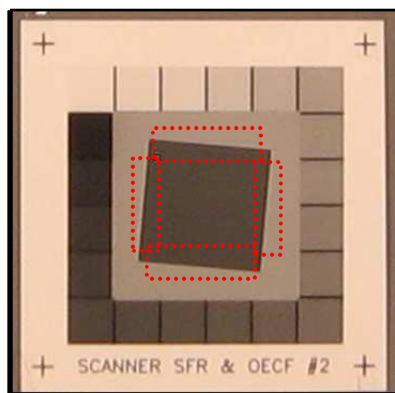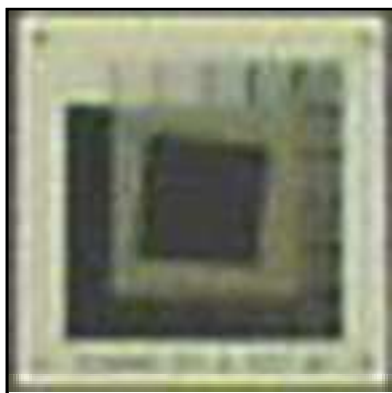
Webcam
(640x480)

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

Wide Dynamic Range
Video (320x240)
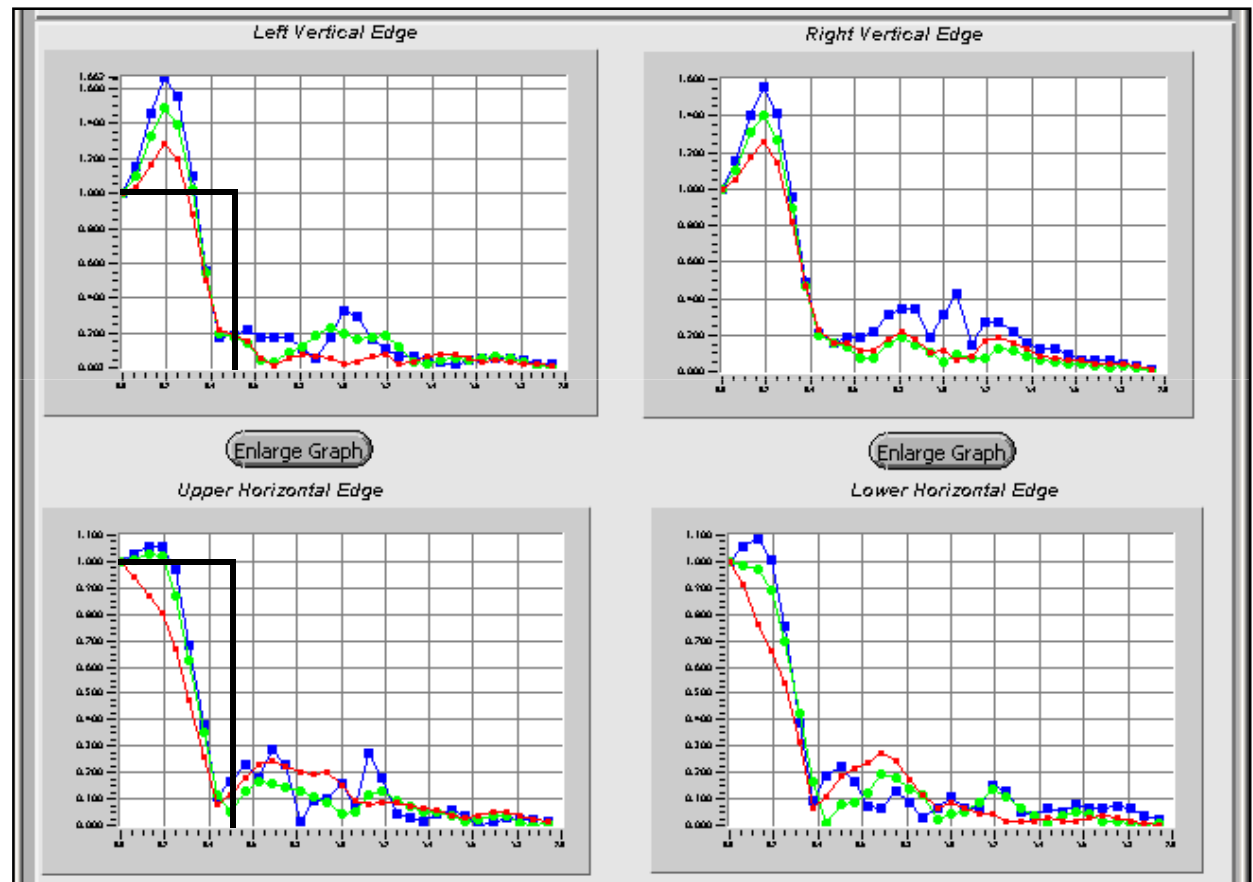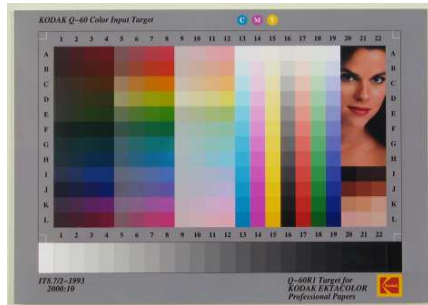
Hi-res Video
(1600x1200)

