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A Review on Face Recognition Techniques

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***Abstract:** In spite of various biometric techniques like fingerprints, iris scan as well as hand geometry, the most efficient and more widely used one is face recognition. Face Recognition plays a major role in Biometrics. Face recognition is computer application capable of identifying or verifying a person from the image or video source. In comparison with other biometrics, the face has some main advantages such as good acceptability, low cost, and contactless acquisition. Face Recognition has received a great attention over the last few years because of it has many applications in various fields. In spite of rapid progress in this field it still has to overcome various challenges like Aging, Partial Occlusion, and Facial Expressions etc affecting the performance of the system. This paper reviews the basics of face recognition system, its recent techniques and challenges.*
***Keywords:** Biometrics, Face Recognition, illumination, Pose variation*

I. INTRODUCTION

Biometrics utilizes biological characteristics or behavioural features to recognize an individual. In real a Biometrics system is a pattern identification system that uses various patterns such as iris patterns, retina design and biological characteristics like fingerprints, facial geometry, voice recognition and hand recognition and so forth. The problem with finger print, iris palm print, speech, gaits are they need active co-operation of person while face recognition is a process does not require active co-operation of a person so without instructing the person can recognize the person. So face recognition is much more advantageous compared to the other biometrics. Among biometric modalities, face biometric systems are deployed in a large number for various security applications such as access control, surveillance and criminal identification. Face recognition has a high identification or recognition rate of greater than 90% for huge face databases with well-controlled pose and illumination conditions [1].

A facial recognition technique is an application of computer for automatically identifying or verifying a person from a digital image or a video frame from a video source.

It is the most natural means of biometric identification. The face is one of the most acceptable biometrics, and it has been the most common method of recognition that human use in their visual interactions. the problem with authentication systems based on fingerprint, voice, iris and the most recent gene structure (DNA fingerprint) has been the problem of data acquisition. for example, for fingerprint the concerned person should keep his/her finger in proper position and orientation and in case of speaker recognition the microphone should be kept in proper position and distance from the speaker. but, the method of acquiring face images is non-intrusive and thus face can be used as a biometric trait for covert (where user is unaware that he is being subjected) system. Face is a universal feature of human beings. Face recognition is important not only due to the capability of its lot of potential applications in research fields but also due to the capability of its solution which would help in solving other classification problems like object recognition [1].

The paper is organized as follows. Section II presents the basics of face recognition technology. Section III describes the face recognition techniques. Section IV describes the literature review on recent face recognition techniques. Section V presents the issues and challenges of face recognition. Section VI presents the conclusion.

II. FACE RECOGNITION TECHNOLOGY

Facial recognition is a type of biometric technology that measures and analyses the unique mix of a person's identifiable biometric facial characteristics [2]. As shown in fig1 face recognition system can be divided into three stages namely face detection, feature extraction and face recognition.

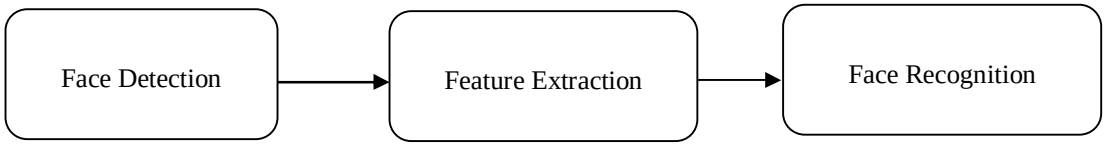

Fig1. Face Recognition Process

A. Facial detection: detecting that a face appears in an image or counting unique faces in an image or across multiple images.
B. Feature extraction: After detecting the face, we need to extract the features. After a face is normalized geometrically and photo-metrically; feature extraction is performed to provide effective information that is useful for distinguishing between faces of different persons and stable with respect to the geometrical and photometrical variations.
C. Face recognition involves authentication and identification.
D. For face matching, the extracted feature vector of the input face is matched against those of enrolled faces in the database;
E. Authentication or verification: matching the face print of a specific individual to a previously collected image of thaindividual for purposes of authenticating or verifying that person, without necessarily associating that face print with other information about the person.
F. Individual identification: comparing a face print of an anonymous individual to a reference set of previously identified individuals for purposes of identifying the individual personally.

