A Summary of Illumination and Sketch Based Face Recognition Techniques

Shivaleela. Patil
Department of Computer Science and Engineering
Godutai Engineering College for Women
Kalaburgi, India.

Dr. Shubhangi. DC
Department of Computer Science and Engineering
VTU Regional Centre
Kalaburgi, India.

*Abstract-*Face recognition has recently received significant attention especially during the past several years as it is one of the most successful applications of image analysis and understanding. The wide range of commercial and law enforcement applications, the availability of feasible technologies after 30 years of research are the reasons which account for this trend. Even though current machine recognition systems have reached a considerable level of maturity their success is limited by the conditions imposed by many real applications. If we consider face recognition with images acquired in an outdoor environment with changes in illumination remains an unsolved problem. It means that the current systems are still far away from the human prospection system capability. This paper depicts the up to date survey of illumination and sketch based face recognition research. To provide with this critical survey we not only categorize existing techniques but also give detailed descriptions of all these approaches within each category.

I.   INTRODUCTION

Person's identity is important in enormous applications. There are many different identification technologies available for the same and many of which have been in commercial use for years. It has been studied by scientists from different areas of psychophysical sciences and those from different areas of computer sciences.

In applications like authentication, security, mug shot data base and surveillance automatic face recognition has a wide scope. From day to night and also between indoor and outdoor environment the lighting conditions changes. These changes severely affect the appearance of the face. It is also used mainly in the field of biometric, access control, law enforcement and security and surveillance systems.

The major face recognition problem can be stated as: For a given still image or video of a scene identification of one or more persons face in the scene by using a stored database of faces. The main problem is classification. Classifying the newly coming test images by training the face recognition system with images from the known individuals into one of the classes is the main aspect of the face recognition system. For a human the topic seems to be easy, where if there is limited memory then there can be a main problem. The problems in machine recognition are manifold. The challenges to face during face recognition are given below:

- *Change in facial expression:* A crying face, a smiling face, a face with closed eye, a small change in the facial expression can affect face recognition system significantly.
- *Change in illumination:* Face recognition success is greatly depended on the direction where the individual in the image has been illuminated. The study on this says that the lighting the face bottom up makes face recognition a hard task.
- *Aging:*   System accuracy is seriously changed by images taken some time apart varying from 5 minutes to 5 years.
- *Rotation:* Even if the image stays frontal with the camera rotation of the individuals head clockwise or counter clock wise affects the performance of the system.
- *Change in image size:* If the original class of the image is of size 256 x 256 and test image is of size 128 x128 then the classification becomes harder.
- *Image angle:* system accuracy is changed by the angle in which the photo of the individual was taken with respect to the camera.

Since security threats are imposed weakness among the implemented security system, systems that relay on face recognition biometrics have gained great impact on security system. Other biometrics for security like fingerprints has got some issue and is not trust worthy. In these survey paper different types of existing face recognition techniques related to illumination and sketch based approach is discussed along with their pros and cons. In face recognition if the user hides their face with sun glasses or hides the face with hijab then it becomes the difficult task to recognize so we can say that face recognition is not an easy task. The various face recognition techniques used are summarized in this paper.

The face recognition system usually consists of modules for face detection and face recognition stages as shown in Figure.1. As depicted in the figure, for the input face image, pre-processing is done based on the dataset chosen. For the detected face, feature is extracted and stored in the knowledge base and then classified to a known individual if a correspondence is found. The performance of face identification is affected by several factors like facial expression, scale, pose, illumination and disguise. Three basic approaches in face recognition are:

- **Feature-based approach -** In this approach the local feature of the face elements like nose, mouth, eye etc are used for face segmentation which is given as a input for face detection block.
- **Holistic approach -** In this approach entire face image is given as an input to face detection block and output of which is fed into face recognition block.
- **Hybrid approach -** It is the combination of both holistic based approach and feature based approach. Where the local feature of the face image and the

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entire face image is given as an input to face detection block.

Illumination variation is one of the major challenging problems in any face recognition system. Usually there are two main approaches: Active approach and passive approach. Active sensing techniques to capture face images which are invariant to environment illumination are applied by active

approaches. Due to environment illumination change passive approach attempt to overcome illumination variance in face image. However matching sketches with digital face images is also one of the important law enforcement applications which have received considerable attention. In criminal investigation to suspect with mug shot gallery set hand drawn sketches are used.
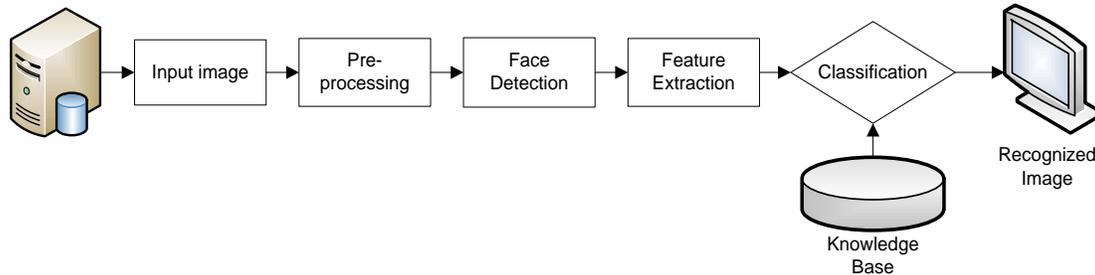

