

## New Developments in Iris Recognition

*Changing How the World  
Looks at Iris Recognition*

CIBRA 2010, Buenos Aires, Dec 2010

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# Tech Development Decade: Snapshot

- 1999-2002
  - Single eye cameras
  - Algorithm monopoly
- 2002-2005
  - Dual eye camera
  - Early mobile/handheld devices
  - Algorithm experimentation
- 2006-present
  - Widespread algorithm exploratory/development
  - Continued mobile/handheld development
  - No contact/automated acquisition platforms
    - “Iris on the Move”:
    - “Iris at a Distance”:

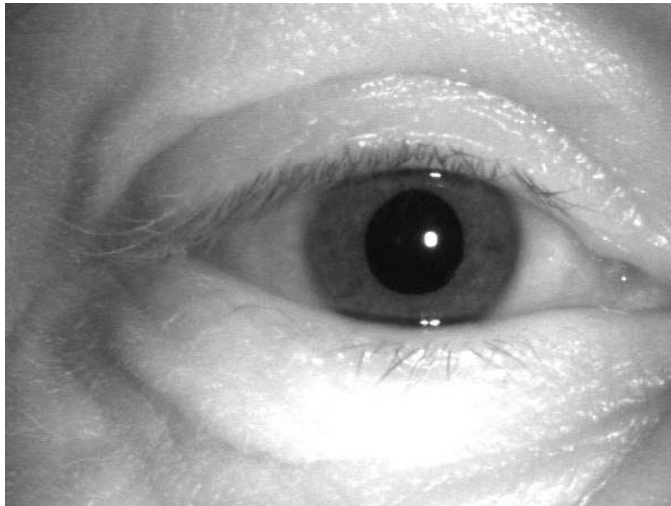
# The Trouble With Labels

- “On the Move”
  - Core proposition: biometric acquisition of moving subjects drives throughput.
- “At A Distance”
  - Differentiation from IOM over-emphasizes technology’s early roots

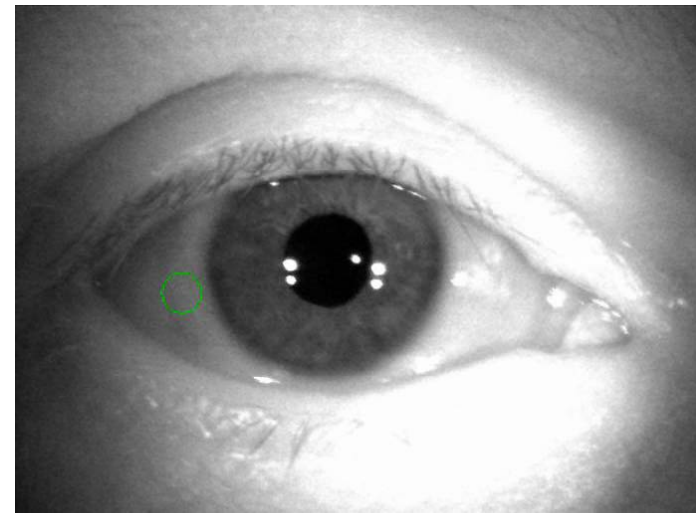
Both aim at throughput, but deliver it in significantly different ways

# Distance and Early AO Experiments

- Outstanding “long stand-off” image quality



Panasonic BM-ET300  
production unit at 12 inches

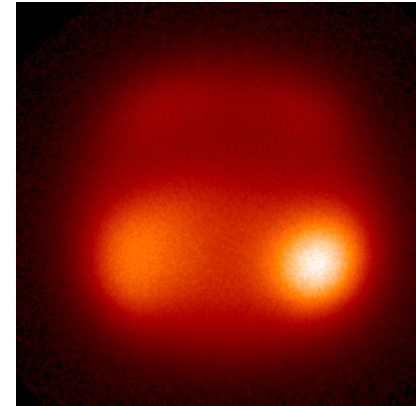


AOptix prototype  
at 10 meters

...

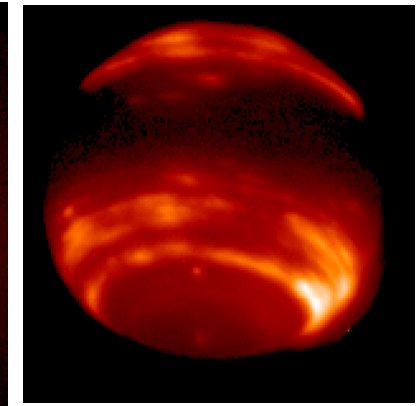
# Adaptive Optics Astronomy Roots

- Originally developed for land-based astronomy
- Corrects for atmospheric distortions between object and receptor
- Improves spatial resolution up to 20x

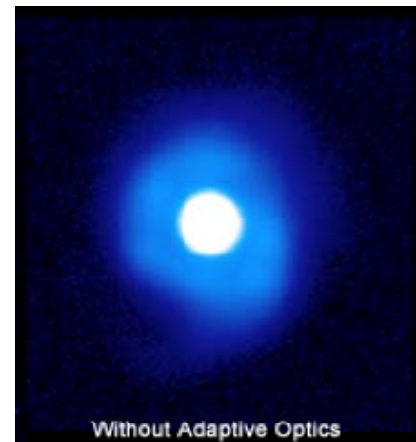


No AO compensation

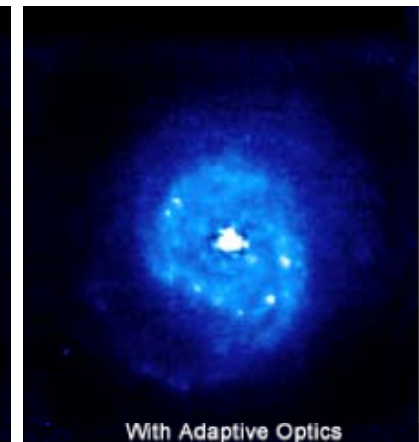
Neptune IR image, *Keck Observatory, 1999*



