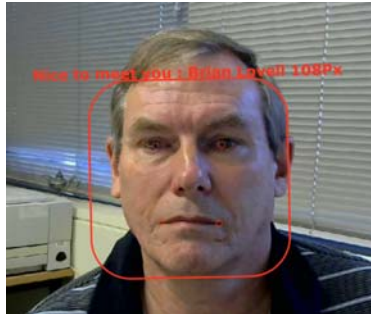


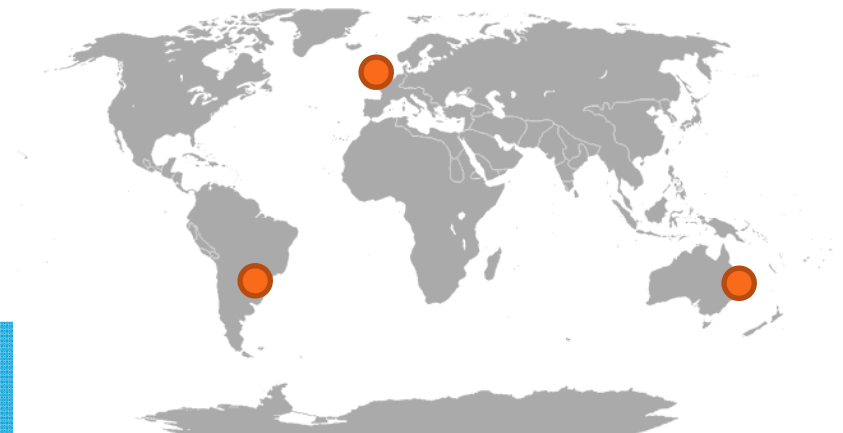
WSB-2017 January 2017



Secure Scalable CCTV, Mobile, and Wearable Video Face Recognition

Brian Lovell

The University of Queensland



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?



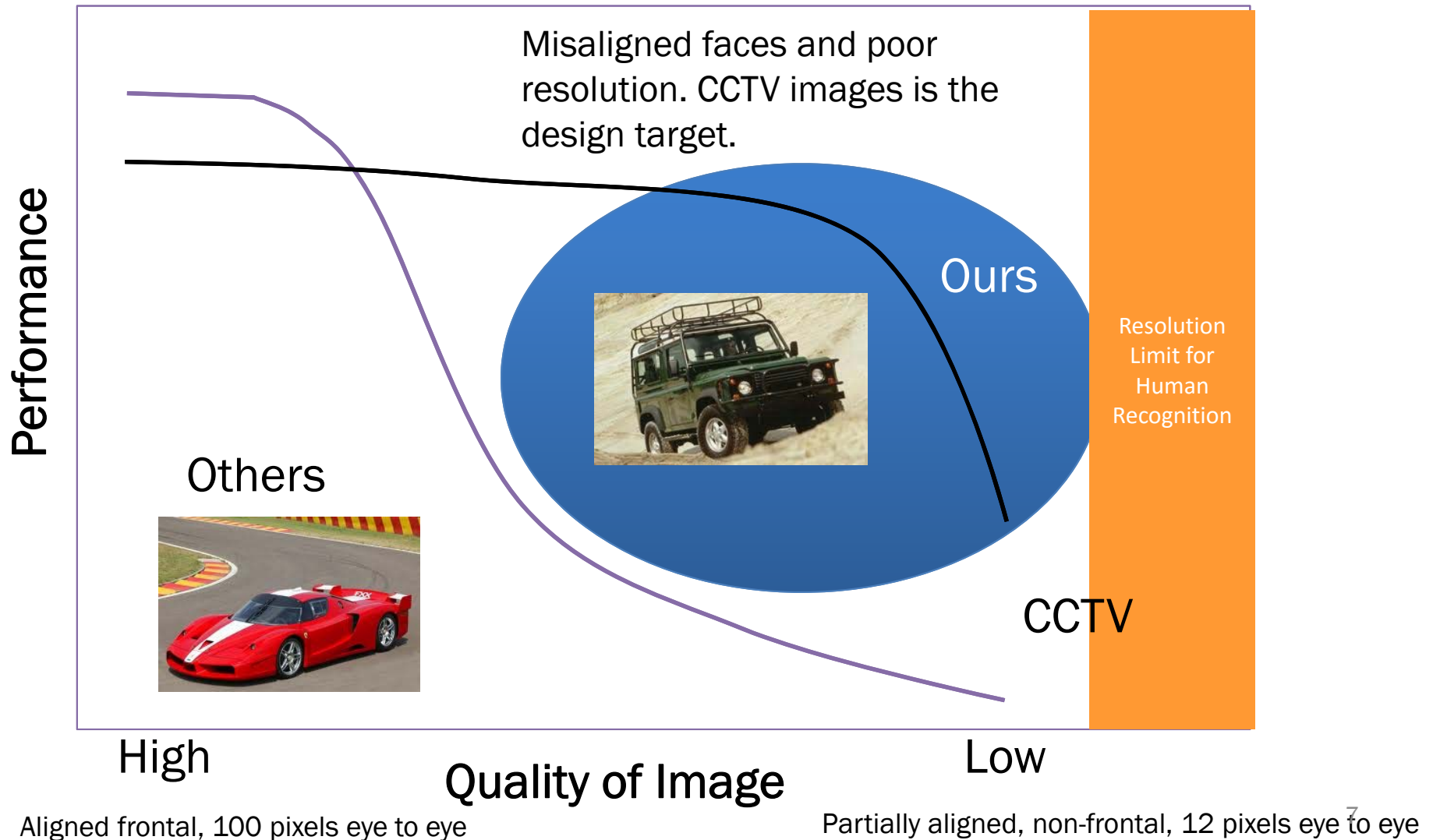


**WE ARE NOT INTERESTED IN THIS
PROBLEM AS IT IS SOLVED (MOSTLY)**



**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



2011: Person Identification in a Crowd




2015: New Generation Software


200x Faster and 50% More Accurate

Imagus iFace Demo

Live Wall Settings Database About



Results Enrol

Brian		Low
	Brian	0.653
	Des Lacy	0.839
	Doctor	0.868
	Ross	0.915
	Ruben	0.916
	Masood	0.925

Include Tags AND

Exclude Tags

Logitech HD Webcam C270 Open

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

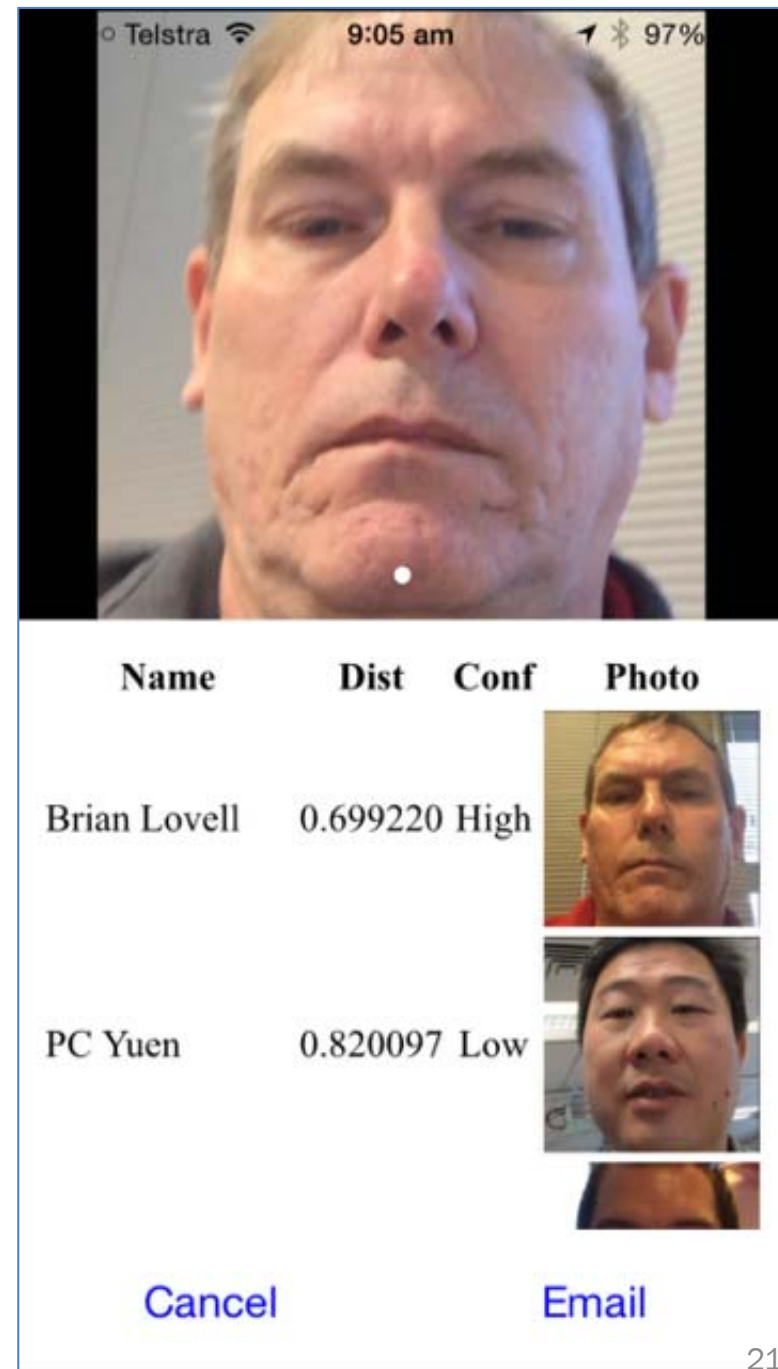
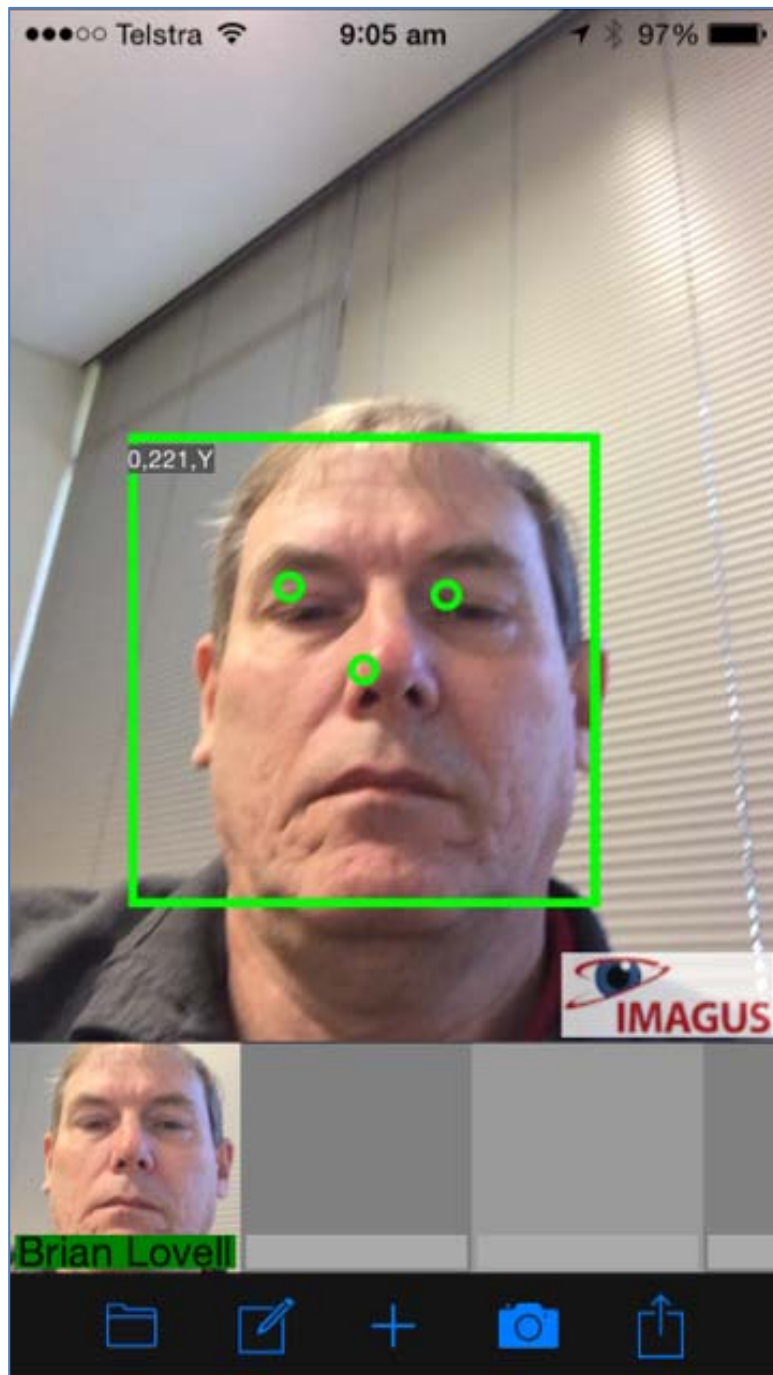
- Still image is relatively easy to process on a phone because there is only one face detection required
- Live video face detection requires real-time detection
- Fortunately modern devices have hardware face detection and sometimes even feature detection

