

SKETCH TO PHOTO MATCHING

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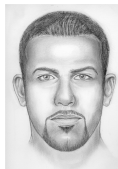
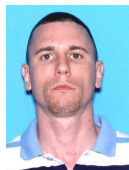
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- 1 INTRODUCTION
- 2 THE FACESketchID SYSTEM
- 3 PERFORMANCE
- 4 FUTURE WORK

MOTIVATION

- Many crimes occur in which no facial image of a suspect is available
- A witness or the victim can provide a verbal description of the suspect's face
- This description is used to create a facial sketch (referred to as a composite)



EXAMPLE VERBAL DESCRIPTION

“The man was about 5ft. 6in. in height, and 34 or 35 years of age, with dark complexion and dark mustache turned up at the ends ... He had a heavy mustache curled up, and dark eyes and bushy eyebrows. He had no side whiskers, and his chin was clean shaven. He looked like a foreigner.”



<http://www.forartist.com/forensic/composite/jacktheripper/jacktheripper.htm>

EXAMPLES OF COMPOSITES TODAY

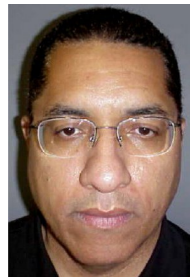


Juan Perez is a detective and artist with NYPD; he creates composites based on victims descriptions. The NYPD produced 273 sketches in 2012.

http://www.nytimes.com/2013/08/19/nyregion/still-finding-value-in-the-vanishing-art-of-police-sketches.html?_r=0



Rene Otero is arrested after the release of a sketch in the sexual abuse case of a 9-year-old girl in the East Village in April 2013.



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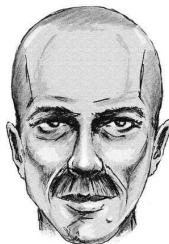
Erika Menendez is arrested after a sketch was released in December 2013 after a man was shoved in front of a subway train.

EXAMPLES OF COMPOSITES TODAY



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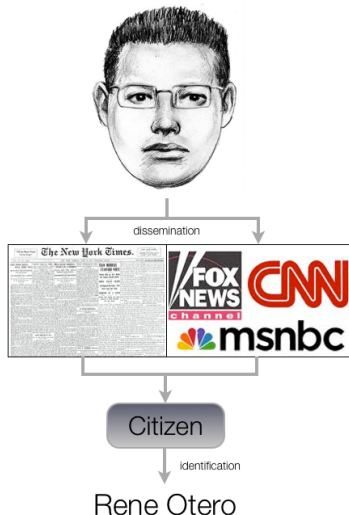
http://www.nytimes.com/2013/08/19/nyregion/still-finding-value-in-the-vanishing-art-of-police-sketches.html?_r=0



Steven Papas' sketch led directly to his identification. He is serving time for kidnapping and sexual assault.

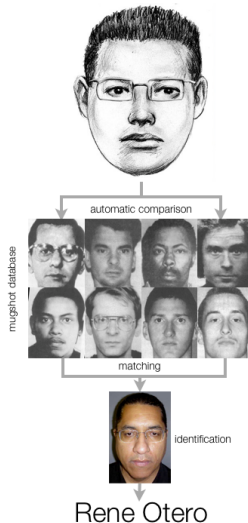
CURRENT APPROACH

- Law enforcement agencies disseminate a sketch to media outlets
- Citizens provide information pertinent to the identification and capture of a suspect
- Slow and tedious process
- Fails to leverage resources available to law enforcement agencies (mugshot databases)



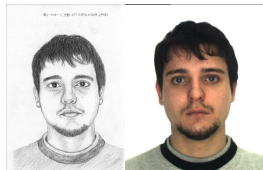
PROPOSED APPROACH

- Match facial composites against mugshots automatically
- Holistic representation (developed by Klare and Jain)
- Component representation (developed by Han et al.)
- Train algorithms using facial composite/mugshot pairs