AO Compensation



Without Adaptive Optics



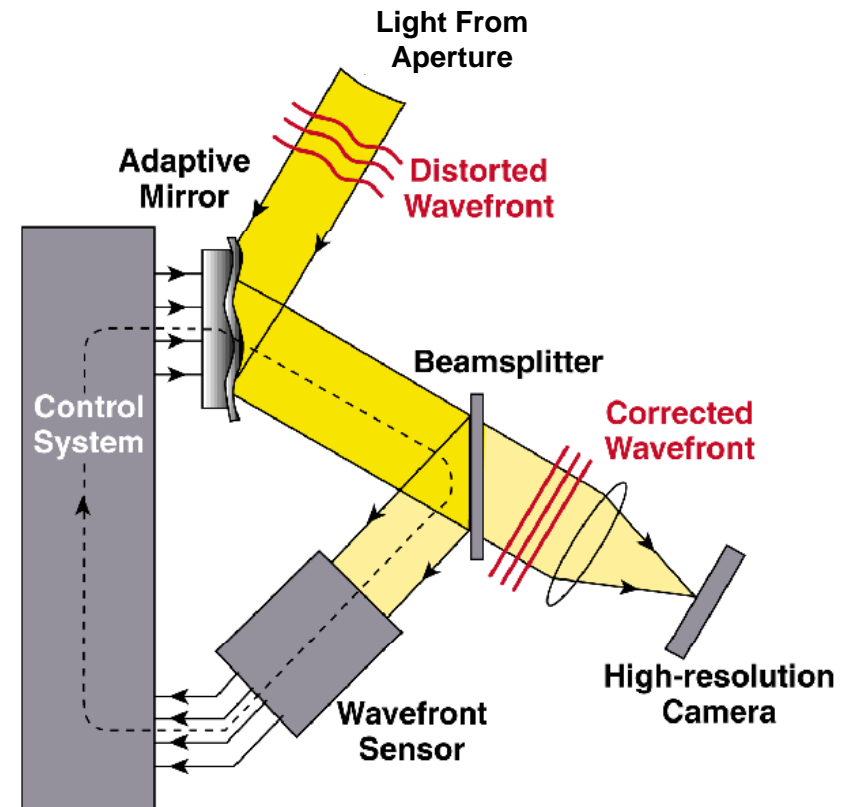
With Adaptive Optics

The nuclear region of the nearby galaxy NGC 7469,  
*CFHT in Hawaii*

# What is Adaptive Optics?

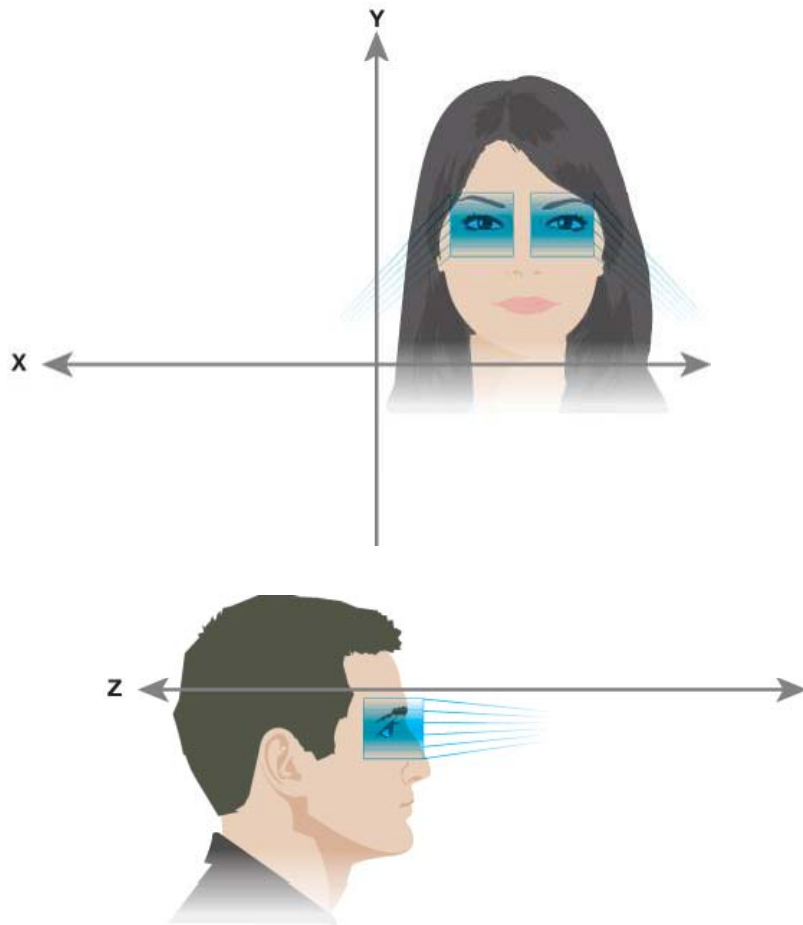
- Definition

“Optical system in which controllable and moveable optical elements optimize performance of the system in presence of wavefront errors.”
- Key Components:
  - Closed loop control** calculates corrections for control of optical elements in real time
  - Wavefront sensor** measures wavefront errors
  - Deformable mirror (DM)** -- the fastest high speed optical actuator

