















# 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



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# 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



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# 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

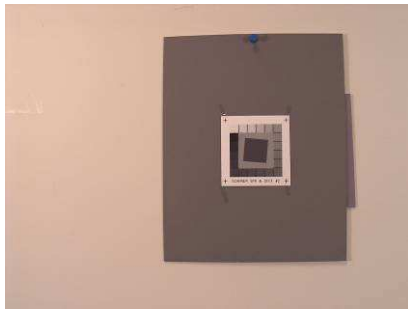
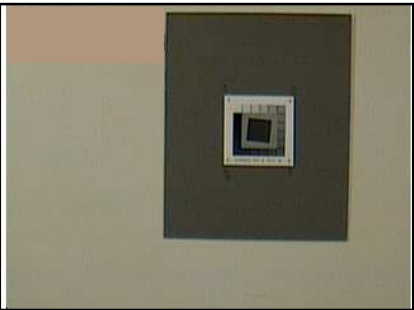
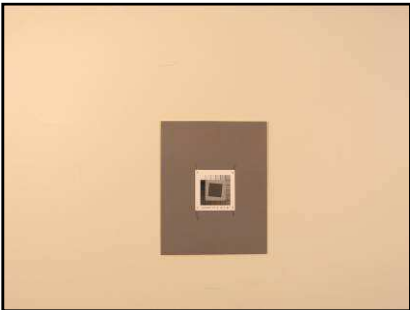
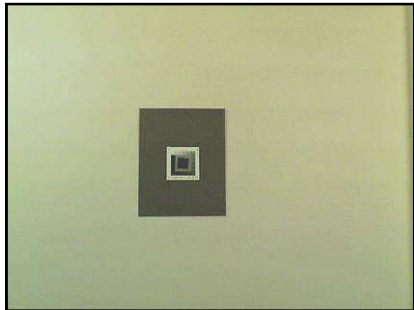
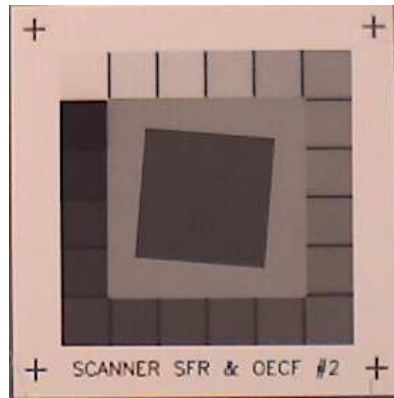
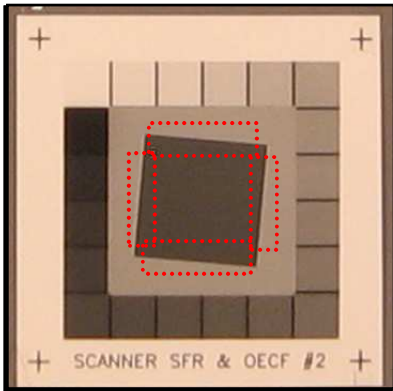


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# Assessing Camera Resolution Using the ISO 16067 Spatial Frequency Response Target



Webcam  
(640x480)

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

Wide Dynamic Range  
Video (320x240)

Hi-res Video  
(1600x1200)