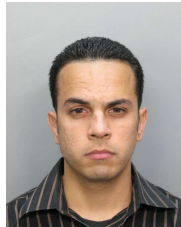


COMPOSITE TYPES

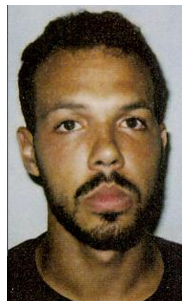
- Viewed hand-drawn composites
 - Drawn while viewing the photograph
 - Not relevant to law enforcement
- Hand-drawn composites
 - Drawn using the description provided by a witness or victim
- Software-generated composites
 - Created using menu-driven software using description provided by a witness



HAND-DRAWN COMPOSITES



SOFTWARE-GENERATED COMPOSITES



ALTERNATE USES FOR COMPOSITES

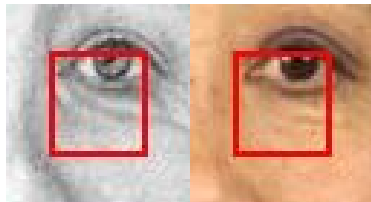
Can be drawn based on low quality video frames (e.g. from a surveillance video)



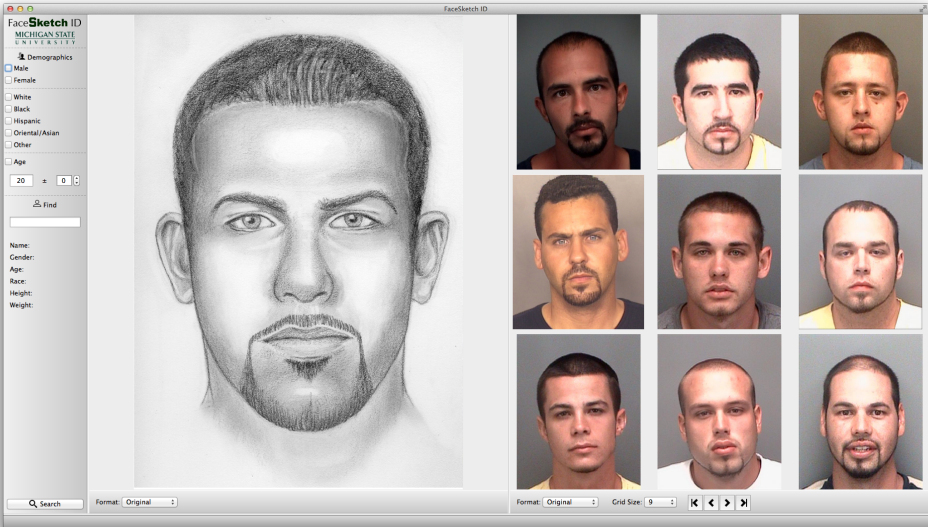
<http://losangeles.cbslocal.com/2011/01/15/disabled-woman-says-she-was-victimized-on-tape/>

CHALLENGES IN COMPOSITE RECOGNITION

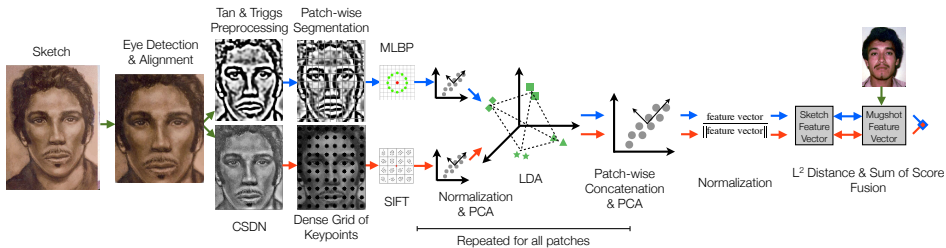
- Inaccurate composites
 - Sketches are drawn from human memory
 - May lead to inaccurate description of the suspect
- Variability in artist skill
- Different image modalities
 - Difficult to compare a composite to a mugshot in terms of pixel intensities
 - The composite has a different “appearance”



