An Enhanced Computer Vision By Using MLP Approach To Forensic Face Sketch Recognition System

Abdulrazag Mukhtar Atomi[1], Walid Hasen Atomi[2], Abdelrazak A. Yousef Elbunan[3] , Inas Mohammed Milad[4]

Higher Institute of Science and Technology, Messallata [1,3]
University of Alhadera for Humanity Applied Science[2] – Elmergib University[2]
Higher Institute of Science and Technology - Al-khomes[4]
[1]abdulrazag.atomi@gmail.com
[2]wal_ltt@ltt@hotmail.com
[3]Abdelrazk.elbunan1892@gmail.com
[4]inasmilad2007@gmail.com

الملخص

أصبحت تقنيات تحديد هوية المشتبه بهم واكتشافها والتعرف عليها أكثر أهمية في السنوات الأخيرة. ونتيجة لذلك ، فإن التعرف على الوجوه يكاد يكون من الشائع استخدام تقنيات القياسات الحيوية. يهتم المحققون من باحثي الرؤية الحاسوبية الجنائية والطب الشرعي بالرسوم التخطيطية للوجه التي رسمها الفنانون. ووفقًا للدراسات ، لا تزال الرسومات التخطيطية للوجه المرسومة يدويًا نادرة للغاية ، سواء من حيث الفنانين أو عدد الرسومات ، نظرًا لأن فناني الطب الشرعي يعدون رسومات الضحايا بناءً على الأوصاف التي قدمها شهود العيان بعد الحادث. تُستخدم الأقنعة أحيانًا لإخفاء ملامح الوجه القياسية مثل الأنف والعينين والشفتين ولون البشرة ، ولكن من المستحيل إخفاء ميزات الخطوط الخارجية للقياسات الحيوية للوجه. ركزت هذه الورقة على تحليل ملامح الوجه حيث يمكنها حساب نسب التشابه و التطابق بين صور القالب و الرسومات الجنائية ، تم استخدام تقنيات الرؤية الحاسوبية مثل تحويل جيب التمام المنفصل ثنائي الأبعاد (2-D DCT) والشبكة العصبية لخريطة التنظيم الذاتي (SOM) لتصميم نظام للتعرف على رسم الوجوه الشرعي.

Abstract

Technologies for suspect identification, detection, and recognition have become more critical in recent years. As a result, face recognition is an almost commonly used biometric technique. Investigators for Criminal and forensic computer vision researchers are interested in the human-recognized face sketches were drawn by artists. Hand-drawn face sketches are, according to studies, still extremely rare, both in terms of artists and number of drawings, since forensic artists prepare victim drawings based on descriptions were provided by eyewitnesses following an incident. Masks are sometimes used to conceal standard facial features such as noses, eyes, lips, and skin color, but face biometrics' outliner features are impossible to conceal. This paper concentrated on a particular face-geometrical feature that could calculate some similarity ratios between composite template photos and forensic sketches. Computer vision techniques such as Two-Dimensional Discrete Cosine Transform (2D-DCT) and the Self-Organizing Map (SOM) Neural Network are used to design a system for composite and forensic face sketch recognition.

Introduction:

Face recognition relies on still images, which can be divided into two categories: image-based and feature-based. Human-machine interfaces, automatic access control systems, and forensic investigations use face recognition to identify faces in images by comparing them to a database of stored faces [3]. It involves the design and development of a system for identifying forensic face sketches. Faces cropped from images are compressed using the 2D-DCT image compression technique. Using pixel reshaping after image compression, the neural network is prepared to accept image classes as inputs. An algorithm for training neural networks using image data is called SOM (Self-Organizing Maps). Simulink assigns unsupervised weights to inputted face sketches during training and learning[6]. Facial recognition systems are used as the basis for this project. Simulation and program source code are executed in MATLAB and Simulink.

Related Work

Face detection matching between two facial photographs is a widely studied problem in computer vision, pattern recognition, and biometrics. Matching facial sketches to photographs and detection is the most problem with only a limited amount for published working [2]. Most study has been used viewed sketches drawn when viewing the mugshot photograph. Further, the studies that considered operational forensic sketches did not address the use of sketches[3].