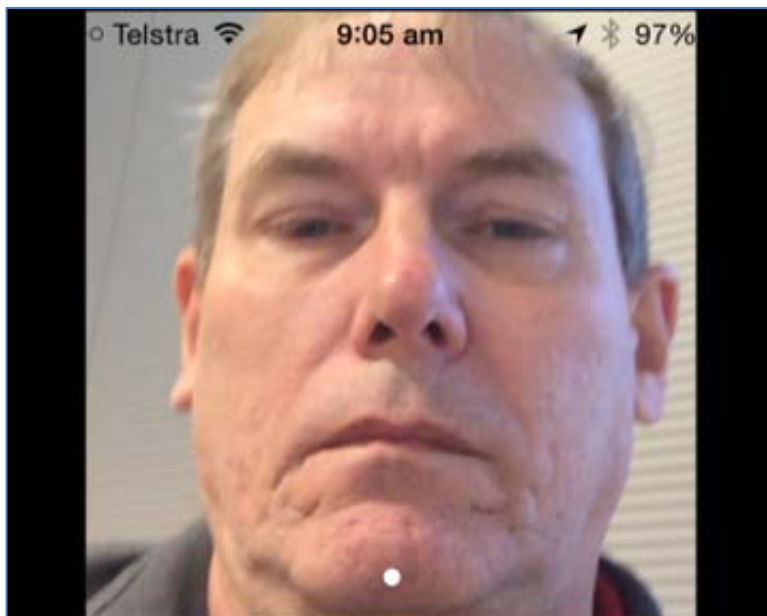
iPhone 6 Version



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



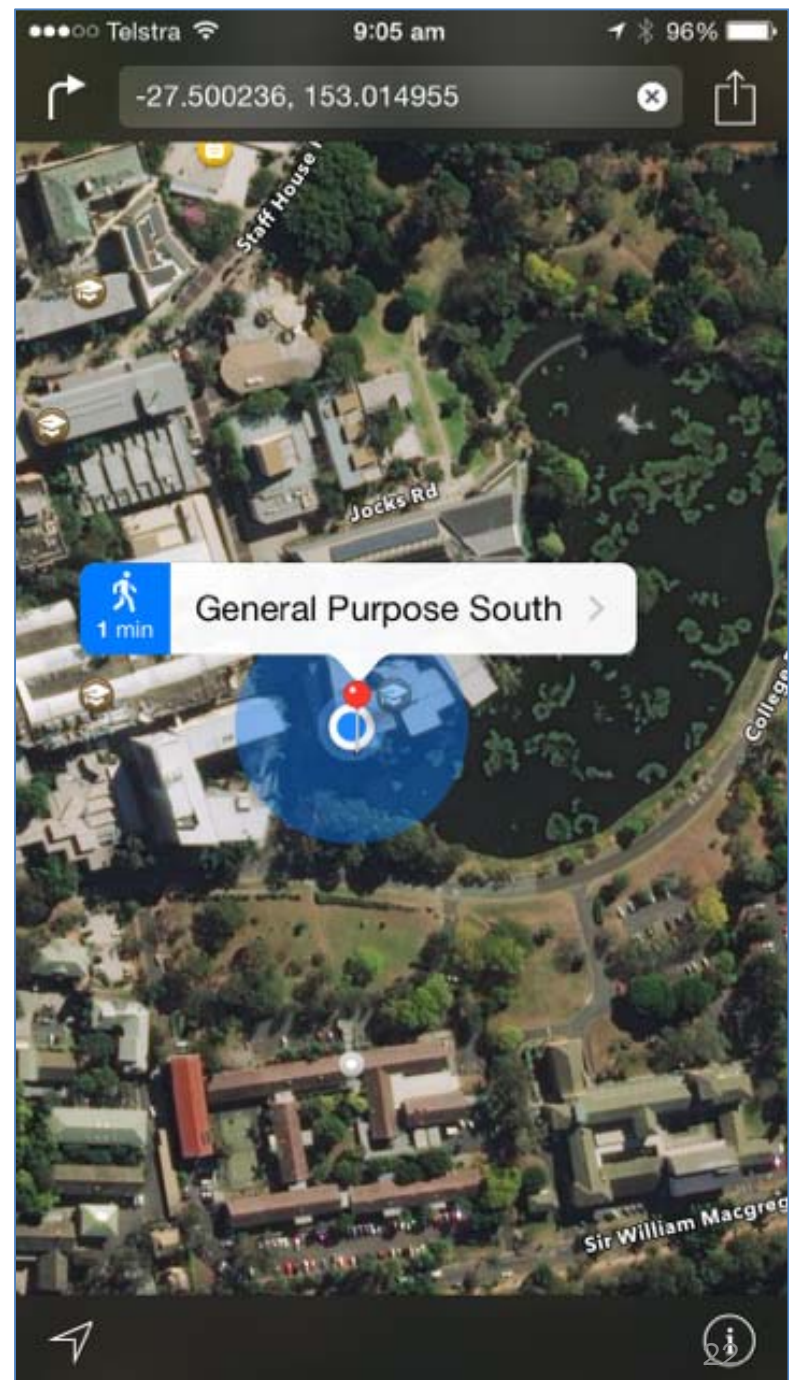


Results

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



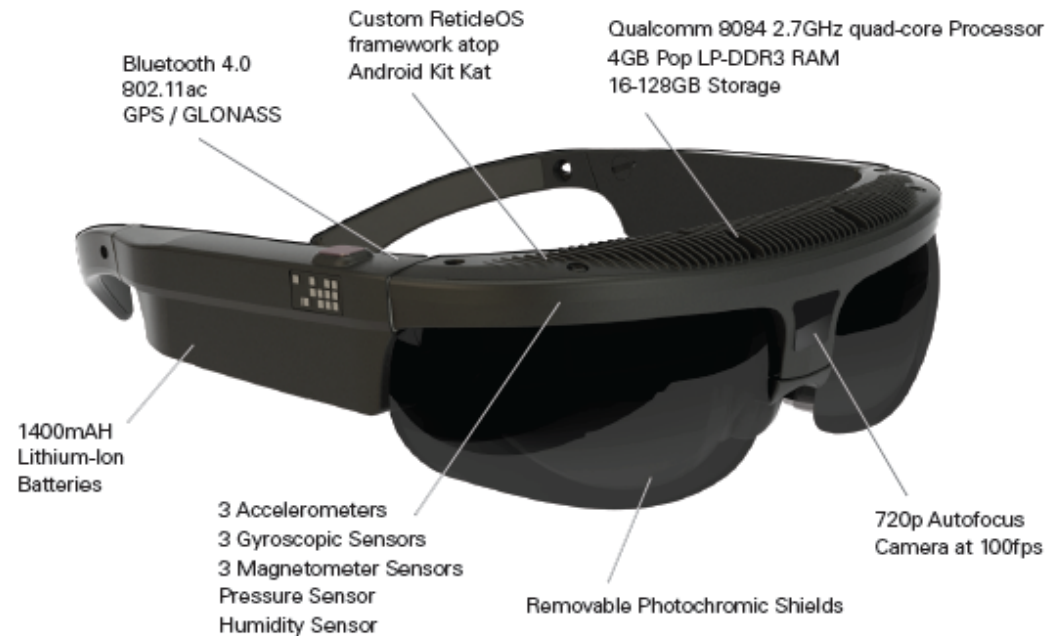
Wearable AR Glasses for Video Face Recognition **ANDROID**



