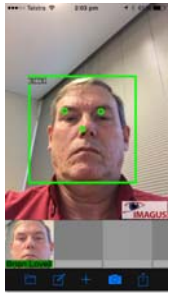
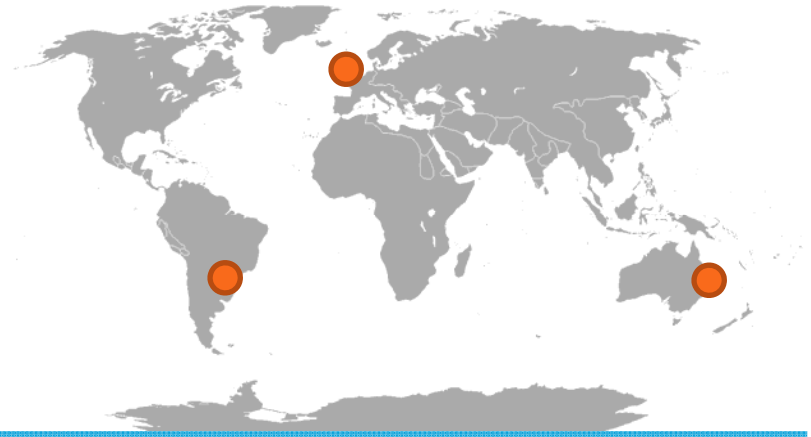
WSB-2017 January 2017



Secure Scalable CCTV, Mobile, and Wearable Video Face Recognition

Brian Lovell

The University of Queensland



ADVANCED SURVEILLANCE

Outline

- Conventional Cooperative Face Recognition
- FITC Technology Circa 2011
- FITC Technology Circa 2016
- Brazil and UK Project
- Pubs and Clubs Project
- Research Issues Arising

Airport

Railway Station

Seaport

The Basics

Cooperative Facial Verification

E.g. Airport smart gates, border control, access control

- Known reference image – e.g. passport photo
- Very high resolution
- Perfect artificial lighting
- Multiple high quality cameras
- No movement, no expression allowed
- One person at a time
- Photo based not video based
- Subject co-operation – the subject wants to be recognised
- One-to-one match – verification only, not true one-to-many recognition

Many Commercial Solutions available fully tested by NIST

Australia was first in the World with Face for Border Control

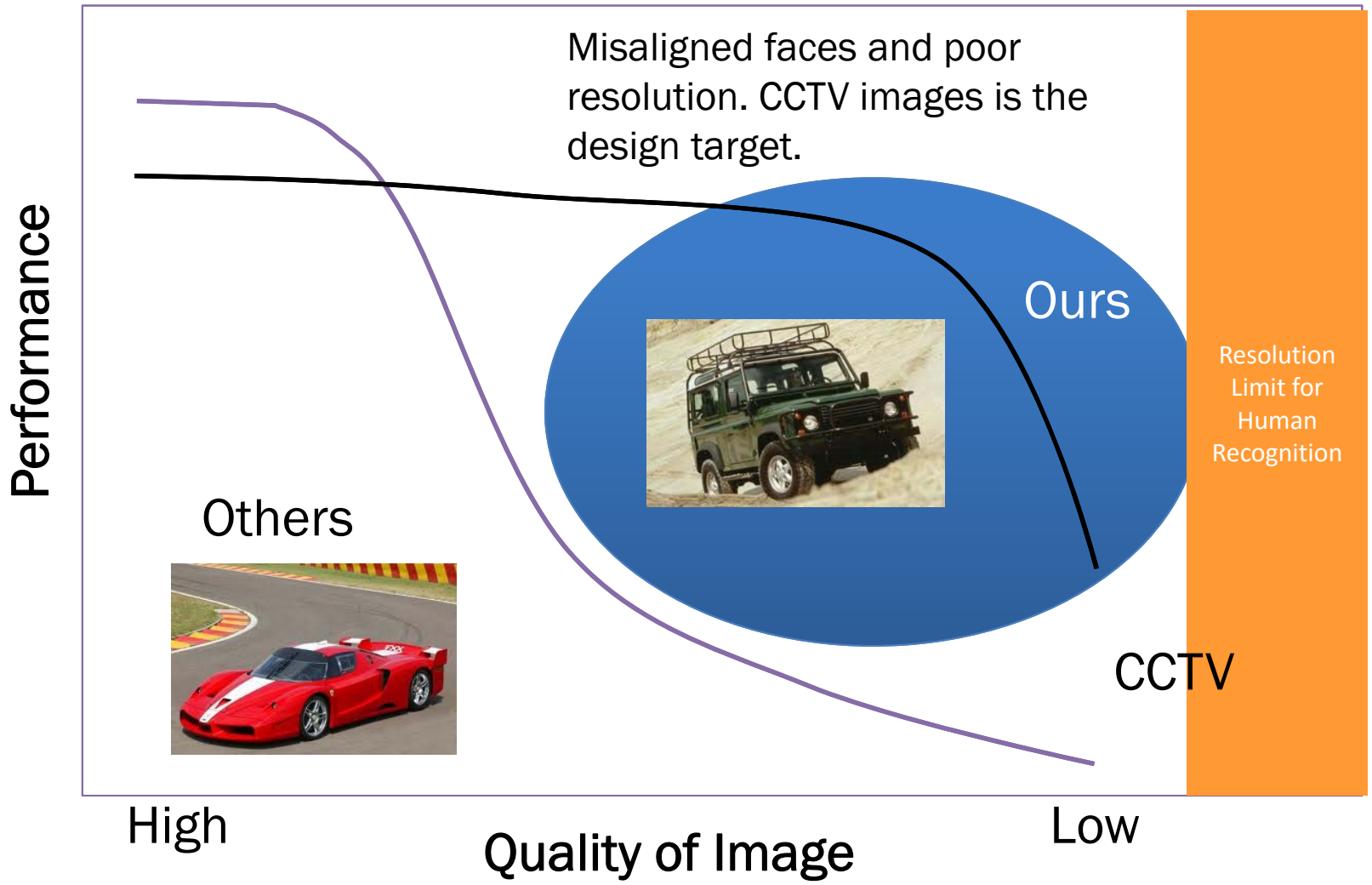
Cooperative versus Non-Cooperative Facial Verification

- *SmartGate*
- Are these two faces the same person?

WE ARE NOT INTERESTED IN THIS PROBLEM AS IT IS SOLVED (MOSTLY)

WHAT WE WANTED IN 2011 WAS FACE RECOGNITION FOR THE MASSES THAT WORKS RELIABLY FROM ANY CAMERA, EVEN A MOBILE PHONE – NOW THIS IS ALSO LARGELY ACHIEVED

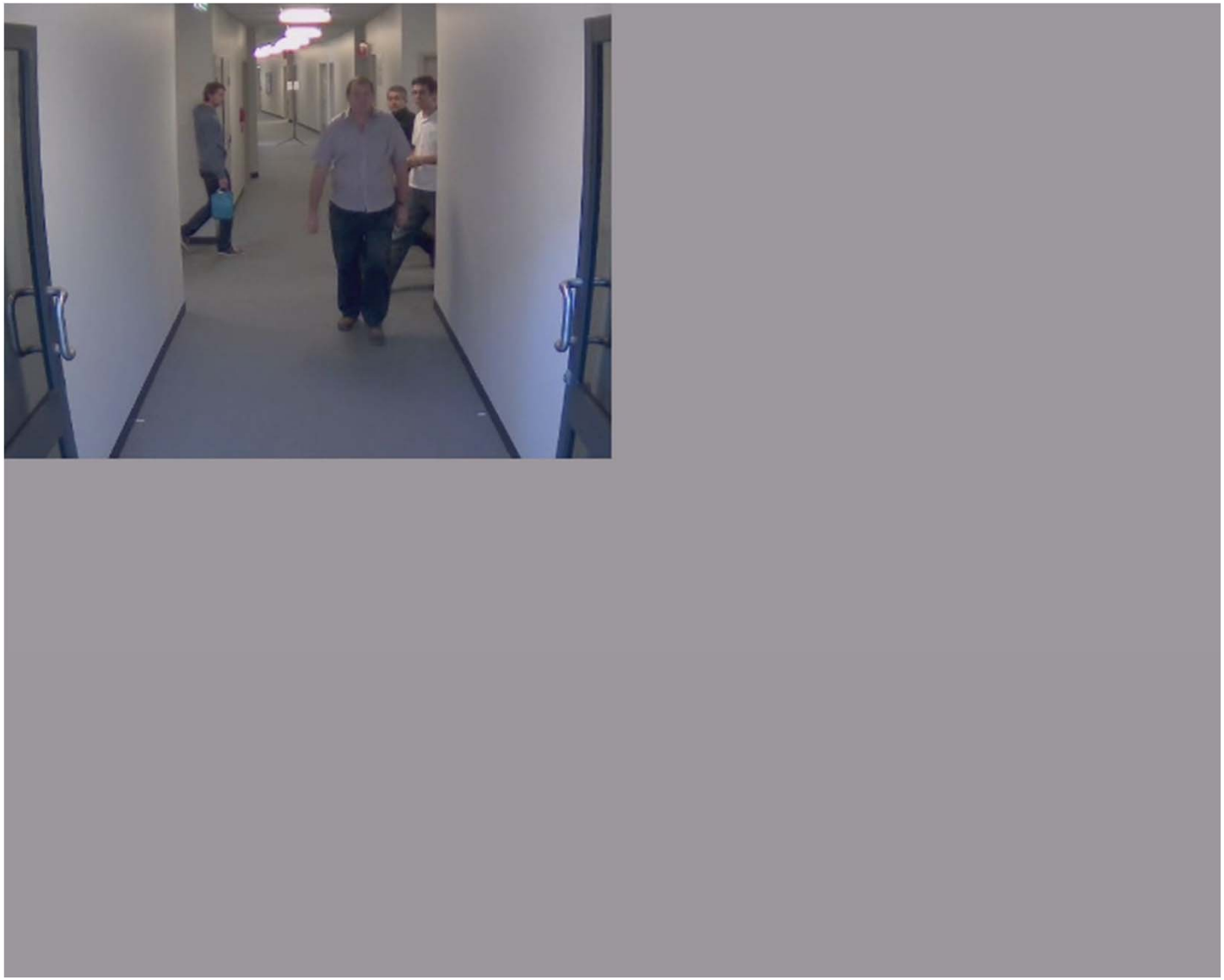
Face Recognition Landscape



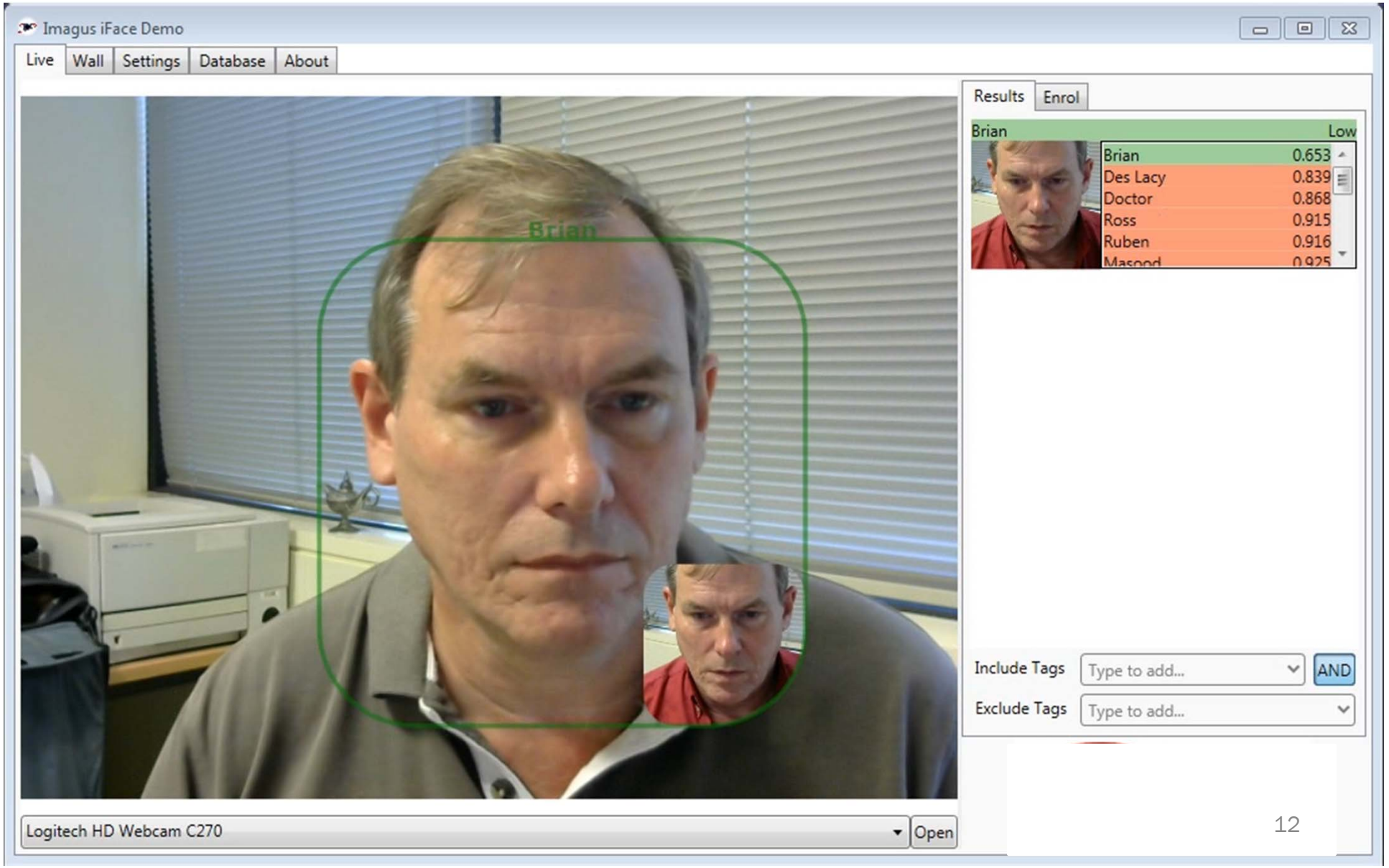
Aligned frontal, 100 pixels eye to eye

Partially aligned, non-frontal, 12 pixels eye to eye

2011: Person Identification in a Crowd



2015: New Generation Software
200x Faster and 50% More Accurate



2016 imQ Development

- Multicamera support in a single instance
- Queuing Measurements
- Cross Camera Transit Time
- Demographics (Age, Gender)
- Better face detection
- NVR functionality
- NVR Integration