Previous studies have been focused on automatic face recognition systems using composite sketches. The first used a combination of local and global features to represent sketches [5], but it required user input in the form of relevance feedback in the matching or recognition and phase detection. The authors in [7] used a small gallery in their experiments (300 facial photographs). The method proposed by Han et al. [9], used a component-based approach to match facial sketches to mugshots. While Han et al. used a large gallery and created a method that is fully automatic by machine, the composite sketches using the create while viewing the mugshot photograph (viewed forensic composite sketches) which does not reflect operational scenarios. This study was used forensic sketches from trusted URL websites (biometrics) and composite sketches were created. Furthermore, were compared the recognition accuracy of composite sketches forensic sketches using two different automated face recognition systems[8].

Problem Statement

Criminal suspect face sketch recognition has grown in popularity due to increased security demands, forensic investigation, and potential commercial and law enforcement applications. Forensic face sketch recognition is a challenging problem, and there is no feasible technique that can provide a robust solution to all situations and different applications. It is for these reasons that this study is focused on developing an efficient face sketch identification system. In addition to being used as an original face image police database, the digital mugshot is thought to be drawn by forensic artists.

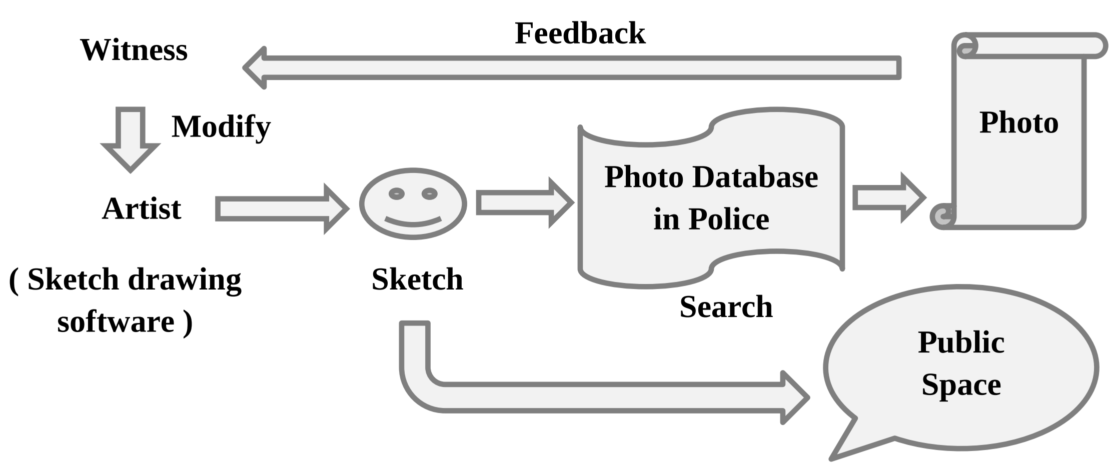

Figure 1 : Search for suspects from photo database using sketch drawing.

Methodology
This work's methodology was developed based on information gathered and processed during the study and research phases. The following technique will be used to design and implement the forensic face sketch identification system.

Step1: Data gathering of face images of subjects from database.
Step2: Pre-processing of face images, i.e., copping, grayscale conversion.
Step3: Importing face images into MATLAB.
Step4: Discrete Cosine Transform (DCT) image compression of face image classes.
Step5: Design of a Self-Organizing Map (SOM) Neural Network in MATLAB.
Step6: Input faces image classes into SOM Artificial Neural Network (ANN).
Step 7: Training the neural network and simulating it for different input face sketch images.
Step8: Testing and validation of the program and technique.