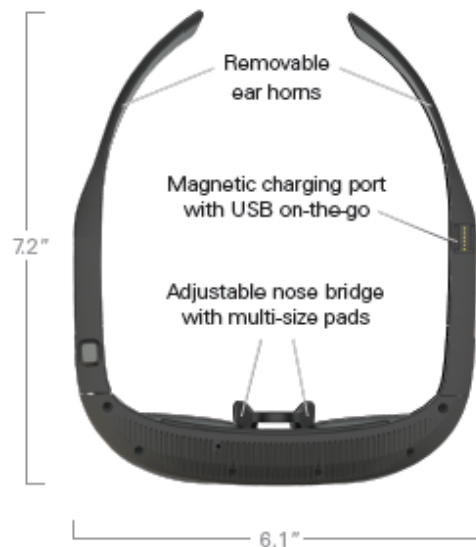
X6 and R7 Glasses



Ralph Osterhout
The Real Life “Q”



TOP VIEW



Dual 720p 16:9 stereoscopic see-through displays at 100fps



REAR VIEW



SIDE VIEW

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 x W Prosopagnosia - Wikipedia... x Imagus Forensic Demo x D The Military Is About to Ge... x +

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

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AA FONT SIZE + PRINT OSTERHOUT GROUP ▼


The Military Is About to Get New Spy Glasses

JUNE 25, 2014 BY PATRICK TUCKER

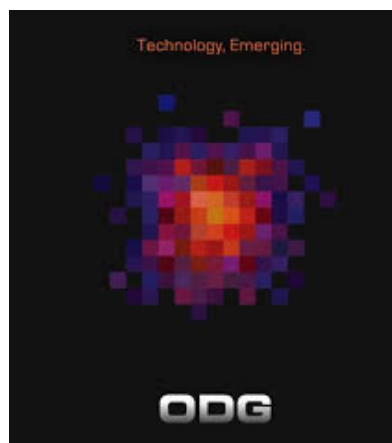
The Defense Department's new smart spectacles go beyond Google Glass. By Patrick Tucker Pentagon ▼ /

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



26



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 from 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