2016 Award CIO Outlook

Mobile

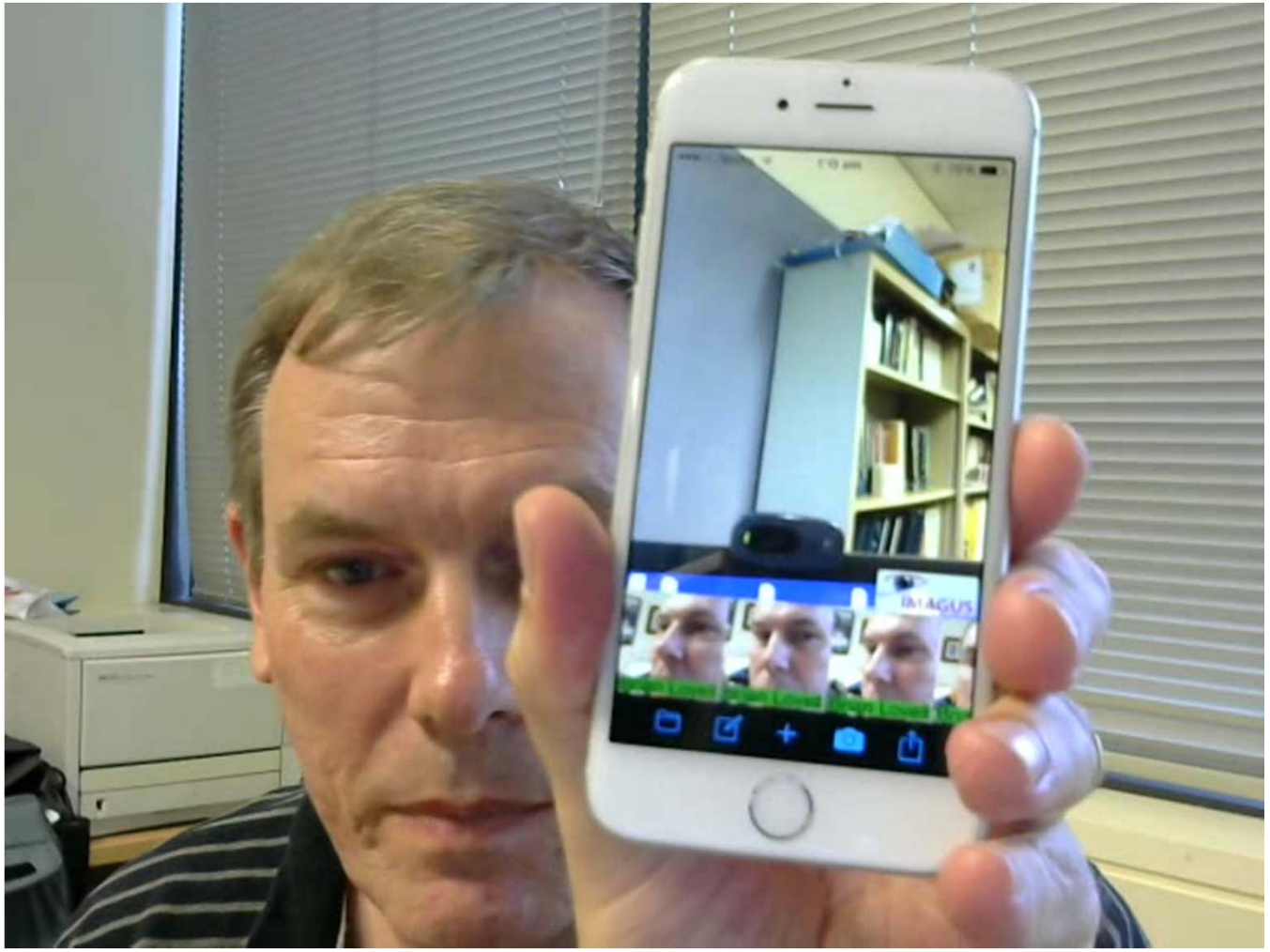
Video Face Recognition

IOS8 AND ANDROID

Mobile Live Video Face Recognition

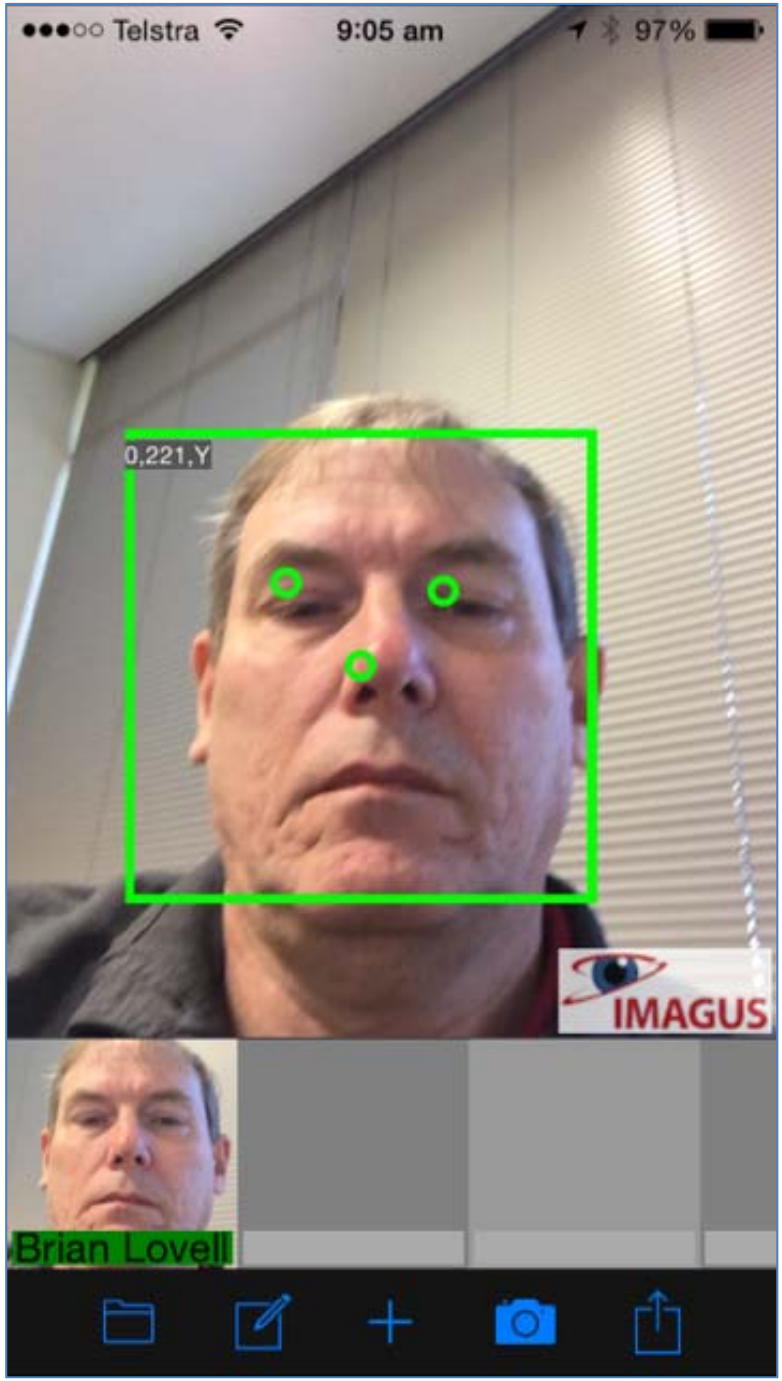
- Still image is relatively easy to process on a phone because there is only one face detection required
- Live video face detection requires real-time detection
- Fortunately modern devices have hardware face detection and sometimes even feature detection

iPhone 6 Version



Why Mobile Face Rec?

- Whole CV system is contained in one app so very easy to deploy compared to CCTV
- Able to capture faces at eye level
- Most CCTV Cameras are badly positioned
- Ability to move camera for better viewpoint
- Originally designed for Police Street Checks and Military Operations
- Gives human validated recognition, time, and location in the field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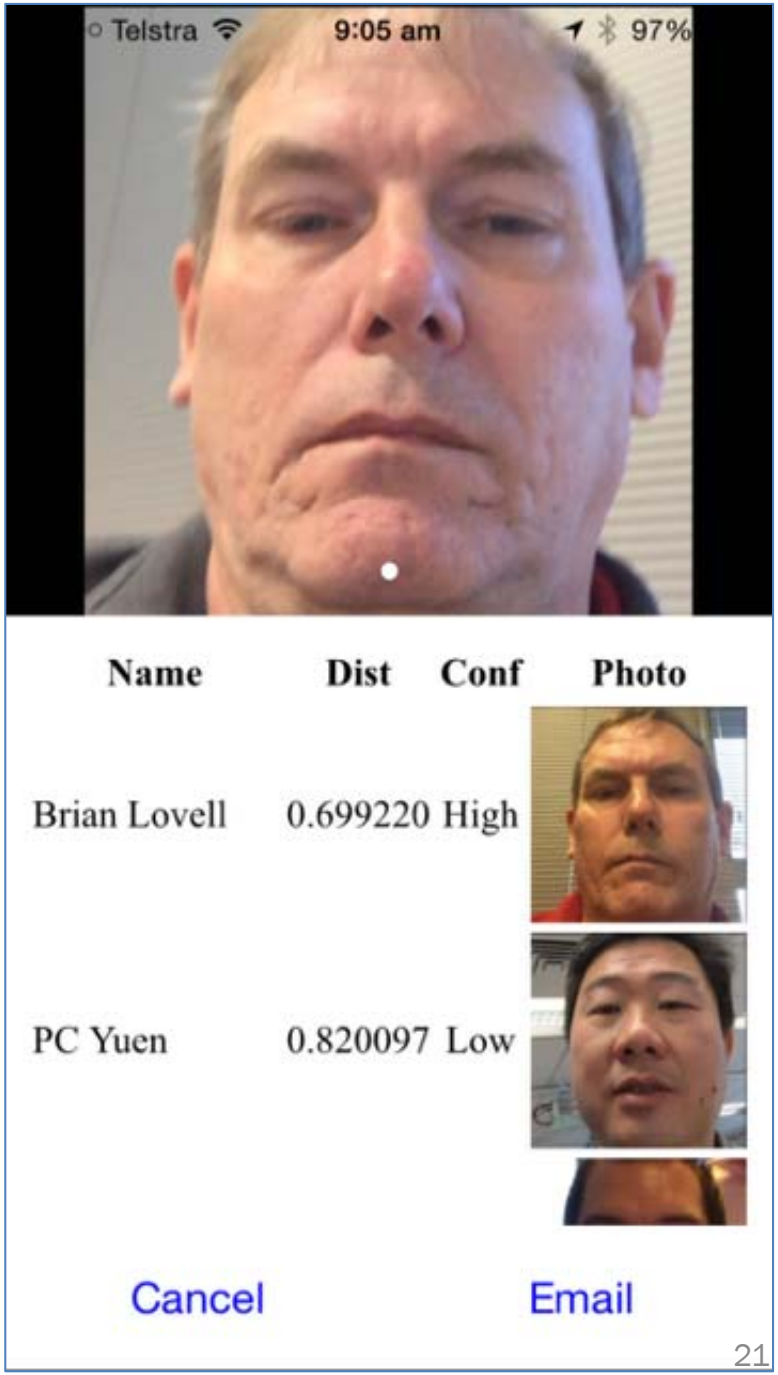
IMAGUS
Brian Lovell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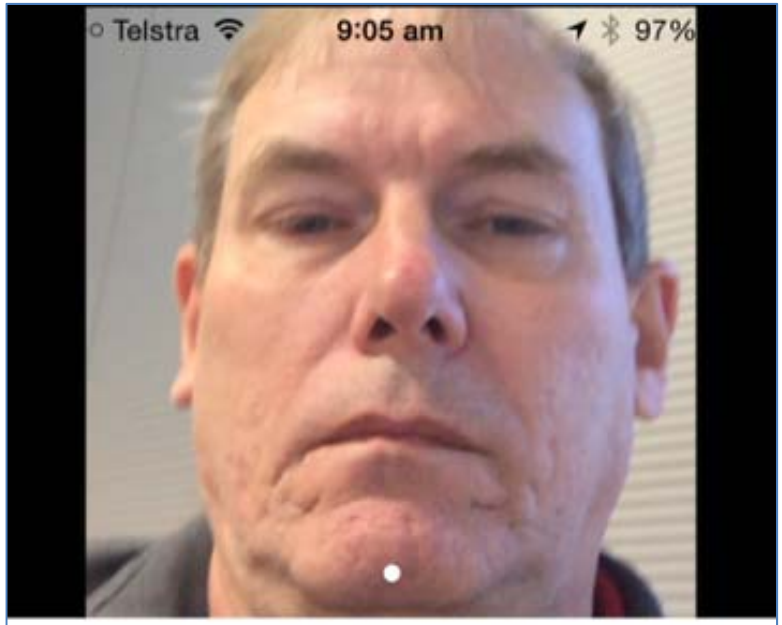
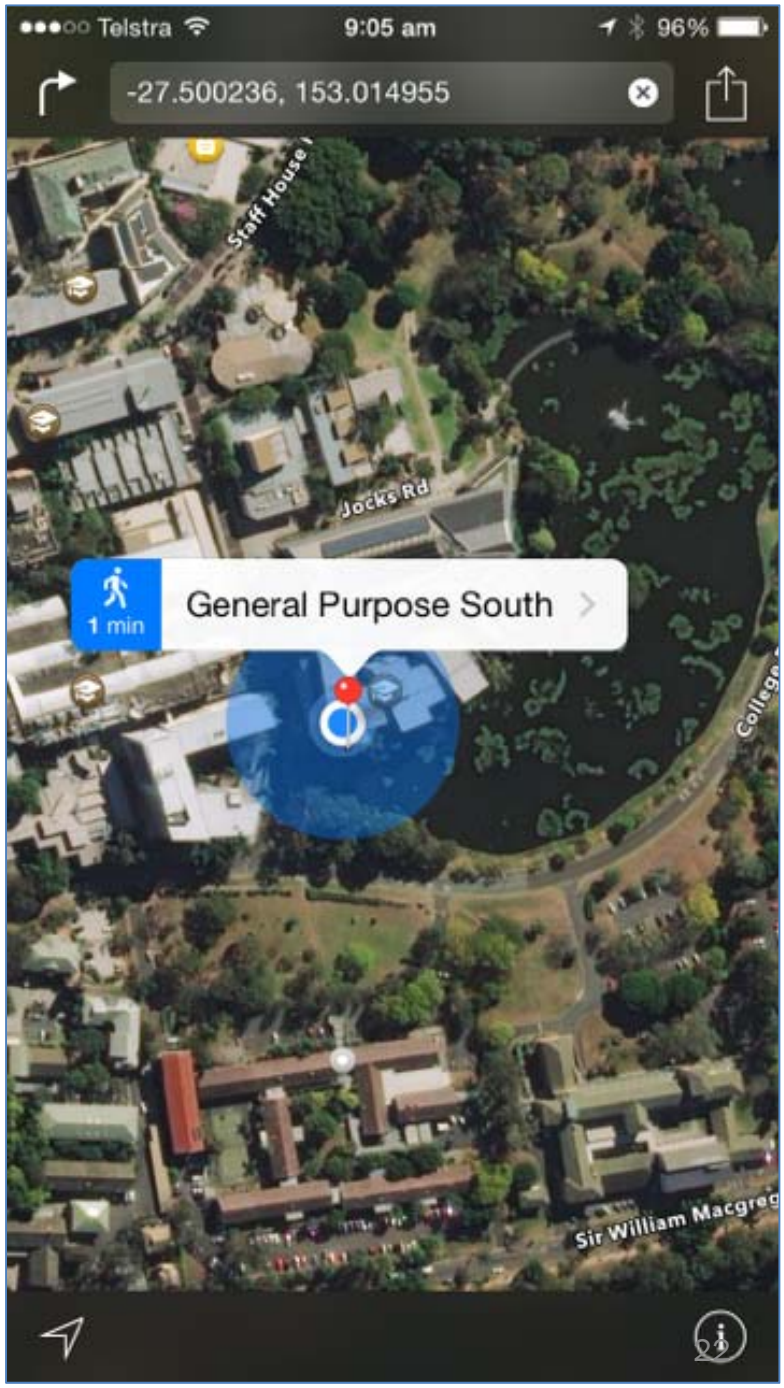


