

Biometrics in Surveillance Videos



Brian Lovell

The University of Queensland

Roadmap to My Presentation

 <p>So Face Recognition is a Solved Problem "It is Now the Golden Age of Face Recognition"</p>	 <p>Our Work on Surveillance Face Recognition through the years</p>	 <p>Face Detection at Very Large Angles</p>	 <p>Human Face Recognition: Prosopagnosia and Super-Recognisers for Policing</p>
 <p>2020 Embedded Face Detection and Recognition</p>	 <p>2019 National Statement on Ethical Conduct in Human Research</p>	 <p>2019 IDEA 2: EDITH Synthetic Face Database</p>	 <p>Covid 19 World Pandemic</p>
 <p>Touch Free Mask Fitting for Covid19</p>	<p>Conclusions</p> <ul style="list-style-type: none">• The performance of Face Recognition in surveillance video has advanced enormously over the last 10 years• Growing pushback on the ethical use of face recognition, but there are technical solutions to some problems emerging• COVID-19 has rendered most earlier systems to be unusable including iPhone FaceID• Recognition of persons in masks is a top-priority for research• First step is creating or gathering large databases• It is a very exciting time for face recognition research due to recent challenges		



So Face Recognition is a Solved Problem
“It is Now the Golden Age of Face Recognition”

Face Recognition for Border Control

Cooperative Facial Verification

Airport smart gates, border control, access control

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

Many Commercial Solutions available, fully tested by NIST



**Australia was first in the World with Face for Border Control
Rollout in 2007 at BNE Airport**

SmartGate

- Are these two faces the same person?
- Primarily used for passenger facilitation not security
- Now used for Australian Departures as well
- Similar Tech is in use in UK, NZ etc



**Australian Customs and Border Control is now working on Digital Passports,
so passengers can cross national borders without any paperwork.
(Initiative Announced at ICB2018)**

Digital Passports: Photo and Passport Information is Stored in the RFID Chip



Step 1 - SCAN


To gain access to the chip in your passport, scan the Machine Readable Zone using the camera.

Apple has only allowed this access from IOS 13 released late 2019 at the request of UK government.

7:06 7

READID

Data Security



Validity

Verification result	Authentic content and chip
---------------------	----------------------------

Personal information

Full name	BRIAN CARRINGTON, LOVELL
Given names	BRIAN CARRINGTON
Name	LOVELL
Gender	Male
Nationality	Australian

Next

7:06 7

READID

Data Security

Chip information

LDS version	1.7
Data groups	1, 2, 15

Validity information

Type of access control	BAC
Active authentication	SUCCEEDED Signature checked
Chip authentication	NOT PRESENT Not supported
Data group hashes	SUCCEEDED All hashes match
Document signer	SUCCEEDED Signature checked
Country signer	SUCCEEDED Found a chain to a trust anchor

Document signing certificate

Serial number	5553
---------------	------

Next

iPhone X 2D and 3D FaceID



- Time of flight proximity sensor
- Powers up other sensors
- IR dot projector for 3D
- IR Flood Illuminator
- IR camera
- Works at night with IR illumination

3D is mostly for anti spoofing
not recognition accuracy.

**Anyone know of a practical 2D
Anti-spoof technique?**

Digital Mobile ID with Face Recognition

- Way back in 2015, Apple Vice President Eddy Cue [told us](#) that replacing passports was one of the company's ambitions. Governments are already exploring use of Apple's devices to [replace driving licenses](#).
- Apple in 2018 enabled use of its devices as [digital ID at student campuses across the U.S.](#). This use of device as ID may also provide Apple with real usage data to help prove its systems work and can be trusted to do so — even by governments.



Our Work on Surveillance Face Recognition through the years

2011: Chokepoint Identification




Notes

- Detection is Viola-Jones Cascade based (Pittpatt)
- Recognition is Bag of Words based
- No CNNs
- Multiprocessed using GPUs and Robot Operating System (ROS)
- We won the IFSEC Major Category of **CCTV System of the Year for Face Recognition in a Crowd in 2011** in Birmingham
- Chokepoint simulates persons walking down an Aerobridge and was intended to address the Undocumented Passenger Problem.
- Chokepoint Dataset released to community.

<https://zenodo.org/record/815657#.XhP2nPXS-Uk>

2011 System Deployed Commercially




A photograph of a building facade with the text "USF UNIVERSITY OF SAN FRANCISCO FOUNDED 1855" in large, raised letters.

BIOMETRICS NEWS
MorphoTrust discusses patent trolls, biometrics

BIOMETRICS FEATURES
BORDERPOL International Security Meeting: Q&A interview with Janice Kephart


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Special Report: Biometrics and Banking

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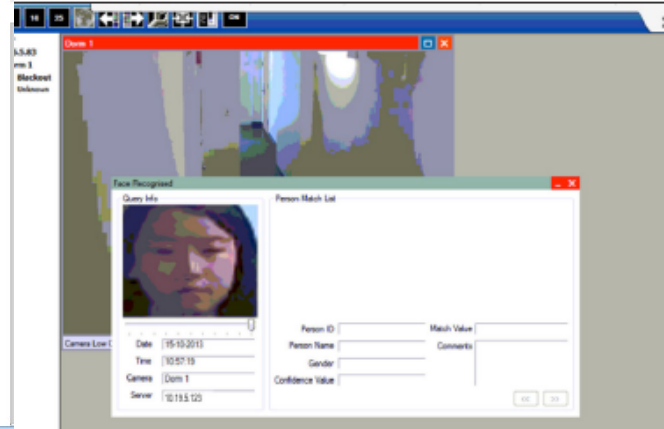
iOmniscient and CISCO provide facial recognition solution to University Of San Francisco



By [Stephen Mayhew](#) [Like](#) [5](#) [Tweet](#) [7](#)

October 27, 2014 - [iOmniscient](#) announced it installed its facial recognition software in partnership with [Cisco](#)'s video management system at the University of San Francisco to improve physical security in residence halls.