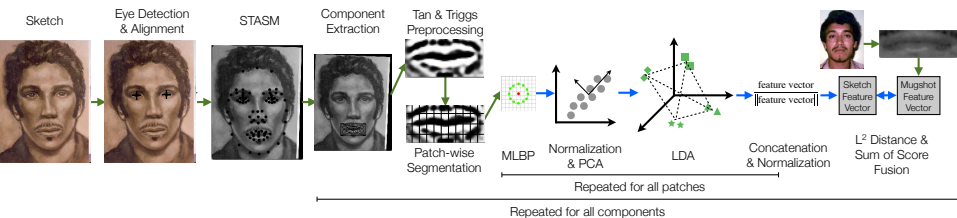
The FaceSketchID System



HOLISTIC ALGORITHM



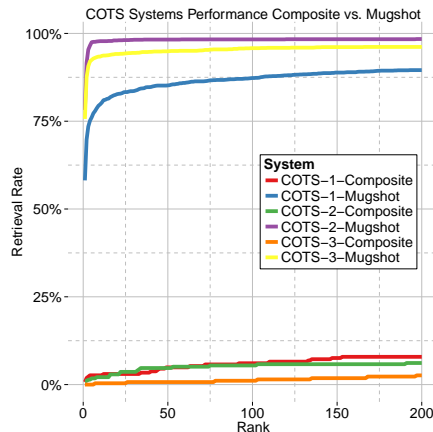
COMPONENT-BASED ALGORITHM



Performance

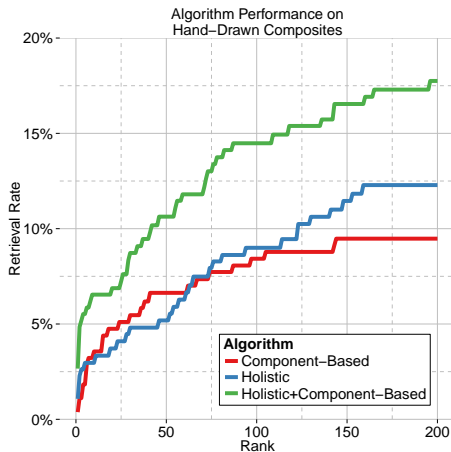
COTS SYSTEM PERFORMANCE

- COTS face matchers perform poorly in the composite to mugshot recognition scenario
- Experiments reflect an enrolled gallery of mated mugshots + 100,000 mugshots from the PCSO database



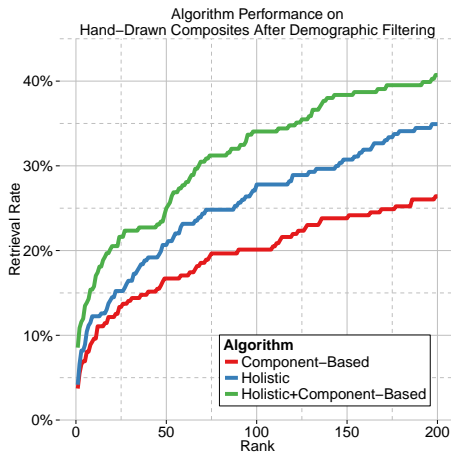
PERFORMANCE ON HAND-DRAWN COMPOSITES

- Query set: 265 hand-drawn composites
- Target set: 265 mugshot mates + 100,000 mugshots from the PCSO database
- 5 fold cross-validation (we cannot train the COTS systems, so they are simply testing splits)
- On average, there are about 53 pairs per fold



PERFORMANCE ON HAND-DRAWN COMPOSITES AFTER DEMOGRAPHIC FILTERING

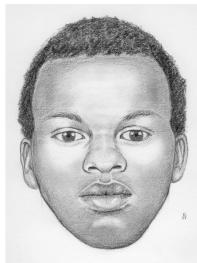
- Same experimental setup
- Subjects in the gallery that are of a different gender or race (white, black, asian, hispanic, other) than the query are removed
- Subjects that fall outside the query's age range are removed



RETRIEVAL RANK EXAMPLE: PRIP DATASET

Ranks correspond to a gallery of 100,000 mugshots with the genuine mates after demographic filtering

System	Rank
FaceSketchID	1
COTS-1	330
COTS-2	221
COTS-3	5482



20-30 Black Male

RETRIEVAL RANK EXAMPLE: NY TIMES

Ranks correspond to a gallery of 100,000 mugshots with the genuine mates after demographic filtering

System	Rank
FaceSketchID	75
COTS-1	238
COTS-2	FTM
COTS-3	365



25-35 Hispanic Female

RETRIEVAL RANK EXAMPLE: SEQUESTERED SET

Ranks correspond to a gallery of 100,000 mugshots with the genuine mates after demographic filtering