Results

Size/Who	Brian Lovell
Activity/What	Face Detection Demonstration
Location/Where	lat: -27.500236, long: +153.014955
Unit/Who	
Time	2015-05-14T23:05:01Z
Equipment/How	

Cancel Email



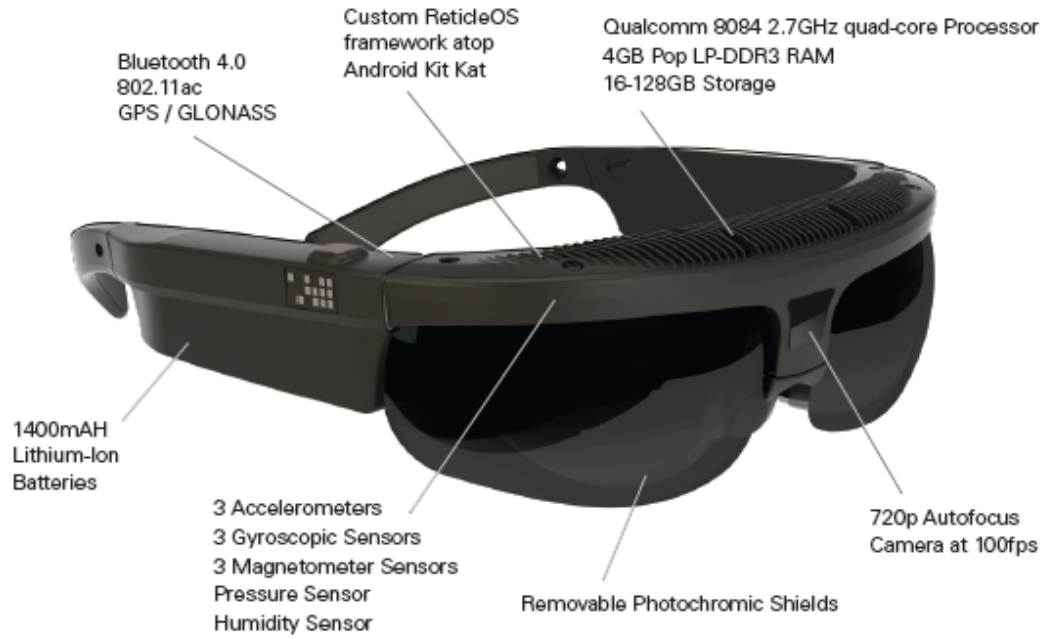
Wearable AR Glasses for

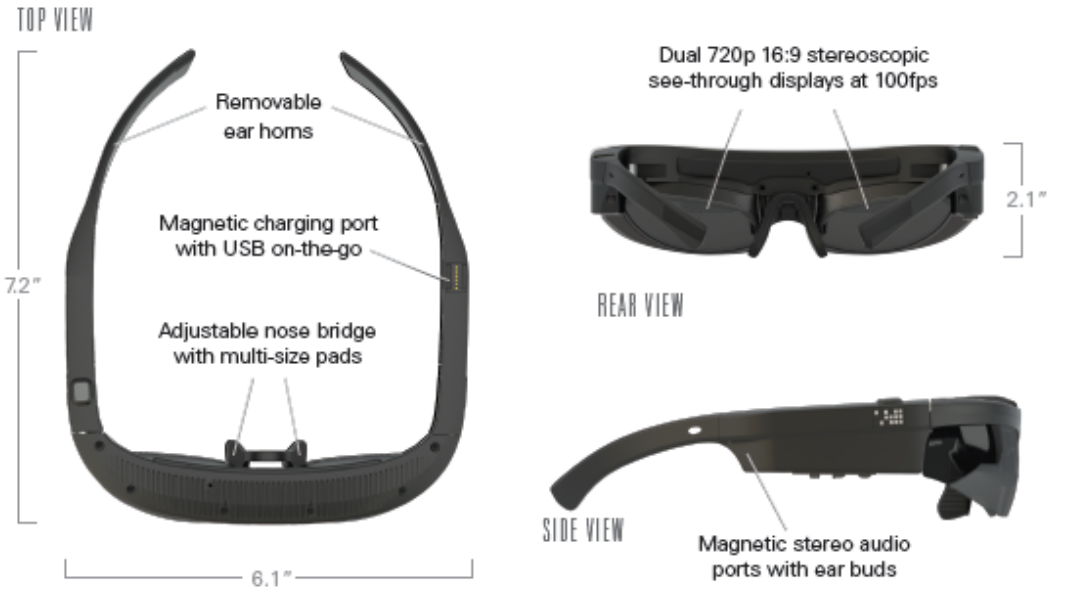
Video Face Recognition

ANDROID

X6 and R7 Glasses

Ralph Osterhout
The Real Life “Q”





Weight: 5.5oz

HARDWARE

Qualcomm Snapdragon 805
8084 2.7GHz quad-core Processor

4GB Pop LP-DDR3 RAM

16-128GB Storage

1400mAH Lithium-Ion Batteries

Adjustable nose bridge with multi-size nose pads

Removable ear horns

OPTICS

Dual 720p Stereoscopic See-through displays at 100fps

Removable Photochromic Shields

COMMUNICATIONS

Bluetooth 4.0

802.11ac

GPS / GLONASS

SENSORS

Integrated Inertial Measuring Unit with 3-axis accelerometer, 3-axis gyroscope, 3-axis magnetometer

Pressure Sensor

Humidity Sensor

Ambient Light Sensor

INPUT/OUTPUT

720p Autofocus Camera at 100fps

2 Digital Microphones (User & Environment)

Magnetic charging port with USB on-the-go

Magnetic stereo audio ports with ear buds

http://www.ab...topic=latest | Prosopagnosia - Wikipedia... | Imagus Forensic Demo | The Military Is About to Ge...

www.defenseone.com/technology/2014/06/military-about-get-new-spy-glasses/87292/

x6 glasses spy

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Wed., May 20: a Discussion with NavSec Ray Mabus

North Korea's Missile Test Is Less Impressive Than You Think

How One Woman Earned Her Way Onto the Special Ops Battlefield

VA to Congress: It's Still Too Hard to Fire Bad Employees

The 'Rubio Doctrine' Is a Rerun

NSA Spying Heads to Critical Senate Showdown

Defense One

NEWS THREATS POLITICS MANAGEMENT TECH IDEAS SEARCH

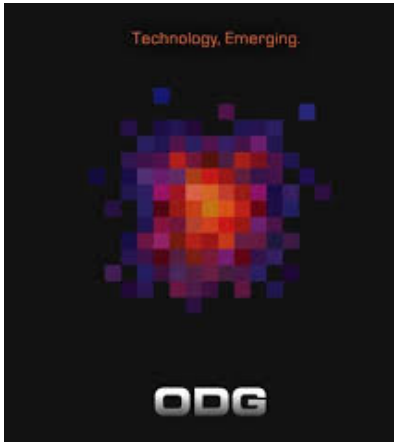
AA FONT SIZE + PRINT OSTERHOUT GROUP

The Military Is About to Get New Spy Glasses

JUNE 25, 2014 BY PATRICK TUCKER

The Defense Department's new smart spectacles go beyond Google Glass. By Patrick Tucker Pentagon / Intelligence / Technology

Getting secret information to specific people, like the location of the nearest nuclear power plant, in a way that doesn't draw attention from outside is a classic spy problem. Another one is giving agents the ability to match names to



Ever been to a gathering where you saw someone's face but you couldn't remember her name or why she was important? It's not just a cocktail party problem but a national security one. A year old startup form Australia called Imagus, has developed a program for the X6 that fixes the problem.

Peering through the glasses at a poster of faces while wearing the X6, a tester using the Imagus facial recognition app sees a pair of small circles appear on the eyes of the various targets and then a quick match showed up in the view as demonstrated in a somewhat unnerving video from General Dynamics Information Technology, GDIT, highlights the "dynamic environment of non-cooperative facial recognition."

The Imagus app can match a face in real time to one in a database at a resolution of just twelve pixels between the eyes according to lead software engineer Steve Brain. (Anything under sixty is considered very good in the facial recognition world.) The size of the headset seems to help with targeting the camera to improve speed and accuracy. The glasses could be modified to connect to a military biometrics databases such as **BEWL, King confirmed.**

GDIT is working with Osterhout, Imagus and other small companies to develop a host of apps and programs around the X6 platform.

"What they want with the glasses is to bring in a lot of different applications. Facial recognition technologies from images is just one example," Lynn Schnurr, vice president at General Dynamics Information Technology, told *Defense One*.

Biometric Access Control (on the Cheap)

Building and Site Security

- Unauthorized persons enter building or site with swipe card
- Impossible to check photo ID on every card
- Design system to Biometrically Check and log every person at full walking speed
- Upgrade any card system to Biometric
- Application: Secure Shipyard or Commercial Port

Cost Effective High-Speed Biometric System for Secure Building or Site

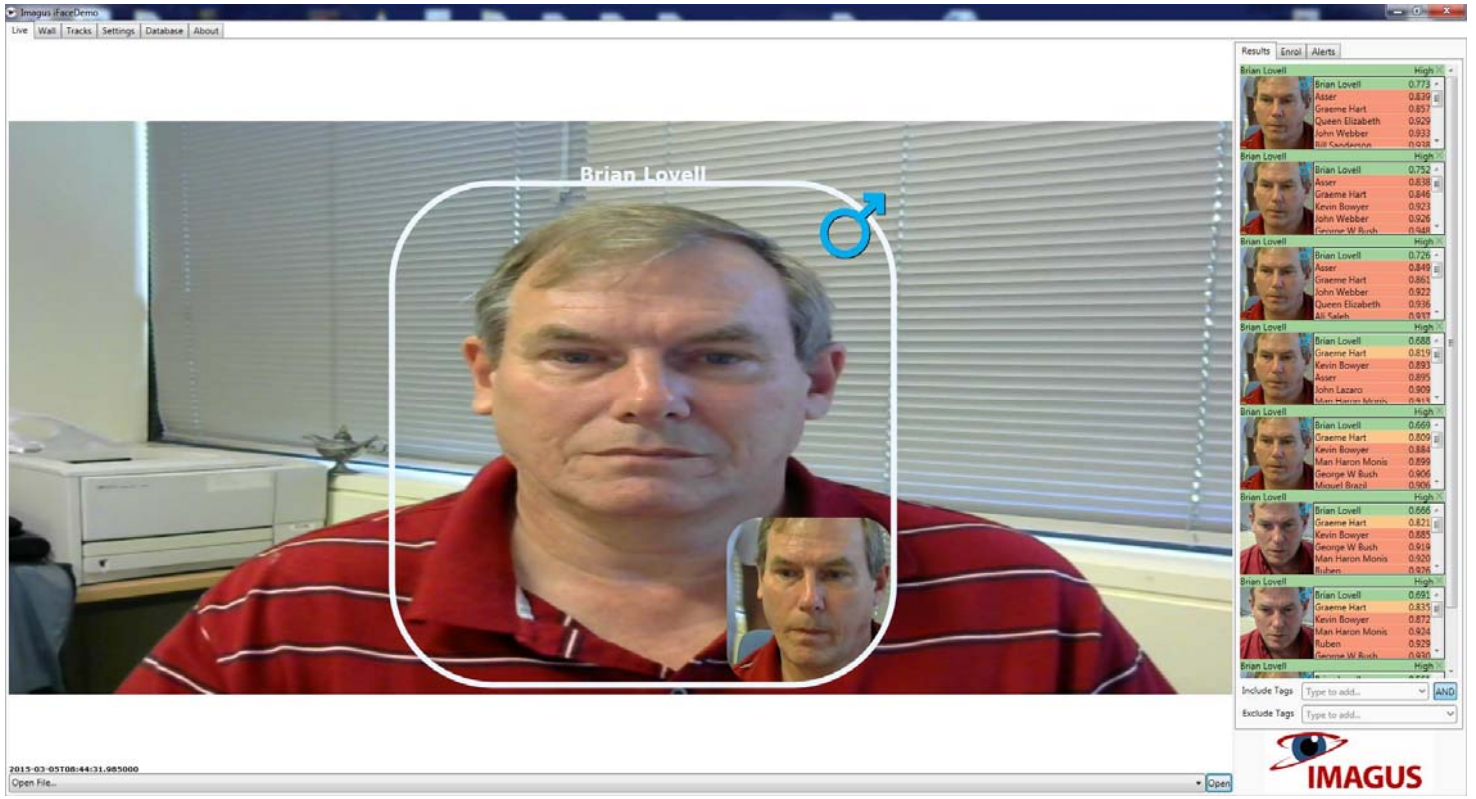
UAV Face Recognition

Airborne Face Recognition

- Some interest in Satellite face recognition but resolution (10cm) and slant angle make this extremely challenging
- More achievable is UAV face recognition
- Noise of UAV may get people to look up
- High speed camera (300fps) could improve speed of capture in crowds
- Problem of slant angle as faces are much harder to recognise from above