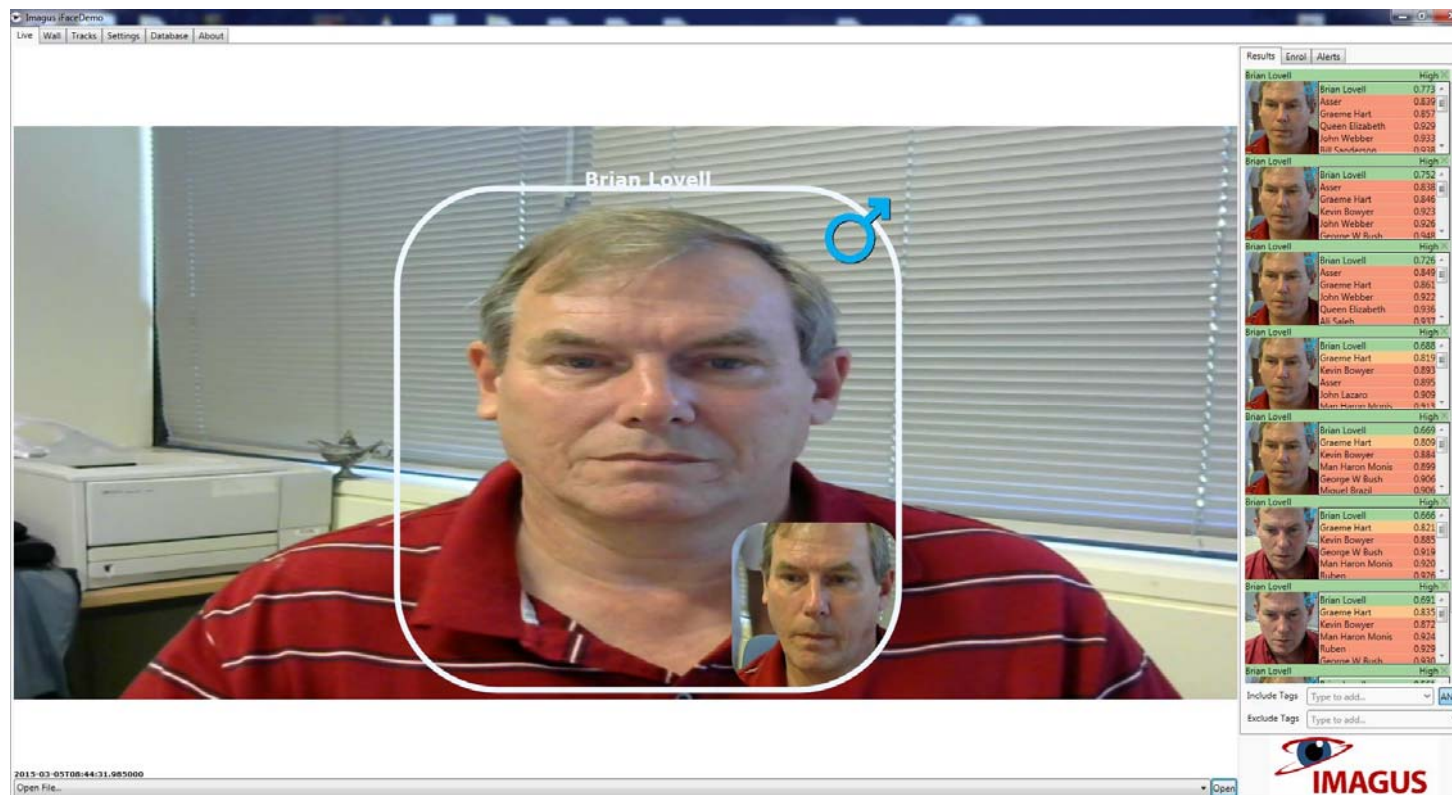
UAV Face Recognition

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



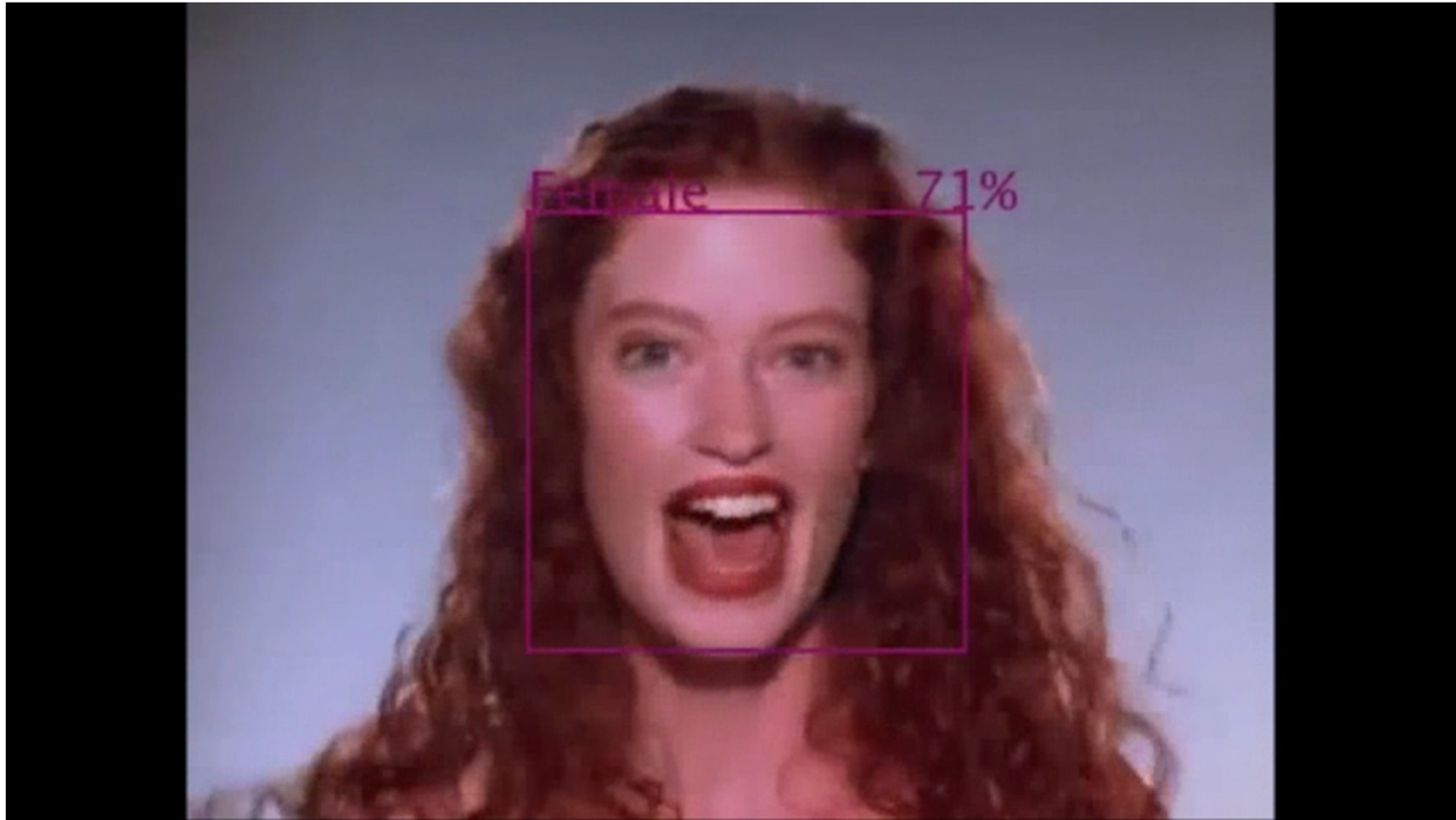


Gender, Age, People Counting

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

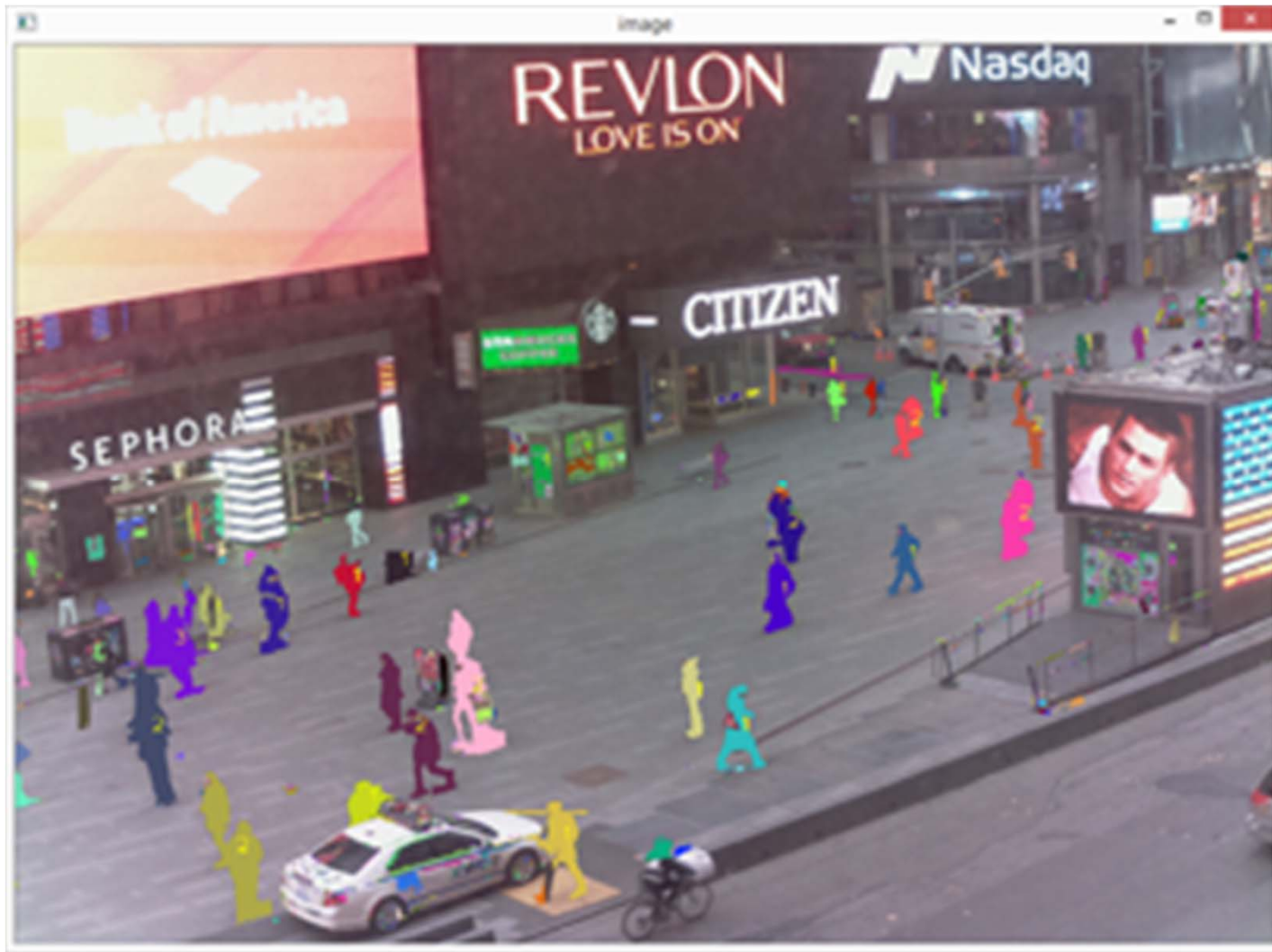
Gender Estimation



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

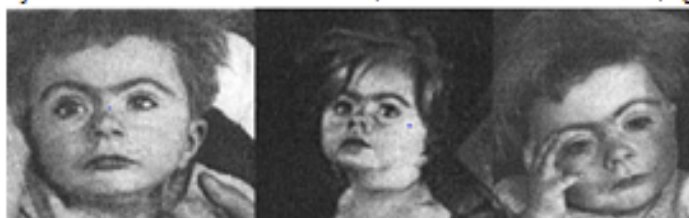
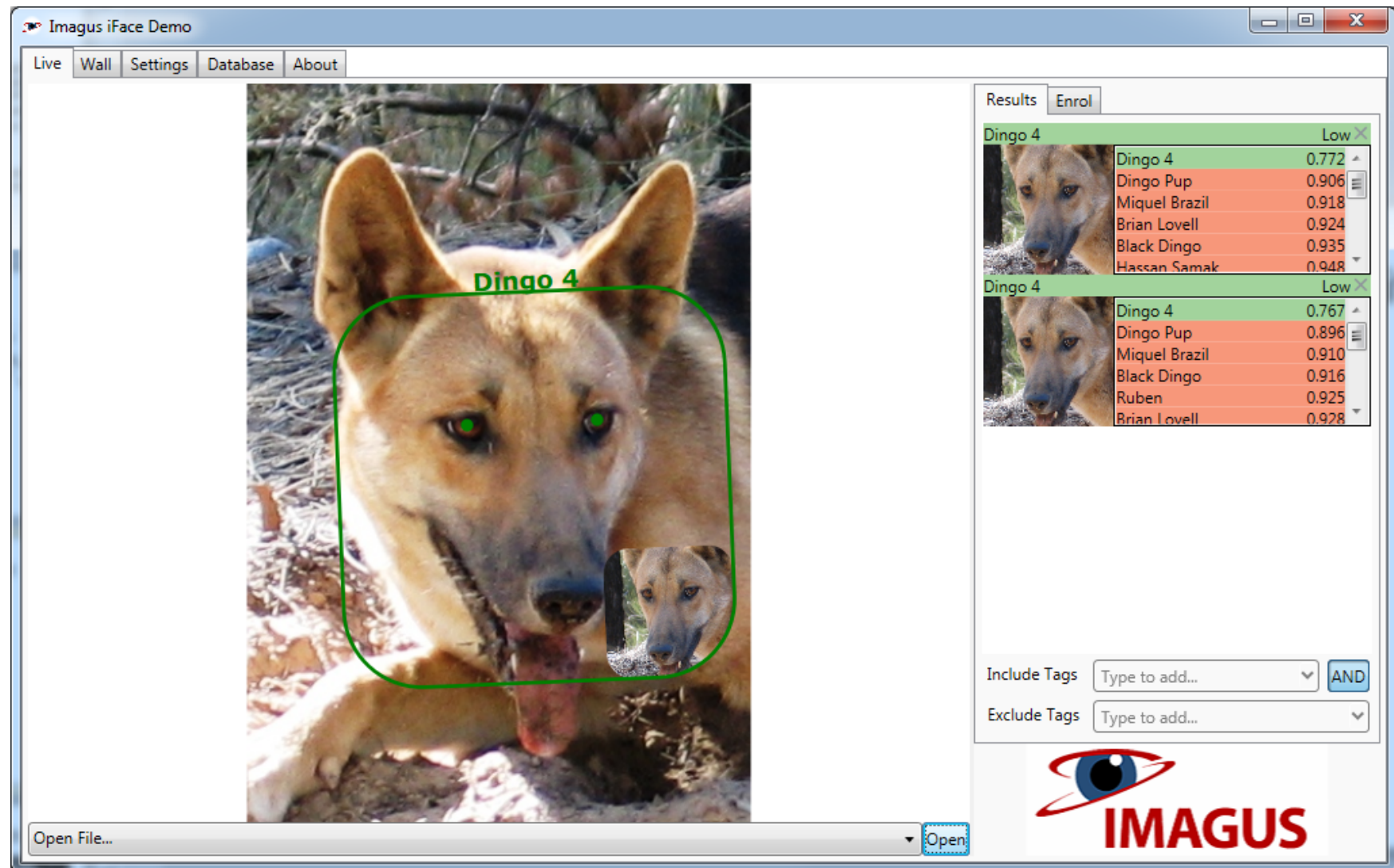


Figure 5. Original published photographs of individuals with Floating Harbor syndrome-From the left: number 4 match; number 1 match; number 2 match, number 2 match; number 3 match

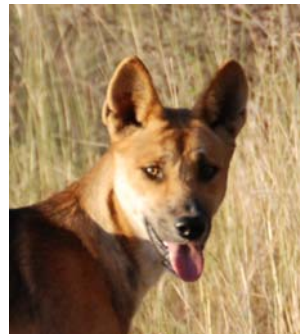
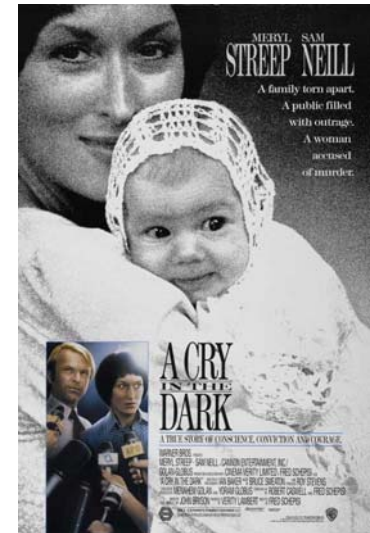


Dingo Face Recognition



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.

