



Facial Recognition

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2019

Ensuring safer  
tomorrows



# Who am I

**Soren Frederiksen**

**VP of Innovation Lab**

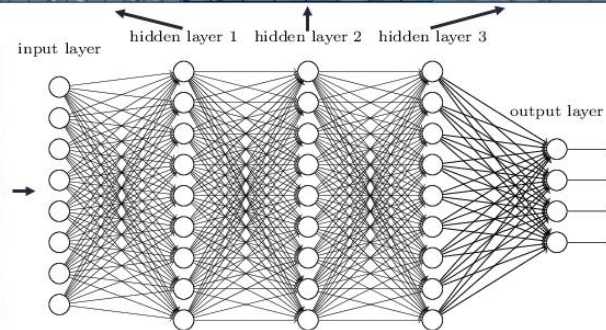
- Electrical Engineer from Denmark
- 30 year developing software
- Neural Networks researcher in 90's
- Founder and CTO of former iView – iTrak product
- Deployed facial recognition in Casinos since 2004

# Facial Recognition History

- 1964 and 1965, Bledsoe, Helen Chan and Charles Bisson
  - 40 pictures per hour, manual measurements
- 1980s and 90s - Eigenfaces
- 1996 ZN-Face started to be used and was “robust enough”
- 1999 Our office used access card with face recognition we developed
- 2001 Baltimore Ravens vs New York Giants, Tampa Bay, Super Bowl XXXV
- 2006 Face Recognition Grand Challenge – 10 times accuracy of 2002 and 100 times 1995
- 2012 Convolutional neural networks
- 2013 to 2017 1 million images FNMR, of 0.068 down to 0.025 FMR =  $1e-03$
- 2017 September, Apple announced Face ID during the unveiling of the iPhone X

# Industry Improvements

- NIST report - NISTIR 8238 Ongoing Face Recognition Vendor Test (FRVT)
  - 127 algorithms from 45 developers
  - Massive gains in accuracy have been achieved in the last five years (2013- 2018)
  - 28 developers' algorithms now outperform the most accurate algorithm from late 2013
- Deep learning



- Convolutional neural network (CNN)
  - ImageNet
    - 14 million images have been hand-annotated
    - 20,000 categories such as "balloon" or "strawberry"
    - 2012 challenge 10.8 percentage points better than runner up



# Facial Recognition - Scenarios

- 1 to 1
  - Cooperative
- 1 to Many
  - Cooperative
  - Non cooperative
  - Black List
  - White list
- Searches vs Alerts
  - Database searches
  - Top N searches
  - Threshold based alerts

# Value proposition

- Reduce black lists to simple alerts
  - Reduce man hours
  - Cope with 10,000 plus black lists
- Reduce fraud, theft and liability