Real-Time Geometric Corrections

- Correct for foreshortening due to slant angle
- Correct for non-square pixels

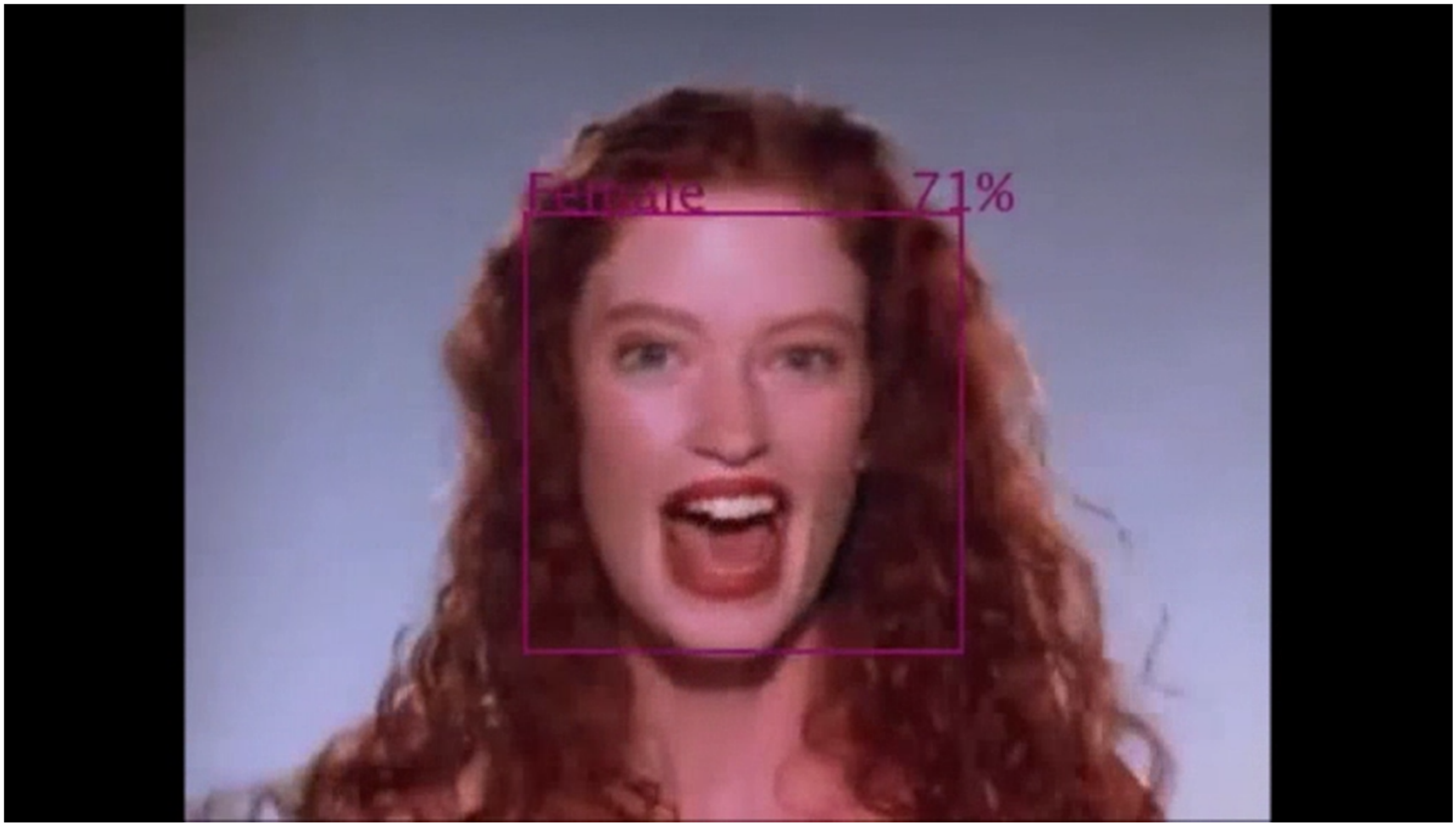


Gender, Age, People Counting

Other Biometrics

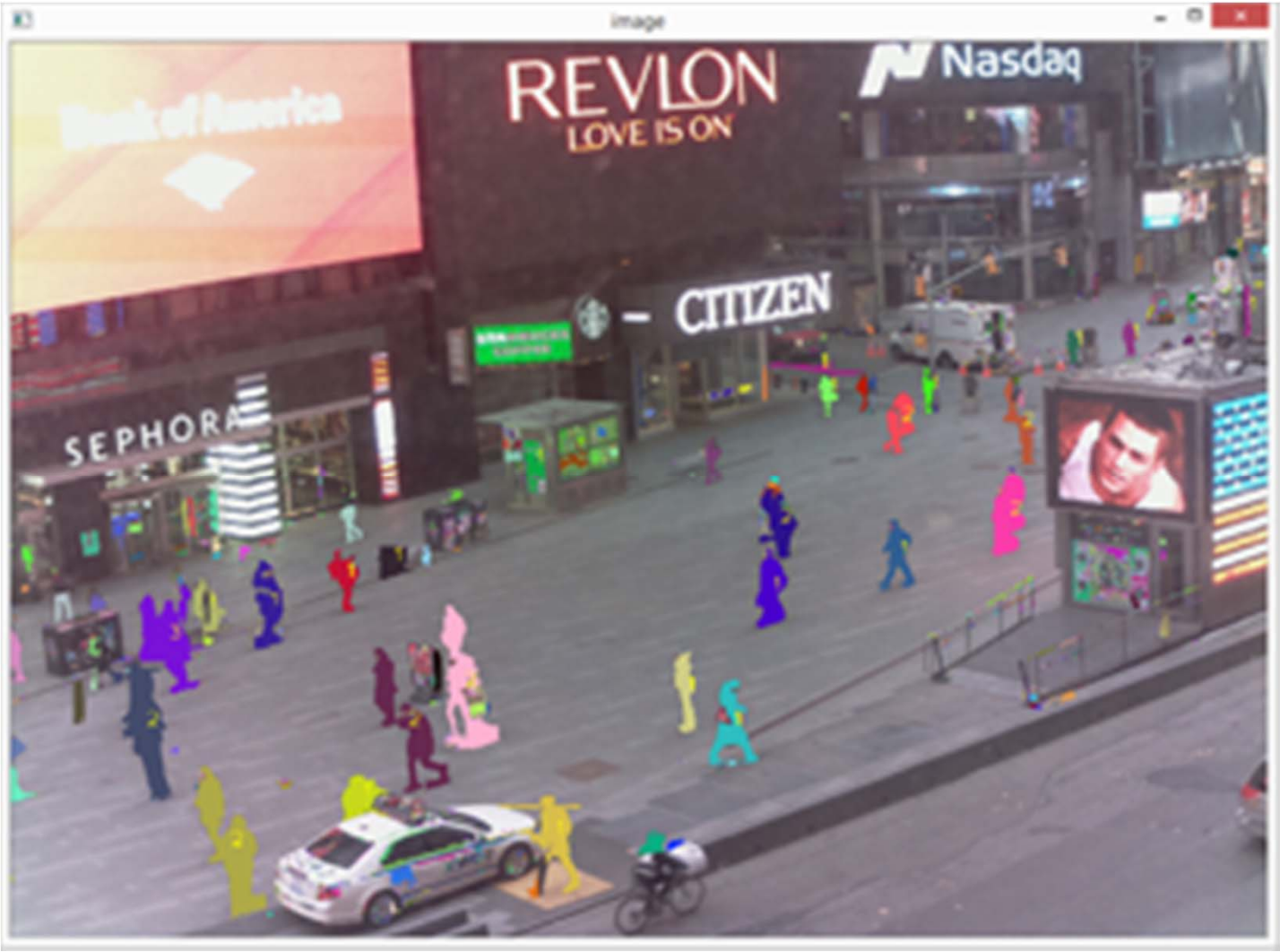
- In many applications most people will not be in the gallery
- How do we add value for these unrecognisable people
  - Gender
  - Age
  - People count
  - Cross Camera Transit times

Gender Estimation



Gender and Age

Billboard Crowd Counting



Times Square

Detecting Genetic Disorders

Table 2 Diagnostic accuracy of NFR technology within database of 3144 photographs				
Syndrome	Total number of photos	Correct diagnosis	Match within top 5	Match within top 10
Coffin-Lowry	164	92 (56%)	145 (88%)	159 (97%)
Cornelia de Lange	193	123 (64%)	183 (96%)	188 (97%)
Floating-Harbor	97	65 (67%)	92 (95%)	94 (97%)
Kabuki	197	108 (55%)		
Rubinstein-Taybi	162	97 (60%)	156 (96%)	162(100%)
Smith-Magenis	135	81 (60%)	133 (98%)	135(100%)
Williams	196	120 (61%)	189 (96%)	192 (98%)

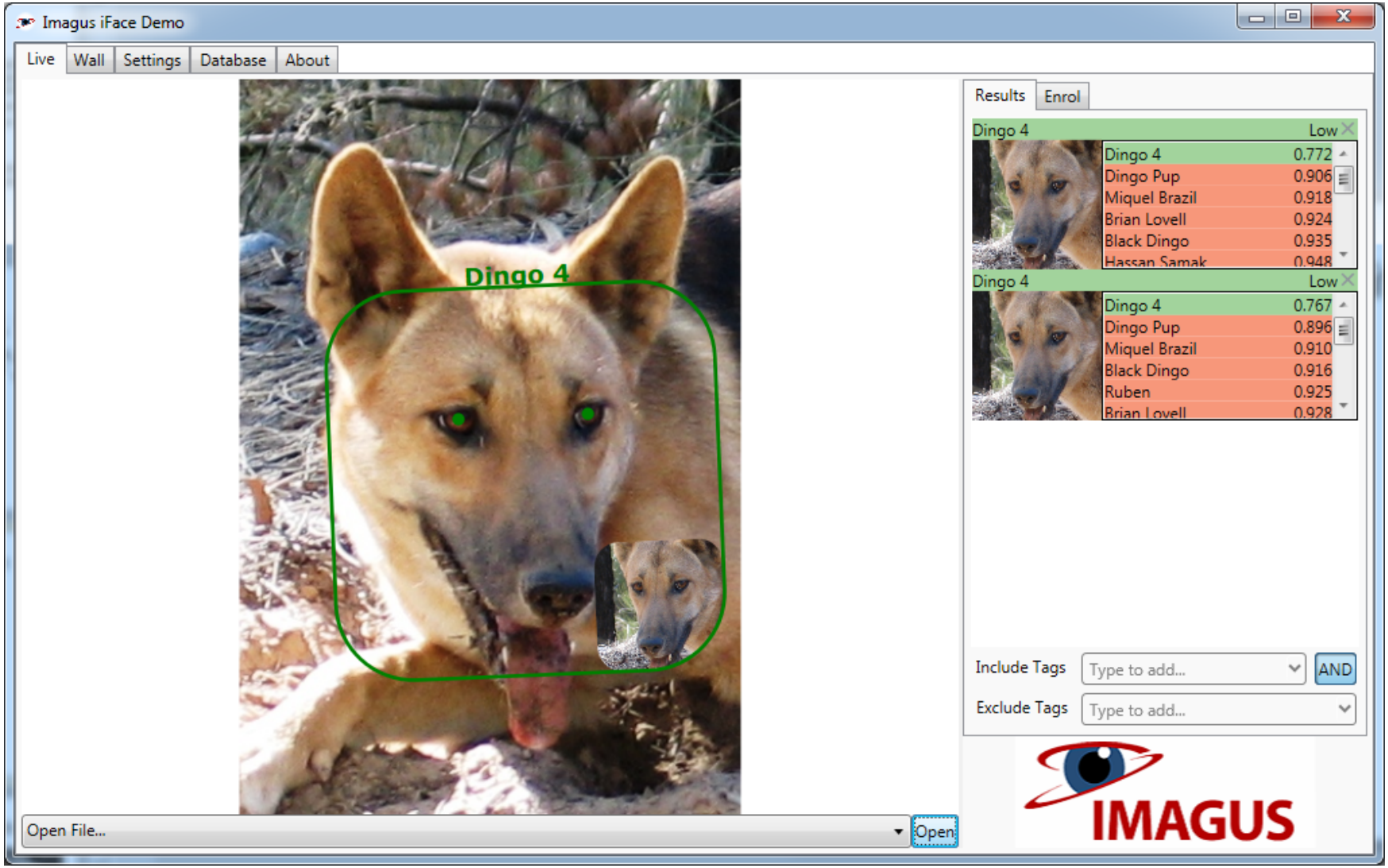
with Tracy Dudding, Geneticist with Hunter Genetics

Figure 3 Original published photographs of individuals with Coffin Lowry syndrome-Top left: number 3 match; top centre: number 1 match; top right number 1 match; bottom left: number 1 match; bottom centre: number 4 match; bottom right: number 1 match

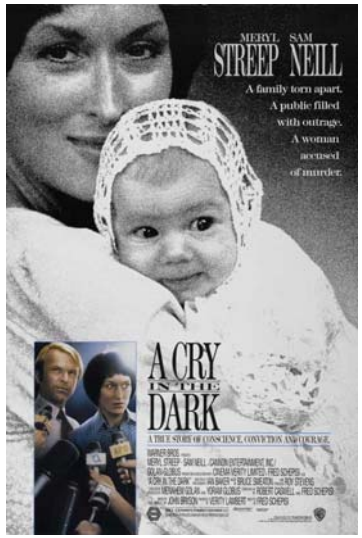
Figure 4. Original published photographs of individuals with Cornelia de Lange syndrome-Left: number 1 match; centre: number 2 match; right: number 1 match

Figure 5. Original published photographs of individuals with Floating Harbor syndrome-From the left: number 4 match; number1 match; number 2 match, number 2 match; number 3 match