System	Rank
FaceSketchID	11
COTS-1	2052
COTS-2	FTM
COTS-3	3658



20-30 White Male

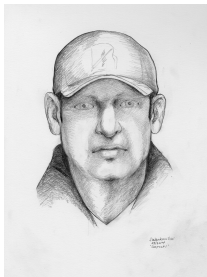
RETRIEVAL RANK EXAMPLE: DZHOKHAR TSARNAEV



15-25 White Male

The FaceSketchID System is able to match a court room sketch to this image of Dzhokhar Tsarnaev at Rank-88 and Rank-2 before and after demographic filtering, respectively.

RETRIEVAL RANK EXAMPLE: TAMERLAN TSARNAEV



20-30 White Male

The FaceSketchID System is able to match a surveillance composite to this image of Tamerlan Tsarnaev at Rank-2113 and Rank-20 before and after demographic filtering, respectively.

RETRIEVAL RANK EXAMPLE: ACTIVE CASE

Ranks correspond to a gallery of 100,000 mugshots with the genuine mates after demographic filtering

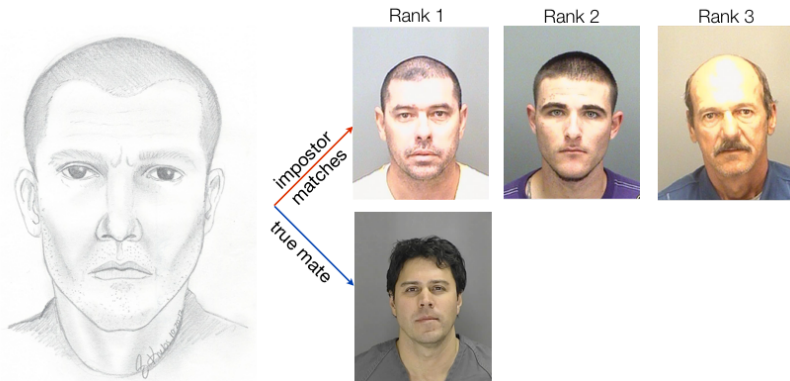
System	Rank
FaceSketchID	1297
COTS-1	5192
COTS-2	FTM
COTS-3	4115



35-45 Black Male

UNSUCCESSFUL MATCHES

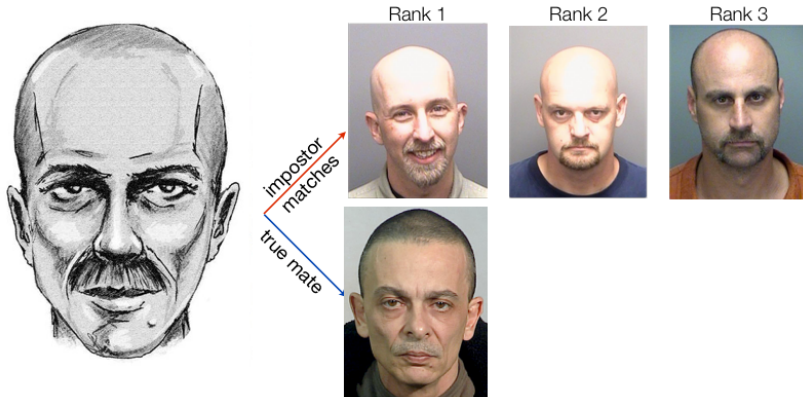
For unsuccessful matches (retrieved at a Rank greater than 1000), the mugshots retrieved at a low rank often look more like the sketch than the true mate



http://www.mlive.com/news/detroit/index.ssf/2012/10/sketch_released_of_suspect_in.html

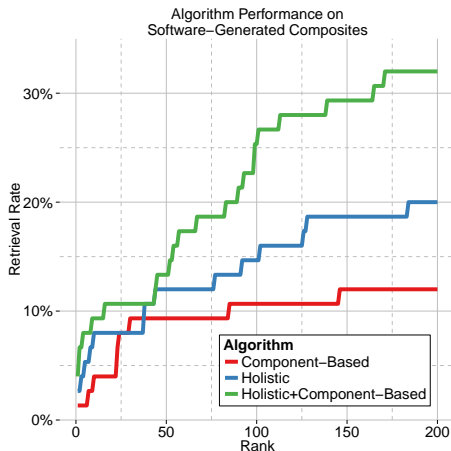
UNSUCCESSFUL MATCHES

There are also cases where both the genuine match and a significant number of impostor matches look like the composite



