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Overview of Multiple Face Model Recognition Techniques

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ABSTRACT: *A facial recognition system is one of the biometric application for automatically identifying or verifying a person from a digital image or a video frame from a video source. It is one of the way of doing comparison from selected facial features from the face image and face database. Mostly it is used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems. Face recognition technology is the least intrusive and fastest biometric technology. It works with the most obvious individual identifier the human face. It measures the overall facial structure, including distances between eyes, nose, mouth, and jaw edges. These measurements are retained in a database and used as a comparison. Face recognition can be largely classified into two different classes of approaches, the local feature-based method and the global feature-based method. Human faces can be characterized both on the basis of local as well as of global features global features are easier to capture they are generally less discriminative than localized features local features on the face can be highly discriminative, but may suffer for local changes in the facial appearance or partial face occlusion. In this survey paper, an overview of some of the Multi-view face recognition methods in each of these categories is provided and some of the benefits and drawbacks of the methods mentioned therein are examined.*

KEYWORDS*: Face Recognition, Human Recognition, Biometrics, Multi-view face recognition.*

I. INTRODUCTION

Image processing is widely used in many applications, including medical imaging, industrial manufacturing, and security systems, face recognition, human recognition, figure print recognition in cyber crime, military application, and medical diagnosis. Now days we need to maintain global security Information, in every organization or individual wants to improve their existing security system. Most of the people need better security system which gives complete security solution. From time to time we hear about the crimes of credit card fraud, computer break-in by hackers, or security breaches in company, in shops, in government buildings. In most of these crimes the criminals were taking advantage of that hacking the information from commercial or academic access control system. The systems do not grant access by who we are, but by what we have, such as ID cards, keys, passwords, PIN numbers. These means they are really defining us or they just want to authenticate us. It goes without Permission of owner's, duplicates, or acquires these identity means, he or she will be able to access our data or our personal property any time they want. Recently, technology became available to allow verification of true individual identity. This technology is based in a field called "biometrics". Biometrics is a technique for identifying people by using a unique physiological characteristic, such as a fingerprint, eye, face, etc. or behavioral characteristics, e.g., voice and signature etc. Biometrics is the use of computers to recognize people, considering all of the across-individual similarities and within-individual variations. Among the various biometric ID methods, the physiological methods such as fingerprint, face, DNA are more stable than methods in behavioral category like keystroke, voice print etc.. Face recognition is one of the biometric methods that to have the merits of both high accuracy and low intrusiveness. It has the accuracy of a physiological approach without being intrusive. For this reason, the face recognition has drawn the attention of researchers in fields from security, Psychology, and image processing, to computer vision. Many algorithms have been proposed for face recognition, Face recognition has also proven useful in other multimedia information processing areas. Facial recognition analyzes the characteristics of a person's face images input through a digital video camera or online face capturing.

In this paper, the section II gives Structure and Procedure of Face Recognition System, section III gives Literature Survey of Face Recognition Techniques and section IV gives the conclusion and future scope for the paper.

II. STRUCTURE AND PROCEDURE OF FACE RECOGNITION SYSTEM

Generally separate the face recognition procedure into three steps: Face Detection, Feature Extraction, and Face Recognition [1].

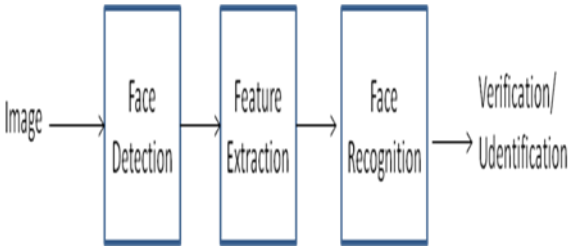

Fig 1 Architecture of face recognition system [1]

As shown in fig 1 the first task of the face recognition system is capturing image by video or by camera and this image is given to the further step of face recognition system that is:

Face Detection:

The main function of this step is to determine whether the human faces appear in given image or not and where the face is located at. The outputs of this step are patches containing each face in the input image, face alignment are performed to justify the scales and orientations of these patches. These step is working as the preprocessing for face recognition, face detection could be used for region of interest detection, retargeting, video and image classification, etc.