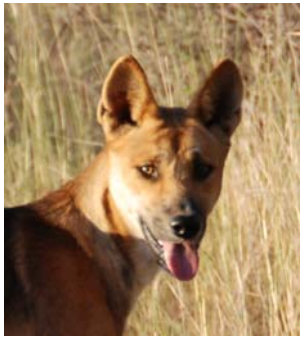
Dingo Face Recognition

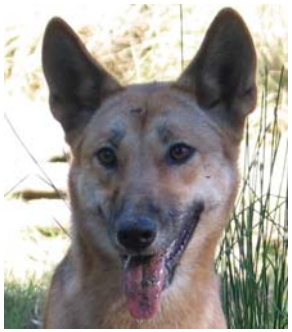


A Dingo Ate My Research



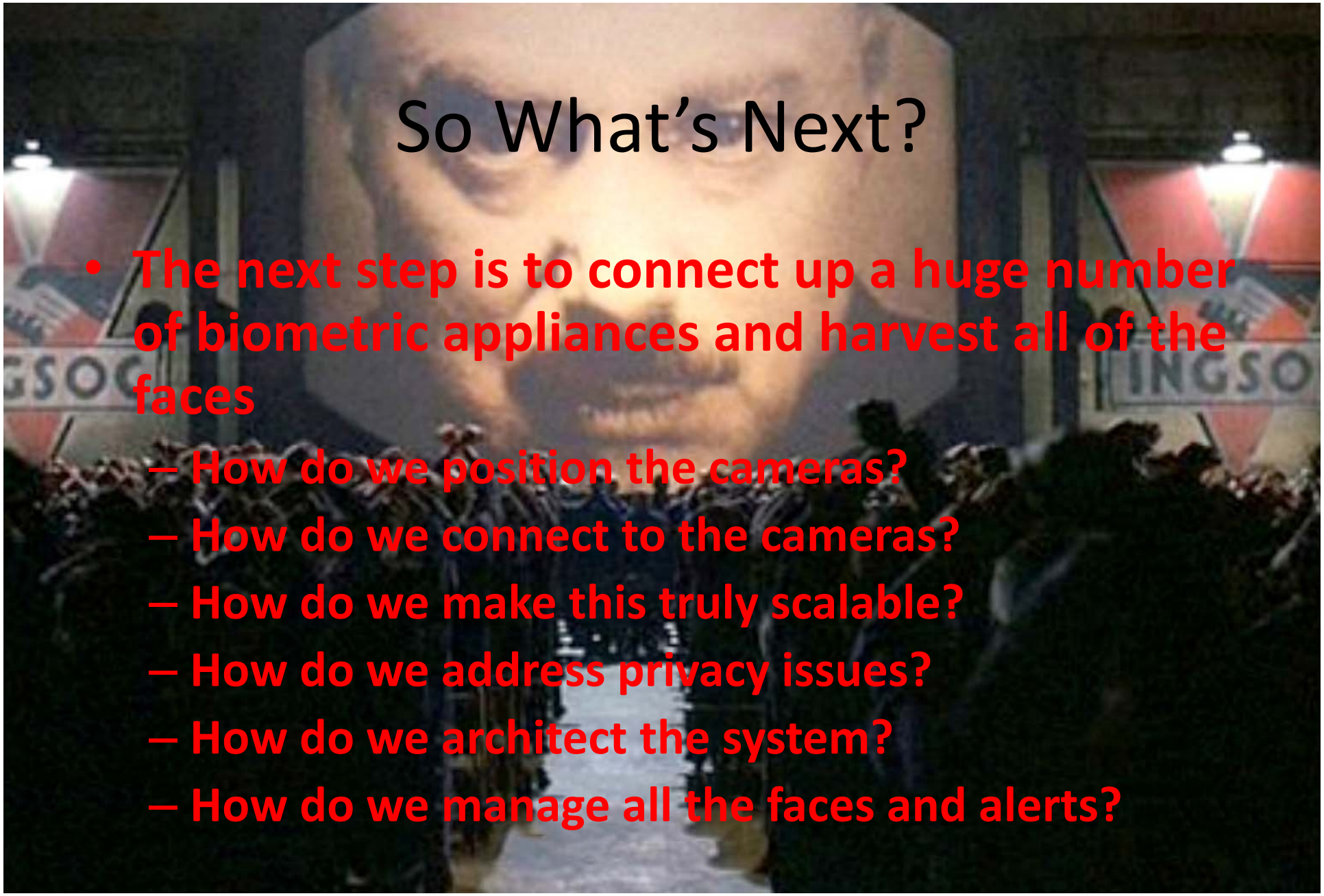
- Dingo Face Recognition
- 80 Animals, 340 images
- 60.9% recognised rank 1
- 78.4% were recognised top 10
- Next Step: A mobile social media app for dingo identification on Fraser island

Mobile Dingo App

- Dingoes could be recognised by the public by photographing their faces with iPhones/Android Devices
- This would give identification, time, and location information which could be collected on a server.
- Animals interacting with humans could be identified and their behaviour captured
- Could also collect video



So What's Next?

- **The next step is to connect up a huge number of biometric appliances and harvest all of the faces**
  - **How do we position the cameras?**
  - **How do we connect to the cameras?**
  - **How do we make this truly scalable?**
  - **How do we address privacy issues?**
  - **How do we architect the system?**
  - **How do we manage all the faces and alerts?**

Issues with Large CCTV Networks

- Data rates are huge and the costs of connecting all cameras by fibre is prohibitive
- Processing should be done at edge or better still in camera
- Then only alerts need be sent to central system
- Could send full frames or just faces
- Privacy can be improved since only small parts of CCTV (possibly none) is sent not the whole video.
- Whole video may contain sensitive material that is hard to vet.

2016 Brazil Project

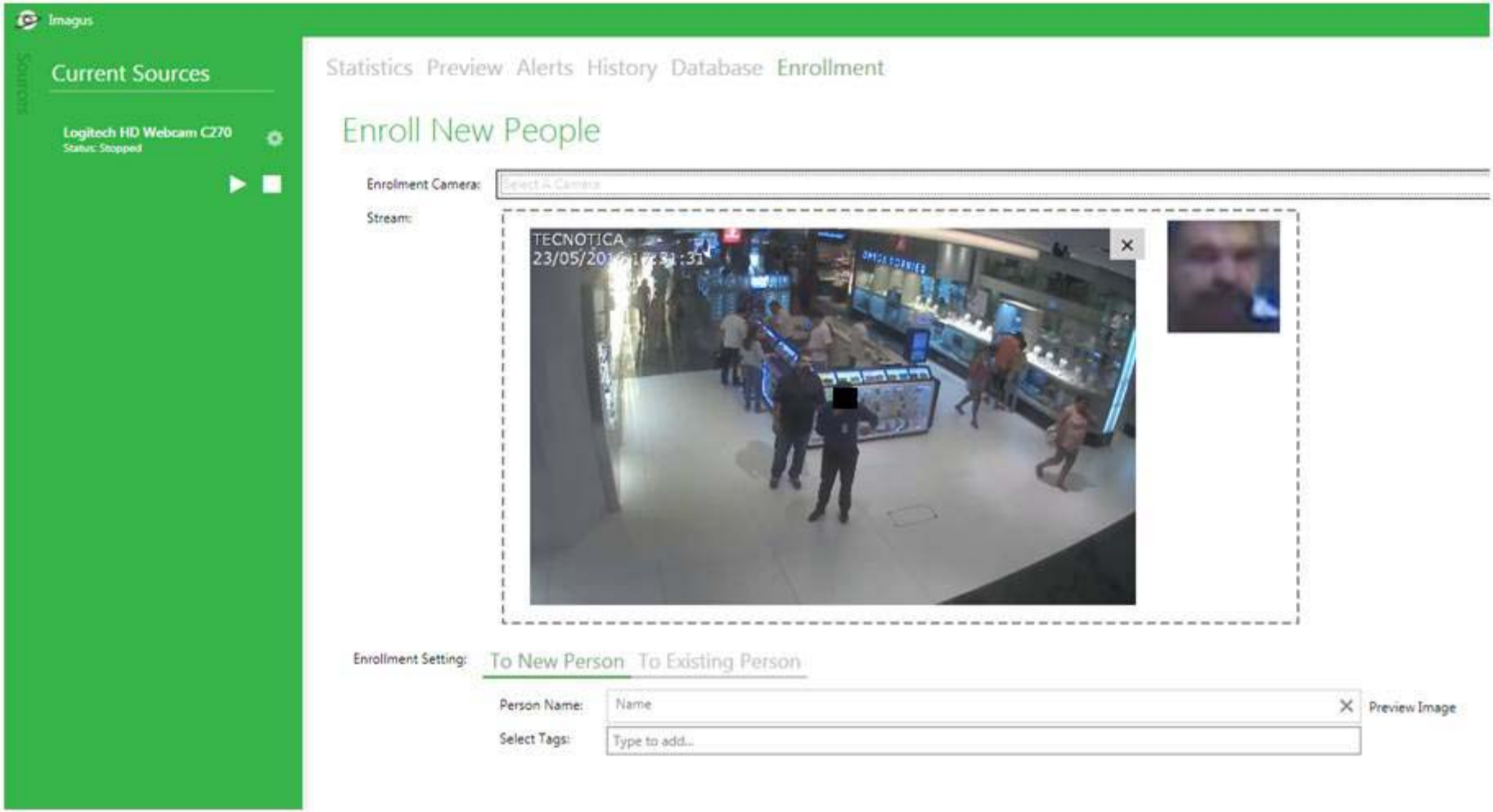
- Approached by Security firms in Brazil to trial non-cooperative face recognition in shopping centres and to consolidate alerts in cloud based incident management system
- Stage 1: Face Detection in cameras and AWS server based recognition
- Stage 2: Face Detection and Recognition in imQ video face recognition appliance

True Transcontinental Surveillance

- Cameras were in Brazil, Australia, and UK
- Face Recognition was performed locally or transcontinentally
- Cost was potentially very low if cameras could do detection
- Highly scalable architecture
- Pilot ran for several months

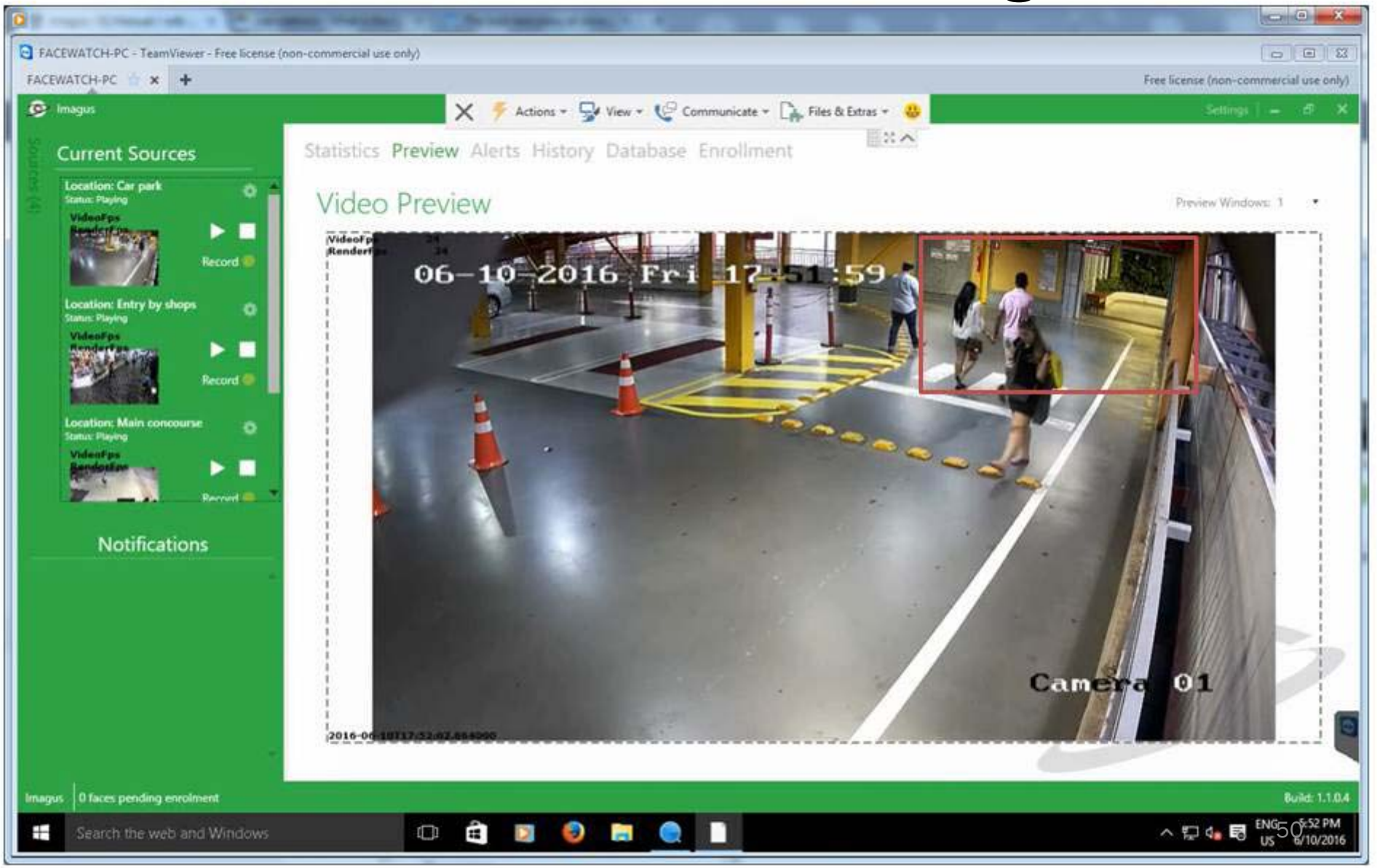
Typical CCTV Cameras – Useless for Face Harvesting