III. FACE RECOGNITION TECHNIQUES

There are basically three approaches for face recognition: Feature base approach, Holistic approach and hybrid approach: In feature based approach the local features like nose, eyes are segmented and it can be used as input data in face detection to easier the task of face recognition, In holistic approach the whole face taken as the input in the face detection system to perform face recognition. Hybrid approach is combination of feature based and holistic approach. In this approach both local and whole face is used as the input to face detection system. Throughout the past few decades there have been many face detection techniques proposed and implemented. Some of the common methods described by the researchers of the respective fields are:

A. Principal Component Analysis

Principal Component Analysis (PCA) is a dimensionality reduction technique which is used for compression and recognition problems. It is also known as Eigenspace Projection or Karhunen-Loeve Transformation and Eigenvector Transform. Turk and Pentland used PCA exclusively for face recognition [17].PCA computes a set of subspace basis vectors for a database of face images. These basis vectors are representation of an images which is correspond to a face like structures named Eigenfaces. The projection of images in this compressed subspace allows for easy comparison of images with the images from the database.

The approach to face recognition involves the following initialization operations [17]:Acquire an initial set of N face images (training images).the M images that correspond to the highest eigenvalues. These M images define the “facespace”. As new faces are encountered, the “eigenfaces” can be updated or recalculated accordingly. Calculate the corresponding distribution in M dimensional weight space for each known individual by projecting their face images onto the “face space”. Calculate a set of weights projecting the input image to the M “eigenfaces”. Determine whether the image is a face or not by checking the closeness of the image to the “face space”. If it is close enough, classify, the weight pattern as either a known person or as an unknown based on the Euclidean distance measured. If it is close enough then cite the recognition successful and provide relevant information about the recognized face from the database which contains information about the faces [3]. Advantages of PCA are recognition is simple and efficient compared to other matching approaches. Data compression is achieved by the low dimensional subspace representation.

B. Linear Discriminant Analysis (LDA)

LDA also known as Fisher’s Discriminant Analysis, is another dimensionality reduction technique which is used for classification problems. Classical LDA projects the data onto a lower-dimensional vector space such that the ratio of the between-class distances to the within class distance is maximized, thus achieving maximum discrimination. The optimal projection (transformation) can be readily computed by applying the Eigen decomposition on the scatter matrices Linear discriminant analysis (LDA)and the related Fisher's linear discriminant are methods used in statistics, pattern recognition and machine learning to find a linear combination of features which characterize or separate two or more classes of objects or events.[4]Advantages of LDA based algorithms outperform PCA based ones, since the former optimizes the low dimensional representation of the objects with focus on the most discriminant feature extraction while the latter achieves simply object reconstruction[4].

C. Independent Component Analysis (ICA)

It is a statistical method for transforming an observed multidimensional random vector into its components that are statistically as independent from each other as possible. ICA is a special case of redundancy reduction technique and it represents the data in terms of statistically independent variables. [5]

D. Neural Network Approach

The Back Propagation Network (BPN) is the best known and widely used learning algorithm in training multilayer perceptron (MLP). The MLP refer to the network consisting of a set of sensory units (source nodes) that constitute the input layer, one or more hidden layers of computation nodes, and an output layer of computation nodes. The input signal propagates through the network in a forward direction, from left to right and on a layer-by-layer basis [6]. This BPNN provide a computationally efficient method for changing the weights in feed forward network, with differentiable activation function units, to learn a training set of input-output data.

E. Support Vector Machines

Support Vector Machines (SVM) are one among the most useful techniques in classification issues. One clear example is face recognition. However, SVM cannot be applied once the feature vectors defining samples have missing entries. A classification algorithm that has been implemented efficiently used in this framework id the all-known support Vector Machines (SVM), which may be applied to the initial look space or a subspace of it obtained when applying a feature extraction technique. The advantage of SVM classifier over ancient neural network is that SVMs are able to do higher generalization performance [7].

F. Multi Dimensional Scaling

Face Recognition by Multidimensional Scaling (MDS) which is useful in reducing feature vector size and there Computation time. MDS transform the biometric based data using Gram Matrix which compute linear independent an if and only if the gram determinant (the determinant of gram matrix)is non-zero. Face Recognition rate of Multidimensional Scaling is more than Principal Component Analysis and Random Projection Method. It also Preserves Privacy of users [8].

IV. RECENT APPROACHES

Some of the recent approaches used for face recognition are discussed in this section.

Zheng Xiang et al.[10] presented a face recognition method based on dense grid histograms of oriented gradients. In this method, the HOG features are extracted based on non-overlapped dense grid face images, and the performances of face recognition under different parameters are analyzed. First, the face image is divided by numerous dense grids from which the HOG features are extracted. Then, all the grid HOG feature vectors are composed to realize the feature expression of the whole face, and the nearest neighbor classifier is used for recognition. According to the proposed algorithm the face recognition method based on the dense grid HOG feature has better recognition performance than the LBP. Moreover, the computational complexity is simpler than the Gabor wavelet.

Salima Nebti et.al [11]: proposed a method to improve the face recognition accuracy through a combination of two classifiers: SVM and HMM. The former is used with the features of PCA, while the latter is a one-dimensional model in seven states wherein features are based on the singular value decomposition (SVD). This approach uses these combination rules for merging the outputs of SVM and HMM. It was successful with a 100% recognition rate for the ORL database.

