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Face Sketch Recognition

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Abstract: Nowadays need for technologies for the identification, detection, and recognition of suspects has increased. One of the most common biometric techniques is face recognition since the face is a convenient way used by people to identify each other. Understanding how humans recognize face sketches drawn by artists is of significant value to both criminal investigators and forensic researchers in Computer Vision. However, research shows that hand-painted face paintings still exist very limited in terms of artists and number of paintings because after each event the forensic artist prepares the victim's drawings instead of a description given by an eyewitness. Sometimes the suspects use a special mask to hide the other common facial features such as nose, eyes, lips, face color, etc. but the external features of the biometric surface one would not hide. In this project, we have concentrated on the implementation of deep learning and different image processing algorithms, such as Histogram of Oriented Gradients to identify real-life people from hand-drawn sketches.

Keywords: *Face Recognition*

I. INTRODUCTION

When a person becomes a victim of a crime and goes to the police station to file an incident report, one of the most important questions asked by the police officer is that can you identify the criminal or not. If the victim can identify the criminal, then he/she is asked to help the sketch artist draw a sketch. This sketch is then used by the police to identify and apprehend the criminal later.

The method of catching criminals by the use of hand-drawn sketches has been in use since the 1980s. The method has been altered a bit to suit the new technologies that kept showing up in the market, but still, in the end, the law enforcement had to either paste the sketches on the walls of the city and rely on citizens to inform them if they ever see the criminal or themselves go on the street and try to identify the man. The only major revolution that ever occurred in this method was the use of fax machines. Using the fax machines, law enforcement officers could send the hand-drawn sketches to other police stations, sometimes even to the offices of other cities (in the case the criminal flees to another city).

One of the most important, popular, and secure biometric authentication systems today is the face recognition system. The above problems motivated me to revolutionize the way law enforcement uses hand-drawn sketches. We have decided to use this technology to identify criminals within a few hours so that the effort of the law enforcement is reduced and they can spend their time and other resources on the remaining open cases.

Our application would allow the law enforcement officers to upload the hand-drawn sketches into the system and either check whether the details of the criminal already exist in their criminal database, or use OpenCV to identify the criminal using a live feed of CCTV worldwide. The application uses deep learning to provide the most accurate result, thus saving the time and energy of the officers. The application has been designed by keeping 'the ease of use' in mind so that no professional training is required to use the application.

II. RELATED WORK

Pong C. Yuen, C.H. Man, "Human Face Image Searching System Using Sketches", IEEE Transactions on Systems, Man, And Cybernetics-Part A: Systems And Humans, Vol.37, No.4, July 2007. This paper describes a face image searching system using sketches. It contains a two-phase method, sketch-to-mugshot matching, and human face image searching which uses relevant feedback, that is designed and developed. In the first phase, they had developed a facial feature matching algorithm using local and global features. They employ a point distribution model to represent local facial features while the global feature consists of a set of the geometrical relationship between facial features. It was found that the performance of the first phase is good if the sketch image looks like the mug shot image in the database. However, in some situations, it is hard to construct a sketch that looks like a photograph. This paper overcomes this limitation by using the concept of Idqyuo human-in-the looprdquo and by proposing a human face image searching algorithm. Positive and negative samples will be collected from the user. A feedback algorithm that employs subspace linear discriminant analysis for online learning of the optimal projection for face representation is then designed and developed. The FERET database and a Japanese database were used for the evaluation of the system proposed in this paper. The results are encouraging.

Saurav Pramanik, Debotosh Bhattacharjee, "Geometric Feature-Based Face-Sketch Recognition", Proceedings of the International Conference on Pattern Recognition, Informatics and Medical Engineering, March 21-23, 2012. This paper presents a novel facial sketch image or face-sketch recognition approach based on facial feature extraction. To recognize a face-sketch, the authors have concentrated on a set of geometric face features like eyes, nose, eyebrows, lips, etc, and their length and width ratio. This step was taken because it was difficult to match faces in photos and faces in sketches. In this system, first, the facial features/components from training images are extracted, then ratios of length, width, and area, etc. are calculated and those are stored as feature vectors for individual images. After that, the mean feature vectors are computed and subtracted from each feature vector for centering of the feature vectors. In the next phase, the feature vector for the incoming probe face-sketch is also computed similarly. Here, the K-NN classifier is used to recognize probe face sketch.