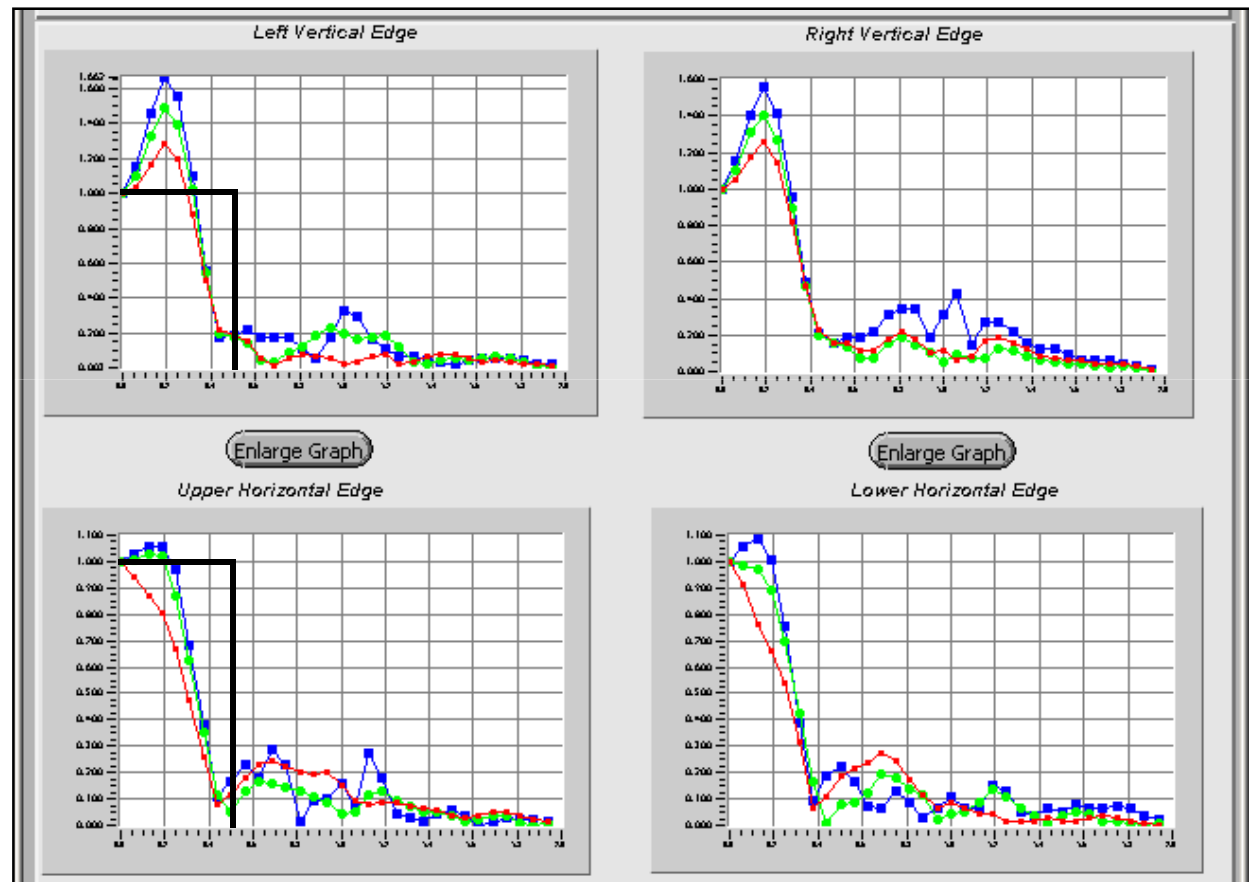
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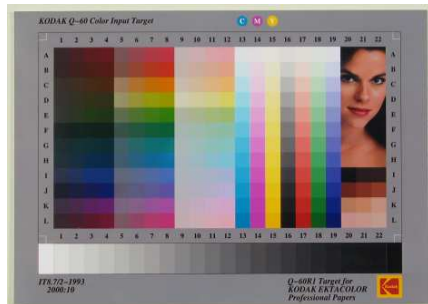
# Measured MTF for Point-and-Shoot Digital Camera

- 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



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# Color Profiling with Little CMS Chart



IT8.7/2

Little CMS

<http://littlecms.com/>

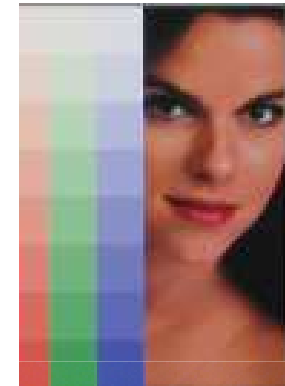
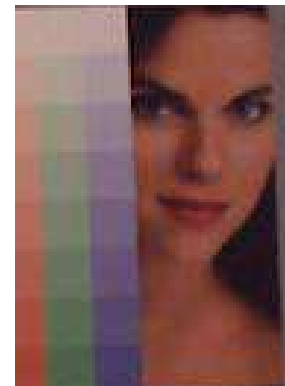
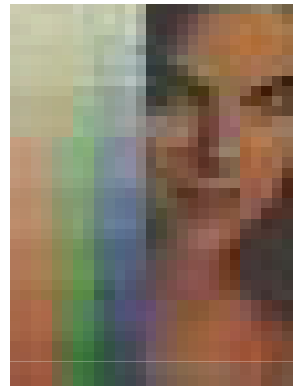
“Liberal open source license”

Webcam

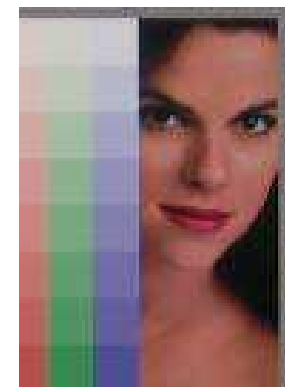
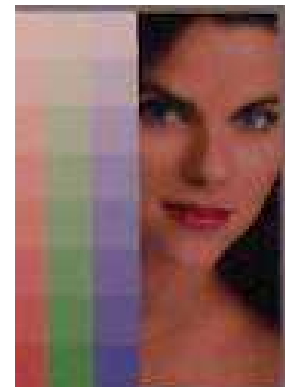
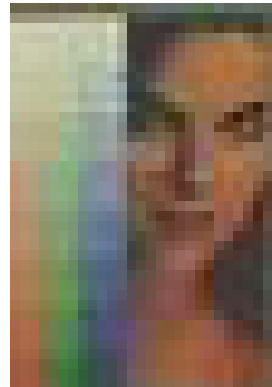
Hi-res Video