Sang-Il Choi et.al.[12]. proposed a method to construct a composite feature vector for face recognition based on discriminant analysis. For this purpose, the holistic and local features were extracted from the whole and sub-images of a face by using NLDA. Then, the amount of discriminative information contained in each extracted feature was measured by discriminant analysis and the composite features consisting of features rich in discriminative information were employed for face recognition. The face recognition performance was evaluated with images obtained from the FERET database, CMU-PIE database ,Yale B database, and AR database.

Motahareh Taheri[13] proposed an effective face recognition rate under various illumination, pose, and facial expression based on the nonlinearCF bank (NCFB). The non-linearity of the CF is achieved by transforming image pixels according to the sigmoid function which extended the uniform dynamic range for enhancing the image contrast. Images are divided into non-overlapping regions and CFs are designed based on the UMACE filter corresponding to each sub-region. This fact makes this method not sensitive to appearance variations. The advantage of this method is accuracy. The disadvantage is that it requires more computational power.

Chihaoui et.al [14]: proposed a hybrid approach called HMM-LBP permitting the classification of a 2Dface image by using the LBP tool (local binary pattern) for feature extraction. It consists of four steps. First, decompose the face image into blocks. Then, features are extracted using LBP. After that, it calculates probabilities. Finally, it selects the maximum probability.

Gao, Y.; Lee, H.J. [15] described affine local descriptors and probabilistic similarity technique which combines the affine transform of invariant features SIFT with probabilistic similarity under a great change of perspective. The affine SIFT, an extension of SIFT

that detects local invariant descriptors, generates a series of different views using the affine transformation. In this context, it allows a difference of views between the face image of the "gallery", the "probe" and the face of the probe. However, the human face is not flat because it contains important 3D depth. Obviously, this approach is not suitable for large pose variation.

V. ISSUES AND CHALLENGES

A. Illumination

The difference between two images of the same person taken under varying illumination is greater than the difference between the images of two different persons under same illumination.

Fig 2: Variation in illumination [16]

B. Pose Variations

Pose variation in an image is also a matter of concern in face recognition as shown in figure 3. The changes in the posture strike a serious problem for the identification of the input image. This is because the available image in the database may have only the frontal view of the face which may differ. People pose differently every time they take a picture. There is no standard similar pose. So this makes it difficult to distinguish and recognize the faces from images with varying poses.

Fig 3: Variation in Pose [17]

C. Ageing

Variation in lighting, pose, and expression, which can be controlled during face image acquisition. Aging is an unavoidable natural process during the lifespan of a person. Compared with other facial variations, aging effects has three unique characteristics:

Fig 4. Aging Variations [18]

1) *The aging progress is uncontrollable:* It cannot be advanced or delayed and it is slow and irreversible.
2) *Personalized aging patterns:* Every people have different aging effect. The aging pattern of each person depends on his/her genes as well as many external factors, such as health, lifestyle, weather conditions, etc
3) *The aging patterns depend on time:* The face status at a particular age will affect all older faces, but will not affect those younger ones.

D. Occlusion

The unavailability of the whole input face is also one of the important challenges as shown in figure 5. This is when some parts of the face are missing for e.g. when an image is captured from a surveillance camera; the face in the image lacks some parts. This is also possible due to glasses, beard, moustache, scarf, etc. Such a problem can severely affect the classification process.

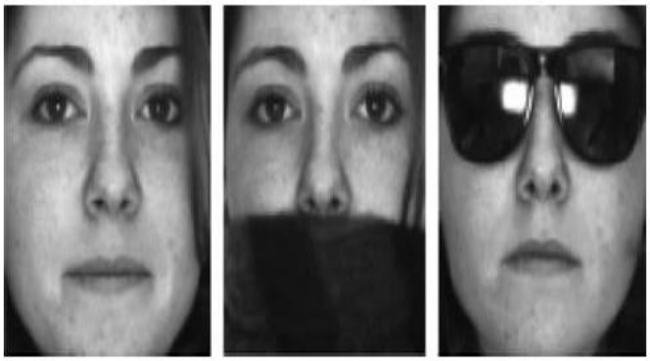

Fig.5: Partial Occlusion [19]

E. Facial expression

Face is one of the most important human's biometrics which due to its unique characteristics plays a major role in conveying human identity and emotion. Because of these emotions human mood varies and results indifferent facial expressions. With this make-up and hairstyle also changes the facial expressions. These differences in facial expressions change the appearance of the face and it becomes difficult for a Face Recognition System to match the accurate face stored in the database.