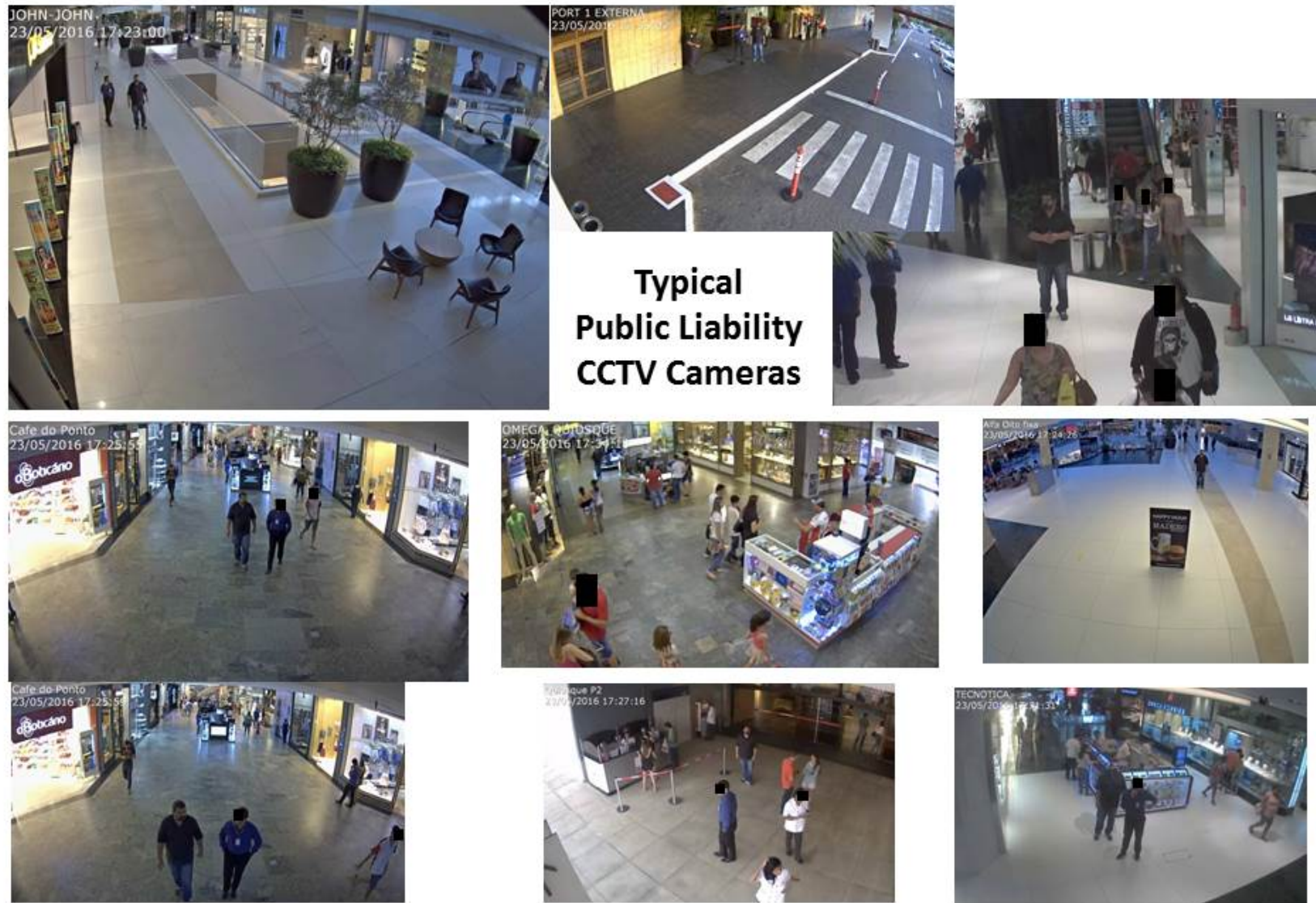
2016 Brazil Project

- 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

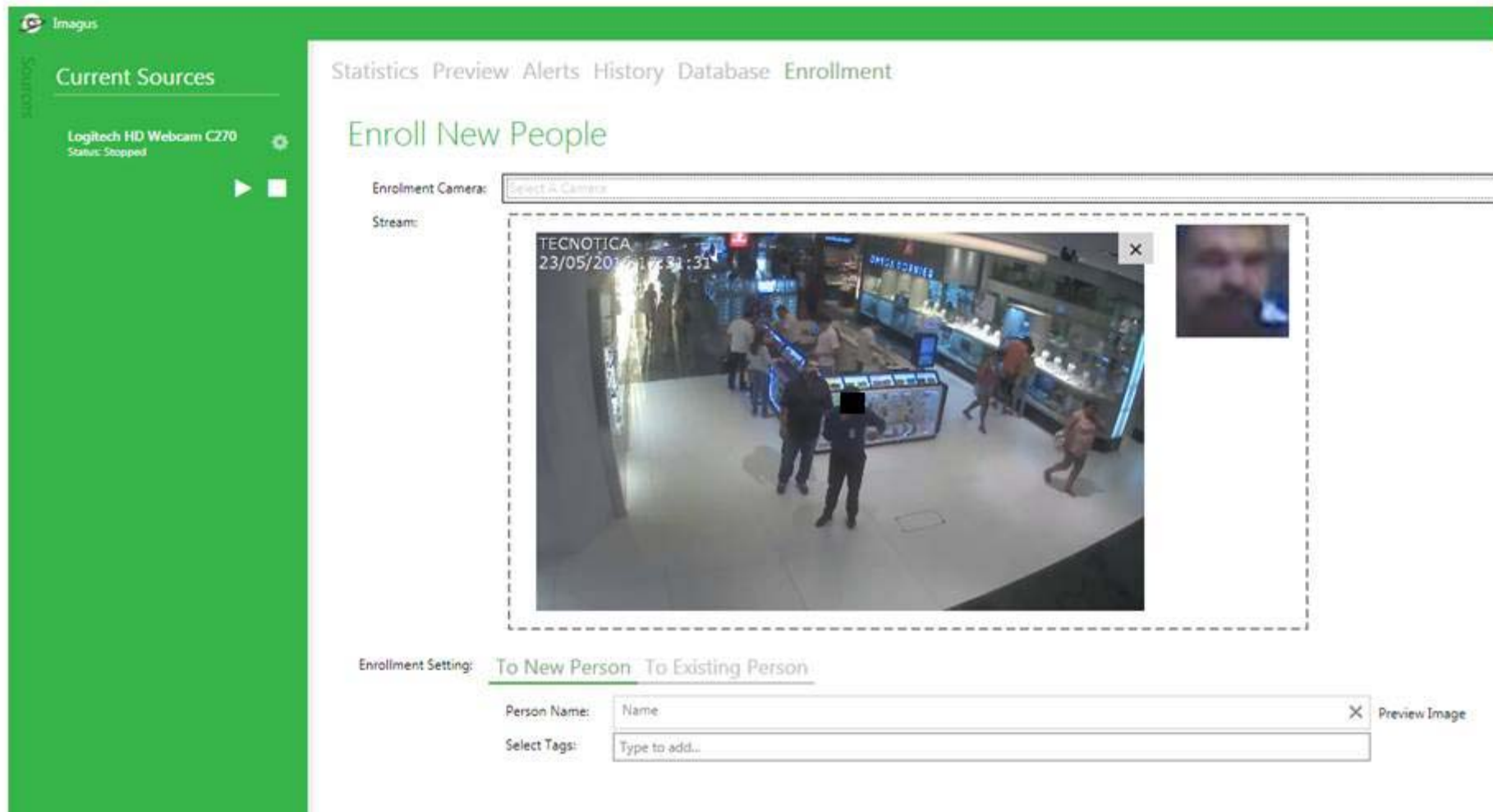
True Transcontinental Surveillance

- 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

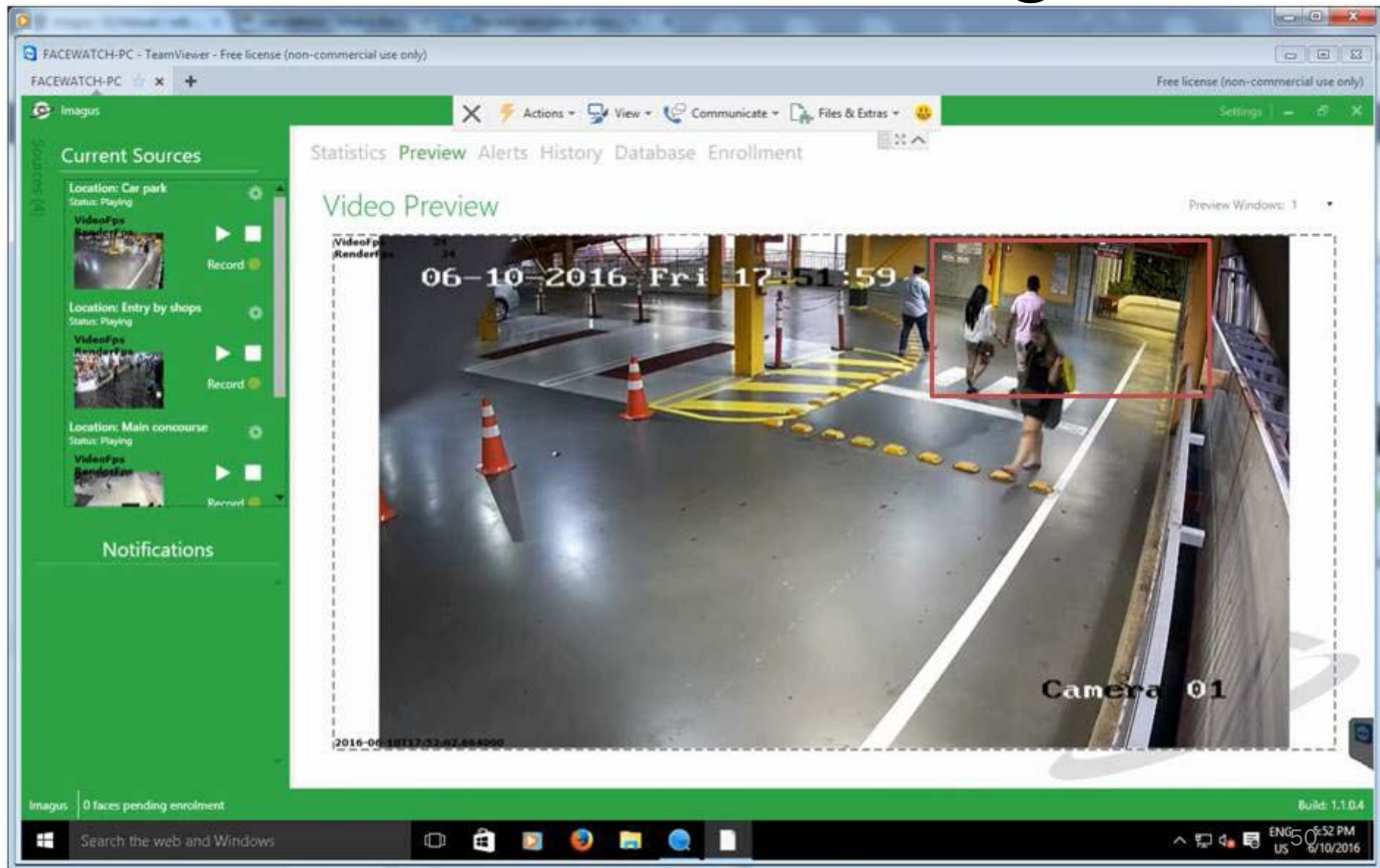


Existing Cameras

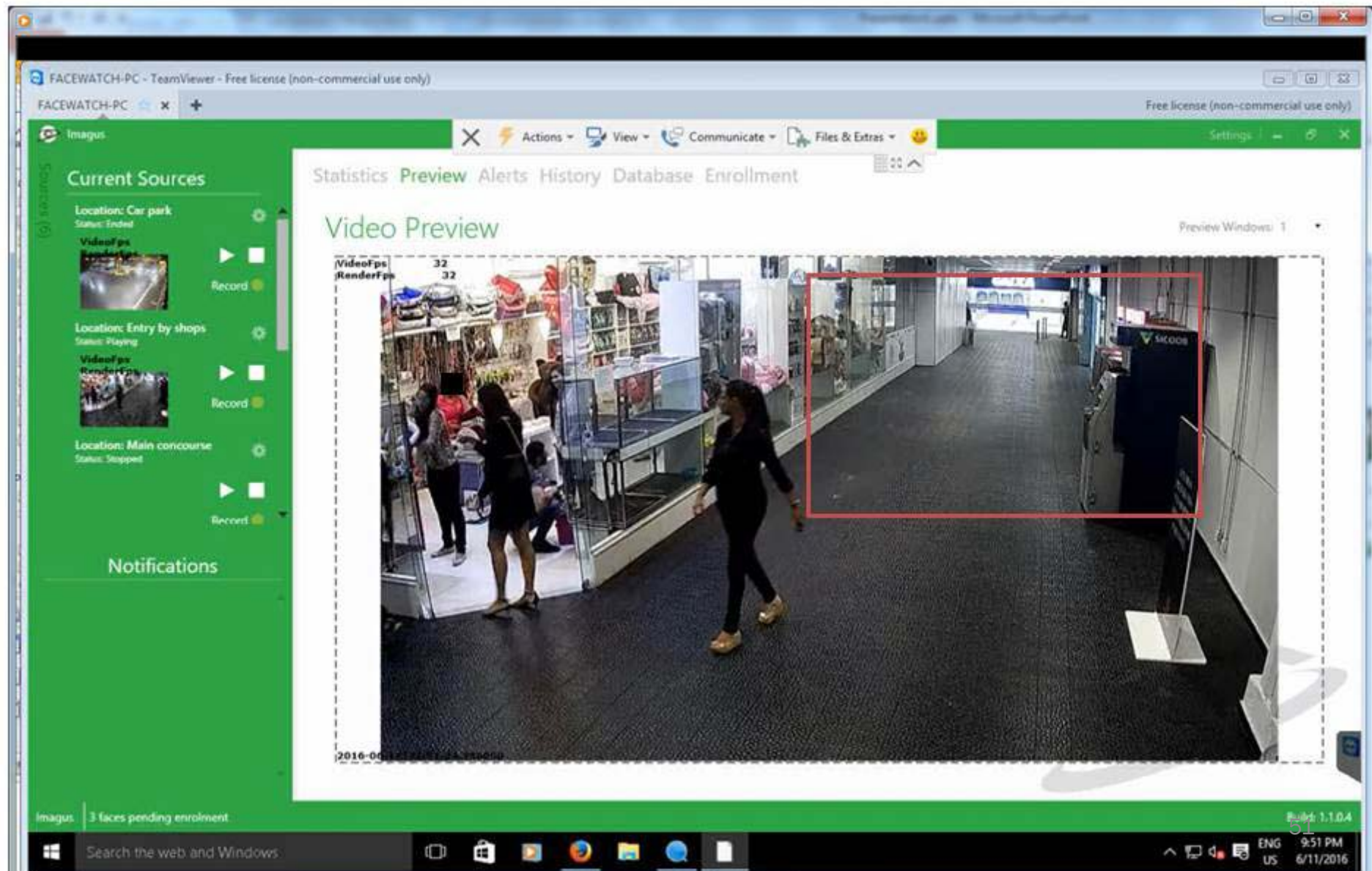


Not enough resolution. Slant angle is excessive.

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



The screenshot displays the Facewatch CCTV software interface. The browser address bar shows the URL <https://www.facewatch-aus.com/app/#imagus>. The top navigation bar includes the Facewatch logo, the text 'CCTV', and a user profile for 'Brian Lovell'. A green button labeled 'Report an Incident' is visible. A yellow banner contains a 'DATA PROTECTION' warning. The left sidebar lists various modules: News Feed, Users, Premises, Groups, Incidents, Watch List, Statistics, **Imagus FR** (highlighted), Police Toolkit, Training, and Support. The main content area features the 'imagus' logo and an 'Alerts' section. This section lists several alerts, each with a subject ID, a small image, a count, and a best similarity score. The most recent alert at the bottom includes a timestamp, a subject image, a name 'Cahn McGreal', a link to 'Brothers', a distance value, and a note about a service match.



Subject	Count	Best Similarity
Subject: SOI118	123	0.5650486
Subject: SOI137	43	0.7017204
Subject: SOI149	73	0.7187948
Subject: SOI124	2	0.7279137
Subject: SOI147	2	0.7464463
Subject: SOI139	1	0.7579593



19:42 | 7th Oct 16 Cahn McGreal → Brothers
Distance: 0.7579593