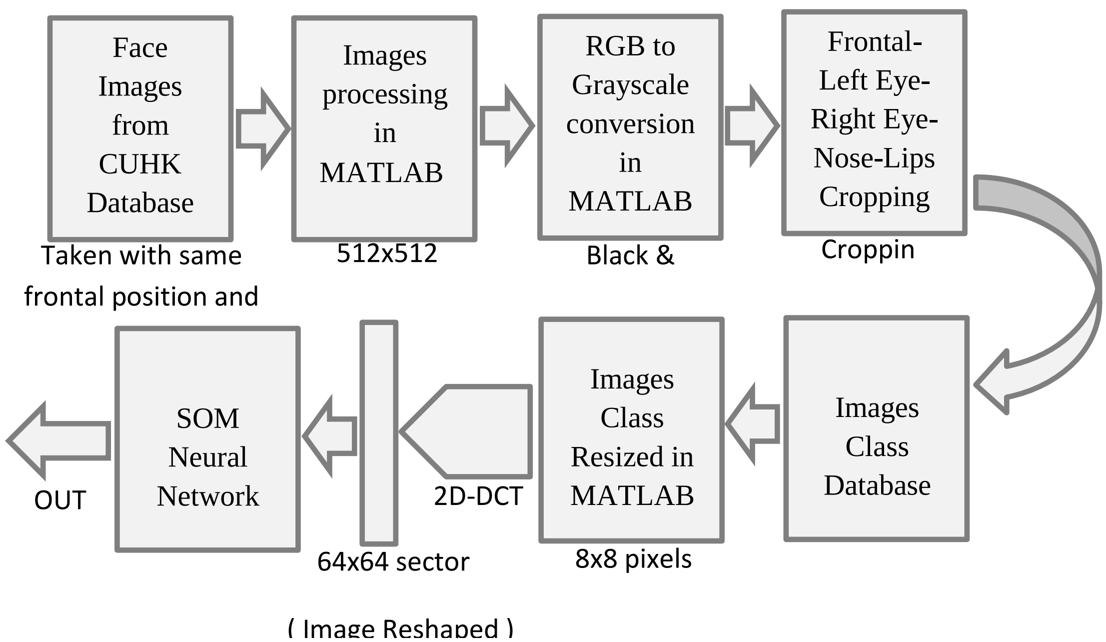

Figure 2: illustrates the flowchart proposed for designing the forensic and composite face sketch recognition system based on the methodology.

Face Detection
To locate and extract the facial region from a face sketch image background, face detection is a necessary first step in the process.
A. General Background
Humans perceive faces in their entirety, not in their features. According to this theory, features' presence and geometrical relationship are far more important than their specific details. Humans can also detect faces in a wide range of conditions, including dim lighting and from a distance[11]. Humans are believed to detect faces in images with two grey levels of 100 to 200 pixels.

Face detection, on the other hand, is a difficult task in computer vision. A face can be detected in a digital image through segmentation, extraction, and verification. A great deal of research has been done on this topic, which is why it is so essential in the computer vision field. As shown in Figure 3, all existing methods for automated face recognition rely on three steps: face detection, facial feature extraction, and expression classification.

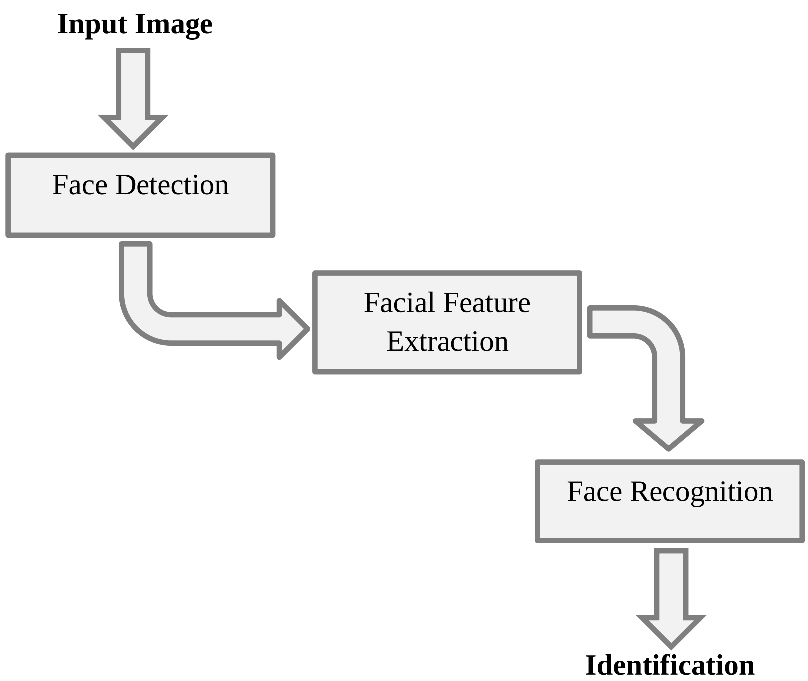

Figure 3: General Steps for Face Recognition

B. Face Sketch Recognition

Generic and discriminative approaches to sketch recognition can be distinguished. Digital images are represented by sketches, which are matched to the query sketch or vice versa. Differential methods extract and match features from a given digital image and sketch pair but do not create the corresponding digital image from sketches.

C. JPEG Image Coding Standard

Encoding and decoding were based on the Discrete Cosine Transform (DCT) when the Joint Photographic Experts Group (JPEG) created the first international standard for still image compression. As a lossy image compression format, JPEG is widely used. Codec and file format are both specified by JPEG. JPEG specifies both the codec and file format. Due to specified by Annex B, it is referred to as "JPEG Interchange Format." In terms of lossy encoding, the JPEG standard specifies three different modes: sequential, progressive, and hierarchical, and a single mode of lossless encoding[13]. When it comes to JPEG image compression, there are four basic steps.