USF was seeking technology that could effectively manage access to their halls of residence halls without it being intrusive or inconvenient for the school's 10,000



A screenshot of a facial recognition software interface. It shows a camera feed of a person's face. Below the feed, there is a "Face Recognized" window with a "Query Info" tab and a "Person Match List" tab. The "Query Info" tab displays a small image of the person's face and the following information: Date: 10-10-2013, Time: 10:57:16, Camera: Dom 1, Server: 10.11.5.123. The "Person Match List" tab is currently empty. There are also fields for "Person ID", "Person Name", "Gender", "Match Value", and "Confidence Value".



2017 Accuracy Greatly Increased by Using DNNs for Face Recognition



Milestone XProtect Smart Client

Live Playback Sequence Explorer Alarm Manager LPR Imagus System Monitor Setup

Preview Alerts History Database Enrollment

History Log

Alerts Historical Tracks



Expected Contractor Actual C100084

Distance Quality

REFINE RESULTS

Access Control Results

Person Name Filter X

Confidence

Filter Results

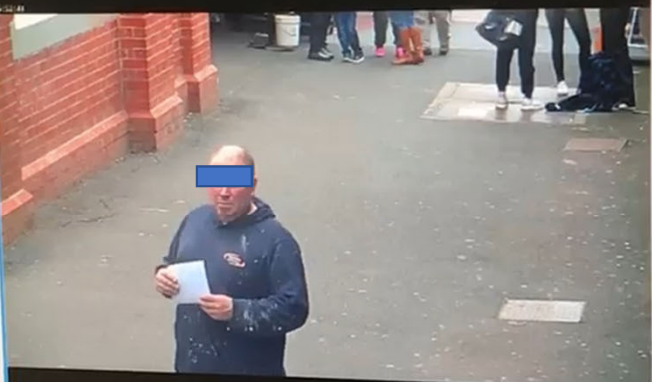
Export

ALERT NA	LOCATION	DISTANCE	QUALITY	ENROLLED	TIME STAMP	ENRO	ALERT
Contractor	Location: 117N 0.4774550199	High	C100040	9/13/2017 7:0			
Contractor	Location: 117N 0.4746968746	High	C100057	9/12/2017 7:2			
Contractor	Location: 118N 0.4963911771	High	C100535	9/11/2017 4:3			
Contractor	Location: 117N 0.4756596386	High	C100462	9/11/2017 4:2			
Contractor	Location: 117N 0.4800182580	High	C100084	9/11/2017 3:5			

Lock selected item in view

License Expires in: 56 Days Build: 1.1.0.473

11/09/2017 3:52:40 PM
Location: 1174-1AlfredSt-PTZ
1174-1AlfredSt-PTZ - 11/09/2017 3:52:44.246 PM



2:30 PM 3:4 11/09/2017 3:52:44.507 PM 4:20 PM

BenQ

11:52 AM 20/09/2017

SAMSUNG

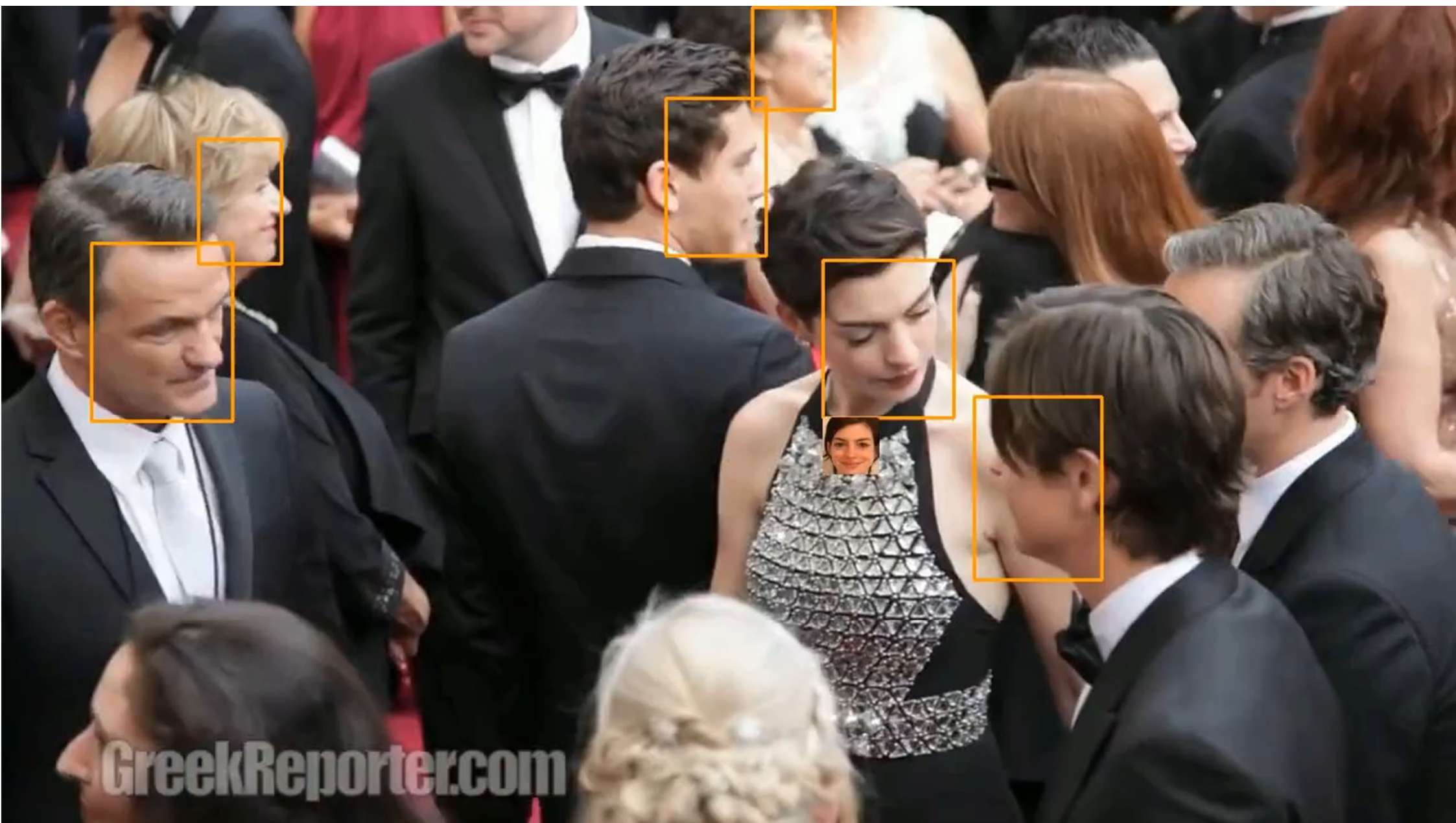
- Notifications
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- Trips
- Saved
- Purchases
- Skip the inbox
- Android Spam
- Unbundled
- Finance
- Social
- Updates
- Forums
- Promos
- Low Priority
- Create new...
- Settings
- Help & Feedback