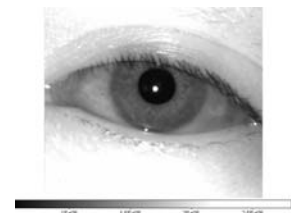


Source: C. Max, University of California, Santa Cruz

# Adaptive Optics (AO) in Iris Recognition



- Gets 3-dimensional information from 2D wavefront sensor
  - Position of face in x-y
  - Distance from camera, z
- Ability to lock on and track the eye, delivers outstanding iris images:
  - always centered
  - always focused



# To Redefine the Subject Experience



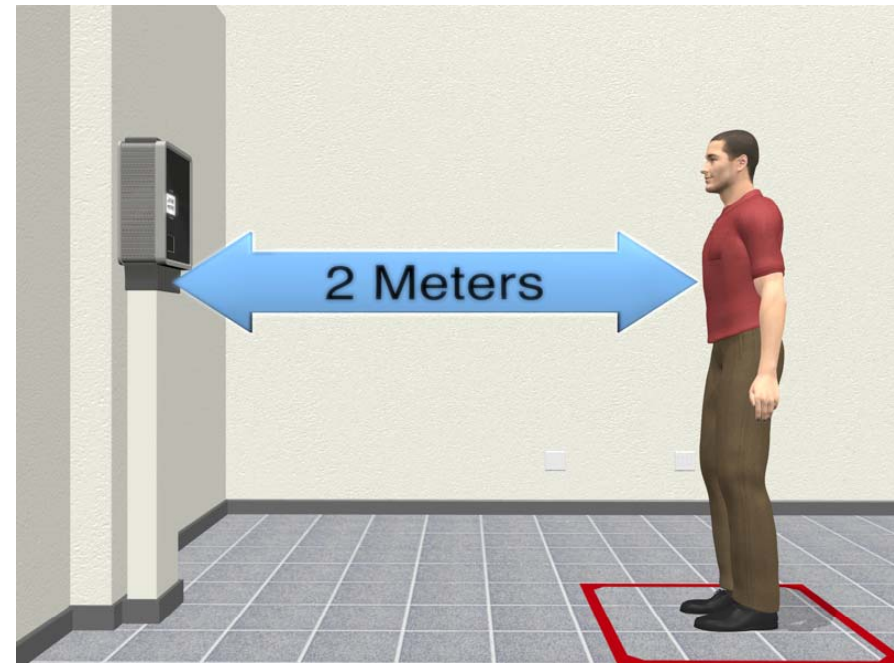
Andhra Pradesh, India ,enrollment of more than 50 million subjects for entitlements card

## Conventional Imagers

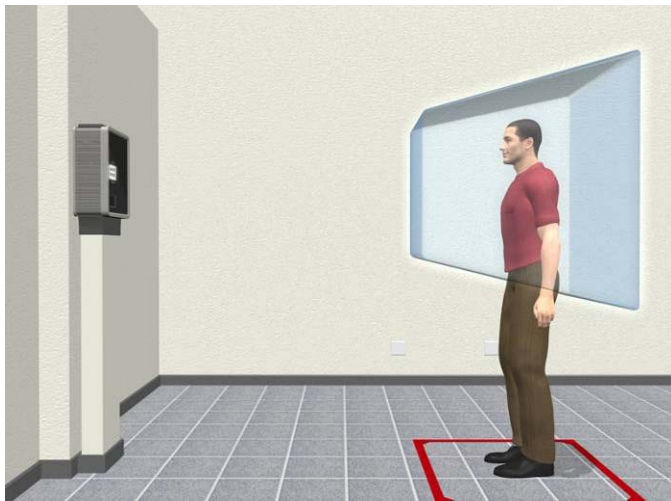
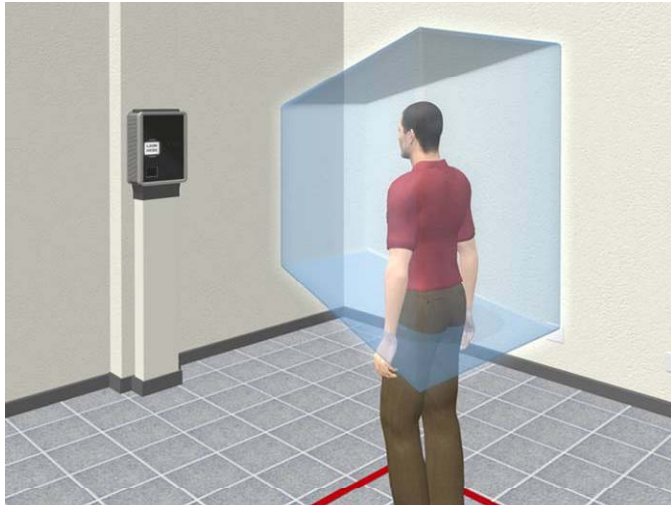
- Improvements needed in man / machine interface
  - Particularly in applications where subject is not “habituated” or where throughput is needed.
- Effort required to properly align and position, even with newer two eye machines

# A Little Cooperation Goes A Long Way

- Why cooperation?
  - Nominal 2 M Stand-off
- Operating range of 1½ to 2½ meters
- Non-intrusive
  - Non-contact for ease of use and hygiene
  - Respects personal space for all cultures
- Delivers queuing efficiency



# The Biggest Capture Zone Ever



- Image capture zone measures .75 cubic meters
  - 1 meter deep
  - 1 meter tall at mid-plane
  - .75 meters wide at mid-plane
- Taller than wide to accommodate full range of subject heights
  - Volume expansion enables very tall/very small to use
  - Mid-zone: Wheelchair height to <math><1.0\text{M}</math>-<math>2.2\text{M}</math> at the back.