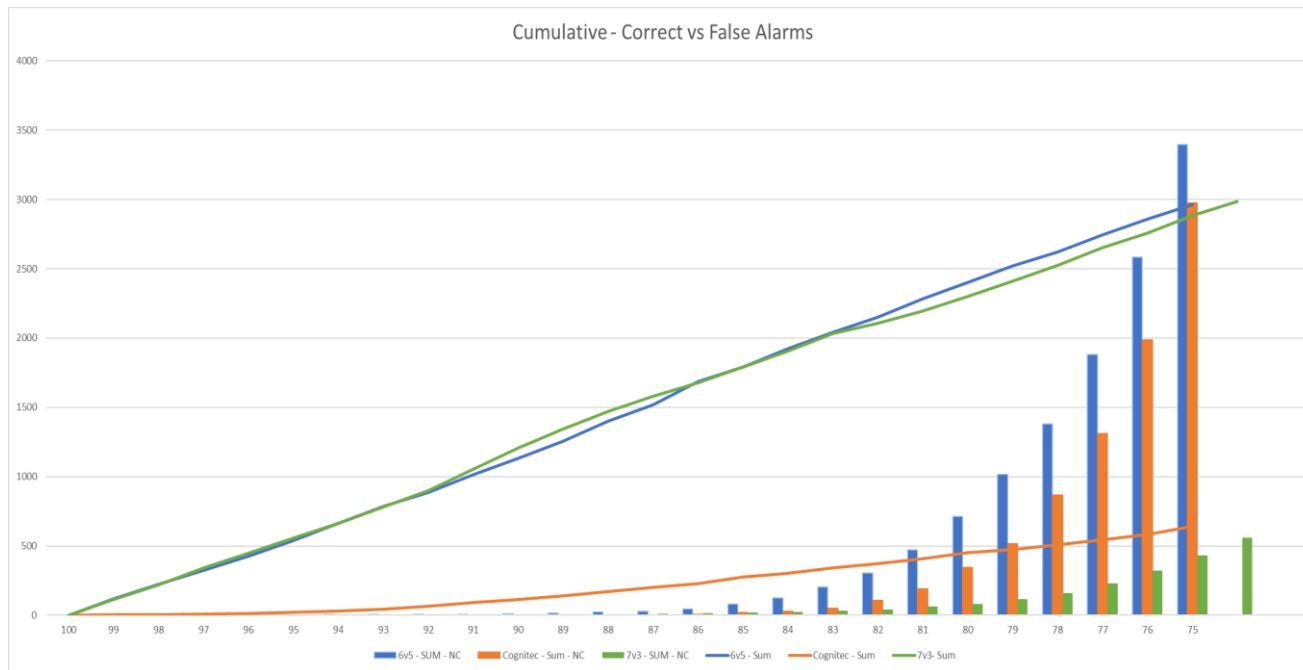
The screenshot shows a web application window with a light blue border. At the top, there are three buttons: 'Accept' (with a green checkmark icon), 'Reject' (with a red X icon), and 'Open Subject' (with a magnifying glass icon). A 'Close' button is in the top right corner. The main content area is divided into two columns. The left column contains a 'Match Score:' section with a large box displaying '83%'. Below this are several input fields: 'AlertId:' with '5676', 'Title:' with 'Face Recognition Alert', 'Date Time:' with '5/30/2019 4:02 PM' and a calendar icon, 'Location:' with 'TestLocation', 'Modified By:' with 'administrator', 'Modified Date Time:' with '5/30/2019 4:03 PM' and a calendar icon, and 'Camera Name:' with 'TestCamera'. The right column has a 'Status:' section with the word 'Accepted' in green. Below the status is a small video feed showing a man with glasses. To the right of the video feed is a 'Subject' section with a 'Name:' field containing 'Jeffrey Connors'. Below that is a 'SubjectPhotos' section with a gallery of two photos; the first photo is a portrait of the same man. Navigation arrows and '2 - 2 of 2 Items' are visible at the bottom of the photo gallery.

# Omnigo Facial Recognition test

- Gallery: 3958, Probe: 758,778
- Recognize 4.7 times more faces with 18% the of the false alarms
- 24.7 times improvement

	Correct	Incorrect
Previous Technology	639	2973
Deep Learning	<b>2986</b>	<b>560</b>

# Threshold chart



Alert impacts:

Technology  
Blacklist size  
Traffic numbers  
Image quality

\* - NC stands for Not Correct (False Alarm)

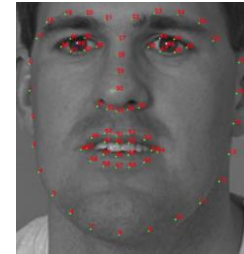
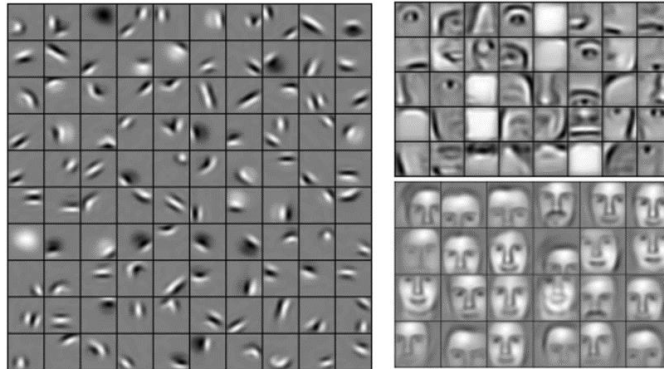