Figure 1: Block Diagram of Face Recognition System

Various face recognition methods are used to solve the problem of matching facial sketches to photograph. Sketch recognition algorithms are also classified into two categories: Discriminative and generative approaches. Discriminative approaches perform matching and feature extraction using the given digital image and sketch pair and do not generate the corresponding digital image from sketches or the sketch from digital images. On the other hand Generative approaches model a digital image in terms of sketches and then match it with the query image or vice versa. Taking this for consideration we make use of both these face recognition techniques and detailed survey for both these approaches is discussed briefly in the paper below.

II. LITERATURE SURVEY

Xiaoyang Tan et.al, [1] proposed a simple and efficient pre-processing approach that eliminates most of the effects of changing illumination keeping the essential appearance details that are needed for recognition unchanged. This paper also depicted the detail about Local ternary pattern (LTP) a generation of the local binary pattern (LBP) which is a local texture descriptor that is more discriminant and less sensitive to noise in region which is uniform and also details about to show that replacing comparisons based on local spatial histograms with a distance transform based similarity metric further improves this face recognition. Robustness is further improved by adding Kernel principal component analysis (PCA) feature extraction. Also set of experiments are performed to show that the proposed method outperforms several existing pre-processors for a range of feature sets, data sets and lighting conditions.

Lian Zhichao et.al, [2] proposed a novel illumination invariant face recognition approach which is different from existing methods. Noise as an additive term is considered in the face model under varying illuminations with multiplicative illumination term in addition to it. To eliminate the effect caused by noise high frequency coefficients of Discrete Cosine Transform (DCT) are discarded. A simple but effective

illumination invariant feature local relation map is proposed based on the local characteristics of human face.

Jiapei Zhang et.al, [3] proposed a method for single image based face recognition under varying lighting conditions. Mean while evaluation by experiments based on some representative methods as well as their combinations are done and the investigation on the underlying principle of the result is done. "Two step" framework including an illumination pre-processing and an illumination insensitive facial feature extraction is followed in the paper.

Reza Shoja Ghiass et.al, [5] described a novel method which addresses few major challenges. The major contribution of this work is to use of active appearance model (AAM) ensemble. In which each of it is specialized to a particular range of poses and a particular region of the thermal IR face space. The effectiveness of the proposed approach is elaborated by experimenting it on the largest public database of thermal IR images of faces and a newly acquired data set of thermal IR motion videos. This method has given perfect recognition performance on both data sets, significantly outperforming the current state of the art methods.

K. Meena et.al, [6] employed different techniques in this paper to enhance the face recognition rate. Different pre-processing methods like Histogram Equalization, Gamma Intensity Equalization, Normalization Chain and modified homomorphism filtering are used. They also made use of texture based models like Local binary Pattern, Local derivative pattern, Local texture Pattern and Local tetra Patterns. All these methods experimented under different lightning conditions using Yale B dataset.

P.T. Chavda et.al, [7] discussed some normalized methods to solve some common problems in face images due to varying lightning conditions. Various pre-processing techniques suggested by different authors and their results are collected. The face recognition system using Principle Component Analysis (PCA) algorithm with Euclidean distance as a

classifier is studied. This approach is experimented using Yale and ORL database.

S. S. Shylaja et.al, [9] investigated the use of five novel approaches for learning low dimensional representation of a face image using the concept of transmutation and its variants. Comparisons among the proposed algorithms have been carried out and experiments taking. Two dataset Grimace and ORL are conducted. The results justified that transmutation method outperforms its variant.

Sailee Salkar et.al, [10] proposed a novel approach which made use of local feature descriptor for face recognition. To extract the feature from the face image Local directional number pattern (LDN) descriptor is used. The approach involves dividing face image into several regions and then the LDN is computed for each region and for the sake of comparison histogram of each region is calculated. To form a feature vector all the histograms are concatenated. Hence they concluded that LDN performs the best recognition under varying illumination condition.

Himanshu S. Bhatt et.al, [11] proposed an automated algorithm that extracts information from local regions of both sketches and digital face images. Using multi scale circular Weber's local descriptor structural information along with the minute details present in local facial regions is encoded. To assign optimal weights to every local facial region to boost the identification performance an evolutionary me metric optimization is proposed.

B. Klare et.al, [12] presented a frame work called as Local Feature based discriminant analysis (LFDA). Using SIFT feature descriptors and multi scale local binary pattern (MLBP) in LFDA we individually represent both sketches and photos. For minimal distance matching multiple discriminant projections are used on partitioned vectors of the feature based representation. This method is used to match a data set containing 159 forensic sketches against a mug shot gallery containing 10,159 images.