Point & Shoot  
(digital still)

Original



After color  
profiling



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# 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



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# Simulated Demonstration of “Quality in the Loop” for Image Selection (Webcam)

**Webcam**



**(15 fps)**

**Video from Digital Point and Shoot**



**(30 fps)**

**Sample video clips to be analyzed**



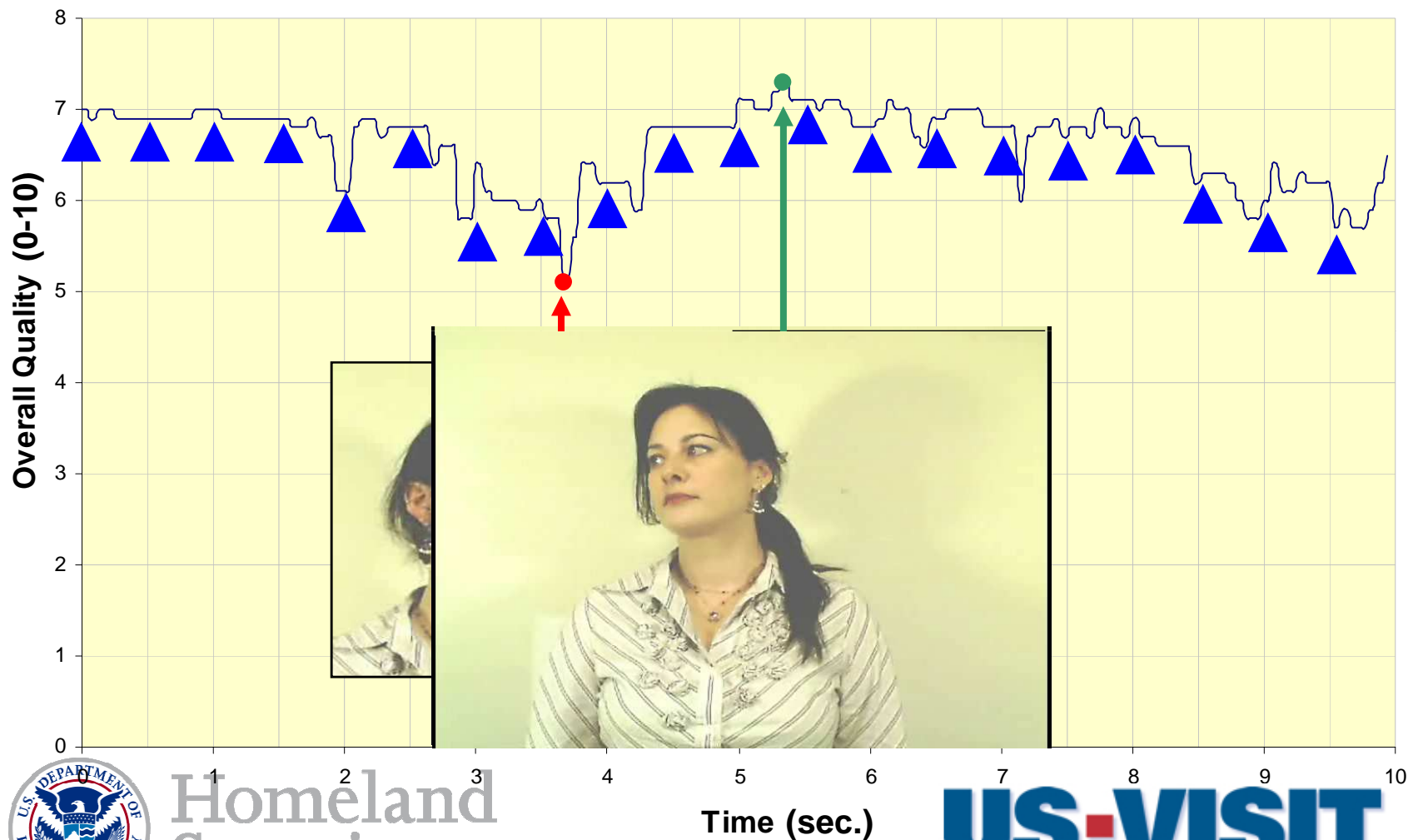
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# Simulated Demonstration of “Quality in the Loop” for Image Selection (Webcam)

