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Dual Mode: Thermal Infrared (IR) and Visible Face Recognition*



Lawrence B. Wolff
Equinox Corporation
9 West 57th Street
NY, NY 10019



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* This development effort supported by the DARPA
Human Identification at a Distance (HID) Program.

Background

- Existing Face Recognition systems primarily use conventional visible cameras
- Thermal IR imaging in combination with visible imaging has potential to bridge the performance gap between passive face recognition systems, and fingerprint/iris biometrics.



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Equinox Face Recognition System

Rank Ordering
Of Face Matches

VisIR
Camera



Fused
Visible/Thermal IR
Image

SPIE Imaging and Optical Technology Exhibition
Seattle, Washington July 2002



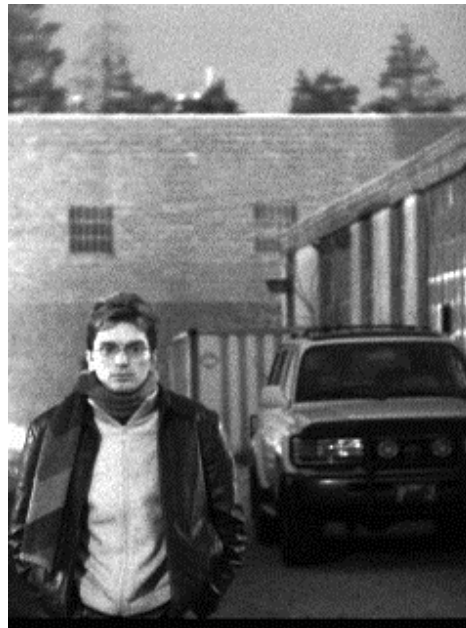
Fused Visible Thermal IR Imagery

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LWIR



Visible



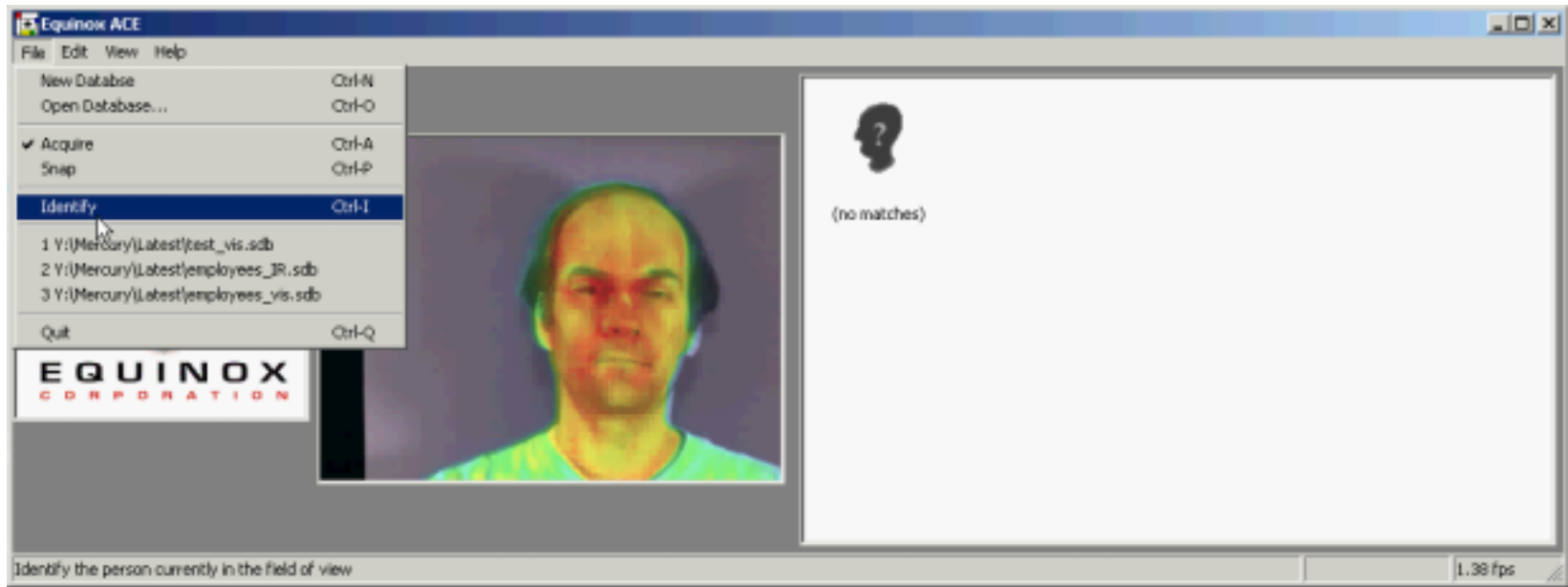
Fused Visible/LWIR





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Equinox ACE System





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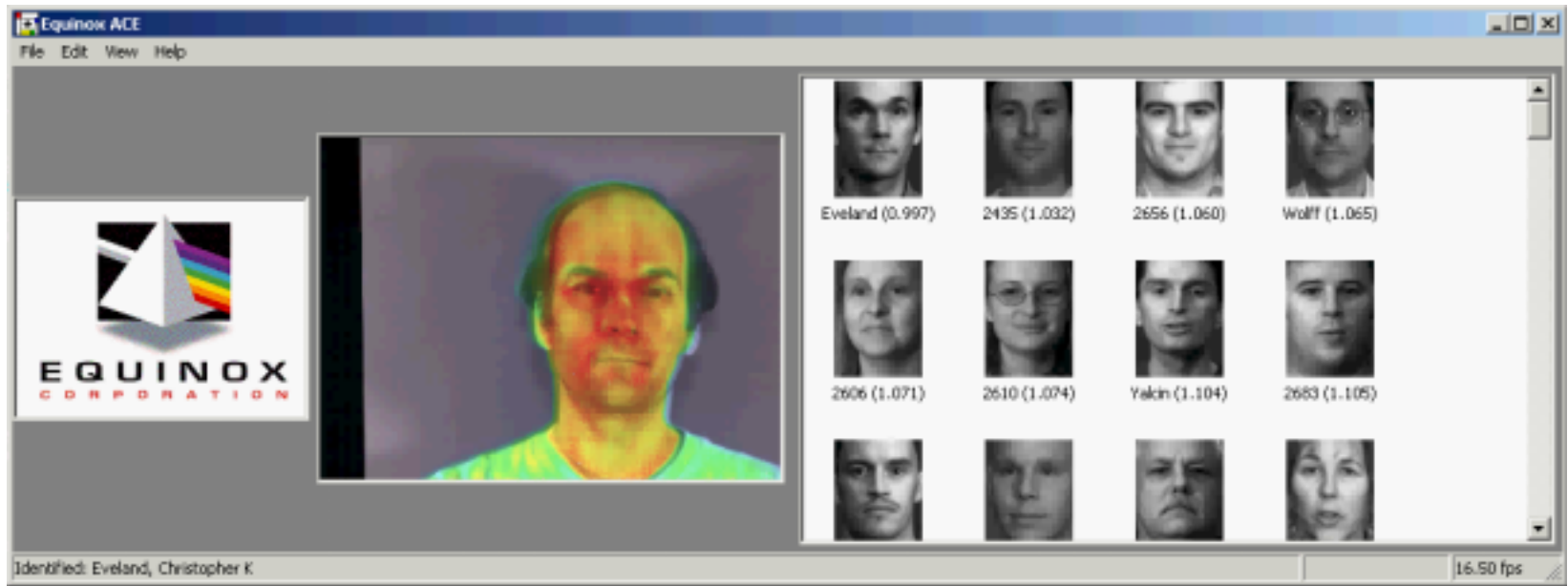
Equinox ACE System





