Who Is There?
Face Recognition Applications

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Why Face Recognition?

Identity: ABC
Age: ~ 40
Gender: Male
Ethnicity: White
Hair: Short, Brown
Moustache: Yes
Beard: Yes
Mole: Yes
Scar: Yes
Other attributes: expression, emotion,..
Identify Repeat Offenders

Habitual Criminal Act of the British Parliament (1869)

H.T. F. Rhodes, Alphonse Bertillon: Father of Scientific Detection, Harrap, 1956
Growing Popularity

• Universality
  – Everyone has a face; covert, touchless, remote acquisition; large legacy databases

• Applications
  – De-duplication, search, surveillance, targeted ads, social media, mobile phones

• Hardware
  – Face matcher: ~1.5 million templates/sec/core

• Benchmarks
Verification: 1 to 1 Comparison

Same Person? What is the confidence?
Search: 1 to N Comparisons

Probe

Gallery

Closed-set v. Open-set search
Semi-automated Search

Who is this?

Law Enforcement

One of them?

Forensic expert
State of the Art: Verification


TAR at 0.1% FAR

LFW Standard Protocol
99.77% (Accuracy)
3,000 genuine & 3,000 imposter pairs; 10-fold CV

LFW BLUFR Protocol
88% TAR @ 0.1% FAR
156,915 genuine, ~46M imposter pairs; 10-fold CV

## State of the Art: Search

<table>
<thead>
<tr>
<th></th>
<th>PCSO (mugshots)</th>
<th>LFW (web)</th>
<th>IJB-A (web)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed set (CMC @ Rank 1)</td>
<td>0.864</td>
<td>0.602</td>
<td>0.676</td>
</tr>
<tr>
<td>Closed set (CMC @ Rank 10)</td>
<td>0.989</td>
<td>0.786</td>
<td>0.764</td>
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<tr>
<td>Open set (FNIR @ 10% FPIR)</td>
<td>0.211</td>
<td>0.412</td>
<td>0.278</td>
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<tr>
<td>Open set (FNIR @ 1% FPIR)</td>
<td>0.333</td>
<td>0.645</td>
<td>0.414</td>
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<tr>
<td>Experimental Setting: Gallery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>size, # genuine queries, #</td>
<td>1M</td>
<td>3K</td>
<td>7K</td>
</tr>
<tr>
<td>imposter queries</td>
<td></td>
<td></td>
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</tbody>
</table>
De-duplication: One Person, One ID

Face-based scrubbing of 13.5M records (>30M photos) in Michigan DMV database; photos of different subjects in the same record!

Courtesy: Pete Langenfeld, Michigan State Police
Routine Traffic Stop

Gallery: 34 million (30M DMV photos, 4M mugshots)

2009 driver license photo
Routine Traffic Stop

Smile makes a difference!

Top-10 retrievals

Gallery: 34 million (30M DMV photos, 4M mugshots)

Courtesy: Pete Langenfeld, MSP
International Border Crossing

SmartGate, Australia & NZ

ePassports from eligible countries

HK-Schenzen border

Fusion of face & fingerprint
Locating Intruders

Unknown Person Alert Security

Visitor Hiroshi Suzuki
Main contact: Stephanie Vidal
REF: 0019320

Contractor Pedro Luis de Souza
Main contact: Stephanie Vidal
REF: 0019320

Courtesy: Allen Ganz, NEC
Passenger Verification
Chengdu Train Station

Face image must match photo on ID card
Face Search: Tag Recommendation

About 606 results (1.70 seconds)

Image size: 224 × 144

Find other sizes of this image:
All sizes - Small

Best guess for this image: obama funny

The viral presidency: Obama's best unscripted moments ...
www.cnn.com/2015/05/.../viral-presidency-obama-unscripted-moments/  
May 20, 2015 - Funny moments from Obama's 1st term 01:47. (CNN) Presidents come into the Oval Office with all sorts of plans, but it's the unscripted moments ...

Funny moments from Obama's 1st term - YouTube
www.youtube.com/watch?v=CDHxvxAfW0  
Jan 18, 2013 - CNN looks back at some of the lighter moments from President Obama's first term in office. For more CNN videos, check out ...
What if Tag is Not available?

Need a reject option
Video Surveillance

Growing market for CCTV projected to reach $25.6 billion by 2018

German Federal Police face recognition trial at Mainz Train Station (2007); ~60% TAR (during daylight) @ FAR of 0.1% (22,673 persons passed through the monitored area/day)
Identifying Suspects

30M CCTV cameras in China & growing

Enrollment

3D Face Capture at Police Station

Railway Station Entrance

Monitor in the console room

Chengdu East Railway Station
Age and Gender Estimation

Blue: correct estimates; red: incorrect estimates; yellow: incorrect ground truth

Improved search, targeted advertisement, personalization
Mobile Face Unlock

Uploaded: Dec 6, 2011 YouTube
How to Increase Application Coverage?
Application Requirements

• Operating environment
• Accuracy *(FRR < 2% @ FAR = 0.01%)*
• Speed/throughput
• Template size
• Security (e.g., spoof detection)
• Usability
• Cost
Face Detection

Faces in a crowd
Invariant & Salient Representation

Jan 1995

Jul 1998

Nov 1999

Nov 2003

Feb 2005

Gallery seed

Score=0.99

Score=0.62

Score=0.41

Score=0.26

http://www.theguardian.com/theguardian/2010/dec/05/barack-obama-doppelganger-ilham-anas
Robust Matching

Images of one subject in NIST IJB-A data, overlaid with V-J detector & dlib landmarks
Use of Micro Features: Scars, Marks & Tattoos

Detroit police linked at least six armed robberies after matching a tipster’s description of the suspect’s distinctive tattoo.
Capacity of Face Recognition

How many distinct identities can be resolved?
Summary

• We cannot trust *credentials* to answer the *Who Is There?* question
• Machine face recognition is a hard problem
• Successful applications rely on constrained image capture and cooperative subjects
• Are the deployed systems (e.g., de-duplication) meeting the requirements?
• Face information needs to be augmented with behavioral (contextual) cues
Identical Quadruplets

Haircuts help to avoid confusion among the four six-year-old twins