Existing Cameras

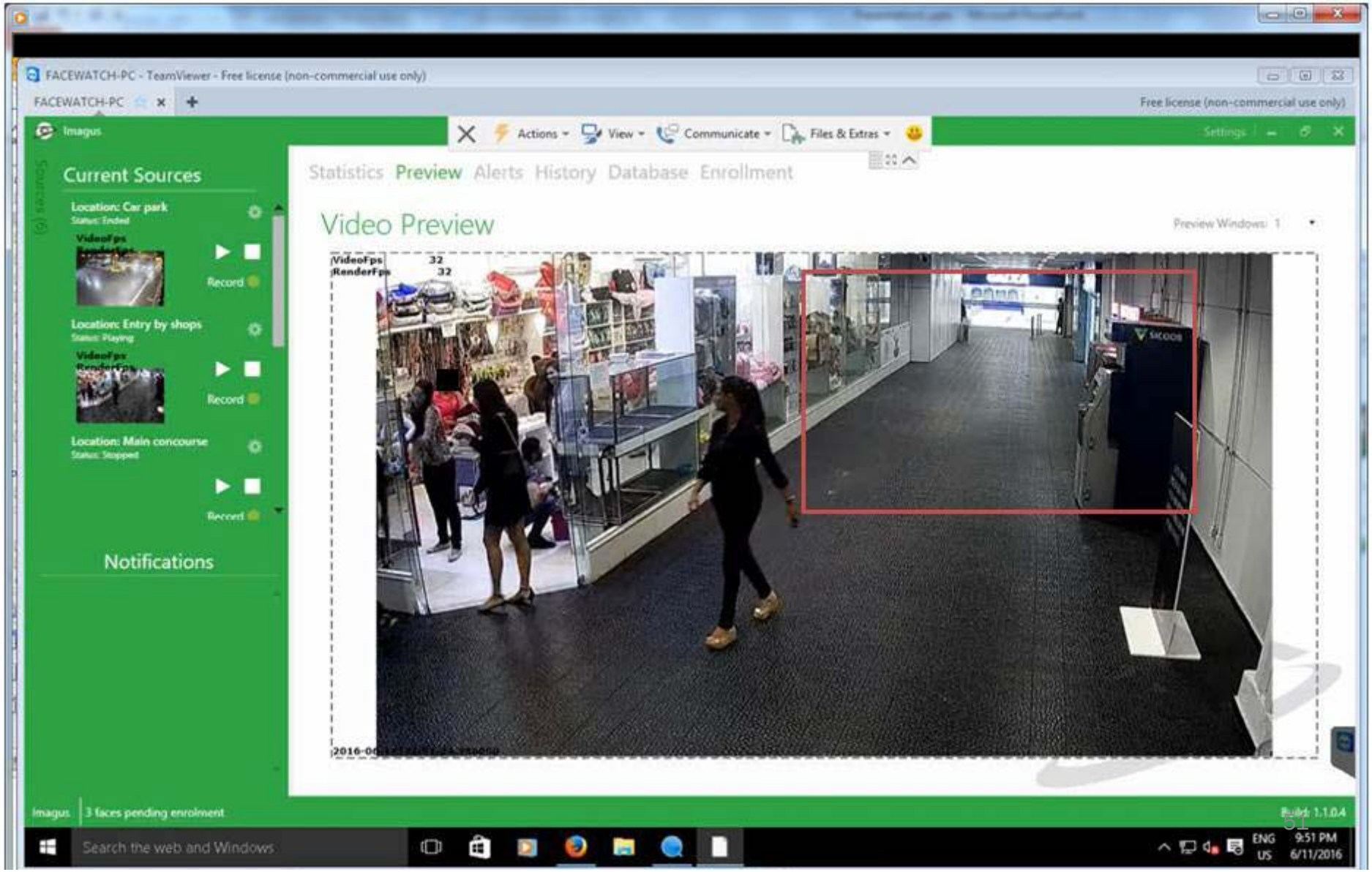


Not enough resolution. Slant angle is excessive.

Need More Focal Length



Need More Focal Length



Issues Encountered in Camera-Based Detection

- Low Cost
- About 60s latency in camera based detection
- Poor detection rates, many bad images
- Large data rates due to full frame image size
- Hard to demonstrate live
- Hard to know what is going wrong
- Low rate of face harvesting as people often do not look at camera
- Some good matches and low false alarm rates

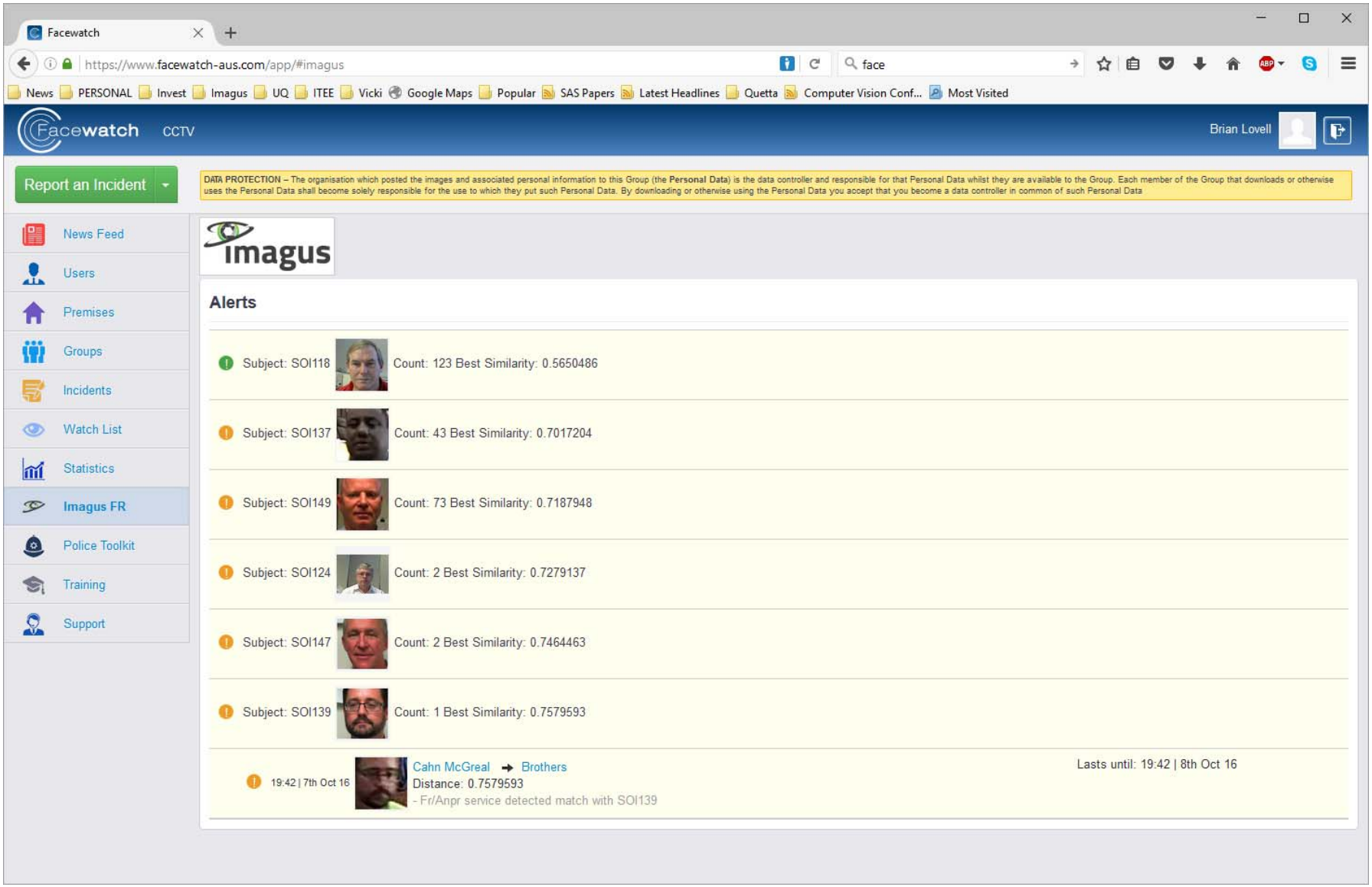
Issues Encountered in imQ Video based detection

- Much better face harvesting due to greater number of frames
- People still do not look at camera
- Motion blur issues on almost all faces
- Strong H264 artifacts obscuring faces
- Much lower latency (2s)
- Instant local feedback and alerts
- Practical system once camera issues sorted

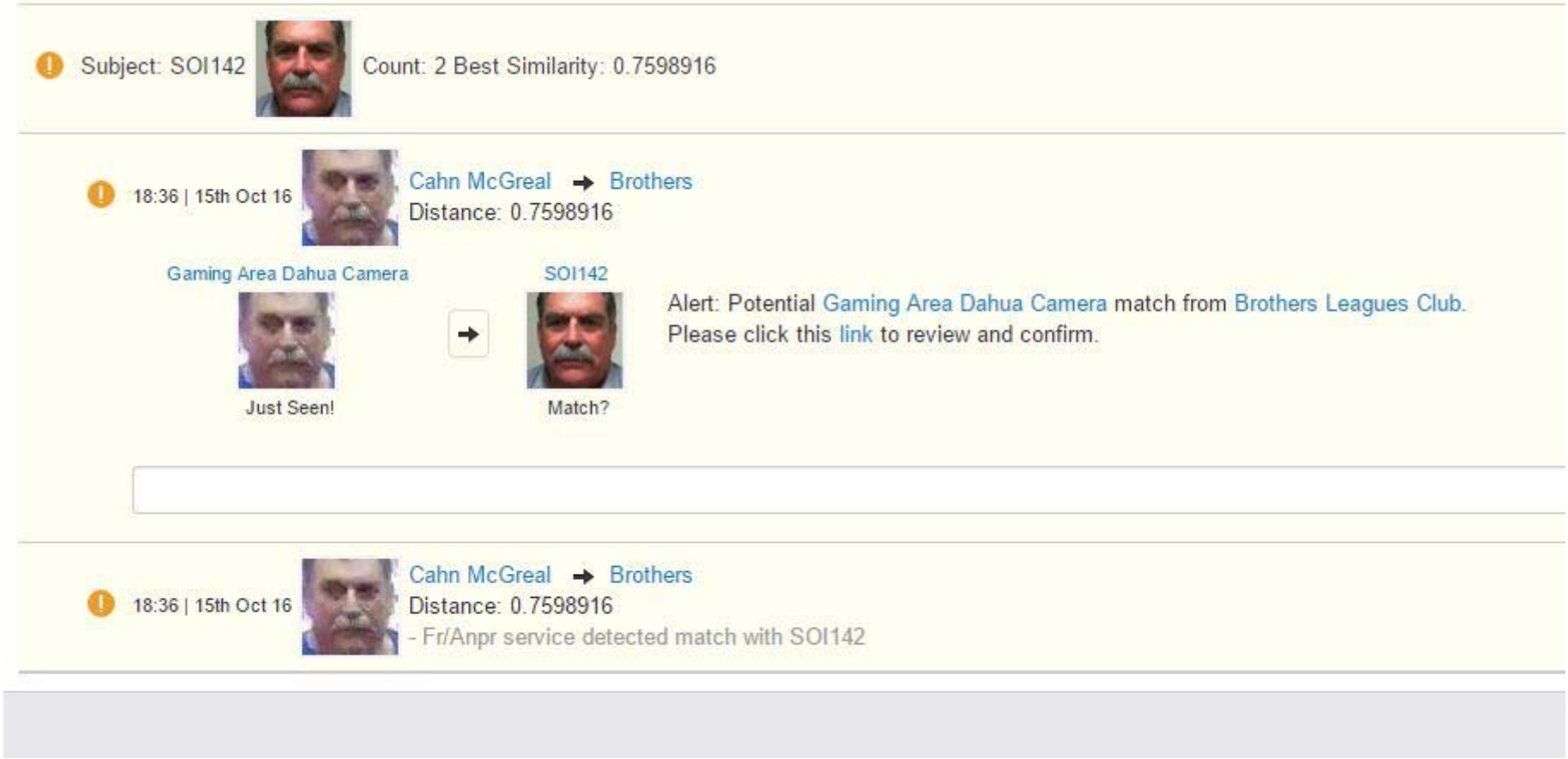
Transuburban Network

- Deployed similar system at Brother's Leagues Club
- Much easier due to local access, no time zone issues, and language
- Good positioning of cameras near eye level
- 3 cameras to cover foyer from a variety of angles
- System working well with regular alerts