Equinox ACE System

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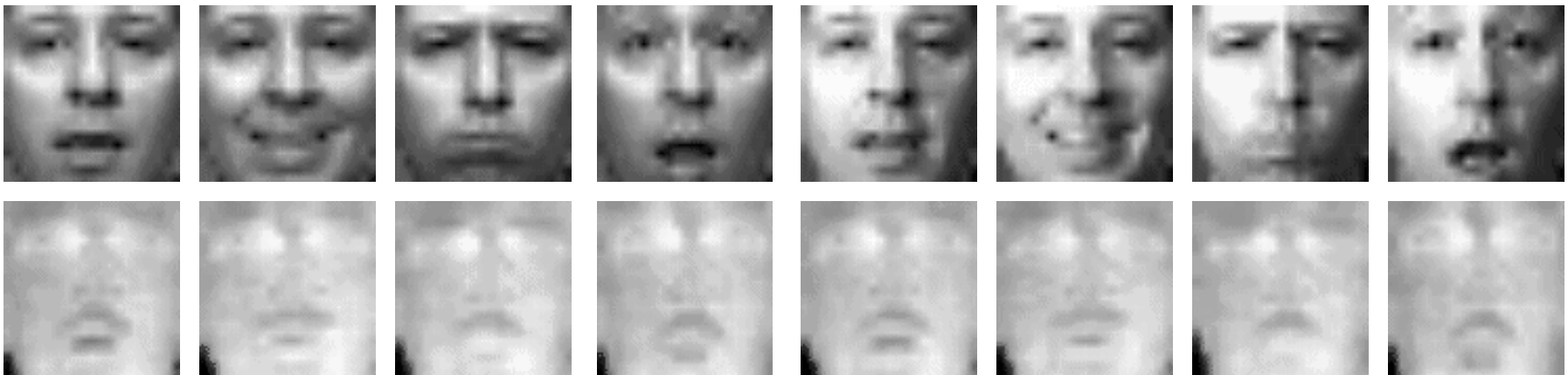




Equinox Face Database

(available at <http://www.equinoxsensors.com/hid>)

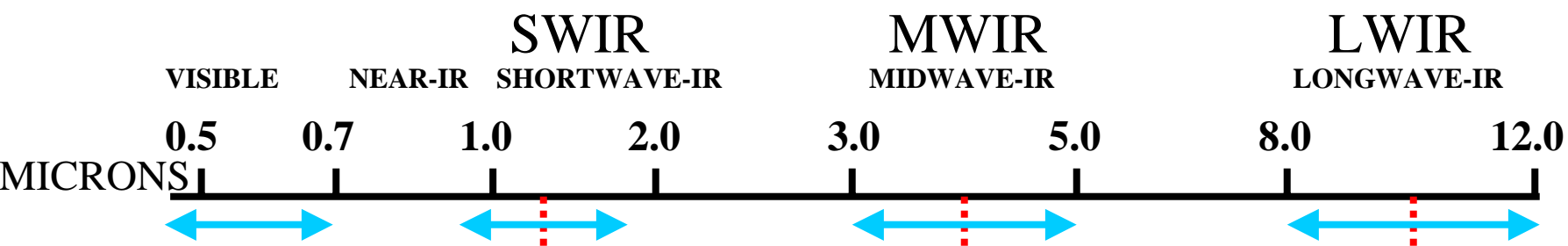
- So far 340 individuals imaged at NIST, Gaithersburg MD. Indoor and outdoor imagery. Further data collections are on-going.
- For each individual:
 - Images simultaneously acquired in visible, ShortWave InfraRed (SWIR), MidWave InfraRed (MWIR) and LongWave InfraRed (LWIR)
 - For each of three illumination conditions
 - 40 frame contiguous sequence while subject recites a standard phrase.
 - 3 different expressions





MULTISPECTRAL FACE IMAGES

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Sensor Set-up for Data Collection

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Use a Monte Carlo approach to gallery/probe resampling to achieve reliable performance estimates and their variances.

Evaluate multiple combinations of subspace representations and distance functions.

Consider the effects of rank, number of gallery images over subject and fusion of modalities.