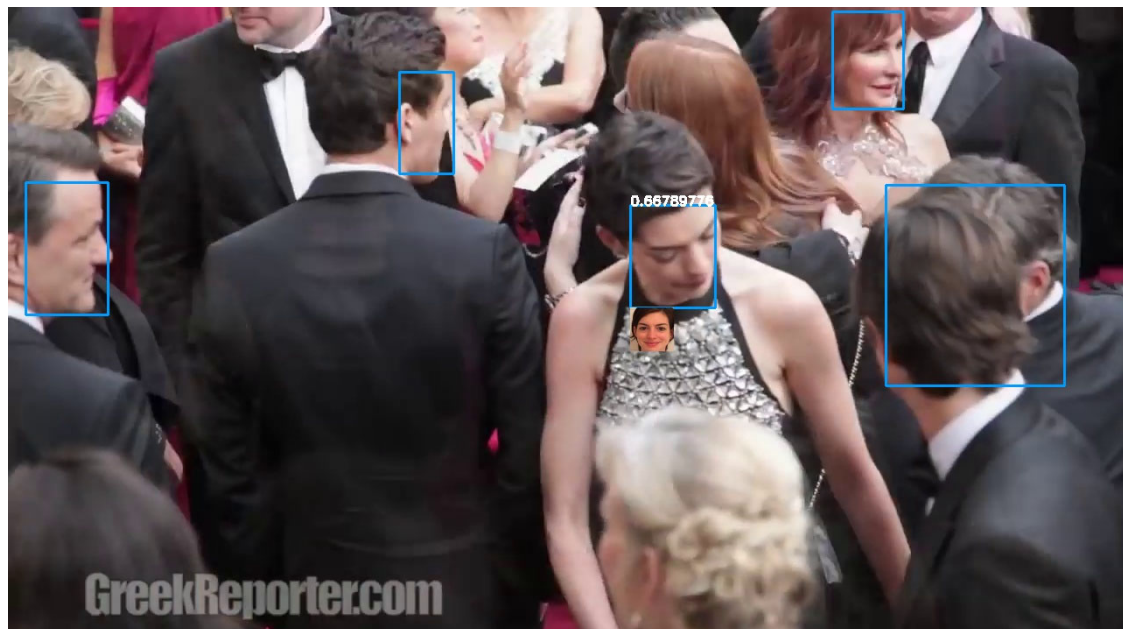
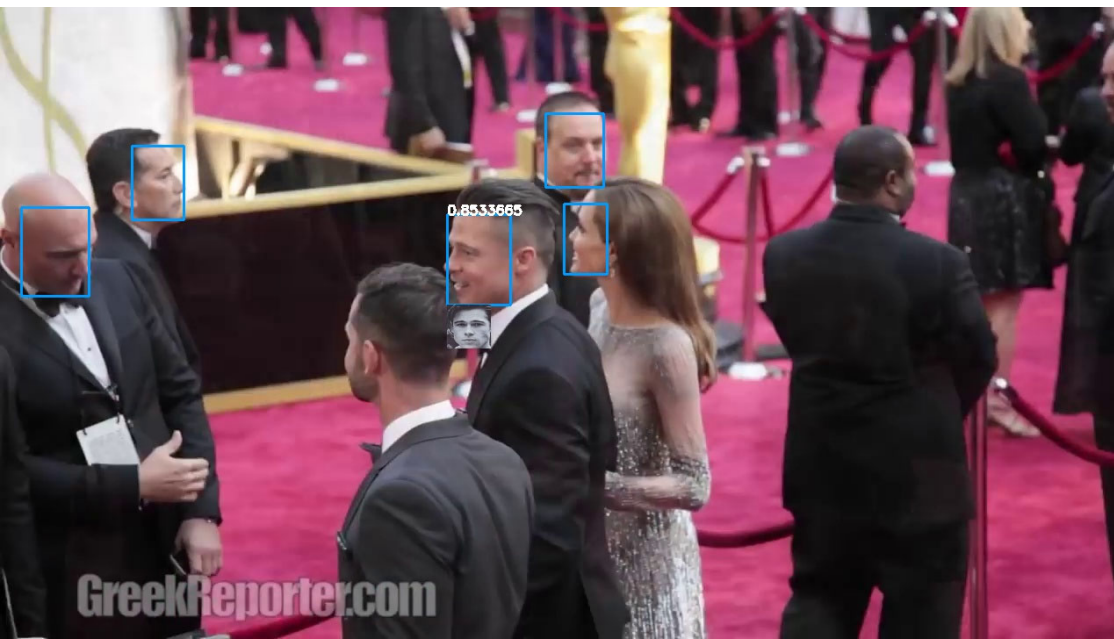
Face Detection at Very Large Angles

The Practical Problem In a Nutshell

- Due to computational requirements, face recognition from surveillance video has mainly used the Viola-Jones Cascade Face Detector on the Front End
- If we want to recognize faces in video at extreme angles, we must use CNN based detectors which are much slower and cannot easily handle the huge camera resolutions (5Mp or more) and multiple streams
- All decoding and detection must take place in the GPU
- We now do face detection with CNNs at 500 fps on small edge devices



GreekReporter.com







Faces in a Milling Crowd


- The problem with CCTV face recognition in many common situations is that people simply do not look at the camera, but we would still like to identify them.
- The Chokepoint scenario addresses this issue because people tend to look straight ahead when walking in a crowd
- This assumption applies to aerobridges, borders, concierge situations, but not to cocktail parties, conferences, shopping centres, check in areas.
- We would like to have much better performance under common non-cooperative conditions where people do not look at the camera.