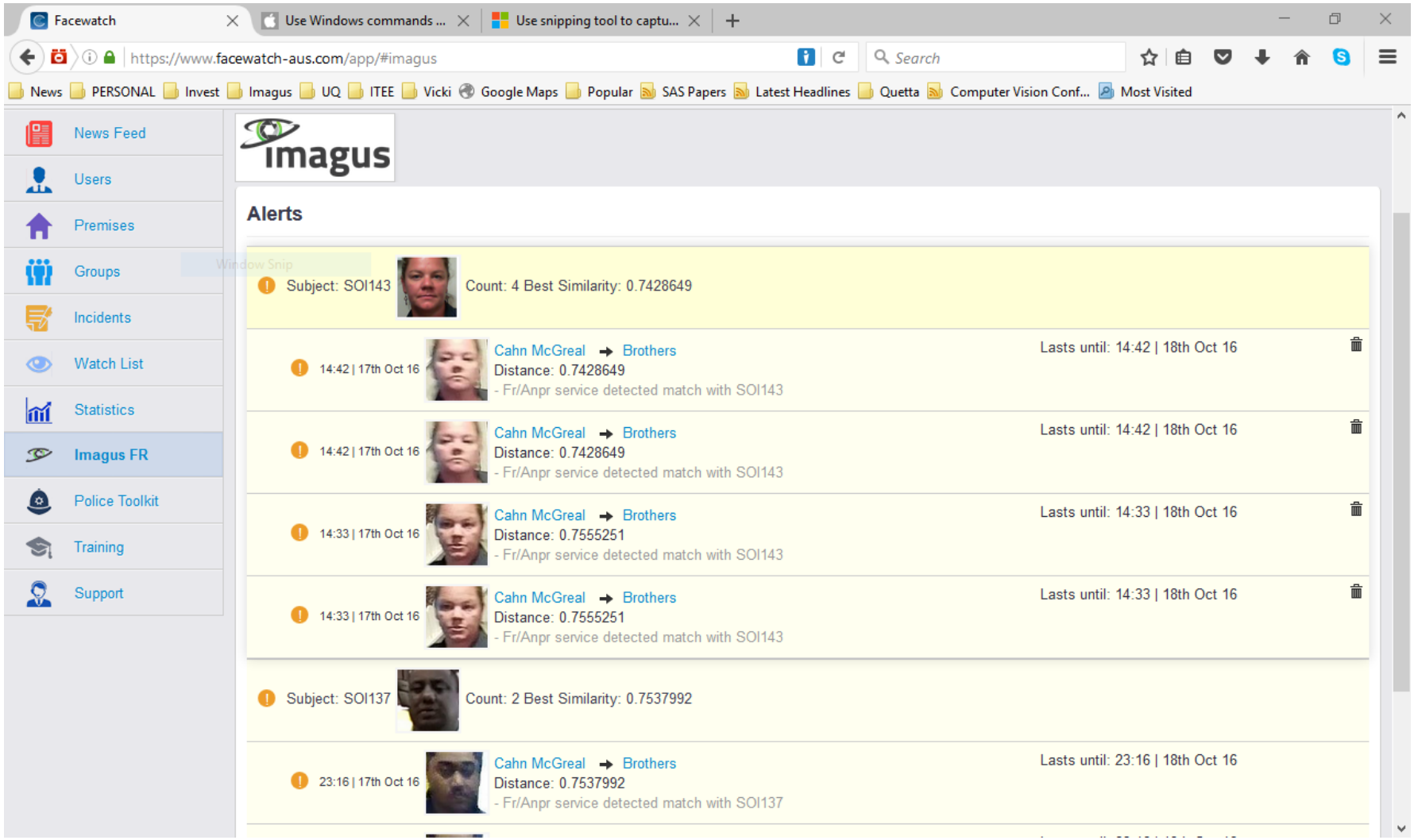
Person Alerts – Marketing Manager



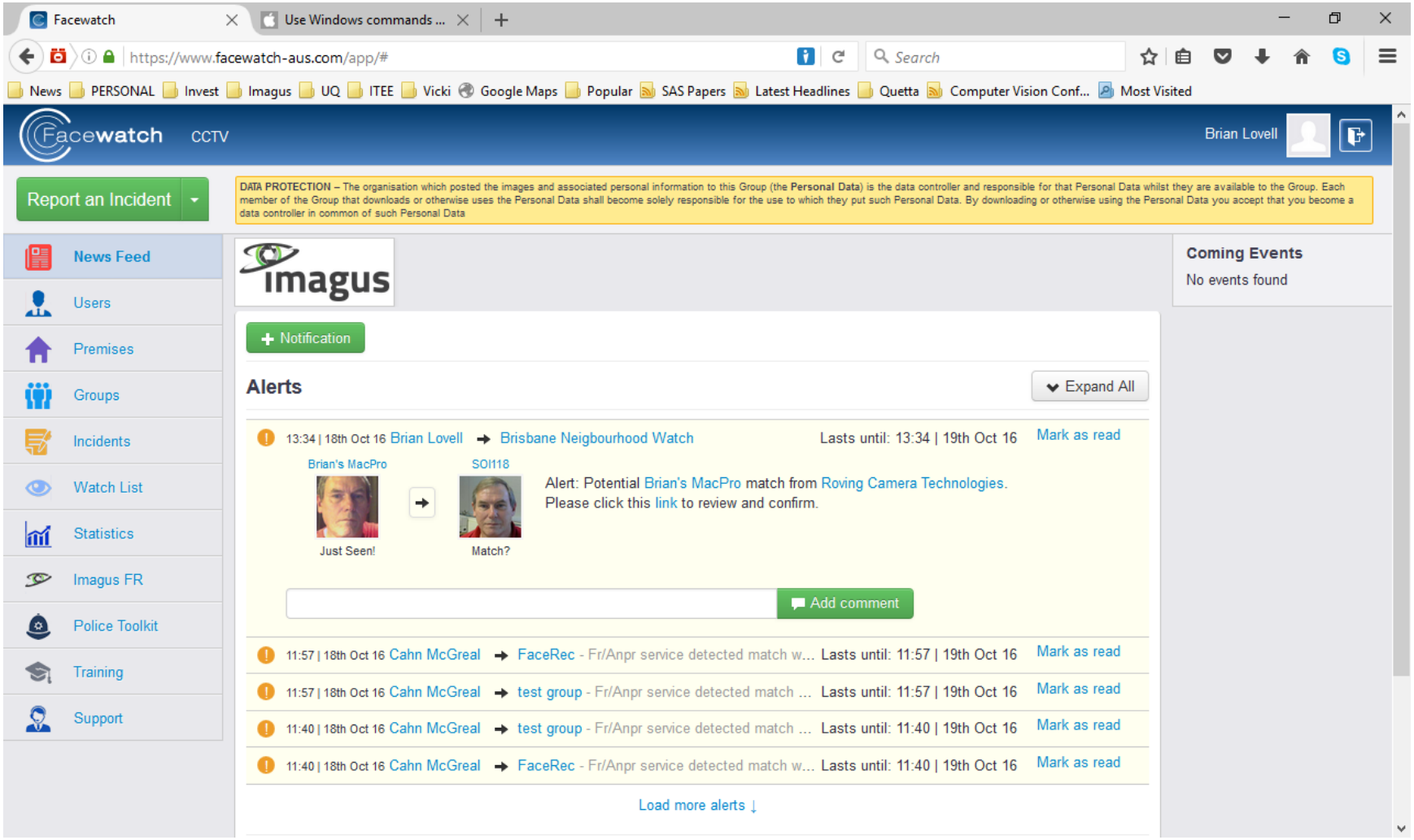
Another Match – General Manager



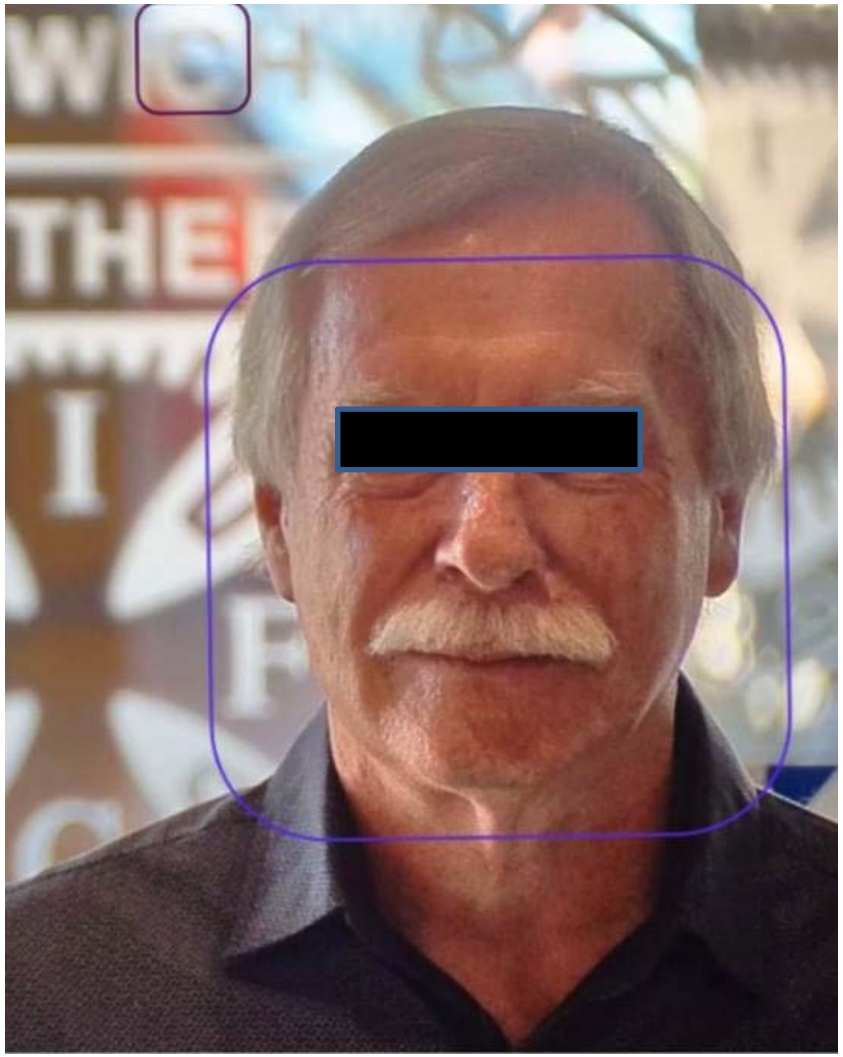
Daily Alerts



Alerting on Me



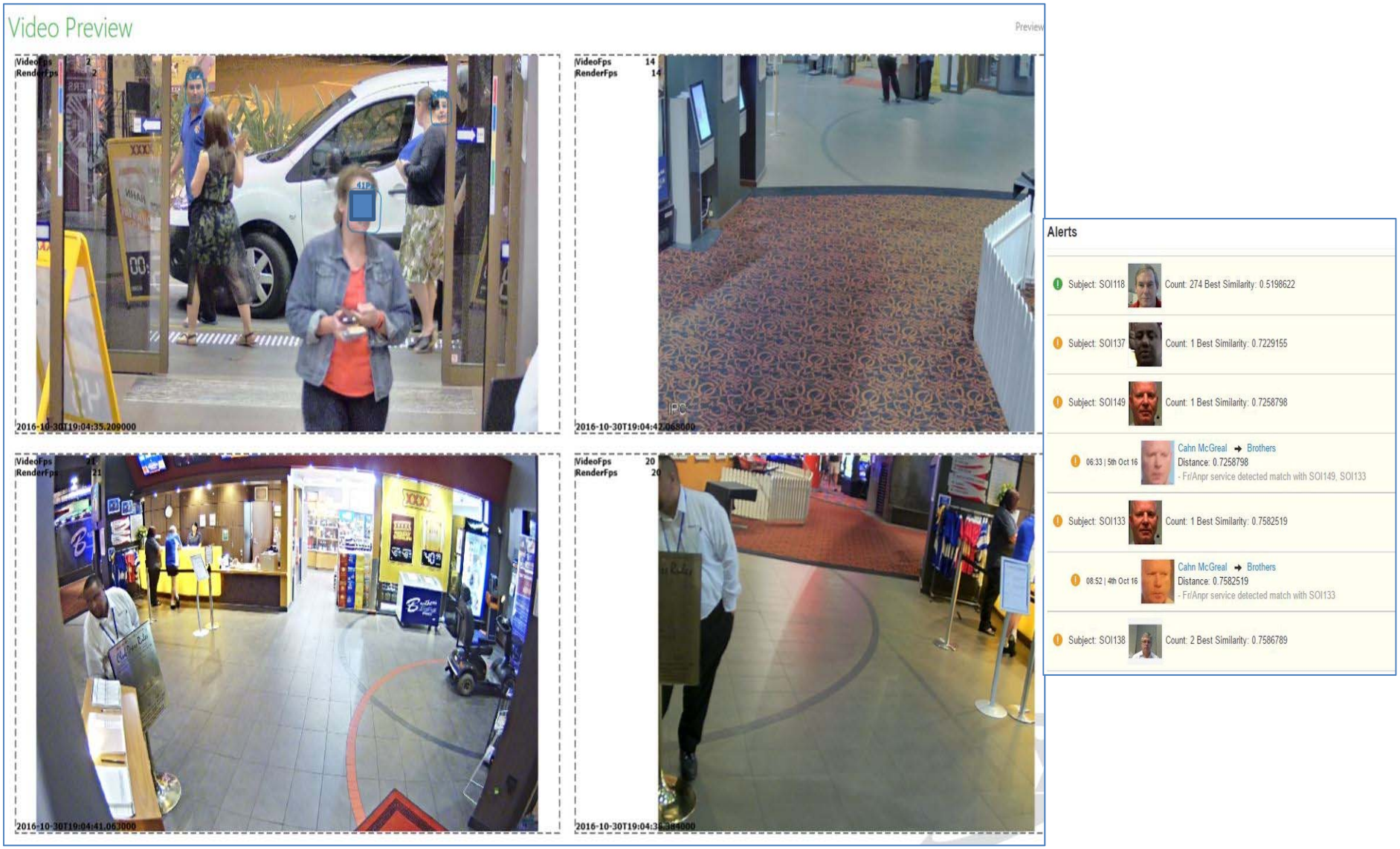
Best Camera for Doorway Installed in October



We tried 15 models of camera and could not get detection on the doorway due to backlight issues.

This model is was installed in October and replaces 3 others.