# Minimizing Subject Participation

## By Totally Automating Image Capture Process

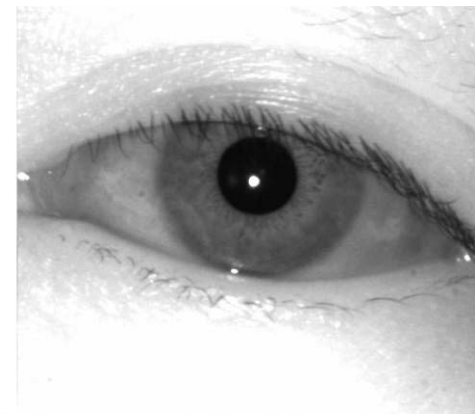
1

Finds face, then eyes in capture zone



2

AO system locks on eye, then captures iris images



1E+08 1.5E+08 2E+08 2.5E+08

# Reinventing the Man/Machine Interface

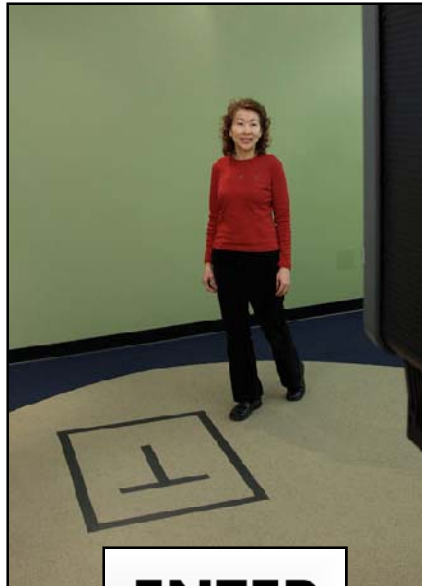
Creates An Iris System That Automatically Finds The Subject—Rather than Other Way Around



- Simple instructions:
  - Position in box
  - Look at target
  - Open eyes

# To Deliver Very Simple ConOps

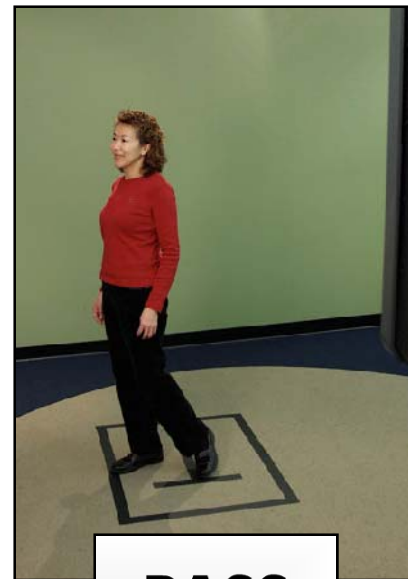
- Engagingly SIMPLE Visual, Not Audio Cues