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			
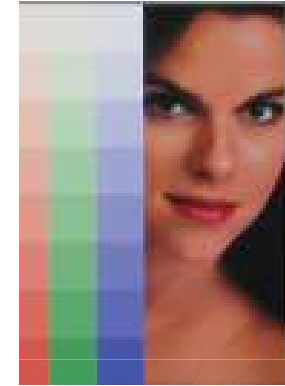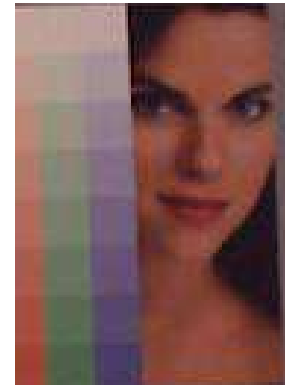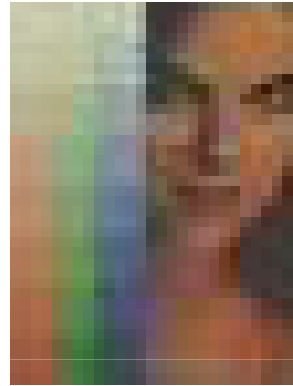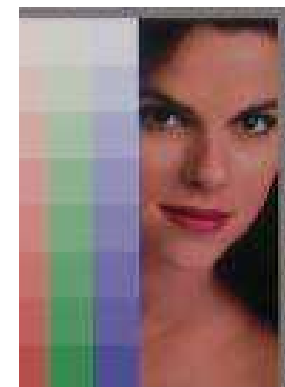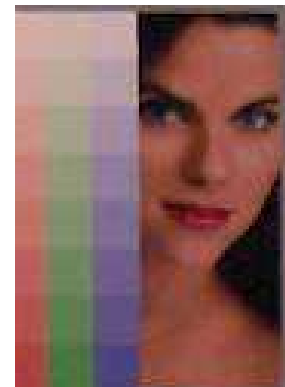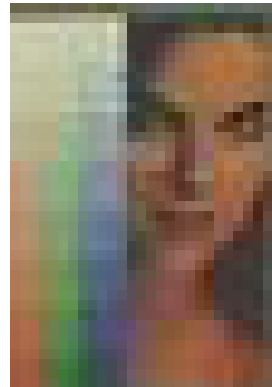
Analysis of Face Image Quality Assessment Products

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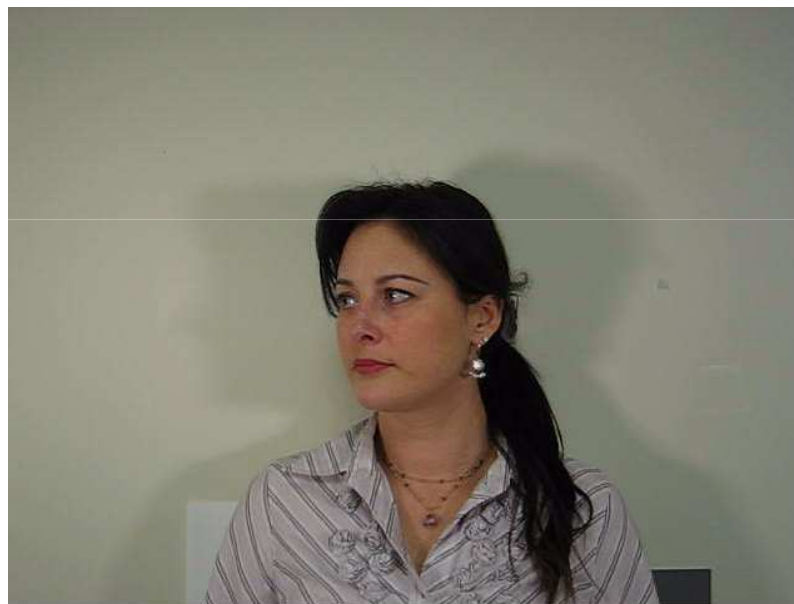- Correlation with human perception
- Correlation with FR performance

