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Matching Face Images of Different Modality in Forensic Science

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Abstract- Attention have been paid to the use of CCTV cameras in important sensitive public places for surveillance to prevent attacks. Many new techniques and technologies are developed to protect things and to stop the crimes. Forensics Science has gained much attention of users and researchers in last few years. Forensics deals with after crime data and the application of scientific principles to analyze data collected by law enforcement agencies. Biometrics in general means the statistical study of biological phenomena. This is usually associates with the use of unique physiological characteristics of a person to identify an individual. Face recognition refers to an automated or semi-automated process of matching facial images with collected face data. In many cases when other forensics evidence are not available, constructing a face sketch is the last resort to solve a crime. The major challenge of sketch based photo retrieval is matching images of different modalities which referred as "modality gap" . The face recognition system based on face descriptors first partitions sketch and face images in to N slices. It then computes image descriptor.

I. INTRODUCTION

The continuous attacks it may be 9/11 tragedy or marathon challenge the researchers in solving crime because the investigators try to solve the crime with help of evidences and software. Many new techniques and technologies are developed to protect things and to stop the crimes but we failed. The nature of committing crime is totally different today compare to earlier days. The criminals intelligently committing the crimes today. Attention have been paid to the use of CCTV cameras in important sensitive public places for surveillance to prevent such attacks in future. There is an emerging need to detect such attacks and attacking persons before any serious tragedy happens.

II. FORENSIC SCIENCE OVERVIEW

Forensics Science has gained much attention of users and researchers in last few years. Forensics deals with after crime data and the application of scientific principles to analyze data collected by law enforcement agencies. It actually tries to help to determine the answer to varied legal questions. "Every contact leaves a trace" this is the main driving principle behind today's modern forensic science investigation. Forensics contain many different disciplines for different kinds of requirements, Ex, Forensic Psychology, Forensic Pathology, Criminalities, Biometrics. Among all these biometrics gained high attention in last few years.

Biometrics in general means the statistical study of biological phenomena. This is usually associates with the use of unique physiological characteristics of a person to identify an individual. Different types of biometrics are there for ex. DNA matching, Iris recognition, Face recognition, Finger print matching, voice verification etc. Iris recognition technology is apparently mature enough to be used commercially in high-security applications in both identification and verification modes with excellent performance results. Fingerprints are the oldest and probably best known biometric identifiers given their intensive use by law enforcement agencies. Face recognition is used every day by humans for identification purposes. It is considered less intrusive than all other technologies and has thus a higher level of user acceptance. the selection of particular biometrics depends on the evidence collected/available about the crime or crime scene.

Investigator may get two kinds of evidences:

- Physical Evidences in terms of materials.
- Eyewitness or Victim.

Trace of materials known as physical evidences found at the scene of crime acts as potent clues that become the most eloquent witness. Physical things involved in the process of committing crime can be a vehicle to reach the scene of crime. Investigator examine all the marks leaved by criminal using different techniques.
Face recognition is one of the most important tasks of forensic examiners. during their investigation if there is video or image material available from a crime scene. The use of automated facial recognition systems will not only improve the efficiency of forensics work performed by various law enforcement agencies but also standardise the comparison process. A Face recognition in forensics is expected to identify faces present in still images and videos automatically. Both methods have their own importance, advantages and disadvantages.

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III. FACE SKETCH

Face recognition refers to an automated or semi-automated process of matching facial images with collected face data. The reason behind choosing face recognition is it is the single biometrics where we don't need a direct contact between the identifying system and suspect. The identification process may be carried out with the suspects knowledge or without the suspects knowledge and the problem faces may be present in still image or video. The system can captures faces of peoples in public areas if needed for minimizing legal concerns. has thus a higher level of user acceptance.

In many cases when other forensics evidence are not available, constructing a face sketch is the last resort to solve a crime. Despite its success and popularity, face sketching is known to have large uncertainties, which in the worse scenario could lead to the false conviction of innocent people.