**ENTER**  
↑



↙ **LOOK** ↘  
**HERE** ↗ ↘



**PASS**  
✓

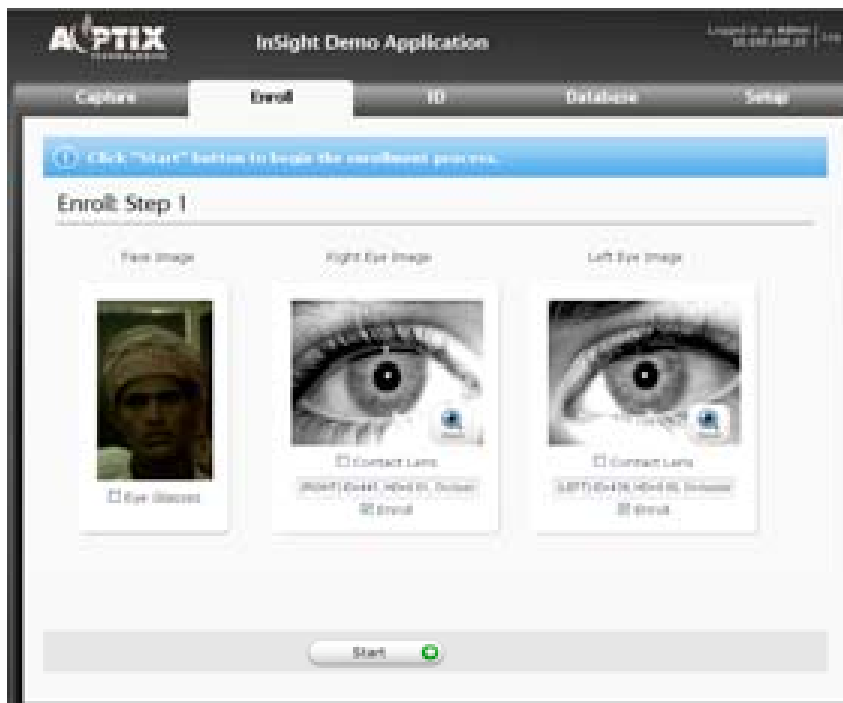


**ENTER**  
↑

- Imaging One/Two Eyes in Mere Seconds

# Quick Capture of Pristine Images

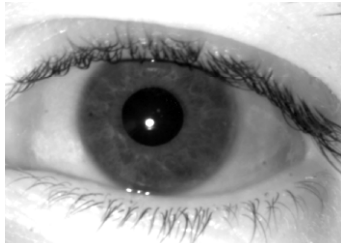
## Sequential L/R Eye Capture



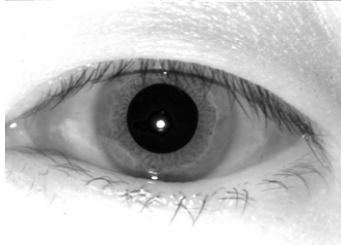
## Auto Check For Duplication



# Improving Subject Image Quality



**Excellent**



**Good**



**Fair**



**Poor**

## Problem:

- Overly occluded eyes and off-angle eye gaze can yield FTE/FTA and impair matching scores.

## Solution:

- Human factors-related instructions yields improvement of IQ at time of acquisition
  - “Please look at target and open your eyes for a few seconds”
- Allows higher *feasible* IQ metric threshold for acceptance
- Very fast system speed permits *immediate* recapture if necessary

# InSight 2M System Productization

- COTS product since Q4 2009
- Market targeting/adoption
  - Border Control
  - Aviation Security & Expedited Passenger Processing
  - Justice Sector
  - Specialty Access Control (Public and Private Sector)



Mounting Options



Affixed



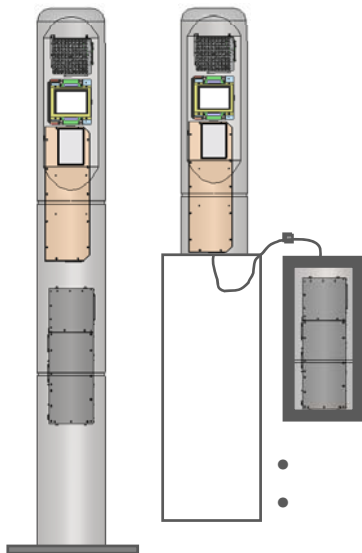
Flush

# VM (Slim) Configuration/Efficacy

## Mechanical Configuration

- Imager footprint <math>.5m^2</math>
- Produces capture volume of <math>.75m^3</math> at distance of 1.5 - 2.5 meters from imager.

- Note: Possible to detach towered imager and computational arrays and reconfigure for integrated use in e-Gate arrays or other constrained applications as separation distances have been tested to 2M.

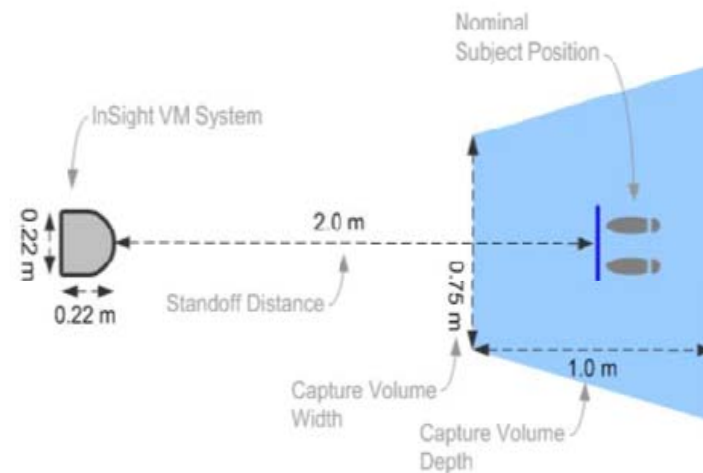


- Separates optics, electronics and illuminator
- Customized skin affords design-complementing aesthetics



## Operational Footprint

### System Footprint – InSight VM



# Field Update

- Recent proof-of-concept trials in Middle East
  - GCC Country 1: Ministry of Interior: real-time national blacklist checks
    - land border crossing checkpoint for truck drivers
    - International Airport – airline passenger at immigration
  - GCC Country 2
    - Expellee Deportation Center

# Results Overview

- Goal of POCs and trials: To measure key deployment parameters in challenging real-world environments
  - Diverse populations
  - Language barriers
  - Limited technology familiarity and acclimation for operators and subjects
- Very positive performance results for key deployment parameters
  - **Low FTA:** 0.0% – 1.2% FTA rates
  - **Fast:** Typical 4 to 5 second capture time for two eye capture