Feature Extraction:

In this step feature extractions are performed to do information packing, dimension reduction, salience extraction, and noise cleaning. After this step, a face patch is usually transformed into a vector with fixed dimension or a set of fiducial points and their corresponding locations.

Face Recognition:

Feature extraction step analyzes the representation of each face; this last step is used to recognize the identities of these faces. In order to achieve automatic recognition, a face database is required to build. For each person, several images are taken and their features are extracted and stored in the database. Then when an input face image comes in, then perform face detection and feature extraction, and compare its feature to each face class stored in the database. There have been many researches and algorithms proposed to deal with this classification problem. There are two general applications of face recognition, one is called identification and another one is called verification. Face identification means given a face image, can be used to determine a person's identity even without his knowledge or consent. While in face verification, given a face image and a guess of the identification, the system must to tell about the true or false about the guess. Face recognition can be largely classified into two different classes of approaches, the local feature-based method and the global feature-based method. The Human faces can be characterized both on the basis of local as well as of global features global features are easier to capture they are generally less discriminative than localized features local features on the face can be highly discriminative, but may suffer for local changes in the facial appearance or partial face occlusion. Now a day's face recognition system is recognize the face using multiple-views of faces, these Multi-view face recognition techniques has proposed by some authors for detecting each view of face such as left, right, front, top, and bottom using some methods like, PCA[2] , Elastic Bunch Graph Matching [3], Neural Network[4], Support Vector Machine[5], Spherical Harmonic Representation[6], Class-based, image-based, rerendering and recognition method[7],

Self-quotient image (SQI) method[8], Hybrid PCA-correlation filter Method[9], Min-Max and Z-score methods by a simple sum of score fusion[10], Class-Dependence feature analysis(CFA)[11], Kernel Discriminative Common Vector method, Gabor wavelets and Local Binary Patterns (LBP)[12], score fusion techniques[13], Color Image Discriminant(CID)model[14], Color information with the following three-fold contributions: RC r Q color space, RGB, YC b C *YIQ* color spaces[15], Fisher's linear discriminant (FLD)[16], Haar-like Features for Visual Tracking[17], a novel illumination-insensitive preprocessing method[18], PCA, LDA, DWT+LDA algorithms[19] etc.The method proposed by Matthew Turk and Alex Pentland[2] suggest that, the PCA method works better on noise reduction and image compression but there are some issues in this method that is it has difficulty in modifying and evaluation of face parts and also there is a problem of recognizing the faces under different illumination condition.

Some of these issues are solve by Elastic Bunch Graph Matching method suggested by Laurenz Wiskott[3]. This method can easily evaluate the face parts using graph structure but there is problem of face recognition accuracy, landmark localization of faces and performance of algorithm is poor . These issues are solved by Neural Network (NN) method proposed by Henry A. Rowley [4]. NN detects the upright, frontal views of faces in grayscale images, and decides whether the each window contains face or not. To estimate the faces from large database is a difficult task for NN and that affects to decrease the performance of face recognition. Using this method some the limitation of Elastic Bunch graph matching method is resolved such as accuracy problem. Still there is one issue in NN method that is performance of the face recognition which is improve in Support Vector Machine and Eigenface combine method proposed by Yongmin Li, Shaogang Gong, Jamie Sherrah and Heather Lidde[5] and computational time is also improve. Some problem of PCA method is discussed in this method such as pose estimation. But still there is one limitation that is accuracy problem and face recognition under different illumination condition. These problems are solved by color based; image based re-rendering recognition which is proposed by Ravi Ramamoorthi and Pat Hanrahan[6] and Amnon Shashua and Tammy Riklin-Raviv[7] .