- Fr/Anpr service detected match with SOI139

Lasts until: 19:42 | 8th Oct 16

Another Match – General Manager



 Subject: SOI142  Count: 2 Best Similarity: 0.7598916

 18:36 | 15th Oct 16  Cahn McGreal → Brothers
Distance: 0.7598916

Gaming Area Dahua Camera  SOI142 

Just Seen! → Match?

Alert: Potential Gaming Area Dahua Camera match from Brothers Leagues Club.
Please click this [link](#) to review and confirm.

 18:36 | 15th Oct 16  Cahn McGreal → Brothers
Distance: 0.7598916
- Fr/Anpr service detected match with SOI142

Daily Alerts

The screenshot shows the Facewatch web application interface. The browser address bar displays <https://www.facewatch-aus.com/app/#imagus>. The left sidebar contains navigation links: News Feed, Users, Premises, Groups, Incidents, Watch List, Statistics, **Imagus FR** (highlighted), Police Toolkit, Training, and Support. The main content area features the 'Imagus' logo and an 'Alerts' section. The alerts are organized into two groups. The first group is for 'Subject: SOI143' with a count of 4 and a best similarity of 0.7428649. It contains four entries, each with a timestamp, a small profile picture, a name 'Cahn McGreal' with a link to 'Brothers', a distance value, and a note '- Fr/Anpr service detected match with SOI143'. The second group is for 'Subject: SOI137' with a count of 2 and a best similarity of 0.7537992. It contains one entry with a timestamp, a small profile picture, a name 'Cahn McGreal' with a link to 'Brothers', a distance value, and a note '- Fr/Anpr service detected match with SOI137'. Each entry also includes a 'Lasts until' date and time, and a trash icon for deletion.