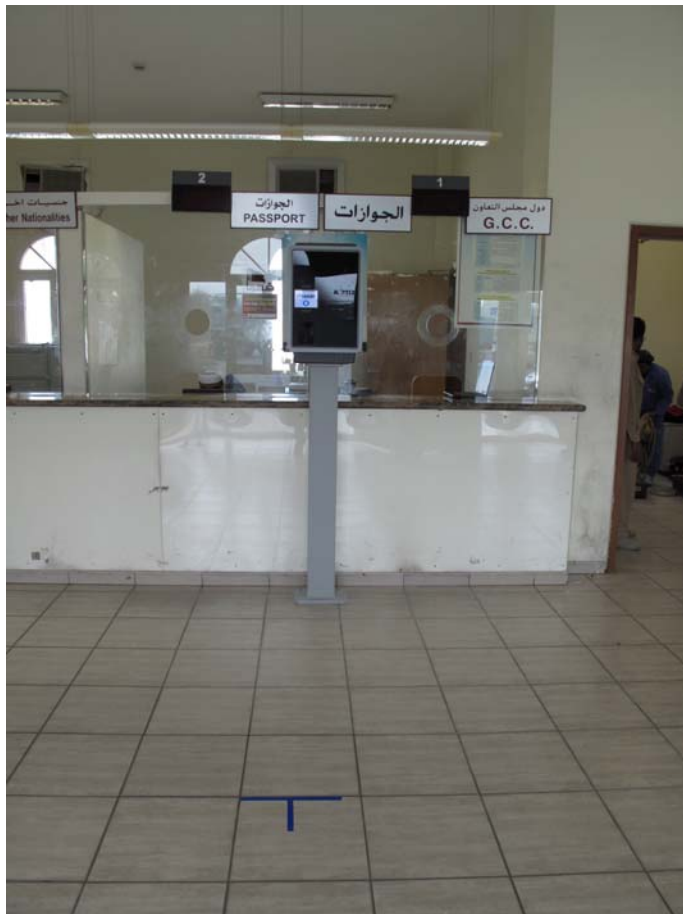
# GCC Land Border Crossing

- Real-time blacklist check for cross-border truck drivers
- ConOps and environment:
  - Pedestrian (not in-vehicle)
  - Two eye capture; retries permitted
  - No signage and minimal instruction set from border control officers
  - Challenging population
    - Skin tone, facial hair, and attire
    - Language barriers
    - No familiarity with technology
- Results from sample of 135 truck drivers:
  - 0.0% transactional FTA
  - Median capture time of 3.8 seconds for two eyes

# GCC 1 Land Border Installation



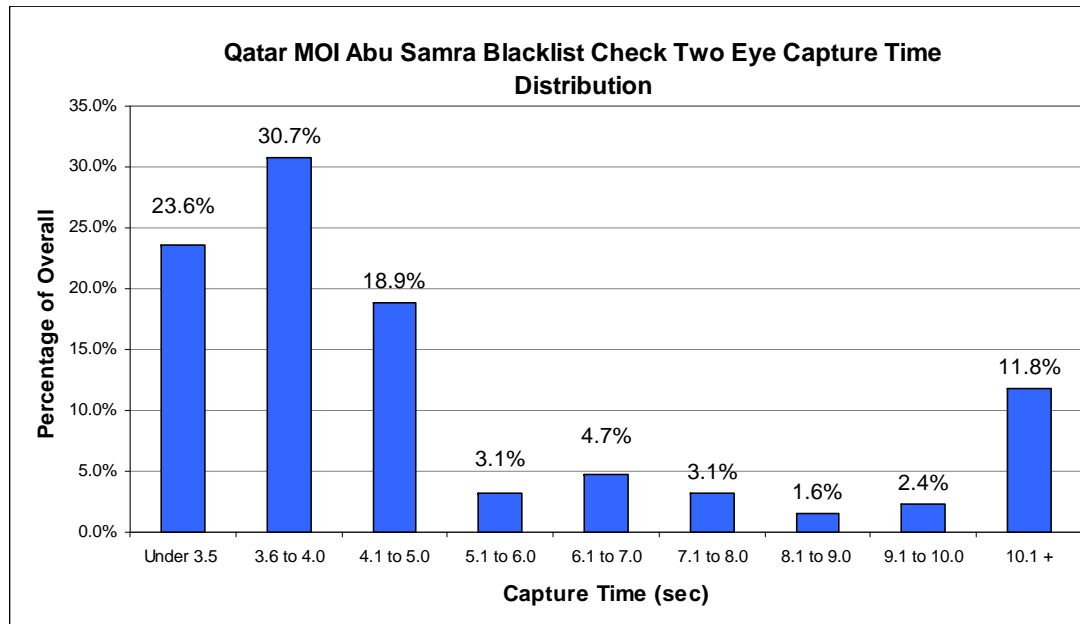
View from Subject Position  
(without Stanchions)



View from Officer Position



# Land Crossing Cumulative Timing Stats



**135 Subjects**

**0.0% transactional FTA rate**

(Eliminating 10+ second captures:)

- Average capture time: 4.6 seconds
- Median capture time: 3.8 seconds

Cause for excessive capture timing (above 7 seconds) – 24 samples total:

- 40% due to “Open Eyes Wide” message (in each case resulting in successful improvement in image quality prior to blacklist submission)
- 30% due to subject motion, not looking in the direction of the system, or not paying attention
- 30% due to miscellaneous subject behavior

# GCC#1 MOI –Airport POC

- Application: Real-time national scale blacklist check for airline travelers entering International Airport
- ConOps:
  - Pedestrian, with capture system located at immigration counter
  - Two eye capture
  - Minimal signage, minimal instruction set from border control clerks
- Over 4100 capture events in first week
- Data collection on 684 Travelers:
  - 1.2% FTA
  - Median capture time of 4.4 seconds for two eyes
  - Diverse, challenging population
    - Skin tone, facial hair, and attire
    - Language barriers
    - No familiarity with technology
  - InSight performed consistently without negatively impacting any other immigration processes.