- Block Preparation
- Discrete Cosine Transform
- Quantization
- Encoding

This transform sums up sinusoids of varying magnitudes and frequencies to represent an image. A two-dimensional discrete cosine transform (DCT) of an image can be computed using the dct2 function. Most visually important information about the image is concentrated in just some coefficients of the DCT for a typical picture. Thus, DCT has become a popular image compression method in recent years. The DCT, for example, is at the heart of the JPEG algorithm, an international standard for lossy image compression.

Simulink Description

Simulink is a dynamic systems modeling, simulation, and analysis tool that comes with MATLAB. System models can be in continuous time, sampled time, or a hybrid. Different parts of a system can be sampled or updated at different rates, making the system multi-rate. A system can be modeled using Simulink, and users can see what happens due to their questions. As well as building models from scratch, Simulink also allows for the addition of existing models[14]. A large number of engineers use Simulink to model and solve real problems in a variety of industries around the world

Neural Network Design

Self-Organizing Maps (SOMs) were selected as the technique for the face sketch identification system based on improved data management and neural network accuracy. MATLAB was used to create the training database for SOM, which consisted of many image data points divided into five classes: left eye, right eye, nose, frontal face, and lips. Next, a SOM was created using MATLAB's Newsom command. Each row of vector P was given a minimum and maximum point in the SOM network's parameters. There were a total of 64 minimum and maximum points chosen.The SOM neural network was trained for 1000 epochs when it was created. The trained images were used to simulate the SOM neural network. This was done after the SOM neural network was trained and simulated for images in the training database. Using a minimum absolute deviation, the SOM neural network is simulated for an input face image. After finding the images from the training database that match the closest, they are classified. In the forensic face sketch recognition system, the subject is classified. Simple if and else statements were used in MATLAB to classify data.

Holistic based face recognition

There were many methods that have been shown to be effective techniques for matching a facial sketch probe against a gallery of mugshots [9]. Following normalization, three filters are applied to both the probe sketch and the gallery image to compensate for the differences in modality. After a facial sketch/mugshot into many uniform patches, SIFT and multi-scale local binary pattern (MLBP) [10] features are extracted from each patched. Training for machines in the form of the sampling linear discriminant analysis (RS-LDA) [12] is used to improve the recognition accuracy.

To measure the similarity between feature vectors, the holistic method uses the cosine similarity measure.

Component based face recognition

The component based method was proposed into match composite sketches to photos using two different facial composite systems (FACES and IdentiKit). In the component based method, facial components are automatically localized by detecting landmarks with an active shape model. A local descriptor-based representation by MLBP , then utilized to capture the texture and structure at various scales in each facial component. The component based method uses linear discriminant analysis to improve recognition accuracy. Block based feature extraction is employed to spatially encode the structural information of each facial component. The most accurate components to be used during score fusion are determined empirically for each sketch modality. This representation is consistent with the process of composite sketch synthesis in facial composite systems.

Experimental Results

In total, our facial sketch dataset consists of many forensic sketches and composite sketches with corresponding mugshots and demographic information. The true mugshot age was calculated to be the average of the age range provided by the volunteer while describing the suspect. To make analysis more realistic, this extended the gallery to include more than 1000 mugshots. resulting in a gallery size of about a thousand . Demographic information of the subjects in this dataset can be found in Table 1.

Table1: Demographic information of the many subjects in the gallery set.

Males					Females				
Ethnicity	Age Range				Ethnicity	Age Range			
	>18 and <25	>26 and <35	> 35 and < 50	> 60		>18 and <25	>26 and <35	> 35 and < 50	> 60
Black	90	270	378	45	Black	8	99	62	0
Dark Skin	490	22	15	3	Dark Skin	98	44	250	2
blonde	0	125	33	77	blonde	40	150	480	0
White	1	15	0	6	White	5	25	0	9

Note that the other race/ethnicity contains all subjects not belonging to the black, hispanic, or white races/ethnicities. Filtering is not performed when encountering a probe with the other race/ethnicity. In forensic and biometrics scenarios involving facial sketch to mugshot matching, the standard procedure involves law enforcement officers looking through top-N matches (rather than only considering rank-one retrieval rates). In our experiments, N = 200. We also used the performance of a commercial-off-the-shelf face matcher, FaceVACS v8.2 [8] as a baseline. As shown in Fig. 5, FaceVACS achieves rank-200 retrieval rates of 4.1% and 6.7% for forensic and composite sketches, respectively. The holistic and component representations each have significantly better performance compared to Face-VACS as ahown in table 2 ,for both forensic and composite sketches under both the filtered and unfiltered scenarios as expained in Fig. 4.