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

Webcam

Video from Digital Point and Shoot

(15 fps)

(30 fps)
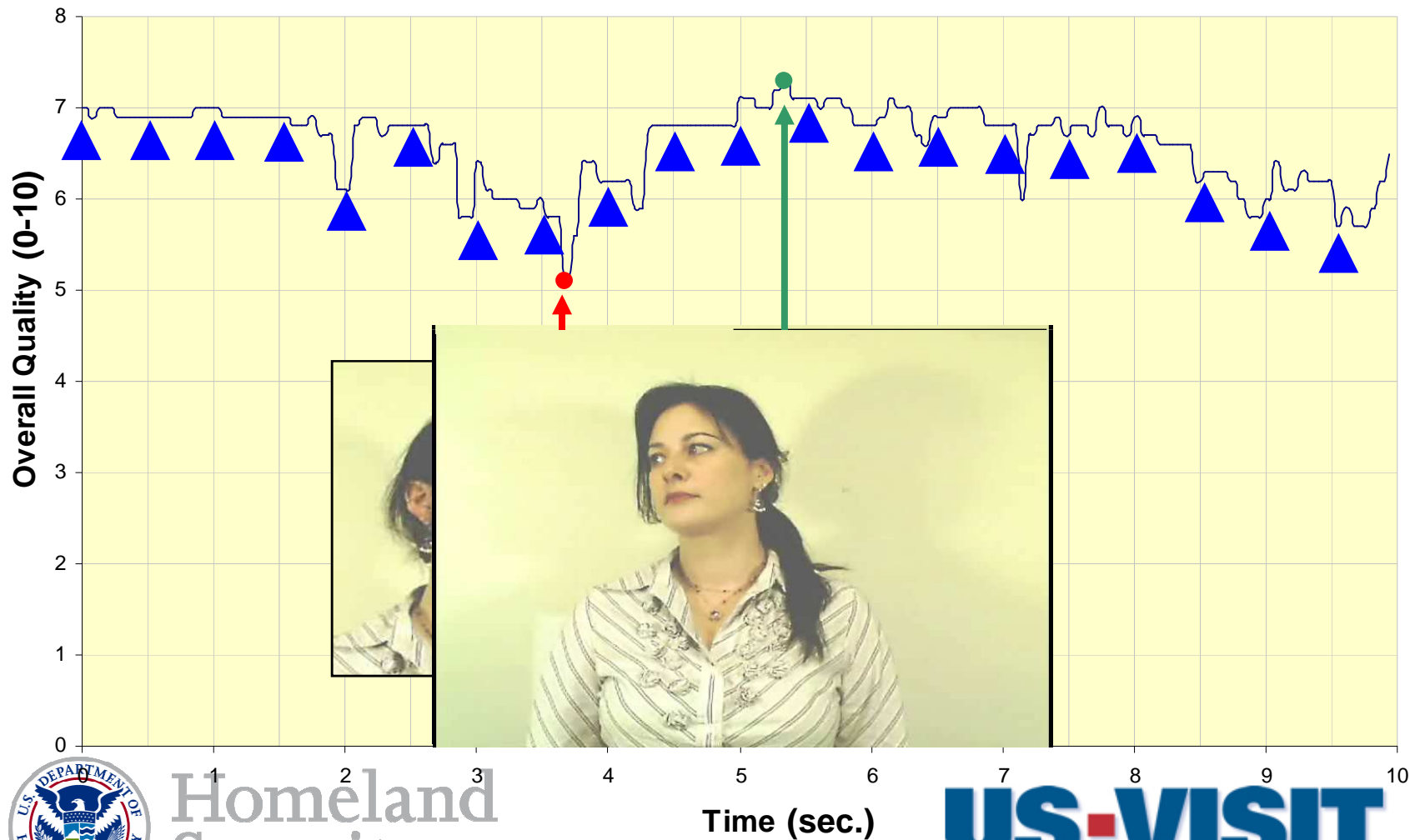
Sample video clips to be analyzed