# Face Rec stages

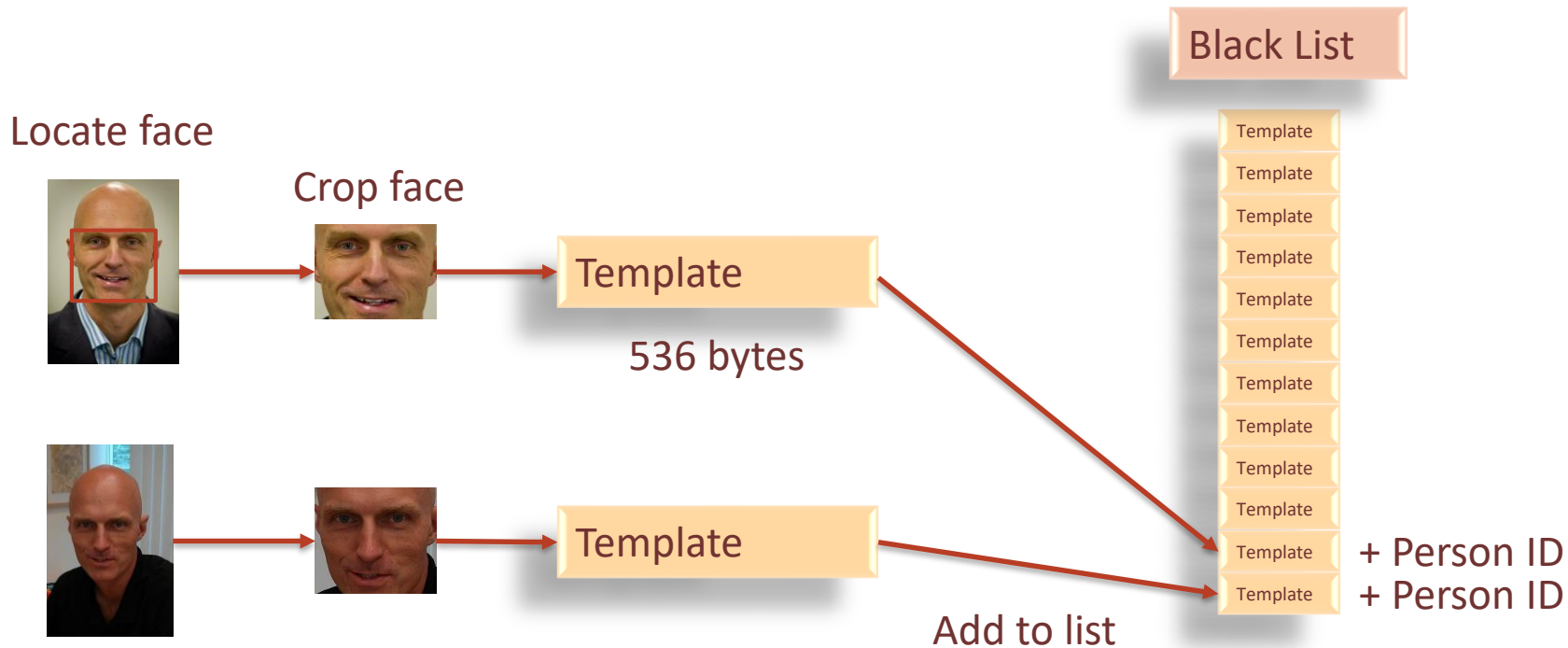
- Collect or convert a blacklist of images
  - Enroll into face rec
- Identify good camera locations
- Deploy cameras and software
  - Detect faces
    - 15 – 30 fps select best
  - Recognize faces
    - Match against black list
  - Send alerts
    - If recognition is above specified threshold
- Deal with alerts
  - Human screening
    - Compare alerts
  - Action
    - Deal with the person found