Fig 6: Expression[20]

F. Low resolution

The images taken from a surveillance camera generally consists of very small face area and so its resolution is very low i.e. it will be smaller than 16 × 16 pixels. Such a low resolution face image consists of very limited information as most of the details are lost. This can drop down the recognition rate drastically.

VI. CONCLUSION

The human face is the most reliable biometric modality owing to its unique characteristic. It has been used in large scale applications for identifying millions of authentic users. Face recognition is a both challenging and important recognition technique. Among all the biometric techniques, face recognition approach possesses one great advantage, which is its user-friendliness (or non-intrusiveness). The effort is being made to present review of the face recognition, as it is active research area due to its several benefits. Face recognition is taking place in many sectors nowadays because it works well under constrained conditions. However, there can be many advances in this direction because there are vast scopes of improvement and development. This study will hopefully motivate future researchers to come up with smarter and more robust face recognition system.

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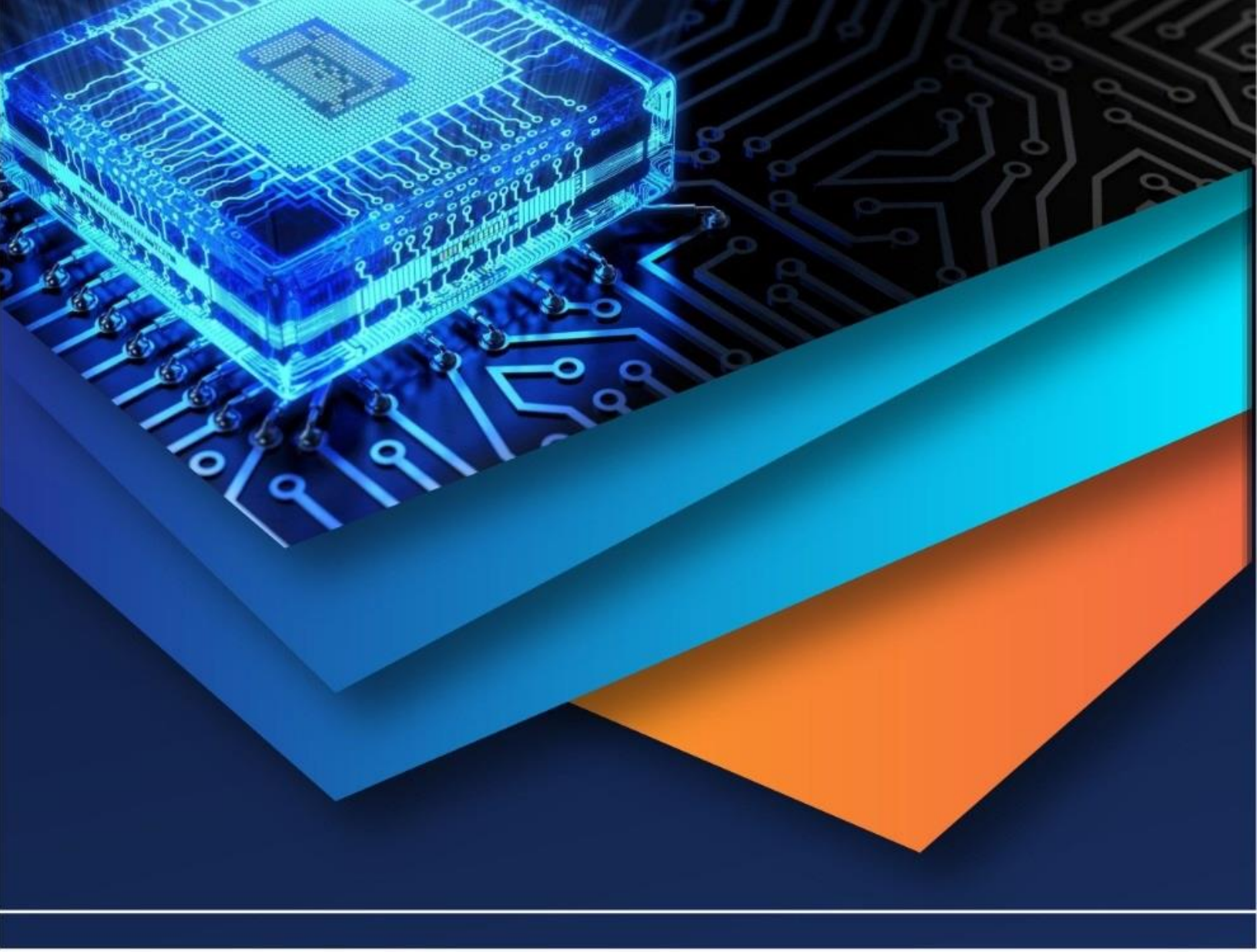

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