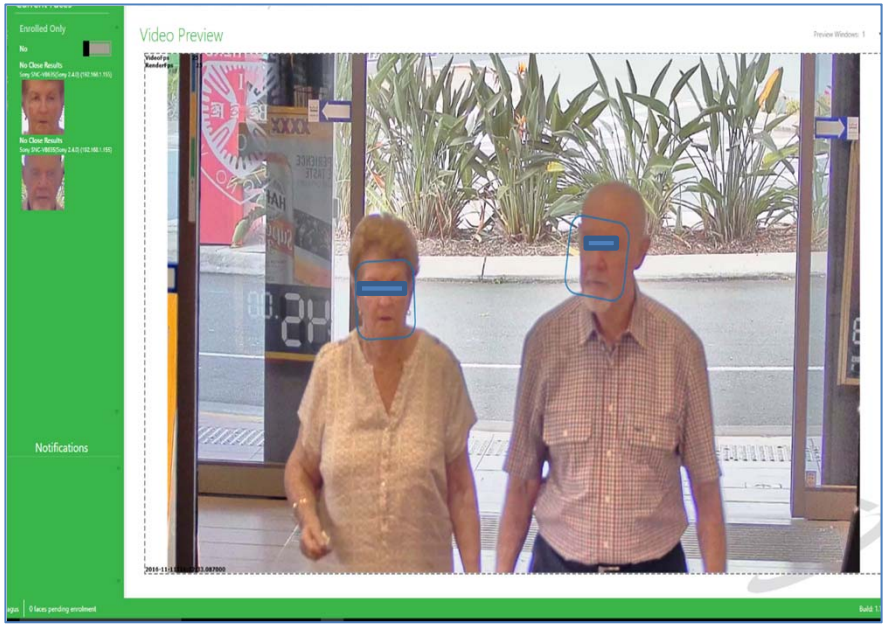
Case Study - IMQ Leagues Club

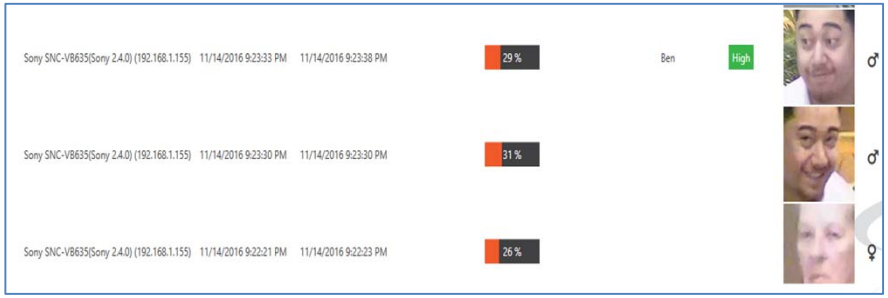


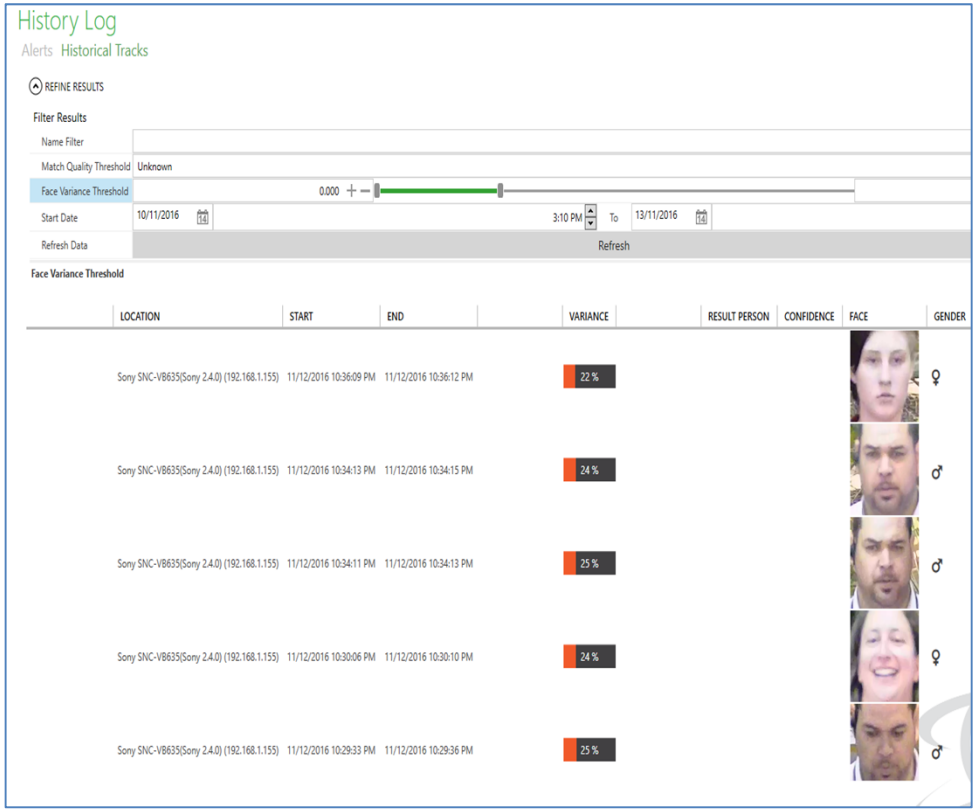
Imagus IMQ PC Platform

IMQ Leagues Club

Imagus IMQ PC Platform

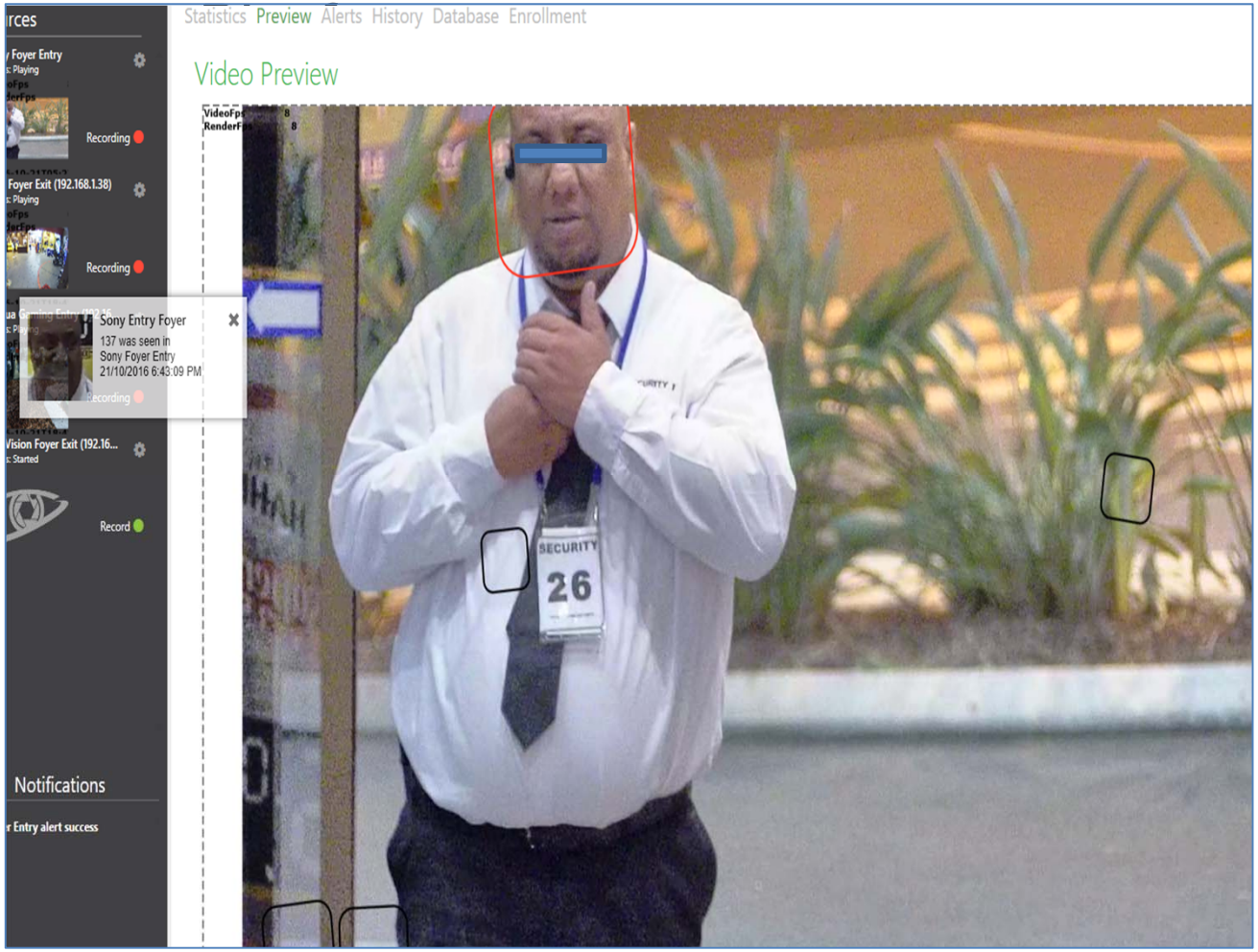






IMQ Leagues Club

Imagus IMQ PC



Where to from Here?

- We are planning to connect up a network of pubs and clubs
- Strong interest from banking sector
- Strong interest from hospitals

Research Issues for My Group

- Primarily we need better Face Detection not better Recognition
- Investigating many new detectors to find a replacement for Viola-Jones
- Evaluating on IJB-A and Wider Datasets
- Need to get false alarms down as much as possible because CCTV provokes this problem
- Investigate joint detection and landmarking

Detectors on IJB-A

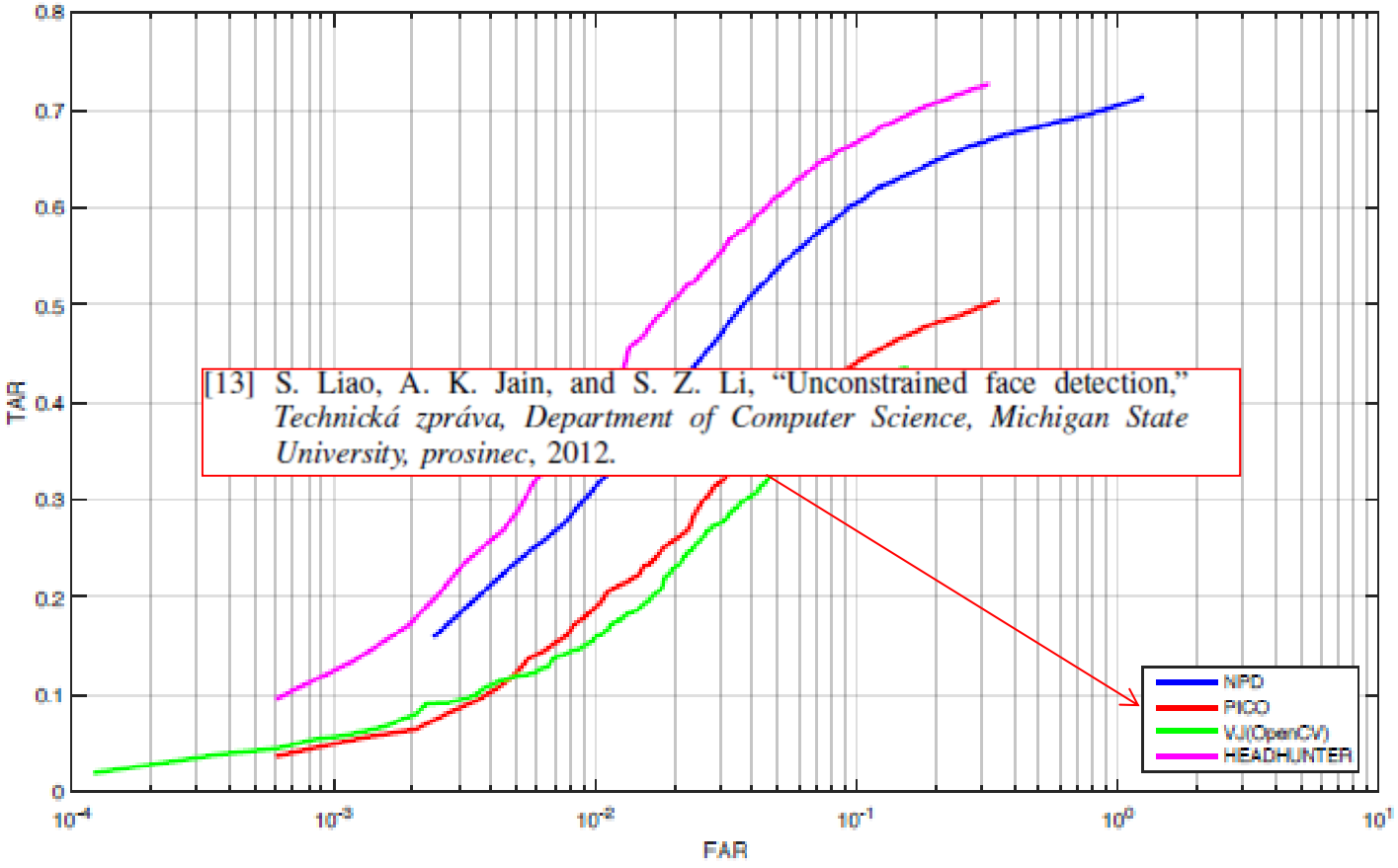


Fig. 1. Discrete ROC curve for IJB-A dataset

IVCNZ16

Pose Angle

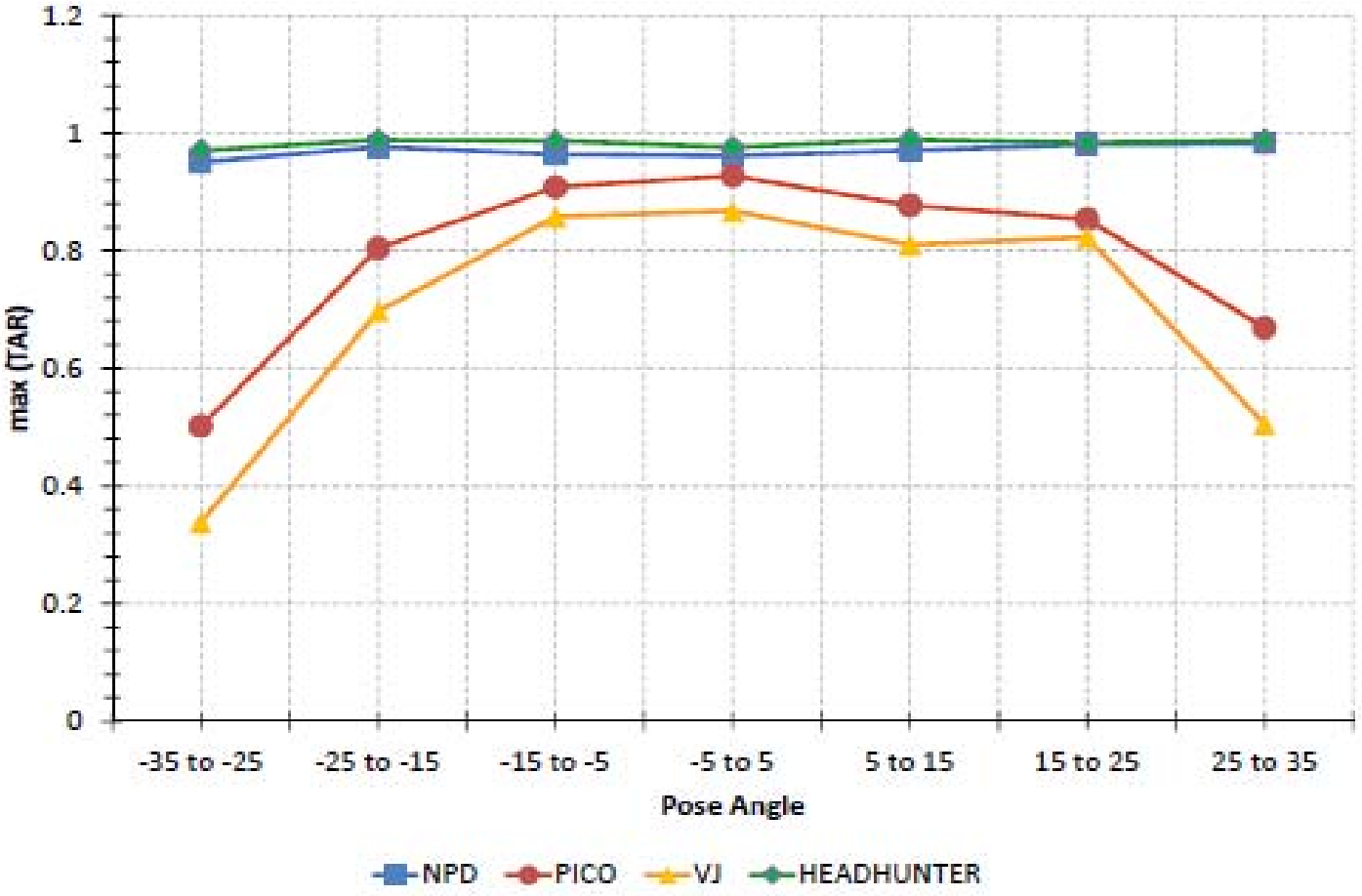


Fig. 3. Pose angle performance on IJB-A dataset

IVCNZ16

Questions


YES, MR. PALMER, WE HERE AT MEGA-CORP DID TRY YOUR "FACE RECOGNITION SOFTWARE," AND FRANKLY, IT DIDN'T WORK WORTH A DARN...