# Face Detection

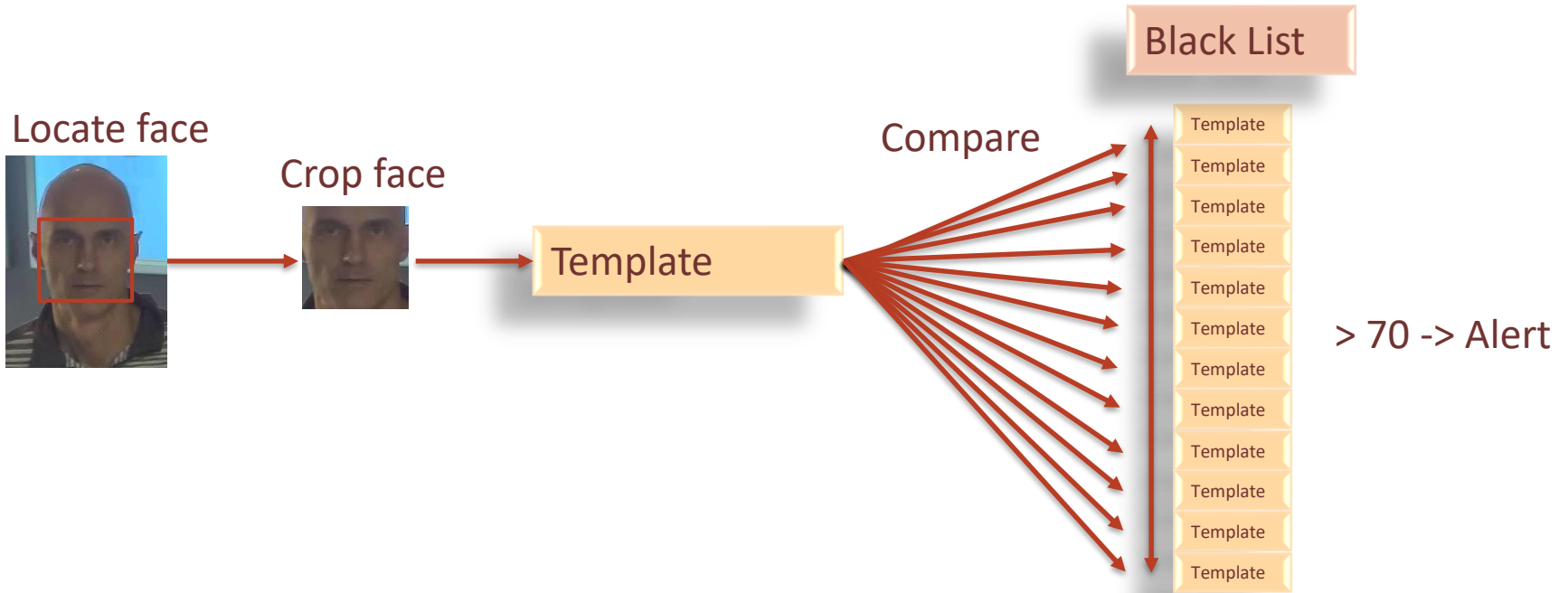
- Locate face in image
- Follow face



# Enrollment



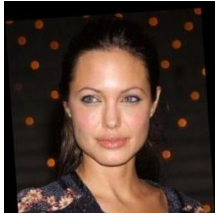
# Recognition



# Performance Impact

- Facial Angle
- Lighting
  - Low light
  - Shadows
- Image Size

## Good images



## Bad images

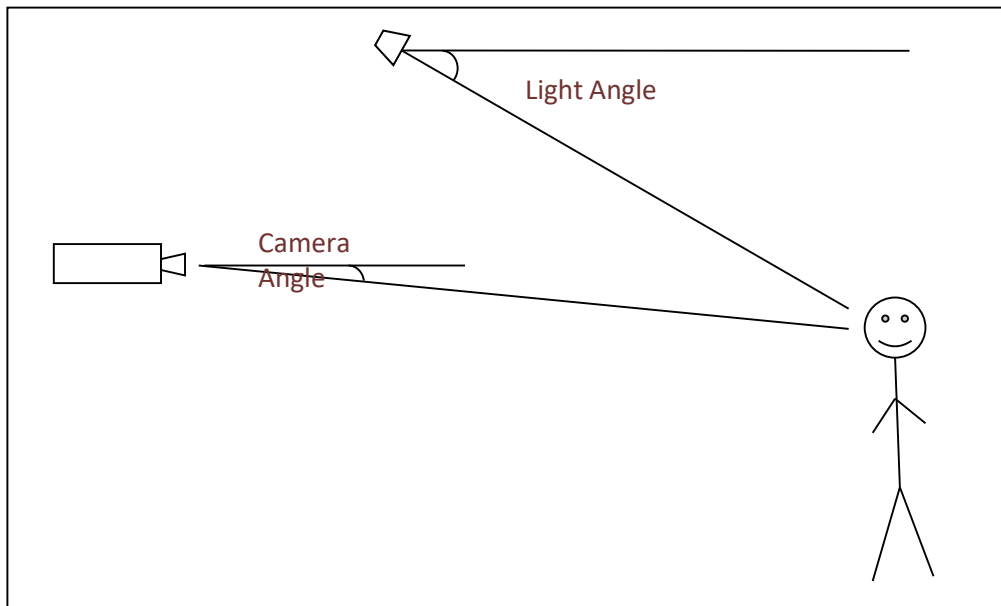


# Omnigo Facial Deployment

- Site Survey
- Target Area
  - Coverage area (Width)
  - Pixels between Eyes
- Lighting
  - Level
  - Direction
  - Changes
- Cameras