Subject	Count	Best Similarity
SOI143	4	0.7428649
SOI137	2	0.7537992

Alerting on Me

The screenshot displays the Facewatch web application interface. The browser address bar shows the URL <https://www.facewatch-aus.com/app/#>. The top navigation bar includes the Facewatch logo, the text "CCTV", and the user name "Brian Lovell" next to a profile icon. A green button labeled "Report an Incident" is visible on the left. A yellow banner at the top contains a "DATA PROTECTION" notice. The left sidebar lists various navigation options: News Feed, Users, Premises, Groups, Incidents, Watch List, Statistics, Imagus FR, Police Toolkit, Training, and Support. The main content area features the "imagus" logo and a "+ Notification" button. Below this, the "Alerts" section is displayed, showing a list of alerts. The first alert, dated 13:34 on 18th Oct 16, is from "Brian Lovell" and is titled "Brisbane Neighbourhood Watch". It includes a "Mark as read" link and a "Lasts until: 13:34 | 19th Oct 16" timestamp. The alert content shows two side-by-side face images: "Brian's MacPro" (labeled "Just Seen!") and "SOI118" (labeled "Match?"). A text box below the images reads: "Alert: Potential Brian's MacPro match from Roving Camera Technologies. Please click this link to review and confirm." Below the alert list, there is a "Load more alerts" link. On the right side of the interface, a "Coming Events" section states "No events found".

Facewatch CCTV

Brian Lovell

Report an Incident

DATA PROTECTION – The organisation which posted the images and associated personal information to this Group (the Personal Data) is the data controller and responsible for that Personal Data whilst they are available to the Group. Each member of the Group that downloads or otherwise uses the Personal Data shall become solely responsible for the use to which they put such Personal Data. By downloading or otherwise using the Personal Data you accept that you become a data controller in common of such Personal Data

News Feed

Users

Premises

Groups

Incidents

Watch List

Statistics

Imagus FR

Police Toolkit

Training

Support

imagus

+ Notification

Alerts

Expand All

13:34 | 18th Oct 16 Brian Lovell → Brisbane Neighbourhood Watch Lasts until: 13:34 | 19th Oct 16 Mark as read

Brian's MacPro SOI118

Just Seen! Match?

Alert: Potential Brian's MacPro match from Roving Camera Technologies. Please click this link to review and confirm.

Add comment

11:57 | 18th Oct 16 Cahn McGreal → FaceRec - Fr/Anpr service detected match w... Lasts until: 11:57 | 19th Oct 16 Mark as read

11:57 | 18th Oct 16 Cahn McGreal → test group - Fr/Anpr service detected match ... Lasts until: 11:57 | 19th Oct 16 Mark as read

11:40 | 18th Oct 16 Cahn McGreal → test group - Fr/Anpr service detected match ... Lasts until: 11:40 | 19th Oct 16 Mark as read

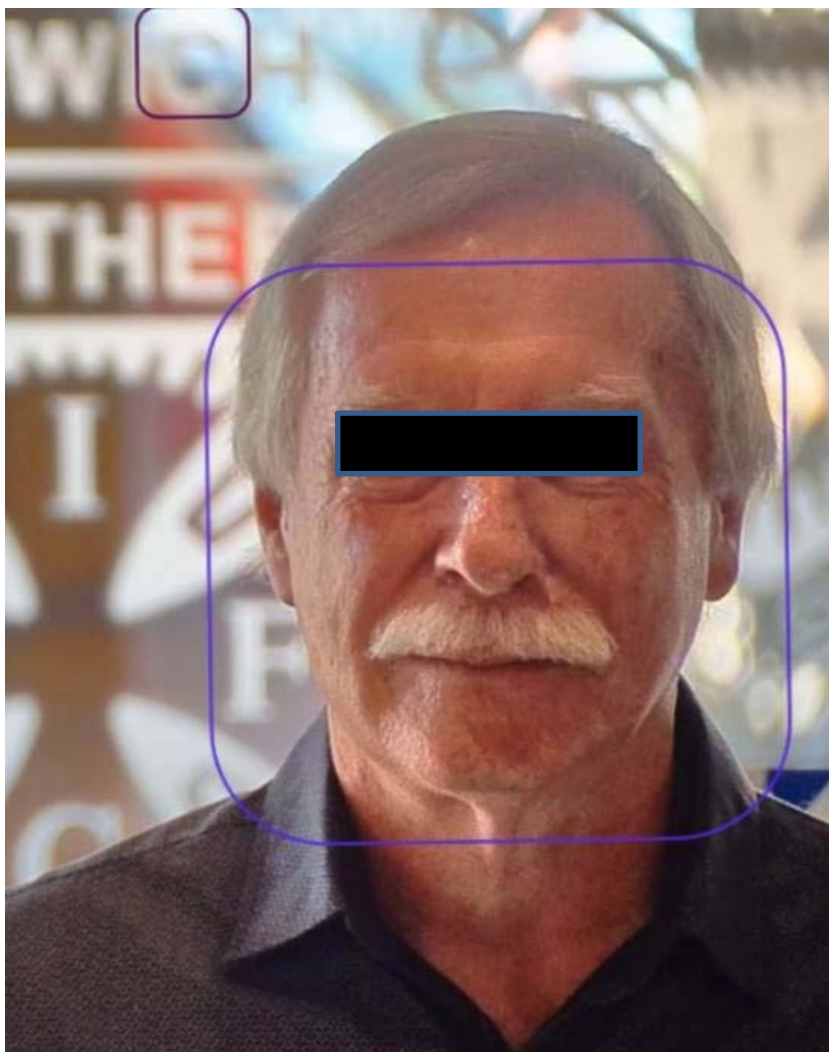
11:40 | 18th Oct 16 Cahn McGreal → FaceRec - Fr/Anpr service detected match w... Lasts until: 11:40 | 19th Oct 16 Mark as read

Load more alerts ↓

Coming Events

No events found

Best Camera for Doorway Installed in October

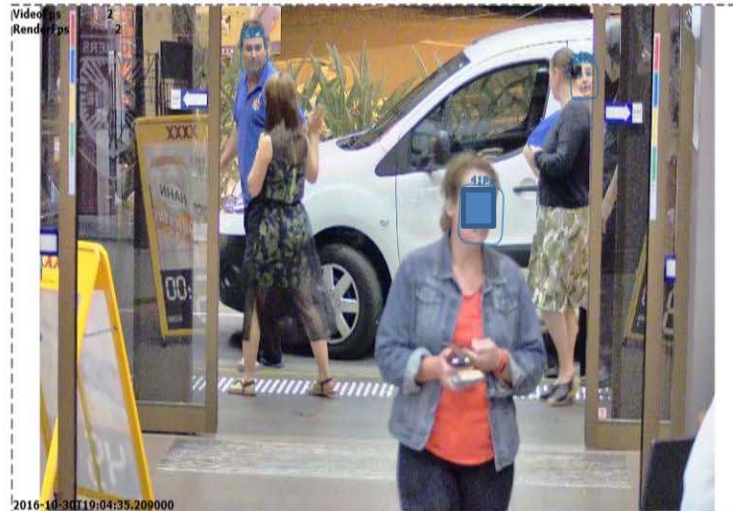


We tried 15 models of camera and could not get detection on the doorway due to backlight issues.

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

Case Study - IMQ Leagues Club

Video Preview

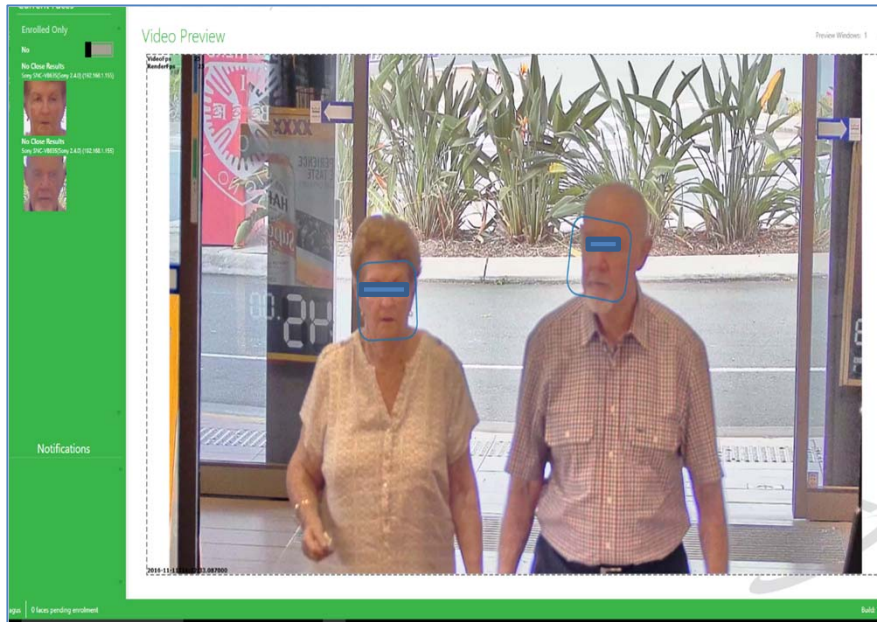


Alerts

- 1 Subject: SOI118 Count: 274 Best Similarity: 0.5198622
- 1 Subject: SOI137 Count: 1 Best Similarity: 0.7229155
- 1 Subject: SOI149 Count: 1 Best Similarity: 0.7258798
- 1 06:33 | 5th Oct 16 Cahn McGreal → Brothers Distance: 0.7258798 - FriAnpr service detected match with SOI149, SOI133
- 1 Subject: SOI133 Count: 1 Best Similarity: 0.7582519
- 1 08:52 | 4th Oct 16 Cahn McGreal → Brothers Distance: 0.7582519 - FriAnpr service detected match with SOI133
- 1 Subject: SOI138 Count: 2 Best Similarity: 0.7586789

Imagus IMQ PC
Platform

IMQ Leagues Club



Sony SNC-VB635(Sony 2.4.0) (192.168.1.155)	11/14/2016 9:23:33 PM	11/14/2016 9:23:38 PM	29 %	Ben	High	♂
Sony SNC-VB635(Sony 2.4.0) (192.168.1.155)	11/14/2016 9:23:30 PM	11/14/2016 9:23:30 PM	31 %			♂
Sony SNC-VB635(Sony 2.4.0) (192.168.1.155)	11/14/2016 9:22:21 PM	11/14/2016 9:22:23 PM	26 %			♀