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
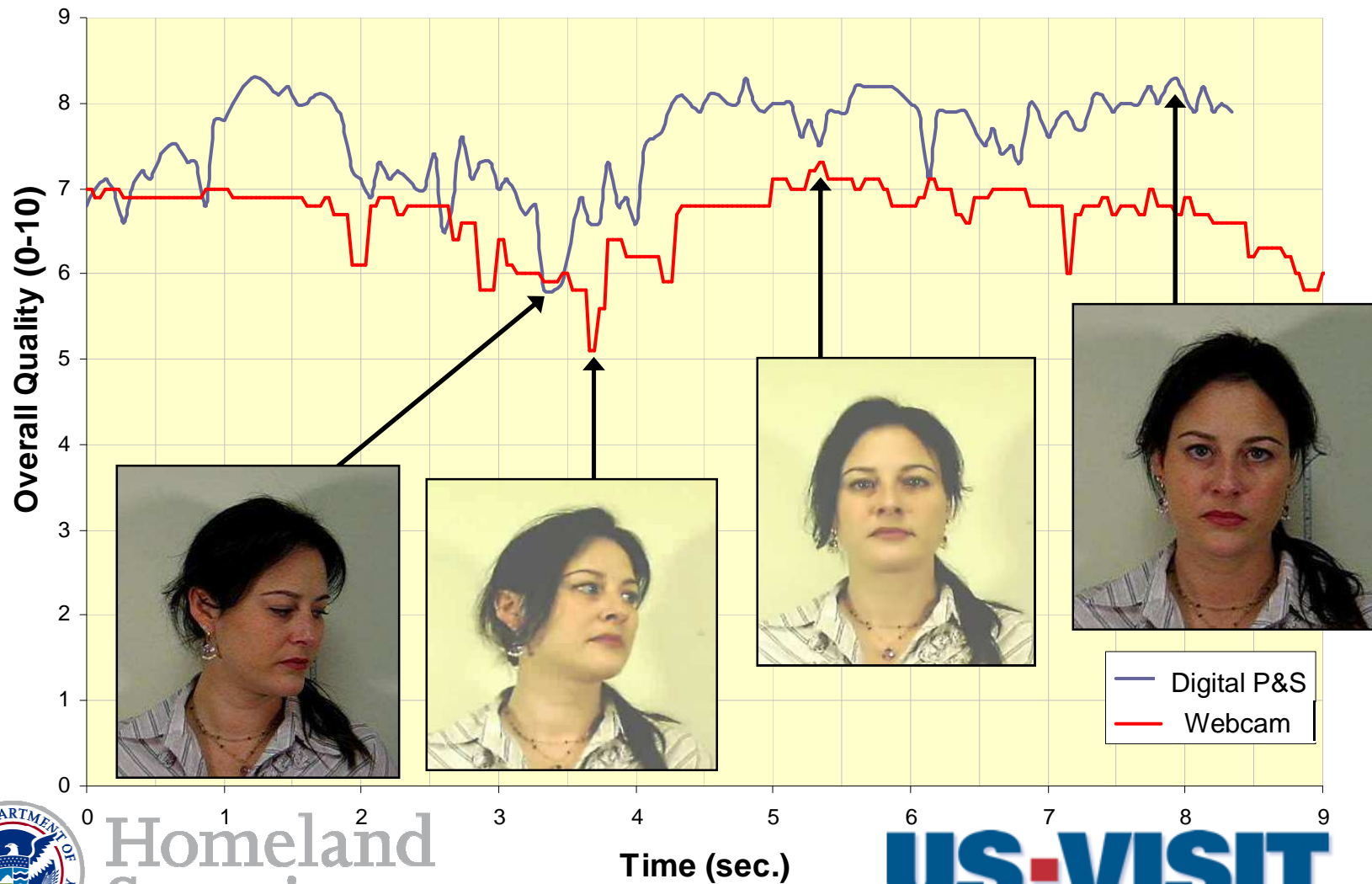
Face Capture Usability Considerations

- 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
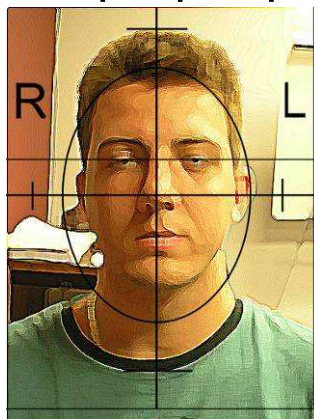
(Illustration courtesy of
NIST Usability Group)

Contact Information

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