  - Camera model
  - Camera mounting
  - Camera lens
- Testing
  - On going



# Site calculations



Example:

Camera Height: 105"

Average Human Height is US: 5' 7" = 67"

Distance to target: 245"

Camera angle (Rise =  $(105 - 67) = 38$ ", Run = 245"): 8.82 degrees

Property  
Location  
Camera Name

# Cameras for face rec

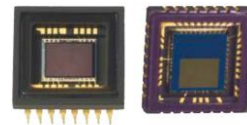


Figure 1. Image sensors: CCD (left) and CMOS (right)

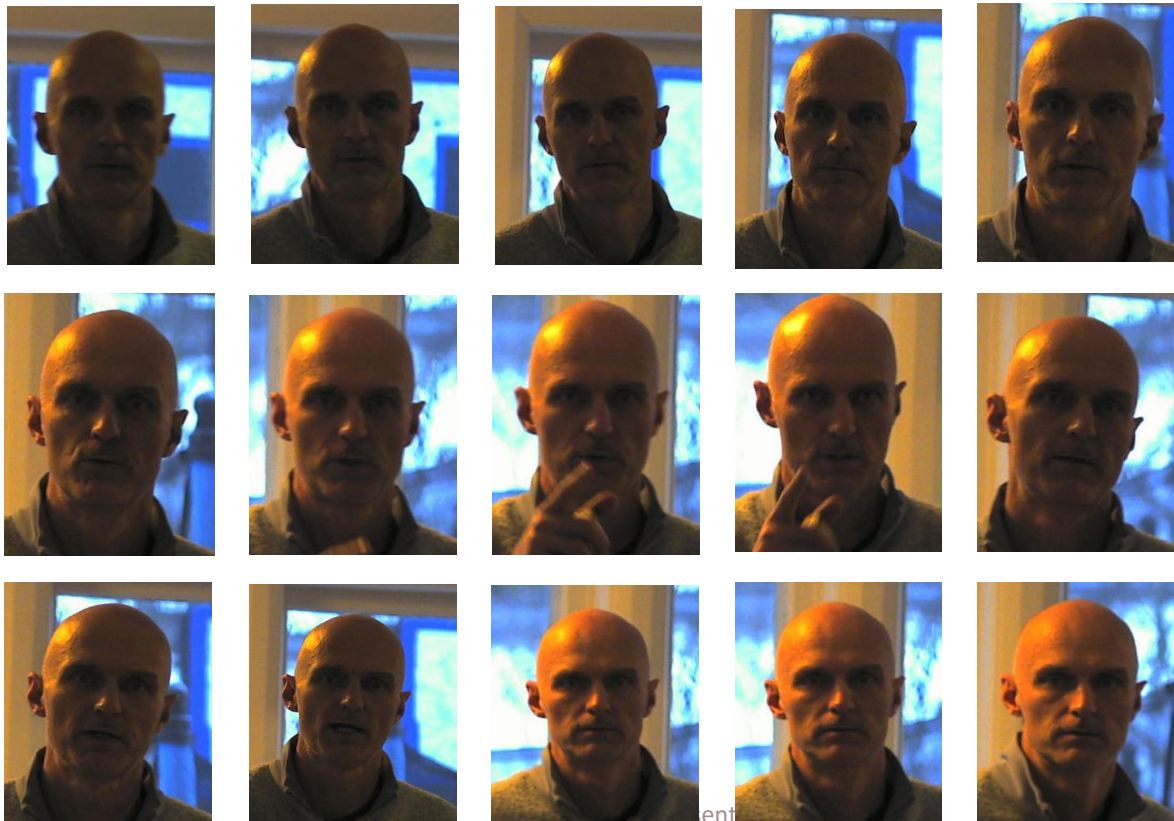
- Sensor Size
- Sensor Type
- Lenses available