Human Face Recognition: Prosopagnosia and Super-Recognisers for Policing


Dr Barry Sandrew (Prosopagnosiac)


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**Barry B. Sandrew** [SEE RANK](#)
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An internationally recognized entrepreneur, digital imaging expert and visual effects pioneer with over 14 patents and 25 years of feature film and TV accomplishments including productions for all 6 major Hollywood studios and 3 major networks. Dr. Sandrew was founder of 2 production studios that became gold standards for color visual effects. In ... [See full bio »](#)

Known For


The Green Hornet
Visual Effects
(2011)


Transformers: Dark of t...
Visual Effects
(2011)


Pirates of the Caribbean...
Visual Effects
(2011)


Ghost Rider: Spirit of V...
Visual Effects
(2011)

Filmography [Hide all](#) [Show by...](#) [Edit](#)
Jump to: [Visual effects](#) | [Miscellaneous Crew](#) | [Producer](#)
Visual effects (11 credits) [Hide](#)

Ghost Rider: Spirit of Vengeance (senior stereographer - as Barry Sandrew)	2011
Transformers: Dark of the Moon (senior conversion stereographer: Legend 3D - as Barry Sandrew Ph.D.)	2011
Pirates of the Caribbean: On Stranger Tides (chief stereographer: Legend 3D)	2011
The Green Hornet (chief stereographer: Legend 3D - as Barry Sandrew)	2011

Quick Links

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Richard Madden Chats About "Bodyguard" Reunion

Golden Globe-winner Richard Madden shares what it was like working with "Bodyguard" co-star Keeley Hawes.

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Prosopagnosia

Prosopagnosia (*prosopon* = face, *agnosia* = unknowing)—also known as *face blindness*—is a medically recognized neuro-cognitive disorder that can be extremely debilitating in social situations. An estimated 2.5 percent of the population—some 8.2 million people in the United States alone—is affected. While many people with a mild case of face blindness may simply conclude they, “are not good with faces,” in reality, they might very well fall within the prosopagnosia spectrum.

- Barry Sandrew

Notable People

- A number of notable people, including the actor, **Brad Pitt**; famed primatologist, **Jane Goodall**; and co-founder of Apple, **Steve Wozniak** suffer to some degree from clinically relevant face blindness
- The social interchange and friendly banter that average people manage innately throughout the day become a huge challenge for those with facial blindness

- Barry Sandrew

Brad Pitt

JAN 11, 12:44 AM EST

Medical Daily VITALITY UNDER THE HOOD INNOVATION THE HILL THE


DELL SAVE UP TO 20%*

XPS 12 (9870)

CONDITIONS

Brad Pitt Says He Has Face Blindness; Prosopagnosia More Common Than Thought

May 23, 2013 06:31 PM By Evan Winchester



People with face blindness are often misjudged as lazy or uncaring. For Pitt, his condition has led to staying at home more frequently, he said. Michael Buckner/Getty Images

Share Tweet Share E-mail

Brad Pitt has face blindness, he said in a recent interview.

"So many people hate me because they think I'm disrespecting them," he said. The interview was for the June/July issue of *Esquire*. "I am going to get it tested," Pitt added.

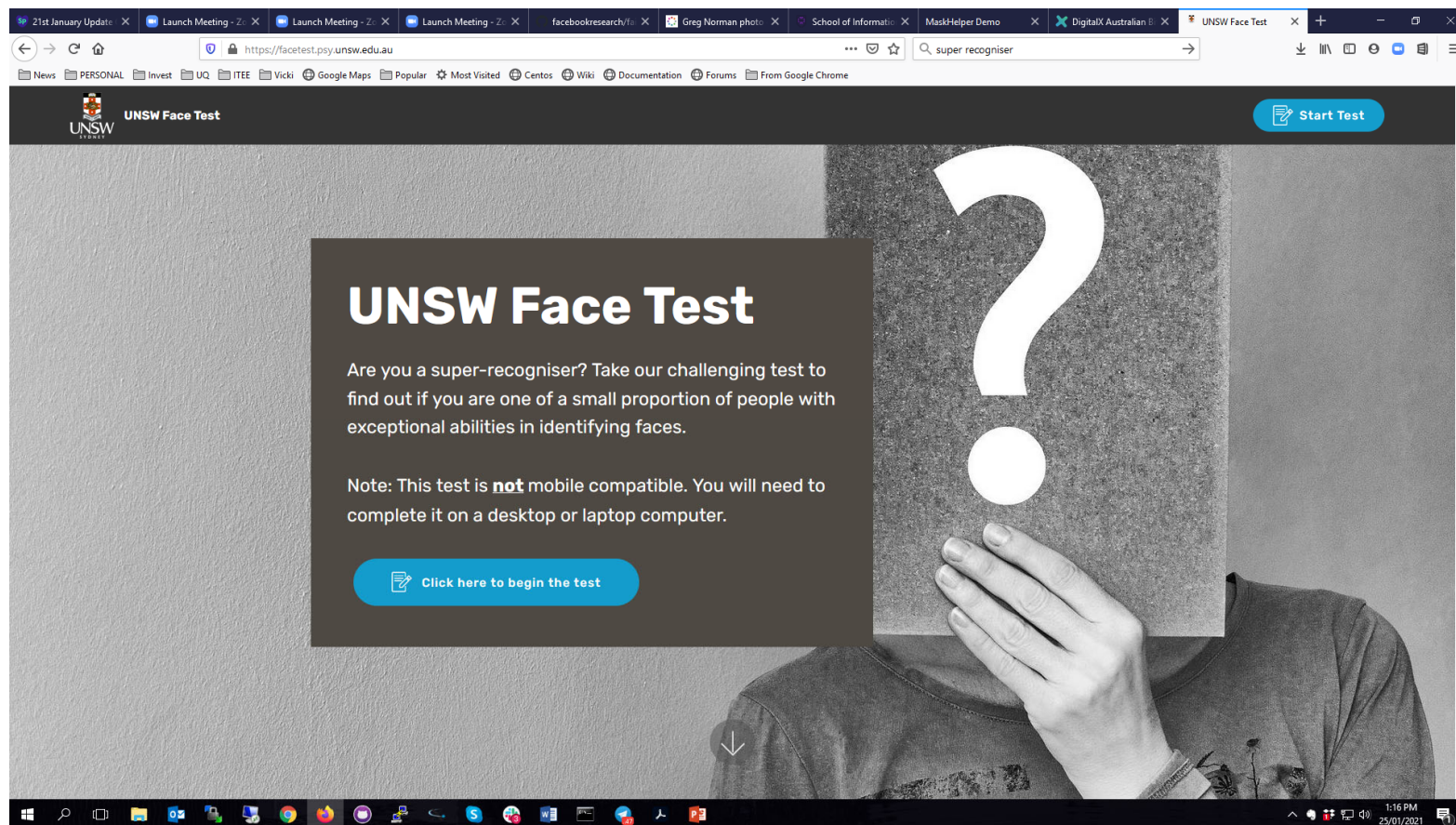
"I swear to God, I took one year where I just said, This year, I'm just going to cop to it and say to people, 'Okay, where did we meet?' But it just got worse. People were *more* offended," said the 49-year-old star of the zombie movie *World War Z*. "Every now and then, someone will give me context, and I'll say, 'Thank you for helping me.' But I piss more people off. You get this thing, like, 'You're being egotistical. You're being conceited.' But it's a mystery to me, man. I can't grasp a face and yet I come from such a design/aesthetic point of view."