Imagus IMQ PC Platform

History Log									
Alerts Historical Tracks									
REFINE RESULTS									
Filter Results									
Name Filter									
Match Quality Threshold									
Face Variance Threshold									
Start Date									
Refresh Data									
Refresh									
Face Variance Threshold									
LOCATION	START	END	VARIANCE	RESULT PERSON	CONFIDENCE	FACE	GENDER		
Sony SNC-VB635(Sony 2.4.0) (192.168.1.155)	11/12/2016 10:36:09 PM	11/12/2016 10:36:12 PM	22 %				♀		
Sony SNC-VB635(Sony 2.4.0) (192.168.1.155)	11/12/2016 10:34:13 PM	11/12/2016 10:34:15 PM	24 %				♂		
Sony SNC-VB635(Sony 2.4.0) (192.168.1.155)	11/12/2016 10:34:11 PM	11/12/2016 10:34:13 PM	25 %				♂		
Sony SNC-VB635(Sony 2.4.0) (192.168.1.155)	11/12/2016 10:30:06 PM	11/12/2016 10:30:10 PM	24 %				♀		
Sony SNC-VB635(Sony 2.4.0) (192.168.1.155)	11/12/2016 10:29:33 PM	11/12/2016 10:29:36 PM	25 %				♂		

IMQ Leagues Club

Imagus IMQ PC



Statistics [Preview](#) Alerts History Database Enrollment

Video Preview

VideoFps: 30
RenderFps: 30

A video preview window showing a security guard in a white shirt and tie. The guard is standing in front of a building with a sign that reads 'IMQ LEAGUES CLUB'. The video is being recorded, as indicated by the 'Recording' status in the top left corner. A red bounding box is drawn around the guard's face, and a blue bounding box is drawn around his hands. A small window in the top left corner shows a thumbnail of the video and the text 'Sony Entry Foyer 137 was seen in Sony Foyer Entry 21/10/2016 6:43:09 PM'. A 'Record' button is visible in the bottom left corner.

Notifications

Entry alert success

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

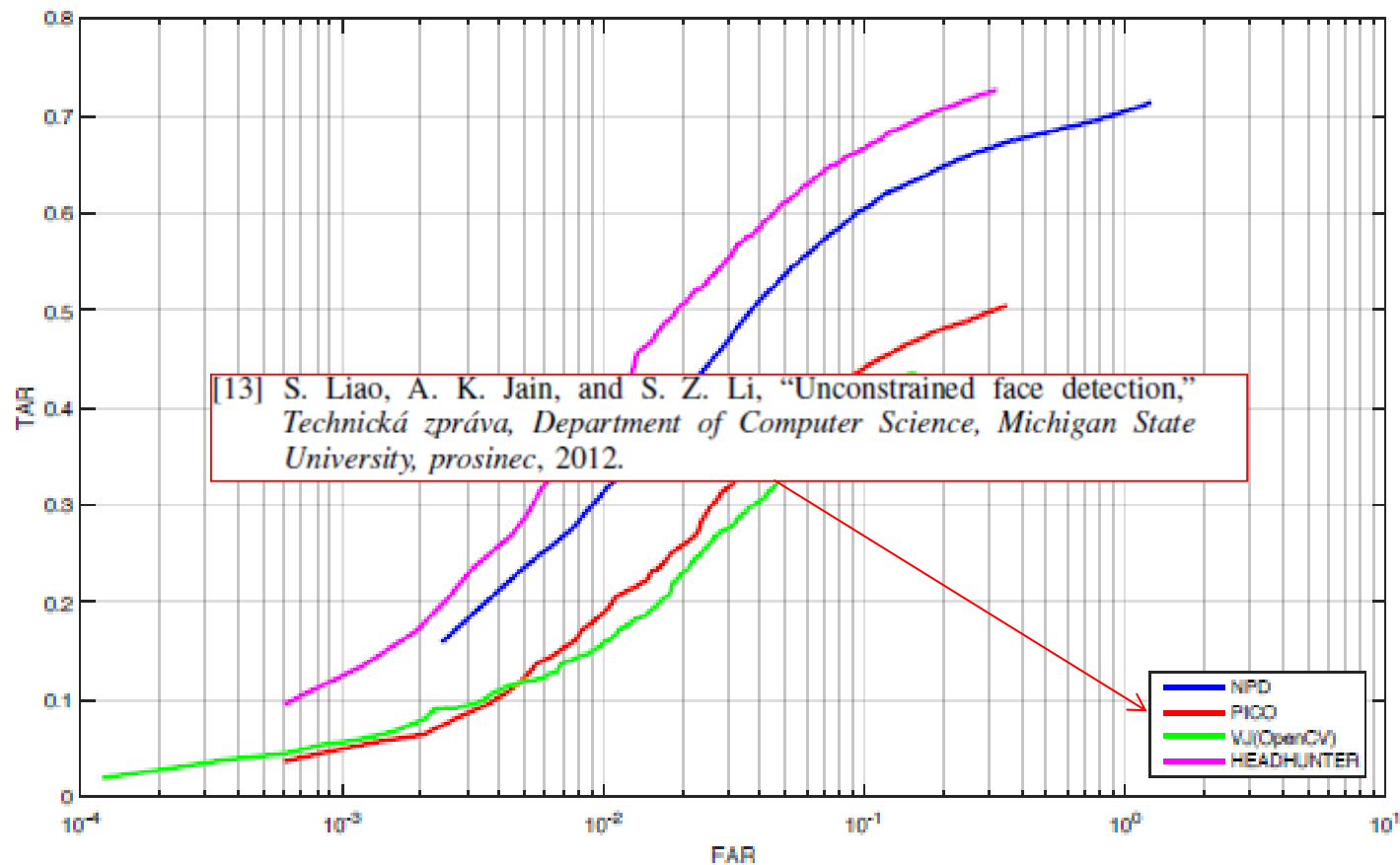


Fig. 1. Discrete ROC curve for IJB-A dataset

Pose Angle

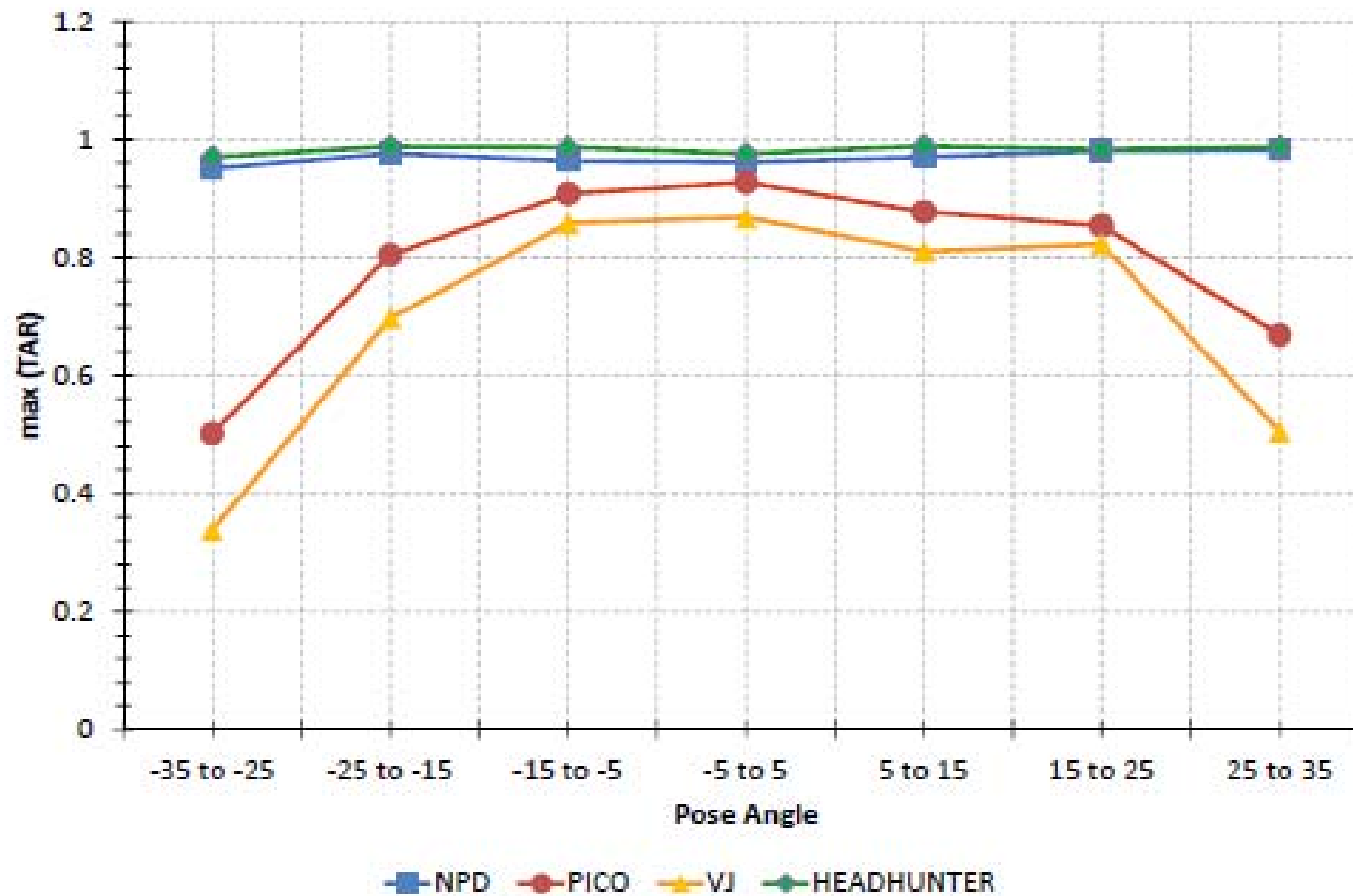


Fig. 3. Pose angle performance on IJB-A dataset

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Questions