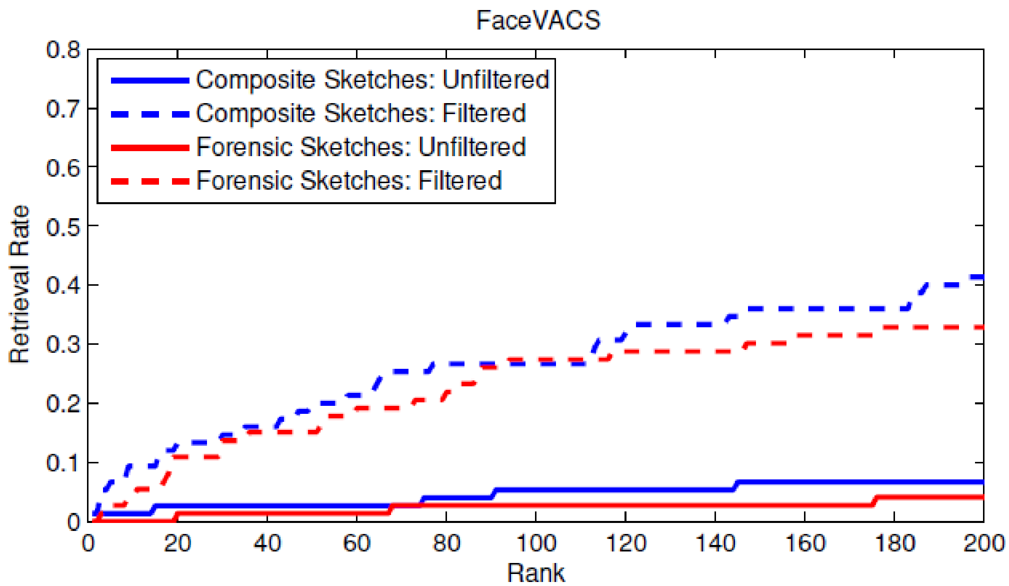

Figure 4: CMC plots for matching facial sketches to mugshots using the commercial matcher FaceVACS

The component based method improves upon the performance of the holistic method in matching forensic sketches when neither system has been trained . The retrieval rate for composite sketches is worse due to the fact that most components are inaccurate . After training , the rank-retrieval rate of the component based method is nearly identical to that of the holistic method for composite sketches and is worse than the holistic method for forensic sketches. This result is perhaps expected, since the training method employed by the holistic method (RS-LDA) is more advanced than the training method used by the component based method (LDA). Similar to the holistic method, training the component based method improves the retrieval rate of composite sketches (12.00% without training to 26.67% with training) more than that of forensic sketches (20.27% without training to 21.62% with training).

Table2: Holistic and face VACS comparison.

Comparing Face Matching			
Face Matcher	**Sketch Type**	**Accuracy**	**Execution Time (Sec)**
Holistic	**Forensic**	***89%***	***58***
	Composite	***92%***	***89***
Face VACS	**Forensic**	***81%***	***67***
	Composite	***90%***	***75***

Conclusion

To reduce DCT processing time and increase program execution time, the optimal number of DCT coefficients should be chosen for face image compression. When simulating a neural network, the size of the input image and training database images is used to determine the optimal number of input neurons. If the SOM neural network output is most accurate with the fewest image pixels, then the SOM neural network's input neurons should be as small as possible.

Summary

Facial sketches drawn by forensic artists (forensic sketches) or created using software (composite sketches) are used by law enforcement agencies to assist in identification and apprehension of suspects involved in criminal activities. Using a new dataset of forensic sketches and composite sketches available at(*http://biometrics.cse.msu.edu/pubs/databases.html*), we have performed the first comparison of the effectiveness of both modalities when used with two state-of-the-art sketchto- photo matchers. A commercial face matcher was also used as a baseline. Demographic information was further explored to filter the gallery (mugshots) to improve the matching performance. Composite sketches were found to be more effective in identifying the suspect's mugshots.

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