Amit R. Sharma, Prakash. R. Devale, "An Application to Human Face Photo and Sketch Synthesis and Recognition", May IJAET 2012. The process of face recognition is as follows. It relies on captured images. These images can be grouped into image-based and feature-based approaches. Face recognition is normally used in applications such as automatic access control systems, biometric authentication systems, and human-machine

interfaces. This process consists of a comparison of uploaded images with the ones in a certain database. The project discussed in this paper involves the design and development of a forensic face sketch recognition system. The technique used to compress the cropped facial features of the image database like frontal face left eye, right eye, nose, and lips are called the 2D-DCT image compression technique. After compression, the image pixels reshaping is used for preparing the image classes as an input for the neural network. The SOM (Self Organising Maps) neural network algorithm is designed for the training image data. The un-supervised weight is assigned during the training and learning in Simulink for the different number of epochs to classify and inputted face sketch. This project is based on the general architecture of facial recognition systems. Program source code and simulation are executed in MATLAB and Simulink.

Wei Zhang, Xiaogang Wang, Xiaoou Tang, "Coupled Information-Theoretic Encoding for Face Photo-Sketch Recognition". In this paper, the authors proposed reducing the modality gap at the feature extraction stage for a new intermodality face recognition approach. A new face descriptor based on coupled information-theoretic encoding is used to capture discriminative local face structures and to effectively match photos and sketches. The coupled encoding is achieved by the coupled information-theoretic projection tree proposed in the system. They created the largest face sketch database including sketches of more than a thousand people from the FERET database. Experiments on this large-scale dataset show that their approach significantly outperforms the old traditional methods.

Forensic Face Sketch Construction and Recognition Asst. Prof. Abhijit Patil [1], Akash Sahu [2], Jyoti Sah [3], Supriya Savage [4], Saurabh Vadekar [5]. In this paper, the authors present a standalone application that would allow users to create composites face sketch of the suspect without the help of forensic artists, who can automatically match the sketch with the details of criminal in the police database by using the drag and drop function

C. Galea and R. A. Farrugia, "Forensic Face Photo-Sketch Recognition Using a Deep Learning-Based Architecture," in IEEE Signal Processing Letters, vol. 24, no. 11, pp. 1586-1590, Nov. 2017, DOI: 10.1109/LSP.2017.2749266. This paper tackles these issues with the following contributions:

1) a traditional model which was pre-trained for face photo recognition was tuned for face photo-sketch recognition by application of transfer learning,

2) a three-dimensional morphable model was used to synthesize new images and expand the training data artificially, allowing the network to prevent over-fitting and learn better features,

3) multiple synthetic sketches were also used in the testing stage to improve performance, and

4) fusion of the proposed method with a traditional algorithm is shown to further boost performance.

Very little work has been done to apply deep learning to face sketch recognition despite its success in numerous application domains including traditional face recognition. This problem occurs primarily due to the limited number of sketch images available, which are insufficient to robustly train large networks. An extensive evaluation of several popular and stateof- the-art algorithms is also performed using publicly available datasets, thereby serving as a benchmark for future algorithms. The proposed system has proven to reduce the rate of error by 80.7 % for the sketches viewed and lower the mean retrieval rank by 32.5% for the real-world forensic sketches.

III. PROPOSED METHODOLOGY

The flowchart shown below illustrates the steps that will be followed in the proposed system. The GUI would be simple in design and would have two options to run the facial sketch recognition system. As this project is designed for the law enforcement department, it is kept simple so that no professional training is required for the officers who use the system, thus saving time and resources for the department.