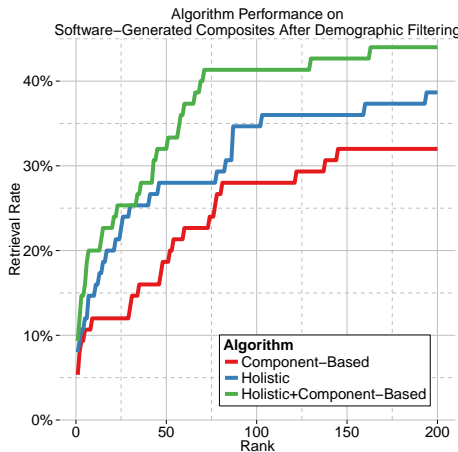
PERFORMANCE ON SOFTWARE-GENERATED COMPOSITES

- Query set: 75 software-generated composites
- Target set: 75 mugshot mates + 100,000 mugshots from the PCSO database
- FaceSketchID System is trained on 1800 viewed hand-drawn composites (from the CUHK-VHDC database)



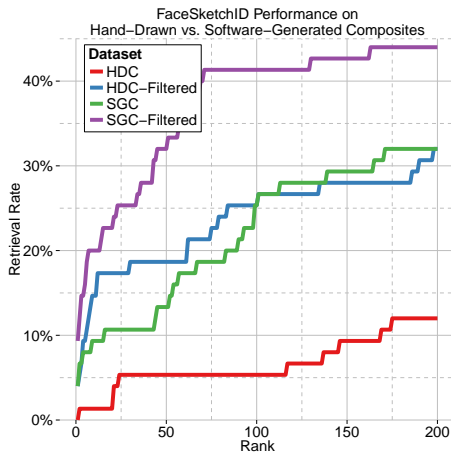
PERFORMANCE ON SOFTWARE-GENERATED COMPOSITES AFTER DEMOGRAPHIC FILTERING

- Same experimental setup
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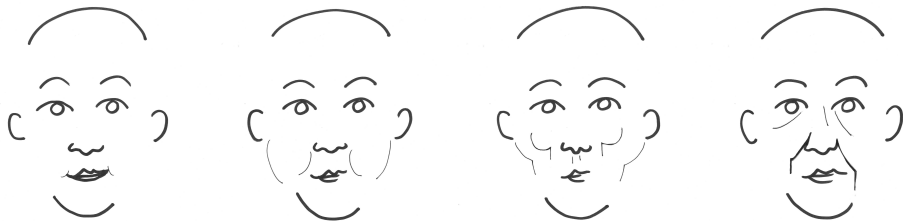
PERFORMANCE ON HAND-DRAWN COMPOSITES VS. SOFTWARE-GENERATED COMPOSITES

- Which modality results in the best performance?
- Comparing a set of 75 hand-drawn composites and 75 software-generated composites that have the same mugshot mate
- Published in ICB 2013 proceedings



Future Work

ATTRIBUTE-BASED FACE RECOGNITION



Can we improve the performance of the FaceSketchID System by incorporating the verbal attributes provided by the witness?

Publications

- S. Klum, H. Han, B. Klare, A. Jain, The FaceSketchID System: Matching Facial Composites to Mugshots, IEEE Transactions on Transactions on Information Forensics and Security (TIFS), Under Review
- S. Klum, B. Klare, H. Han, A. Jain, Sketch Based Face Recognition, IEEE Biometrics Council Newsletter, pp. 4, 2013
- S. Klum, H. Han, A. Jain, B. Klare, Sketch Based Face Recognition: Forensic vs. Composite Sketches, International Conference on Biometrics, 2013
- J. Klontz, B. Klare, S. Klum, E. Taborsky, M. Burge, A. Jain, Open Source Biometric Recognition, Biometrics: Theory, Applications and Systems, 2013

Thank you!