# GCC #1 Airport POC



*InSight VM* Positioned In Immigration Counter



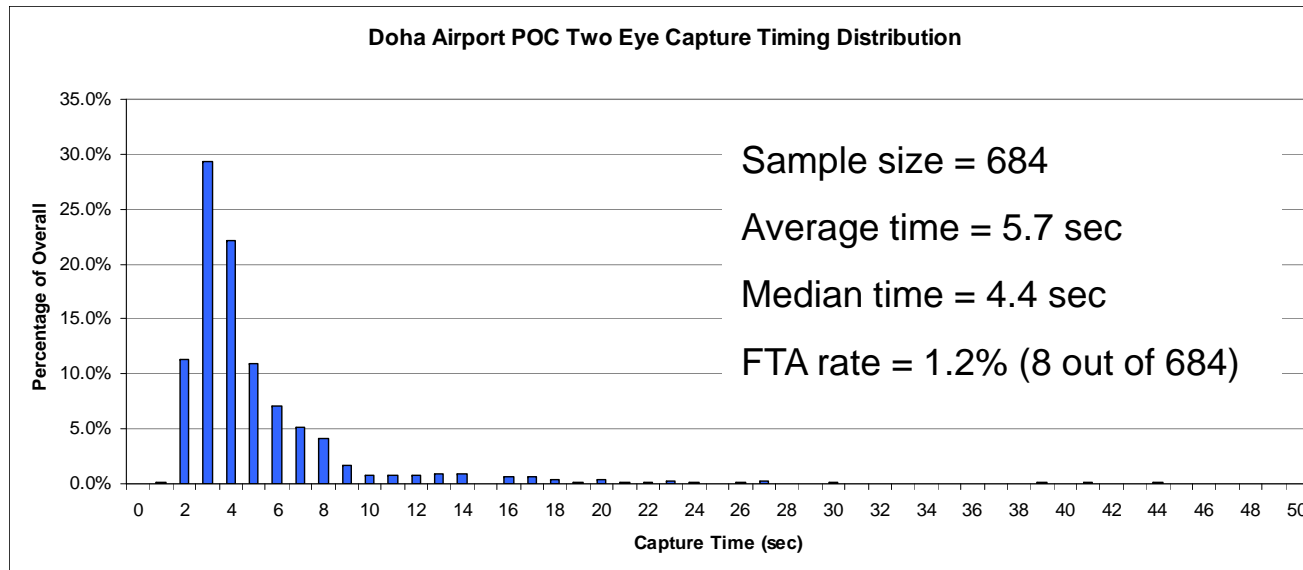
English / Arabic LCD Screens



Footprints for Intuitive Placement



# Cumulative Timing Statistics

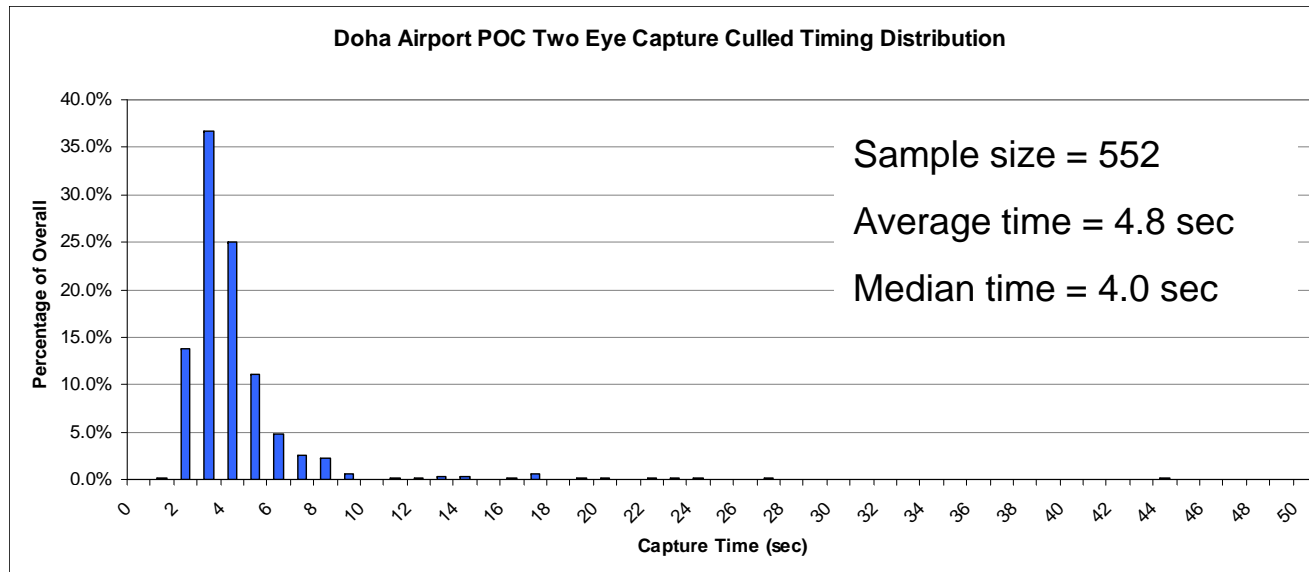


## Cause for excessive capture time:

1. Open Eyes Wide messages – 46 samples (6.7%)
2. Subject looking down or away – 44 samples (6.4%)
3. Subject moving – 43 samples (6.3%)
4. Backend system interruption – 25 samples (3.6%)
5. Poor subject position – 17 samples (2.5%)
6. Face finding issues (not FTA) – 9 samples (1.3%)
7. Subject initially wearing glasses – 6 samples (0.9%)
8. Miscellaneous issues (confusion, eye gaze, talking, hair in eyes, etc...) – 22 samples (3.2%)