Super-Recognisers

- While prosopagnosia has been recognised for some time, it was thought that it was an on-off condition – either you have it or you don't
- Recent studies have shown that face recognition ability is on a continuum and ability varies between individuals
- Testing has demonstrated this and research shows that face recognition is an innate skill that you are born with
 - Does not appear to improve with training or experience
- Scotland Yard (London Met) have tested many people and have assembled a team of super-recognizers with extraordinary ability.
- Mick Neville's Team recognized and prosecuted 300 people from London Riots in 2011.

<https://www.newyorker.com/magazine/2016/08/22/londons-super-recognizer-police-force>

UNSW Super Recogniser Test



<https://facetest.psy.unsw.edu.au/>

My Score 😞

On the UNSW Face Memory Test you scored 22 out of 40.

On the UNSW Face Sorting Test you scored 44 out of 80.

Your overall score on the UNSW Face Test was 55%.

For your information, based on the first 6300 participants on the UNSW Face Test:

Top 5% scored 72% and above

Top 10% scored 69% and above

Top 25% scored 65% and above

Top 50% scored 61% and above

Think about placement of cameras.



How do We Recognise a Person Now?

- People are moving, blurred, wearing balaclavas and masks
- They do not look at the camera
- For such challenging videos, super recognizers can make reliable matches
- Super recognisers are often assisted by computer databases to narrow the search space – usually just text based queries
- While computer face searching is fast, a super recogniser is still the best.



2020 Embedded Face Detection and Recognition

Move Face Detection to the Edge

- Embedded System based on NVIDIA Nano
- 600 FPS Face Detection
- Conversion to 512d feature vector
- Recognition performed on Secure Server
- Currently being deployed in the UK through AR Live Systems/Facewatch



Recognition to Deter Low Level Crime

The screenshot shows the Daily Mail Australia website. The main headline is "Meat, nappies, razor blades and deodorant top the list of Britain's most shoplifted items, reveals the company behind a facial recognition camera system used to spot criminals". The article is by Sean Poulter, Consumer Affairs Editor for the Daily Mail, and was published on 9 January 2021. The article text states: "Meat, nappies, razor blades and deodorant are Britain's most shoplifted items. Facewatch operates in some Southern Co-op stores, Budgens, garden centres. System sends alert to staff when someone on watchlist walks through the door." The article has 11 shares and 158 comments. There are several advertisements on the page, including one for Marley Spoon (Reduced-Carb Recipes) and one for PETstock (Your Local PETstock Store). A video thumbnail on the right shows a woman with the text "Russian woman posts video of how to impersonate an American".

21st January Update Cu X Launch Meeting - Zoom X Launch Meeting - Zoom X Launch Meeting - Zoom X facebookresearch/faiss X Greg Norman photo X School of Information X Meat, nappies, razor bla X DigitalX Australian Bric X

https://www.dailymail.co.uk/news/article-9128315/Meat-nappies-razor-blades-deodorant-list-Britains-shoplifted-items-reveals-the-company-behind-a-facial-recognition-camera-system-used-to-spot-criminals

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Meat, nappies, razor blades and deodorant are Britain's most shoplifted items

Facewatch operates in some Southern Co-op stores, Budgens, garden centres

System sends alert to staff when someone on watchlist walks through the door

By SEAN POULTER CONSUMER AFFAIRS EDITOR FOR THE DAILY MAIL

PUBLISHED: 12:46 AEDT, 9 January 2021 | UPDATED: 13:00 AEDT, 9 January 2021

Share 11 shares 158 View comments

Meat, nappies, razor blades and deodorant are Britain's most shoplifted items, a company behind a controversial facial recognition camera system to spot criminals has revealed.

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Albany Creek

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Russian woman posts video of how to impersonate an American

I'm American!!!

Stop Crime
Before it happens

[Home](#)[Sectors](#)[Privacy](#)[Contact Us](#)[Facewatch Blog](#)[Accredited Partners](#)The main banner image shows three men walking through an automatic glass door. The man on the left is wearing a dark jacket and a white face mask. The man in the middle is wearing a dark jacket, a white t-shirt, and a blue surgical face mask. The man on the right is wearing a dark hoodie, a black baseball cap with "XIX" on it, and a black face mask. In the foreground on the right, a hand is holding a circular digital overlay that shows a clear, unmasked face of a man with short dark hair. The background is a blurred street scene with buildings and a green sign.