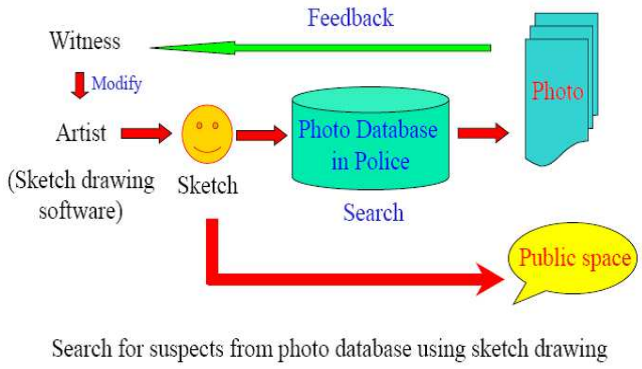

Fig:1.Suspect face recognition using sketch drawing

Sketches are the figures, drawn by trained artists on a piece of white paper with a single pencil or a bunch of pencils. In general, sketches are classified into two categories:

1. **Viewed Sketches:** These are the sketches drawn by an artist, directly looking at the subject or the photograph of the subject.
2. **Forensic Sketches:** These are the sketches drawn by specially trained artists based on the description of subject by an eye witness.

Fig:2. Examples of face photo/sketch pairs

Since viewed sketches are drawn, by directly looking at the subject or the photograph of the subject, they carry a very good detail of the original subject in terms of accuracy. On the other hand, since forensic sketches are drawn, just based on the verbal description, their accuracy is considerably low. It is succinct to say that the accuracy of forensic sketches is directly proportional to the remembrance capability of the eye witness.

IV. DIFFERENT MODALITY FACES

The major challenge of sketch based photo retrieval is matching images of different modalities which referred as "modality gap" . Basically, a face photo is captured by a digital camera, while a face sketch is drawn by an artist. shape might be exaggerated by artist or facial texture might be lost or replaced by artistic rendering in face sketch. This problem will be more exacerbated for forensic investigations, when the eye-witness cannot exactly recollect the suspect's face. To date, various works have addressed the problem of face photo sketch matching; which can be categorized into two classes: intra-modality and inter-modality approaches. Intra-modality approaches synthesize pseudo photo (sketch) from input sketch (photo) for matching sketches and photos in a same modality (photo or sketch). Consequently, the performance of these methods is highly dependent on the effectiveness of image synthesis, which might be even harder than retrieval problem. On the other hand, inter-modality approaches directly match face photos and sketches using discriminative features which are integrated with advanced classifiers. Image feature descriptors describe an image or image region using a feature vector that captures the distinct characteristics of the image. The face recognition system based on face descriptors first partitions sketch and face images in to N slices. It then computes scale-invariant feature transform(SIFT) and multiscale local binary pattern(MLBP) descriptors for each slice, which remain stable between sketch and photos. Next, it uses local-feature-based discriminate analysis(LFDA) to extract the most salient feature vectors to match sketch with photos.

A. Scale Invariant Feature Transform(SIFT)

* Introduction

Scale-invariant transform(SIFT) is an algorithm to detect and describe local features in images. The algorithm was published by David Lowe in 1999. The algorithm is patented in the US: the owner is the university of British Columbia. In using SIFT feature descriptors, the intrapersonal variations between the sketch and photo modality were diminished while still maintaining sufficient information for interclass discrimination.

***** Overview

For any object in an image, interesting points on the object can be extracted a "feature description" of the object. This description, extracted from a training image, can then be used to identify the object when attempting to locate the object in a test image containing many other objects. To perform reliable recognition, it is important that the features extracted from the training image be detectable even under changes in image

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scale, noise and illumination. Such points usually lie on high-contrast regions of the image, such as object edges.

Another important characteristics of these features is that the relative positions between them in the original scene shouldn't change from one image to another. For example, if only the four corner of a door were used as features, they would work regardless of the door's position; but if points in the frame were also used, the recognition would fail if the door is opened or closed. Similarly, features located in articulated or flexible objects would typically not work if any change in their internal geometry happens between two image in the set being processed. However, in practice SIFT detects and uses a much larger number of features from the image, which reduces the contribution of the errors caused by these local variations in the average error of all features.