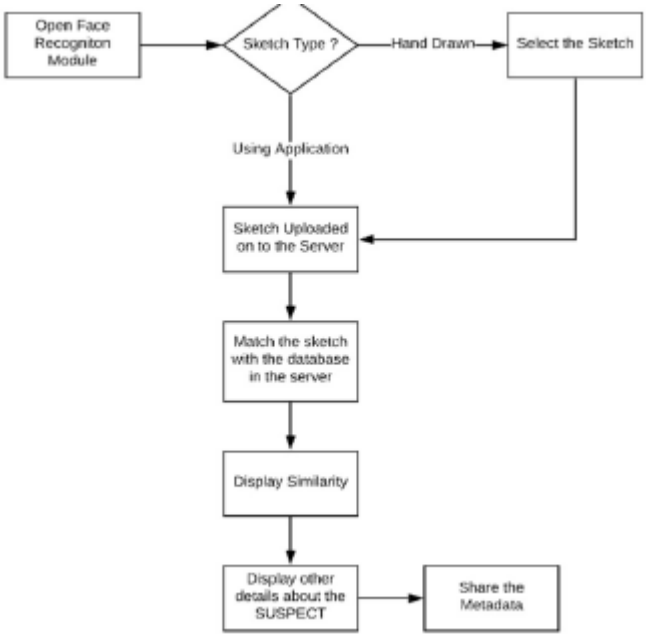

Fig 1: Flowchart of Proposed System

There are two ways of using this application: 1) By manually uploading the sketch to match with the images in the databases 2) By implementing the program in the live feed of CCTV citywide to catch the criminal in real-time.

A. Upload the Sketch

The first step of the process is to digitally encode the sketch that is uploaded in the system. For this, the system would use the dlib library of python. Once uploaded, the system converts the face in the sketch into a 128 bits matrix of numbers.

B. Match the Sketch with the database in the server

The second step of the process is to scan the entire database and match every photo with the sketch uploaded. In this step, the system first selects a photo from the database, encodes it into the 128-bit data, and then tries to match it with the 128-bit data of the sketch uploaded. While matching the data, the algorithm uses the Euclidean distance formula to match the two images. If the image does match, the algorithm moves on to the next image in the database. This process keeps going on until the system reaches the last image in the database.

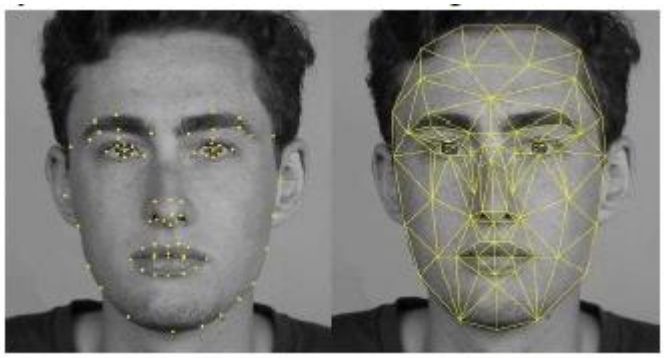

Fig 2: An example of the face mapping

C. Display the Similarity

The threshold is set to 1.0. The score of the Euclidean distance closest to 1.0 is declared a match and the similarity is displayed. The algorithm used in this system is Histogram of Oriented Gradients (HOG) and is used in deep learning projects.

D. Display the Details of the Suspect

After the system matches the sketch with a suspect, the program displays the image of the sketch as well as the image of the suspect it matches with. A text box also displays the name, age, and sex of the suspect.

IV. SCOPE

This project of Face sketch recognition has been designed on a few scenarios with limited learning from a few images. It is designed on a small scale, i.e., for a few photos in a small database.

With further research and development, this platform can be upgraded and enhanced to work on a global level and with databases with flows of photos. It can accustom to work with various media and surveillance systems, which would give the program a much wider database from which to learn and train the model. By implementing 3D mapping and other image processing techniques, the platform can be modified to recognize face sketches with human faces from the video feeds from live and pre-recorded CCTV videos.

Social media is also a possibility. The program can be modified to work with social media as social media is an ocean of data, include photos. Although unclear now that how this program would be useful in social media, it is a platform that can surely benefit from this technology. Overall, the platform has features and can be modified to use more useful features that will make this program unique, but easy to upgrade and use for anybody.

CONCLUSION

This project is being designed especially for law enforcement who need to use traditional methods to find suspects. This project will be designed by keeping real-world scenarios and challenges in mind. Furthermore, this project will be made easy to use so that no professional training is required for the user and hence no time and additional resources would be wasted.