- Axis
- Hik Vision
- Panasonic
- Dahua

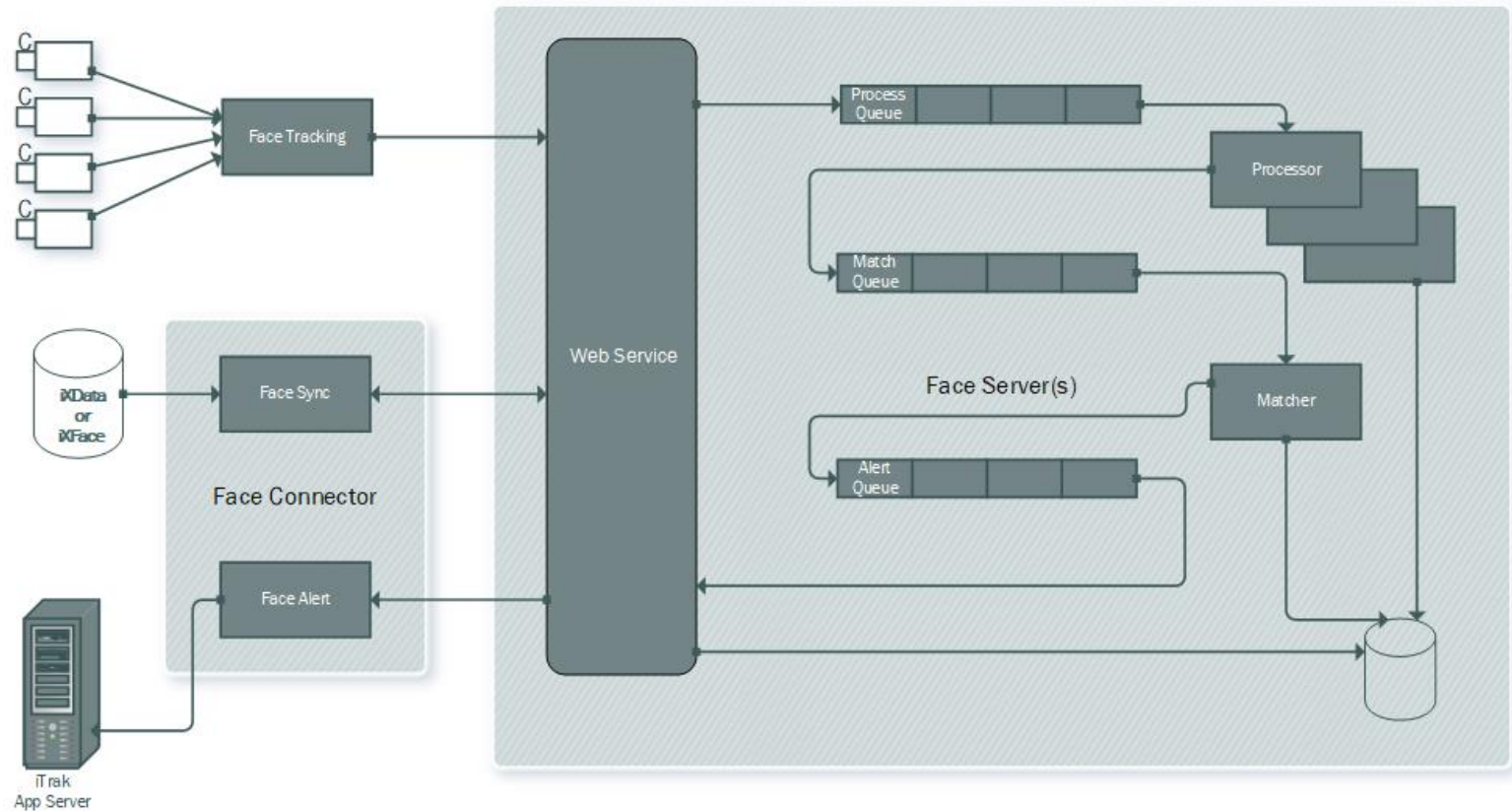
Manufacturer	Model	Approx. Price	Lens(es)	Eye Pixels 60	Eye Pixels 50	Eye Pixels 40	Resolution
Lumenera	LE165		Adjustable CS-mount				1376x1032
Lumenera	LE165		25mm	4.2m Width=1.5m			
			35mm	6.0m Width=1.5m			
			50mm	8.4m Width=1.5m			
			75mm	12.6m Width=1.5m			
			100mm	17.0m Width=1.5m			
AXIS	Q1645		Varifocal, IR corrected, CS-mount 3.9–10.0 mm, F1.5 2 MP (16:9): Horizontal field of view: 109°–42° Vertical field of view: 58°–23° I-CS lens	2.9m 903p/m Width= 2.1m	3.4m 770p/m Width=2.5m	4m 955p/m Width=2.9m	1920x1080
			Fujinon Varifocal Lens 8-80 mm, DC-iris	21m 935p/m Width=2.1m	26m 756p/m Width=2.5m	30m 655p/m Width=2.9m	
			Lens CS 12-50 mm F1.4 P-Iris 8 MP	14m 935p/m Width=2.1m	17m 770p/m Width=2.5m	20m 655p/m Width=2.9m	
AXIS	Q3515LV			7.5m 917p/m Width=2.1m	9m 764p/m Width=2.5m	10.5m 655p/m Width=2.9m	1920x1080
			Ricom 2MP Lens DC-Iris 8-26 mm F0.9				
AXIS	Q1659		AXIS Q1659 24 mm, f/2.8 - EF/EF-S mount (ALL)	6.5m 932p/m Width=4.1m	8m 758p/m Width=5.1m	9m 673p/m Width=5.7m	Used: 3840x2160