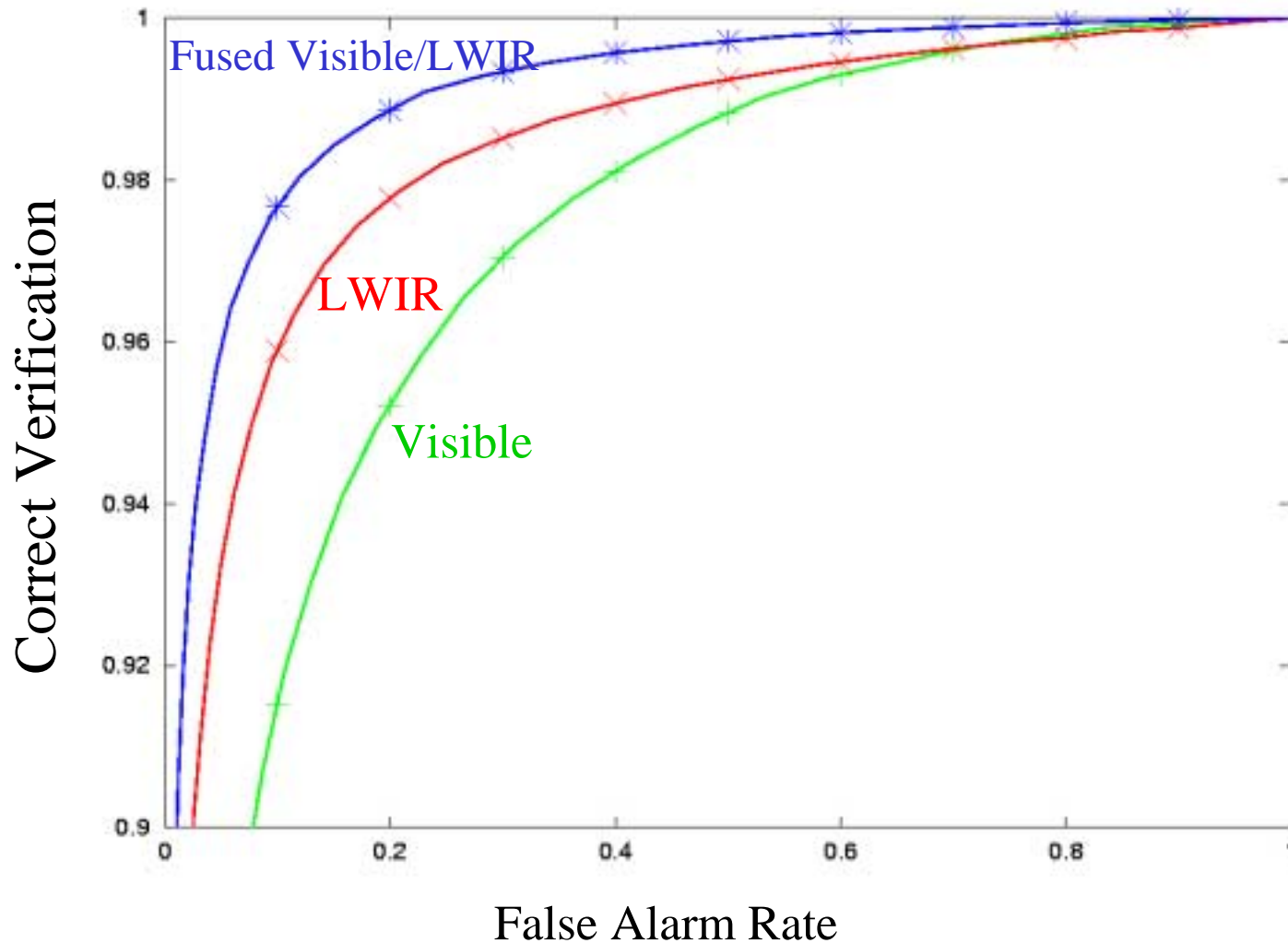
Carry on paired tests to guarantee comparison of respective algorithms/modalities under the same evaluation sets.