So Ra Cho et.al, [13] proposed a new face recognition algorithm for photographs and sketches. They used eye alignment and retinex filtering to normalize pose, size and illumination to overcome the decrease in matching accuracy due to pose and illumination variation. Comparisons of performance of various face recognition methods like PCA,LSB,MCT, local non negative matrix factorization (LNMF) and support vector machine discriminant analysis (SVMDA) for the photographs and viewed sketches matching. These face recognition methods are combined on the basis of score level fusion to enhance matching accuracy. Experimental results are obtained using CUHK data set thereby overcoming the limitations of single face recognition methods.

Hu Han et.al, [14] proposed a component based representation (CBR) approach to measure the similarity between a mugshot photograph and composite sketch. Specially using an active shape model (ASM) we first automatically detect facial landmarks in composite sketches

and face photos. Using multi-scale local binary patterns (MLBPs) features are then extracted. By filtering the large gallery of mug shot images using gender information matching performance is further improved. Experimental results taking matching 123 composite sketches against two galleries with 10,123 and 1,316 mugshots show that the proposed method achieves promising performance.

M. A. A. Silva et.al, [15] proposed a work in which they deal the problem of face recognition through forensic sketches with focus on the eigen transformation method and local feature based discriminant analysis (LFDA). To synthesize a photo from a sketch, and is sensitive to gross characteristics such as face shape and skin color Eigen transformation method uses this. LFDA describe structures in the face that are relevant to face recognition using local descriptors.

Sweety Kshirsagar et.al, [16] presented a robust approach called as cascade object detection along with viola jones technique for face detection. Initially preprocessing is done in this approach to enhance sketches and digital images. SVM method is used for face sketch recognition which leads to high recognition rate and good accuracy. For feature extraction we use EUCLBP which stands for extended uniform circular linear binary pattern technique. For face detection we use cascade object detection with viola jones techniques. The elements like Face, Nose, Left eye, Right eye and Mouth along with control point of these Elements are used for detection.

Deepinder Singh et.al, [17] described a novel approach for matching facial composite sketches to police mug shot images. This approach is based on geometric feature. We focussed on face geometric features like nose, lips, eyes, eyebrows and face cutting along with their length and width ratios to recognize a facial composite. This method involves five steps such as extracting components from a composite sketch, computing ratios of length, width and area, representing component in each image as a vector. To get a set of vectors called zero mean vectors Mean of the vectors are computed and subtracted from each component vector and at the end for mug shot images in the database are searched based on a query sketch drawn by an artist.

R.Prabhu et.al, [18] proposed an approach which briefs about cross modality face reorganization problems such as sketch-photo and high-low resolution face matching. Using which major complexity of great incongruity existing between the infrared face images and corresponding optical face image are solved which is caused because they are captured by different imaging devices. To extract the common features, new learning-based face descriptor was first proposed. To obtain the final result effective matching method is then applied.

Liliang Zhang et.al, [21] proposed a novel approach for photo sketch generation aiming to automatically transform face photos into detail-preserving personal sketches. This approach takes whole of the input face image and gives corresponding sketch image as output directly aiming to

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automatically transform face photos into detail-preserving personal sketches. A discriminative regularization term is incorporated into the photo-sketch generation, enhancing the differentiability of the generated person sketches against other individuals in particular to get good accuracy and efficiency.

Table.1: Comparison of Illumination Variation Methods

Methods	Database	Accuracy	Year
LBP+LTP+PCA+ Gabor wavelets [1]	Yale-B, CAS-PEAL-R1, FRGC-204	88.1%	2010
DCT [2]	Yale B, Extended Yale B and CMU PIE	91.9%	2012
Gradient Face + LTP for uncontrolled images [3]	FRGC 2.0	87.27%	2012
Retinex + LOG (DCT) + LBP [4]	Yale B	92%	2013
LTrPs [6]	Yale B and CMU-PIE	89%	2013
PCA + Euclidian Distance [7]	ORL and Yale	80%	2014
LFD [8]	Yale B	95.13%	2014
Transmutation Method [9]	ORL	93.5%	2014

Table.2: Comparison of Different Sketch Based Methods

Methods	Database	Accuracy	Year
MCWLD [11]	CUHK and IIIT-Delhi Sketch database	91.25%	2010
CBR+ ASM+MLBP [12]	Mug-shot photographs	89.4%	2011
PCA+LBP, SVMDA+ LNMF + MCT + Score Level Fusion [13]	CUHK Face	93.396%	2012
LFDA [15]	CUHK Face	80%	2013
CBR +Component length Measurement [19]	Mug-shot photographs	78.3%	2015
Component based representation (CBR) [20]	Composite Sketches and Mug shot	80%	2015

CONCLUSION

One of the challenging as well as important recognition technique is face recognition. In this paper an extensive survey of different face recognition systems is provided. Two key problems for any face recognition system: the illumination problem and the sketch based recognition problem are discussed to solve by proposing different methods. Summarizing the overall techniques every method has pros and cons and each technique is effective with in its own area. The main purpose of this survey is to collect the information of those techniques which are useful in the face recognition

system and combining these techniques into one document so that it's helpful for those researchers they want to work further more in this area. Table 1 gives the Comparison based on illumination variation methods. Table 2 gives the Comparison of different sketch based recognition methods.

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