This method is has problem of pose variation and that is solve by SVM method, But this method does not work well when large number of database is used for face recognition. This problem problem is solved by Hybrid-PCA method suggested by M. Savvides, B. Kumar, and P. Khosla[9], which works better when large database is consider for face recognition, this method is also work on partial faces, as well as illumination condition but the accuracy of recognizing faces is somewhat poor. This accuracy problem is slightly resolved in elastic bunch graph matching method. And the Problem of NN method that also occur in Kernel based face recognition method suggested by Xiaoyang Tan and Bill Triggs[12],these problem of additional feature set resolve in likelihood ratio based score fusion technique which is proposed by Karthik Nandakumar[13], which increase the recognition rate without need of additional parameters. Some of these methods works only on local features of face image, but the Fisher Linear Discremenant method suggested by Yu Su, Shiguang Shan, X. Chen, and W. Gao[16],works on both the features like local and global features of face image, but the problem of illumination condition is not solve using this method. This problem is solve by Hybrid Fourier feature method suggested by Wonjun Hwang, Haitao Wang, Hyunwoo Kim[18], This method works well on different illumination condition, works only in frequency domain. Because of this reason the computation time is increase for extracting the features from face. And this also effects on efficient face recognition performance. All this methods are discussed in below section.

III. SURVEY OF FACE RECOGNITION TECHNIQUES

The methods for face recognition system have discussed below. Each and every method has some advantages and disadvantages. The work on the developing more efficient face recognition method is focus of many researchers.

A. Principle Component Analysis (PCA)

Matthew Turk and Alex Pentland[2] has proposed, The Principal Component Analysis (PCA) is one of the most successful techniques that have been used in image recognition and compression. PCA is a statistical method. The purpose of PCA is to reduce the large dimensionality of the data space to the smaller intrinsic dimensionality of feature space, the jobs of PCA can do are prediction, redundancy removal, feature extraction, data compression, etc. Because PCA is a classical technique which can do something in the linear domain, applications having linear models are suitable, such as signal processing, image processing, system and control theory, communications, etc.

The Image Recognizer class applies PCA on each image, the results of which will be an array of Eigen values that a Neural Network can be trained to recognize. PCA is a commonly used method of object recognition as its results. The method of which PCA is applied can vary at different stages so what will be demonstrated is a clear method for PCA application that can be follows as, This capture data is simple and makes the calculation of our covariance matrix now this is not the subtraction of the overall mean from each of our values as for the subtraction of the mean of each row from each element in that row, simultaneously the mean of each column from each element in the column. This would adjust the way how to calculate the covariance matrix. After calculating the covariance matrix calculate the Eigen vectors and Eigen values from the covariance Matrix. Eigen values are found by multiples of the covariance matrix by a vector in 2 dimensional spaces. The Eigen value is closely related to the Eigenvector used and is the value of which the original vector was scaled. Once Eigenvectors are found from the covariance matrix, the next step is to order them by Eigenvalue, highest to lowest. Here the data can be compressed and the weaker vectors are removed and producing a lossy compression method.

The final stage in PCA is to take the transpose of the feature vector matrix and multiply it on the left of the transposed matrix and adjusted the data set. The Image Recognizer class performs all of this and then feeds the transposed data as a training set into a Neural Network. When it is passed an image to recognize it performs PCA and compares the generated Eigen values and Eigenvectors to the ones from the training set the Neural Network then produces a match if one has been found or a negative match if no match is found [2].

B. Elastic Bunch Graph matching

Elastic bunch graph matching method has been proposed by Laurenz Wiskott [3]. This technique is based on Dynamic Link Structures. A graph for an individual face is generated as follows: first step is any one pixel is chosen from face and that is considered as fudical point of face after that a set of neighbour points on the face are chosen. Each neighbour point is a node of a full connected graph, and is labelled with the Gabor filters' .Each arch is labelled with the distance between the correspondent neighbour points. A representative set of such graphs is combined into a stack like structure, called a face bunch graph. Once the system has a face bunch graph, graphs for new face images can then be generated automatically by Elastic Bunch Graph Matching. Recognition of a new face image is performed by comparing its image graph to those of all the known face images and picking the one with the highest similarity value.