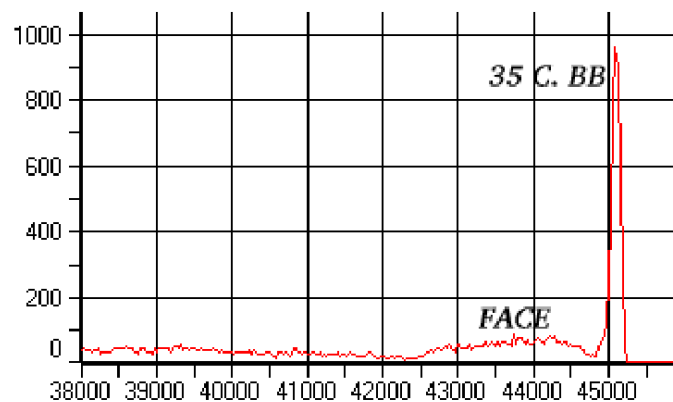
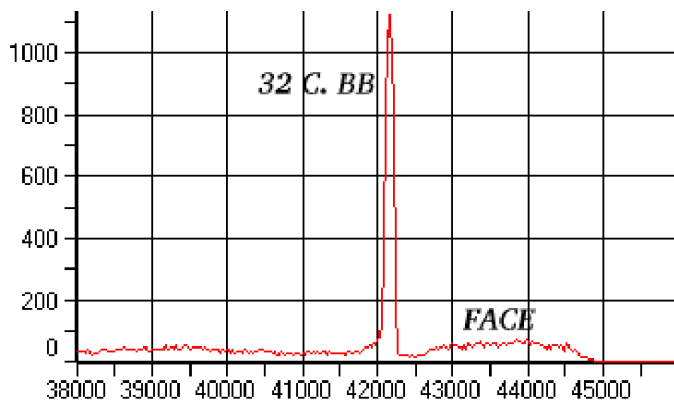
Extract mean paired performance differences under constraints of statistical significance.



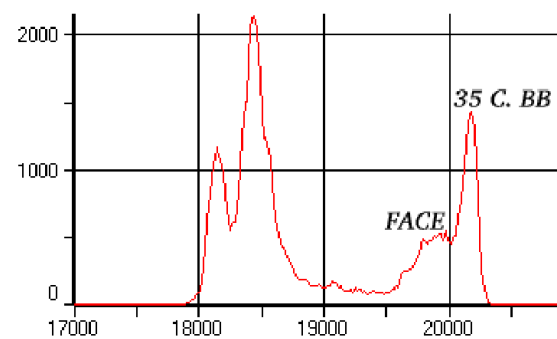
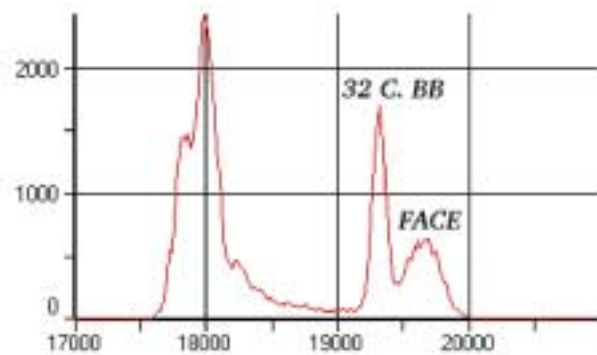
ROC Performance

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LWIR



Estimate of the average emissivity of human facial skin

BC2002

$$\epsilon_{\text{MWIR}}^{\text{skin}} > \frac{\text{SKIN}_{\text{energy}}^{\text{mean}}}{\int_3^5 Q(\lambda, 310^\circ \text{K}) d\lambda} = 0.91$$

$$\epsilon_{\text{LWIR}}^{\text{skin}} > \frac{\text{SKIN}_{\text{energy}}^{\text{mean}}}{\int_8^{14} W(\lambda, 310^\circ \text{K}) d\lambda} = 0.97$$



Results of Illumination Variation Outdoors

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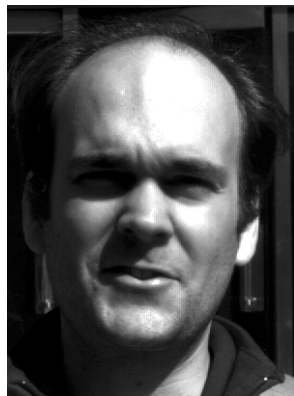
Visible

SWIR

MWIR

LWIR

Right Sun
Illumination



Frontal Sun
Illumination