Overall Quality vs. Time



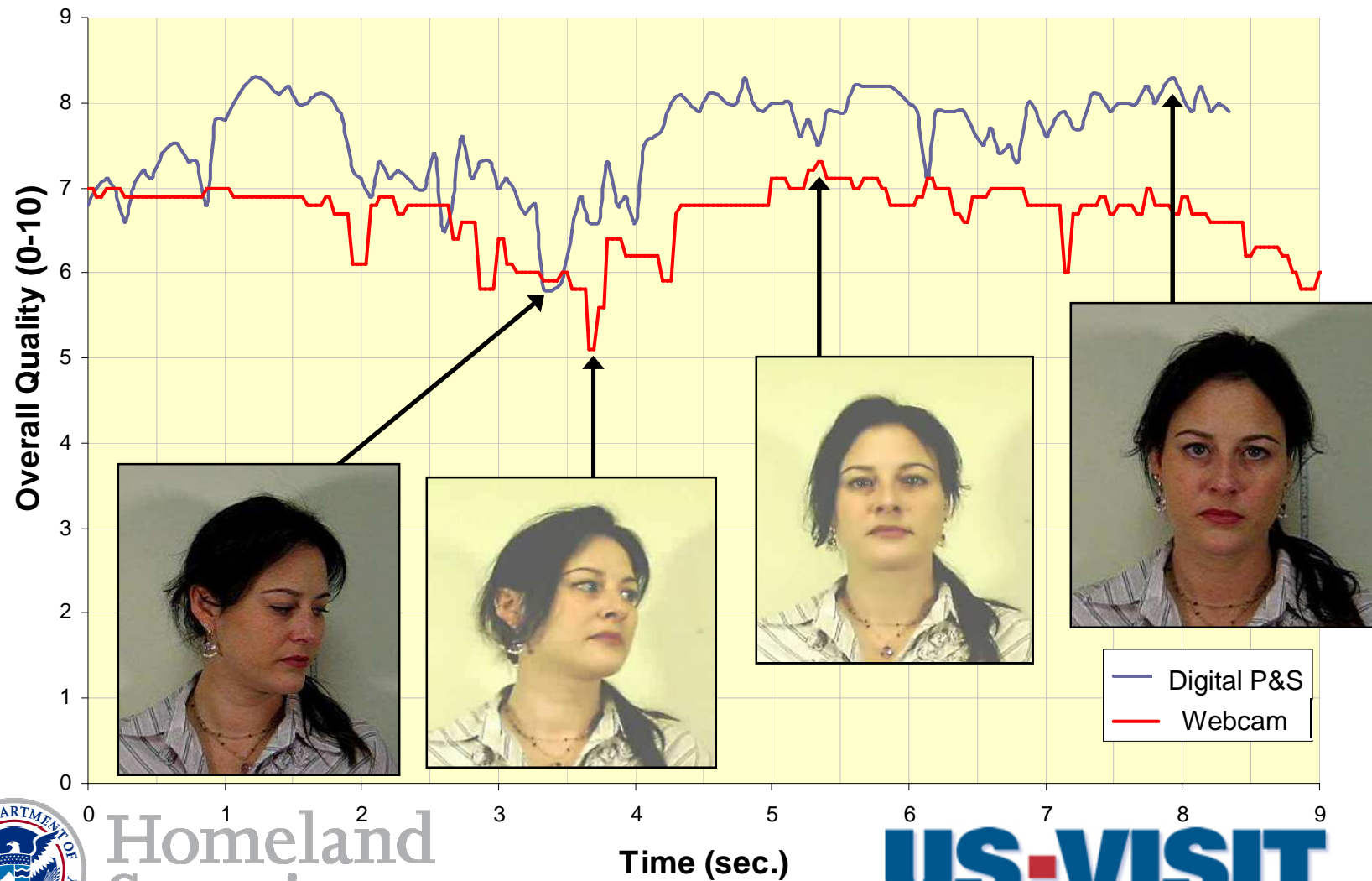
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# Comparative Quality of Webcam and Video From a Digital P&S Camera



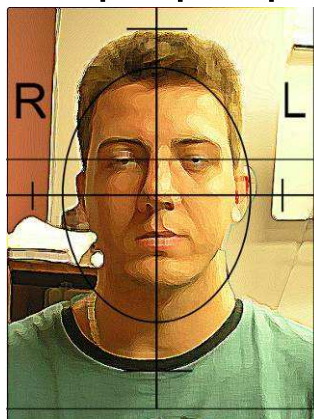
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# Face Capture Usability Considerations

- 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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