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Sketch Recognition: What Lies Ahead? ☆

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ABSTRACT

“What is the state-of-the-art in sketch recognition and what are some important future research directions in matching sketches with digital face images?” This opinion paper focuses on answering these questions through proposing three important steps that need to move the field forward: (i) create a large, real world forensic sketch database, (ii) develop fundamental understanding of *human cognition* of processing sketches, and (iii) develop improved algorithms for matching sketches with mugshot photos.

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1. Introduction

Matching facial sketches with digital (mugshot) photos is an important aspect of criminal investigation and widely used by law enforcement agencies. There are two aspects of sketch matching: (i) creating a facial sketch based on the description of an eyewitness and (ii) matching it against a database of digital face photos. Fig. 1 shows some real world examples of sketches that are generated during forensics and security investigation. It is clearly evident that information content in sketches is significantly different compared to digital images. While digital images have both macro and micro information, sketches primarily contain macro facial outline (only selected unique features are emphasized) with minimal texture information. Due to the *heterogeneity* in information content coupled with variations due to eyewitness description and artist's skills, a sketch may look very distinct compared to the corresponding digital face image.

Facial sketches can broadly be divided into two categories: hand-drawn sketches and software-generated composites. Based on the description of an eyewitness, hand-drawn sketches are drawn by an expert forensic sketch artist, whereas composite sketches are created via specialized software by trained technicians. As shown in Fig. 2, sketch generation process is further divided into three categories:

- viewed sketch: when the artist/technician draws the sketch by observing the person or an image of the person,

- semi-forensic sketch: when the artist draws the sketch based on his/her memory of the person/image, and
- forensic sketches: a forensic artist draws the sketch based on the description provided by an eyewitness.

For hand-drawn sketch recognition, CUFS [1], CUFSF [4], and IIIT-D [2] sketch databases are some of the popular viewed and semi-forensics sketch databases. While these sketches are important for research, forensic sketches are of paramount interest and are used in real-world law enforcement applications. Except a few samples that are made available (via their books) by Lois Gibson, Karen Taylor and other sources on the World Wide Web, there is a scarcity of hand-drawn forensic sketch database for research. In recent past, commercial composite generation software such as evoFIT, FACES, and IdentiKit have received attention from both academic community and user agencies. However, research in composite sketch recognition is still in its nascent stage and only PRIP and e-PRIP databases [3], [5] are available for research.

After the sketch is created, it requires matching them with a database of mugshots (digital face images). In the literature, researchers have explored different types of algorithms which can broadly be divided into (i) subspace based approaches along with handcrafted features, (ii) representation learning based techniques and (iii) other approaches such as graphical methods and hybrid approaches. Table 1 describes some of the approaches for hand-drawn and software generated sketches. While very high recognition

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Fig. 1. Some real world examples of sketches and corresponding digital faces.

accuracies are reported for viewed and semi-forensic sketches, the accuracies are relatively very low on forensic sketches. Most of the algorithms, on forensic sketches, do not report more than 50% recognition accuracy.

2. Path forward in sketch recognition

Several factors contribute to hold back research in sketch-to-photo matching, in particular the lack of real-world databases and the lack of proper understanding of the sketch recognition process in human mind. In order to improve the performance and make it useful for law enforcement agencies, as shown in Fig. 3, we assert that focused efforts in the following three directions are required.

2.1. Large scale real world forensic sketch database

There are huge volumes of face databases available for face recognition with variations in pose, expression, illumination, and low resolution. However, there are very few publicly available datasets that can help in extending the research related to sketch recognition. Further, existing databases are limited not only in terms of total number of subjects but also in the number of images per subject. For instance, IIITD sketch database comprises images from only 238 subjects for viewed sketches and 140 for semi-viewed sketches. More importantly, limited availability of forensic sketches severely affects the overall growth of research efforts. Due to small size databases, data intensive learning based approaches such as representation learning are less explored in sketch to photo matching. It has also

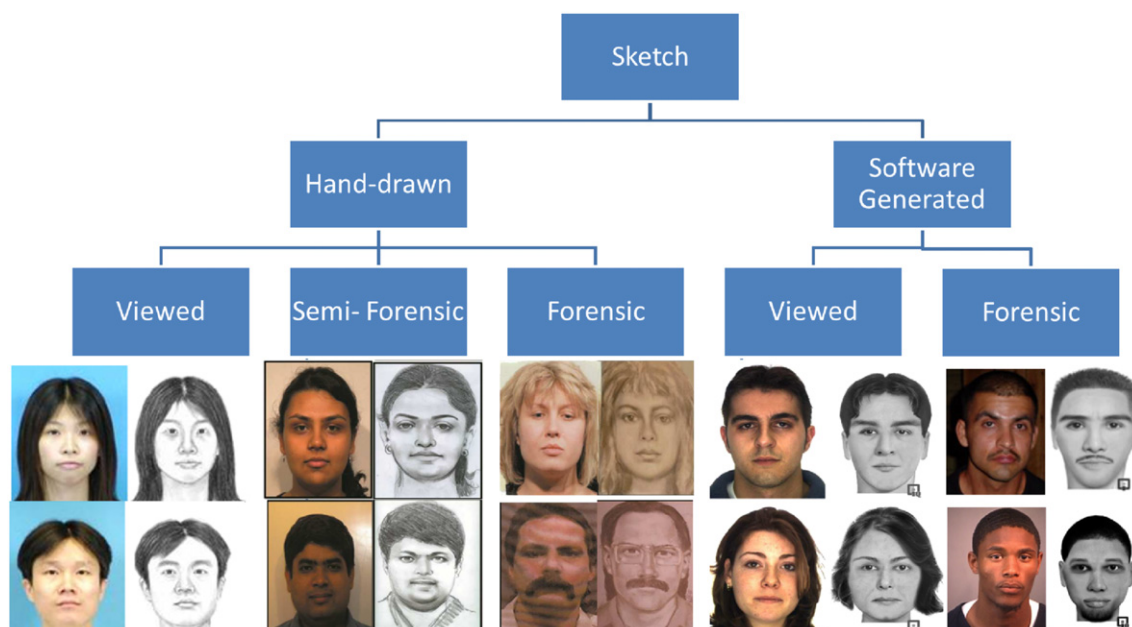


Fig. 2. Illustrating samples of different types of sketches: hand-drawn and software generated. Images are taken from [1], [2], [3], and world wide web.

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