**The biggest advance in security
since the introduction of CCTV**



works with facemasks

The UK's leading facial recognition security system

Facewatch is one of the UK's leading facial recognition companies. Facewatch's cloud-based facial recognition security system safeguards businesses against crime. Our facial recognition technology sends you

It is the ONLY shared national facial recognition watchlist. Simple, secure and affordable, we are the premier choice of retail security companies in the UK. Facewatch is proven to stop crime before it happens. It's time for



Looking good. So what could possibly go wrong?



2019 National Statement on Ethical Conduct in Human Research

Ethics in AI

NHMRC

BUILDING
A HEALTHY
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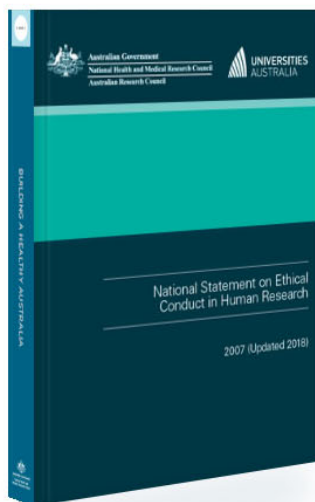
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National Statement on Ethical Conduct in Human Research (2007) - Updated 2018



The *National Statement on Ethical Conduct in Human Research (2007)* (National Statement (2007)) consists of a series of guidelines made in accordance with the *National Health and Medical Research Council Act 1992*.

Public consultation on National Statement content

The public consultation on the revised draft Section 4 and Section 5 of the National Statement is now open. The closing date for submissions is Friday 30 October 2020.

Further information is available from [NHMRC's Online Services portal](#).

Publication Data

Reference number: E72

ISBN: 1864962755

2018

Current

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National Statement - In a Nutshell

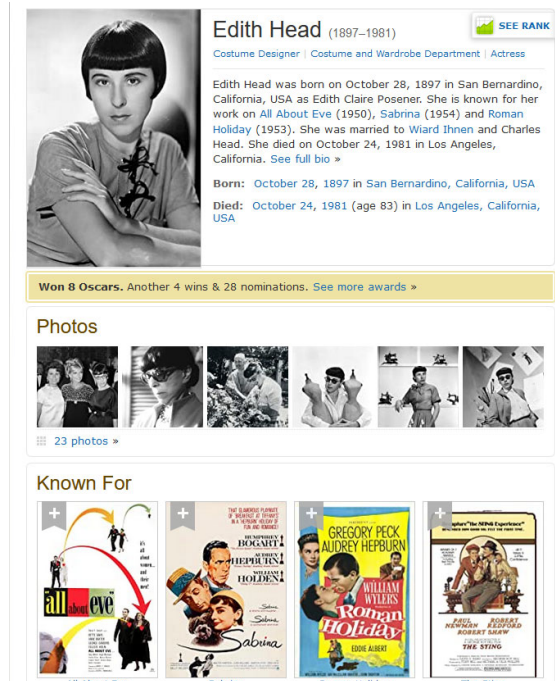
- All databases collected off the internet require ethical approval
 - No ability to use datasets that do not have ethical approval
 - All datasets of faces must have fully informed consent of persons concerned to use for face recognition research
 - No usage of international datasets that do not comply
-
- **So how do we continue to research and test face recognition systems?**
 - **Need to find a way to create databases with full consent or no requirement for consent**



2019 IDEA 1: EDITH Ethical Face Recognition Database using 3D Heads

Development of EDITH Database

- Ethical Database of Interactive Training Heads
 - Edith Head was a famous Hollywood Costume Designer
- Idea – Capture 3D Heads instead of Images
- Generate thousands of images from each head
- Add masks glasses etc
- Greatly reduces burden of obtaining consent
- Only release projected images and not heads themselves
- Generate photos to order



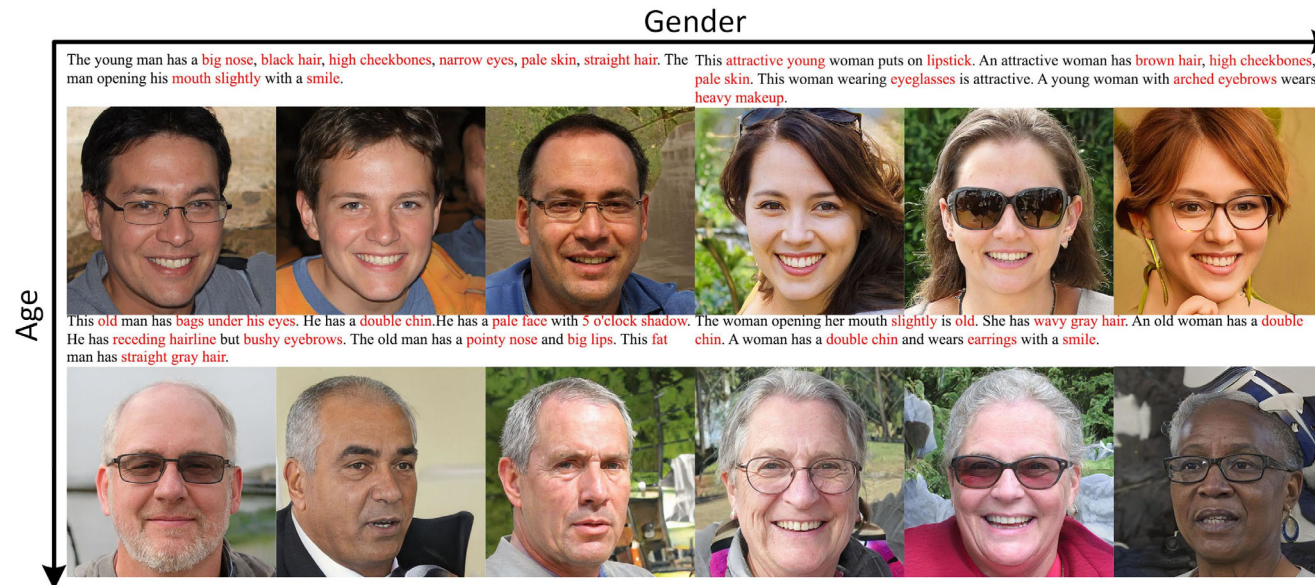
3D Head Database including Masked Faces





2019 IDEA 2: EDITH Synthetic Face Database

Faces à la Carte: Text-to-Face Generation via Attribute Disentanglement



Tianren Wang, Teng Zhang, Brian Lovell

The University of Queensland

Text-to-face tasks (TTF)

- Natural language contains **high dimensional information** which is often less specific but also much more abstract than images.
- The linkage between face images and their text descriptions is **much looser** than for popular text-to-image tasks, e.g. birds and flower images.
- Addressing emerging issues of **data scarcity** arising from the growing **ethical concerns** regarding informed consent for the use of faces scraped from the internet in modern biometrics research.