			AXIS Q1659 35 mm, f/2a	9m 962p/m Width=4m	11m 787p/m Width=4.9	13m 666p/m Width=5.8m	
			AXIS Q1659 50 mm, f/1.4a	13m 945p/m Width=4.1m	16m 768p/m Width=5.0m	18m 683p/m Width=5.6m	Max: 5472x3648
			AXIS Q1659 85 mm, f/1.2La	23m 902p/m Width=4.3m	27m 769p/m Width=5.0m	31m 670p/m Width=5.7m	
			AXIS Q1659 100 mm, f/2.8L - (4K resolution)	27m 905p/m Width=4.2m	32m 764p/m Width=5.0m	37m 661p/m Width=5.8m	
			AXIS Q1659 10–22 mm, f/3.5-4.5				
			AXIS Q1659 70–200 mm, f/2.8L	54 905p/m Width 4.2m	64m 764p/m Width=5.0m	75m 652p/m Width=5.9m	
			AXIS Q1659 55–250 mm f/4-5.6				
AXIS	Q1786		4.3–137 mm, F1.4–4.0 Horizontal field of view: 60°–2.3° Vertical field of view: 39°–1.3° Autofocus, automatic day/night Thread for 62 mm filters, max filter thickness: 5 mm	FoV~10: 16m 911p/m Width=2.8m FoV~2: 70m 911p/m Width=2.8m	FoV~10: 19m 767p/m Width=3.3m FoV~2: 85m 750p/m Width=3.4m	FoV~10: 22m 654p/m Width=3.9m FoV~2: 95m 671p/m Width=3.8m	2560x1440
AXIS	M5525-E PTZ		4.7–47 mm, F1.6–3.0 Horizontal field of view: 61.8°–6.7° Vertical field of view: 37.2°–3.8° Autofocus, auto-iris	FoV~7: 18m 912p/m Width=2.1m	FoV~7: 22m 746p/m Width=2.6m	FoV~7: 25m 657p/m Width=2.9m	1920x1080