Note: One subject may have multiple issues

# Airport Culled Timing Statistics



- 132 of the 684 capture events (19.3%) were slowed due to subjects not understanding or following the basic instructions.
  - The graph above represents the timing distribution for the 552 subjects who followed the basic instruction set
- *Improving signage should have a significant impact on throughput*

# GCC Country #2 –Deportation Center POC

- Deportee enrollment for GCC Country with large foreign worker population
  - Enrollment of subjects who are required to leave country
  - Prevents re-entry at later date with fraudulent documentation
  - Subjects principally manual laborers from Middle East, Indian sub-continent and South-east Asia
- ConOps:
  - Installed inside Deportation Center as part of enrollment process
  - Two eye capture
  - Controlled environment with instructions to deportees
  - Multiple attempts permitted (total of 5 attempts per subject)
- Challenging population
  - Skin tone, facial hair, and attire
  - Language barriers
  - No familiarity with technology
  - Some are physically constrained (in hand and foot shackles)

# Deportation Center POC Setup

000111001110

000110001110

1001

100110000011

10000111



# GCC#2 Deportation Center POC Setup

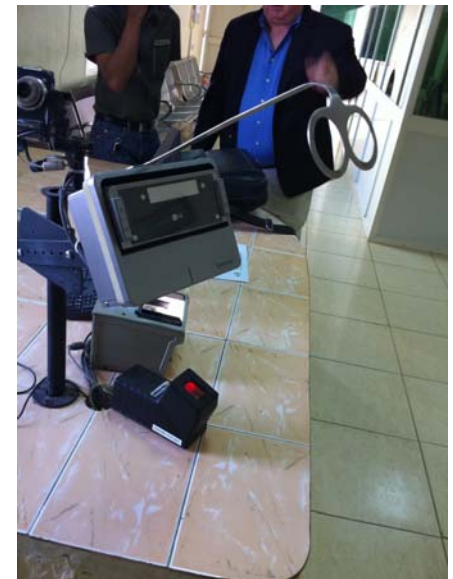
Multi-Language Instructions  
(English, Arabic, Urdu, Hindi)



Usability Challenges

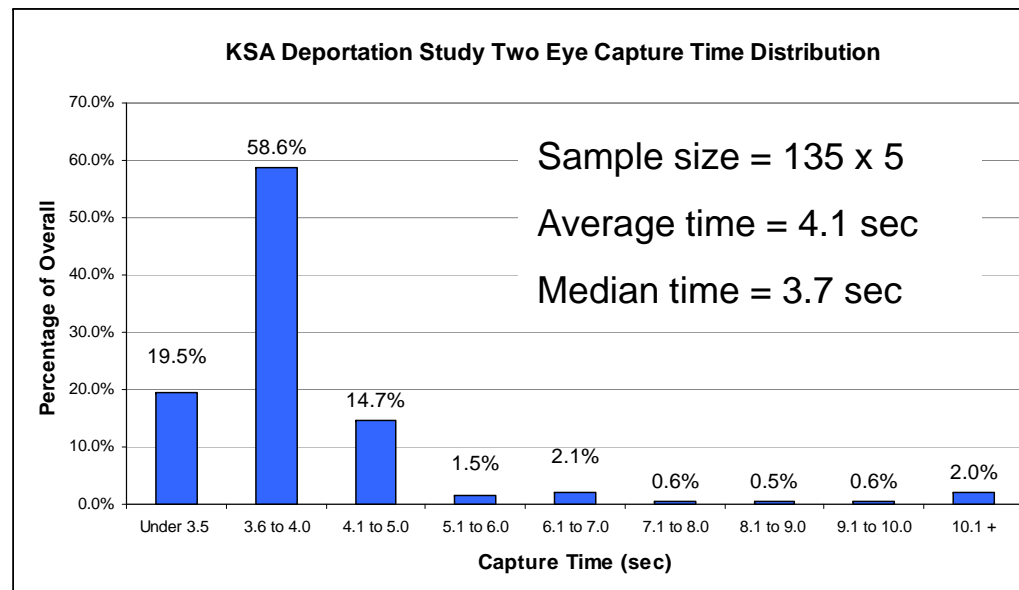


Previous Attempt to  
Control Human  
Factors



# GCC #2 Deportation Center Results

- Data collection on 135 deportees:
  - 0.0% transactional FTA
    - Attempt FTA rate of 1.9%
    - No subject had more than 2 attempt FTA's out of 5 total attempts
  - Median capture time of 3.7 seconds for two eyes



# Summary:

- Enhanced imaging is improving iris performance
  - Lower FTE's
  - Lower FTA's
  - Enhanced Image Quality (less occlusion/off-gaze) can enhance matching
  - Potential of iris + multimodality on track.
- Not necessary -- for subjects to be “in motion” to ensure high throughput.
  - One at a time, time after time, with low FTA A IS a cost-efficient security and throughput formula
    - Conops (especially if there is a stop involved: gate, PPT reader, or card reader.
    - Space and or People: preventive/recovery mechanisms