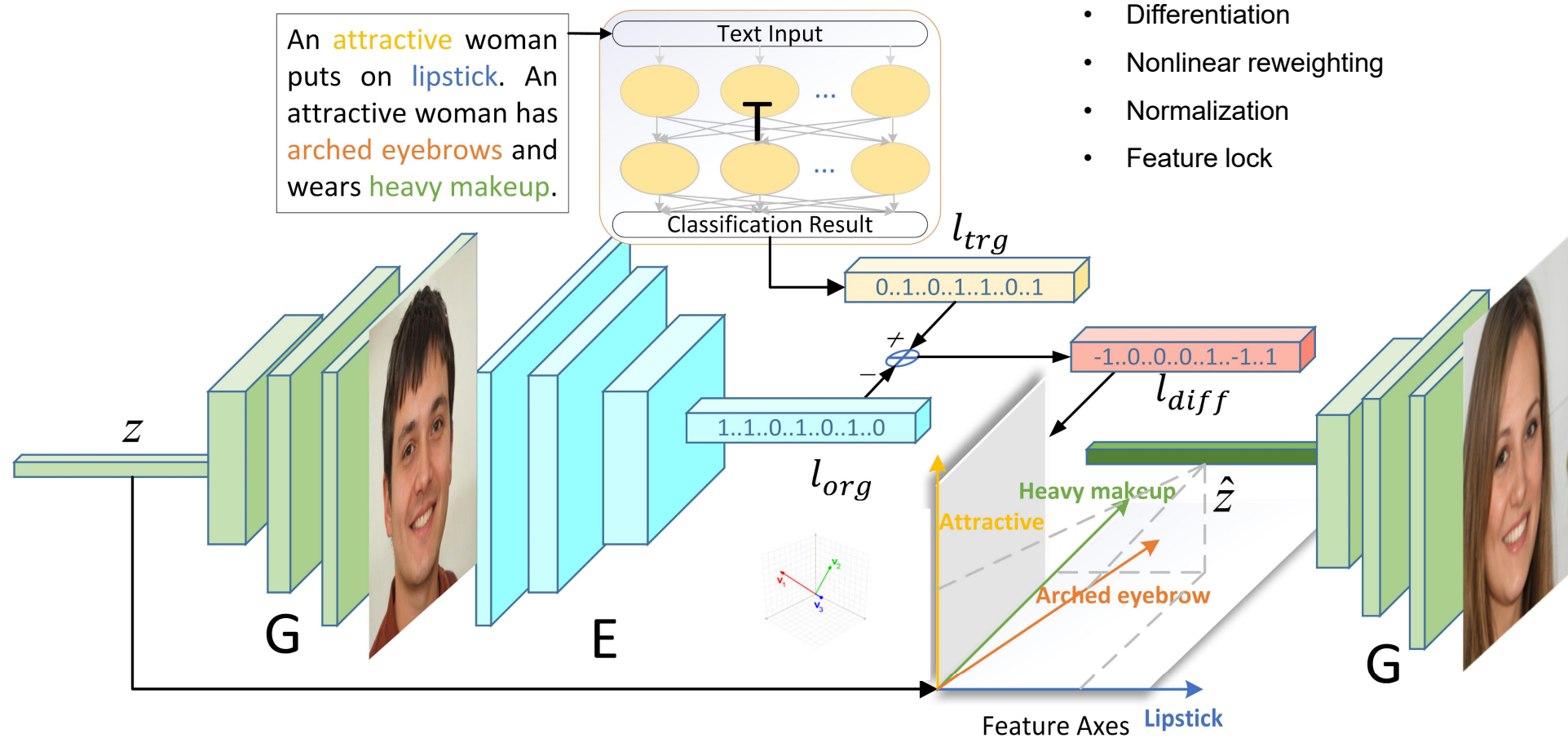
Contributions



- Propose a novel TTF-HD framework comprising a **multi-label text classifier**, an **image label encoder**, and a feature disentangled **image generator** to generate high-quality faces with a wide range of variation.
- Add a novel 40-label **orthogonal coordinate** system to guide the trajectory of the input noise vectors.
- Use state-of-the-art StyleGAN2¹ as the generator to map the manipulated noise vectors into the disentangled feature space to generate **1024*1024** high-resolution images.

1. Karras, Tero, et al. "Analyzing and improving the image quality of stylegan." *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 2020.

Model



Results & Evaluation



Methods	<i>IS</i>	<i>CS*</i>	<i>LPIPS</i>
TTF-HD (ours)	1.117±0.127	0.664	0.583±0.002
AttnGAN	1.062±0.051	0.511	—

Single-sentence output

*Maximum for each group.

An
woman has an
oval face and
wears heavy
makeup with a
smile.



The attractive
man has a pointy
nose.



The old woman
has gray hair
with a smile.



The man has a
big nose and
gray hair.



All faces are
Synthetic!

Ablation Study



A: Full setup

B: w/o feature lock

C: B + w/o normalization

D: C + w/o nonlinear reweighting

E: Blank group

This **old** man has **bags** under his eyes. This **chubby** old man has a **double chin**. He has **5 o'clock shadow**. He has **receding hairline** but bushy eyebrows. This fat man has **straight gray** hair. His face is **pale** with a **pointy nose** and **big lips**.