## Entry Series of images



# Architecture



# Facial Recognition integration with iTrak incident reporting

The screenshot displays the iTrak web application interface. The top navigation bar includes a sidebar with links to Home Page, Daily Log, Incident File, Briefing Log, Subjects, Personnel, Contacts, Vehicles, Reports, Alerts, Notifications, and Administration. The main content area features a grid of 24 personnel photos, each with a name label below it. The names are: REDEL ALLAN, SIMMONS ANDY, HADIN ANN, AHMED BASHIR, MARTINEZ BETTINA, ROBERTSON BOBBY, FISHER CHAD, ROGOFF CRAIG, ARNOLD DAN, WALTERS DAN, NEUMANN DANIEL, SCHULTE DANIEL, HOLDWAY DAVID, MCGUIRE DEREK, HYATT EDWARD, SOLIMAN FABIANA, and 10 others. Below the grid is a table of alerts. The table has columns for AlertID, Date Time, Property, Location, SubLocation, Title, Summary, Comments, AlertType, SentBy, Status, AlertLevel, and Modified By. The table shows three alerts, all of which are 'Face Recognition Alert' and 'Accepted'.

AlertID	Date Time	Property	Location	SubLocation	Title	Summary	Comments	AlertType	SentBy	Status	AlertLevel	Modified By
16176	5/30/2019 4:02 PM	Omnigo Toronto	TestLocation		Face Recognition Alert	Jeffrey Connors		IGWatch Alert	TestCamera	Unhandled	8.1	
16175	5/30/2019 3:45 PM	Omnigo Toronto	TestLocation		Face Recognition Alert	Robert Lee		IGWatch Alert	TestCamera	Accepted	7.5	administrator
16174	5/30/2019 3:44 PM	Omnigo Toronto	TestLocation		Face Recognition Alert	Steven Trudell		IGWatch Alert	TestCamera	Accepted	7.5	administrator

A notification pop-up at the bottom right of the screen reads: "Face Recognition Alert Jeffrey Connors".

# Alert interface

Alert interface window showing match score, status, and subject details.

Buttons: Accept, Reject, Open Subject, Close

Match Score: 83%

Status: Accepted

Subject: Jeffrey Connors

SubjectPhotos: 2 - 2 of 2 items

AlertId: 5676

Title: Face Recognition Alert

Date Time: 5/30/2019 4:02 PM

Location: TestLocation

Modified By: administrator

Modified Date Time: 5/30/2019 4:03 PM

Camera Name: TestCamera

Subject Profile: Jeffrey Connors

Buttons: Edit, Print, Create Incident, Print Badge, Best Practices, Design, Done

Physical Characteristics: Race, Gender, Age Range, Hair Color, Eye Color, Calculated Age, Height, Weight, Custom 1

Custom 3, Custom 4, Comments, Offices

Bar Information: Add New, Open, Delete

Risk Classification: Number, TypeOfBan, ReasonForBan, BeginDate

Created: 5/30/2019 4:17:38 PM

Modified: 5/30/2019 4:06:20 PM

Incident File - IN2019000001

Buttons: Save, Save & Close, Close, Print, Best Practices, Design, Actions

Report Details: Narrative [1], Participants, Media, Attached Records, Savings and Losses, Supplemental Entries, Forms, Custom Forms, Document C...

Daily Log Related Info: Incident File Number, Incident Type, Reported Date, Occurred Date, To Date, Status, Risk Management Status, Risk Classification, Category Description

Narrative: Created by: administrator 5/30/2019 4:10:45 PM, Title: Banned permanently

Executive Brief

Created By: administrator 5/30/2019 4:10:04 PM, Modified By: administrator 5/30/2019 4:10:04 PM

Quick access to persons data is a must have

Alerts must be monitored

# Privacy and Security

- 1) Anonymization at source
  - a. NO Personally identifiable information (PII) is transferred or stored on the Omnigo server(s).
  - b. All person and image keys are encrypted at source using customer held encryption keys
    - i. Omnigo does not have access to the encryption keys
- 2) No secondary use
  - a. We do not retain the original images – only keep the biometric templates
  - b. Only users with the source encryption key can use the facial recognition system
- 3) Breach or stolen database
  - a. We hold no PII in the facial database
  - b. We store only biometric templates, not facial images
  - c. We use TDE encryption on entire database
  - d. We encrypt all biometric data at the field level on top of TDE
  - e. No caching of templates
- 4) End of Life
  - a. We use an automated sync tool to select the people and images added to the biometric database
  - b. The biometric sync tool at runs at the source and controls templates stored on the Omnigo Server
  - c. Only active people have templates stored on the Omnigo Server