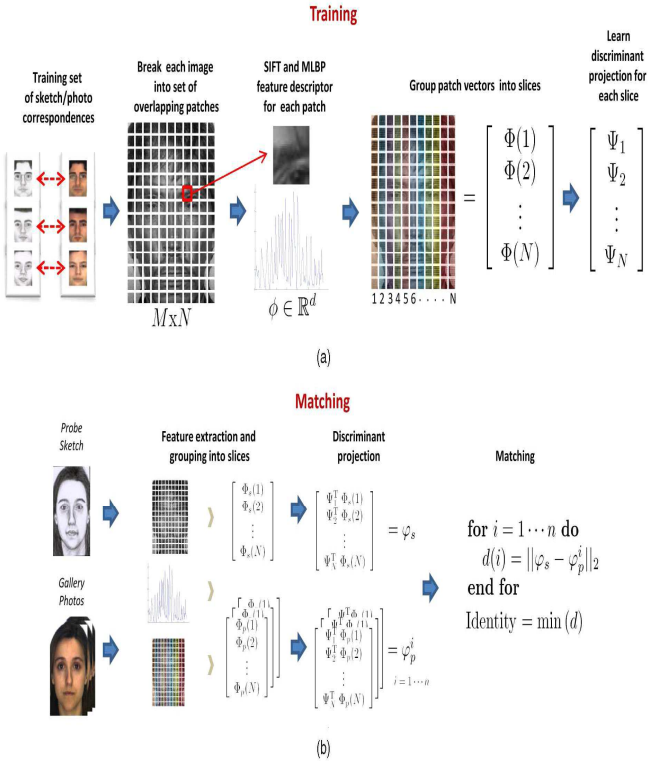

Fig:3. Photo and Sketch Face matching process

B. Local Binary Pattern(LBP)

Local descriptors have received attention in face recognition due to their robustness to scale, orientation, and speed. Local Binary Pattern is one of the widely used descriptors where texture features are computed for every pixel of the input face image. The basic methodology for LBP based face description is as follows: The facial image is divided into local regions and LBP texture descriptors are extracted from each region independently. The descriptors are then concatenated to form a global description of the face, as shown in Fig. It should be noted that when using the histogram based methods the regions do not need to be rectangular. Neither do they need to be of the same size or shape, and they do not necessarily have to cover the whole image. It is also possible to have partially overlapping regions.

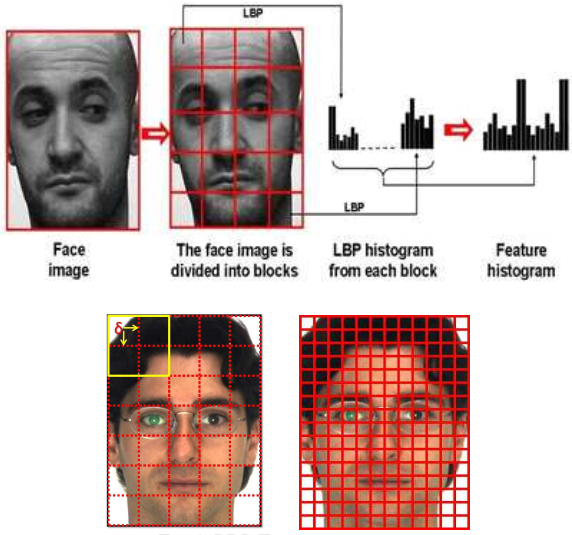

Fig:4. LBP Feature extraction

C. Weber's local Descriptor(WLD)

This descriptor is based on Weber's law and draws its motivation from both SIFT and LBP. It is similar to SIFT in computing histogram using gradient and orientation, and analogous to LBP in being computationally efficient and considering small neighbourhood regions. WLD computes the salient micro patterns.

V. CONCLUSION

The application of face sketch recognition is increasing day by day. Matching photos from sketch is a difficult problem. So many methods are developed to address this issue. We presented local descriptors, SIFT, LBP, WLD, to create distinct identity of a person. These image based feature descriptors have shown success in face recognition in the past year.

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