A



B



C



D



E



Exp. Settings	Evaluation Metrics		
	<i>IS</i>	<i>CS*</i>	<i>LPIPS</i>
Group A	1.122±0.043	0.754	0.634±0.005
Group B	1.116±0.080	0.739	0.608±0.005
Group C	1.187±0.062	0.762	0.603±0.005
Group D	1.101±0.095	0.683	0.521±0.006
Group E	1.102±0.033	0.706	0.532±0.005

*Maximum for each group

- The text-to-feature accuracy in each image batch needs improvement.
 - The image encoder E is the bottle neck which needs to be improved in accuracy.
- Features in the latent space are still not well disentangled.
 - Inspired by GANSpace¹, establish feature axes in intermediate space of StyleGAN2² (W space), rather than the noise vector space extracted from normal distribution.

1. Härkönen, Erik, et al. "GANSpace: Discovering Interpretable GAN Controls." arXiv preprint arXiv:2004.02546 (2020). 2. Karras, Tero, et al. "Analyzing and improving the image quality of stylegan." Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2020.



Covid 19 World Pandemic



**All Face Recognition Systems developed to date are useless.
Need to handle masks at high angles for both detection and
recognition stages.**



Fully Synthetic Faces at Various Angles with and without Masks



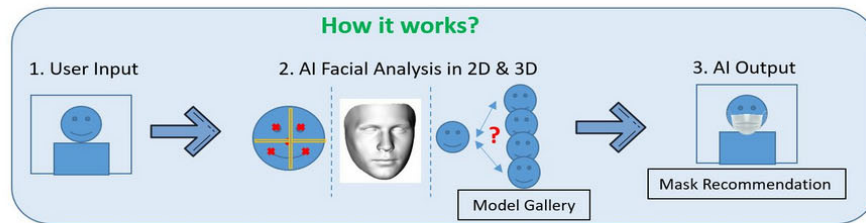


Touch Free Mask Fitting for Covid19

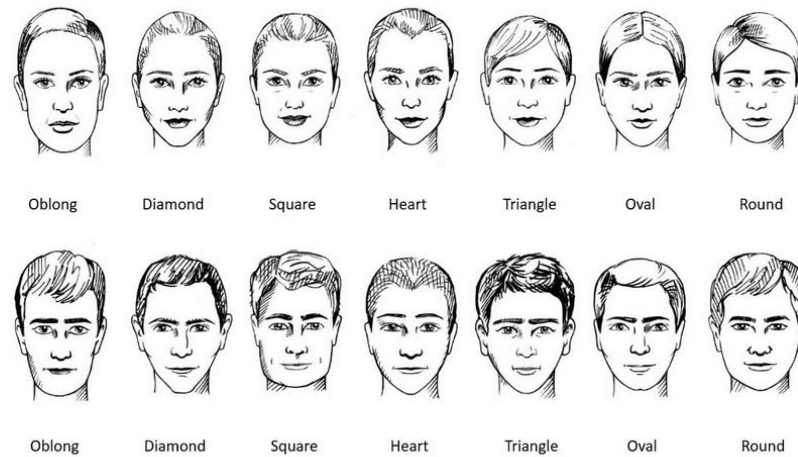
Mask Helper App



Tips: How to wear a mask correctly



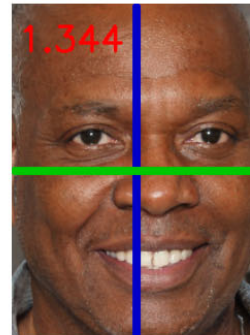
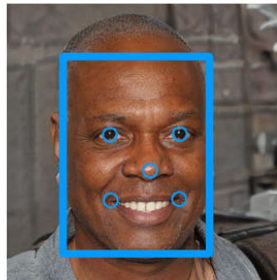
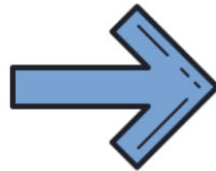
(Required) Frontal Photo :	<input type="button" value="Browse..."/> 159994_0.png
(Required) A codename :	<input type="text" value="Random User"/>
(Required) Face shape :	<ul style="list-style-type: none"> <input type="radio"/> Oblong <input checked="" type="radio"/> Diamond <input type="radio"/> Square <input type="radio"/> Heart <input type="radio"/> Triangle <input type="radio"/> Oval <input type="radio"/> Round
(Required) Nose shape :	<ul style="list-style-type: none"> <input type="radio"/> Downturned <input checked="" type="radio"/> Upturned <input type="radio"/> Hooked or Beaked <input type="radio"/> Straight
	<ul style="list-style-type: none"> <input type="radio"/> Short



3D Reconstruction and Mask Fit



[<- Delete user data and go back](#)



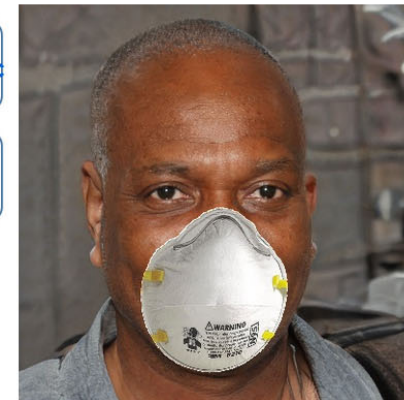
----- Prediction Result Below -----

Face Analysis:

Random User, Face Ratio:1.344, Contour: Check, 3D Landmarks: Check

Mask Ranking:

Proshield_Duckbill_Medium; System confidence [0~1] is: 0.5



Interesting Results

- We believe that this is the first time that a realistic 3D reconstruction has been made from a synthetic face
- Leads to the possibility of generating fully synthetic 3D heads
- Good progress towards the ultimate aim of creating fully synthetic ethical face databases

Conclusions

- The performance of Face Recognition in surveillance video has advanced enormously over the last 10 years
- Growing pushback on the ethical use of face recognition, but there are technical solutions to some problems emerging
- COVID-19 has rendered most earlier systems to be unusable including iPhone FaceID
- Recognition of persons in masks is a top-priority for research
- First step is creating or gathering large databases
- It is a very exciting time for face recognition research due to recent challenges