C. Neural Network

A neural network-based algorithm is proposed by Henry A. Rowley[4] to detect upright, frontal views of faces in grayscale images. The algorithm works by applying one or more neural networks directly to portions of the input image and arbitrating their results. Each network is trained to output the presence or absence of a face. Unlike face recognition, in which the classes to be discriminated are different faces, the two classes to be discriminated in face detection are images containing faces and images not containing faces. Face detection using neural network having two stages: It first applies a set of neural network-based filters to an image and then uses an arbitrator to combine the outputs. The filters examine each location in the image at several scales, looking for locations that might contain a face. The arbitrator then merges detections from individual filters and eliminates overlapping detections. The raw output from a single network will contain a number of false detections. As the number of face data is increase the performance of detecting the face is decreases.

D. Support Vector Machine

Yongmin Li, Shaogang Gong, Jamie Sherrah and Heather Lidde[5] proposed support vector machine and Eigenspace modeling method, which combines three methods such as the eigenface method, the Support Vector Machine (SVM) based method, and a combination of the two methods, are investigated. The eigenface method, which seeks to estimate the overall probability distribution of patterns to be recognized the SVM-based method only models the boundary between faces and non-faces. By solving a quadratic programming problem, the SVM-based method is guaranteed to converge to the global optimum. Then the solution is expressed directly by a subset of important training examples called Support Vector. The combined method can achieve an improved performance by speeding up the computation and keeping the accuracy to a preset level. It can be used to automatically detect and track faces in face verification and identification systems. The whole process consists of a coarse detection phase by the eigenface method followed by a fine SVM phase. In the first phase, the probability density of each class is estimated as simply as possible. Unlike the eigenface model, then the two threshold values are considered, a rejection threshold and an acceptance threshold are defined. For a test sample pattern, if the value of confidence given by Equation is less than rejection threshold, it is rejected as a negative example. If the value is larger than acceptance threshold, it is accepted as positive. If the value falls between rejection threshold and acceptance threshold, it is considered as ambiguous and left to the SVM classifier in the next phase. The SVM method is the most accurate in terms of error in detection scale and location, but also the slowest. The eigenface method is the fastest, but less accurate.

E. Class-based, image-based, re-rendering and recognition method

Class-based, image-based re-rendering and recognition method is proposed by Ravi Ramamoorthi and Pat Hanrahan[6] and Amnon Shashua and Tammy Riklin-Raviv[7] , Here the discussion about the problem of class-based image-based recognition and rendering with varying illumination. The rendering problem is defined as, the given a single input image of an object, and a sample of images with varying illumination conditions of other objects of the same general class, re-render the input image to simulate new illumination conditions. The class-based recognition problem is similarly defined as a given a single image of an object in a database of images of other objects, some of them are multiply sampled under varying illumination, identify and match any novel image of that object under varying illumination with the single image of that object in the database. Also focus on Lambertian surface classes and in particular the class of human faces. The result in this approach is based on a definition of an illumination invariant signature image which generates the image space with varying

illumination show that a small database of images in these method as few as two images are sufficient for generating the image space with varying illumination of any new image of the class from a single input image of that image.

F. Hybrid PCA-correlation filters Method

Hybrid PCA-correlation filters method is proposed by M. Savvides, B. Kumar, and P. Khosla[9], This novel method is proposed for performing robust illumination tolerant face recognition. This method works well when partial faces are also captured and tested under uncontrolled illumination. A hybrid PCA correlation filter which links the best of two major approaches in face recognition: Principal Component Analysis (PCA) for capturing the variability in a set of training images and advanced correlation filters which have attractive features such as illumination tolerance, shift-invariance, and can handle occlusions. These is method called as 'Corefaces' it shows the 'core' face representation that remains relatively invariant to illumination variations. Coreface means selecting one of the calculated eigenvaleue of image. By using PCA method simply compute the sum-squared error between the reconstructed test sample and the actual sample. After that considering smaller the error, it considers more likely this sample and belongs to the class label of the subspace. This classification metric is use to overcome the errors, [11]. In the frequency domain, each shift takes the form of a linear phase and another term added at each frequency, it produces a very misleading reconstruction error. Therefore to do this another measure have been used to examine how well this phase spectrum is reconstructed; this is done by simply multiplying the conjugate of the reconstructed phase spectrum with the of phase spectrum of the test image. All the phases should cancel out if the reconstructed phase spectrum is identical to the test phase spectrum, resulting in a constant flat spectrum or a pure linear phase term if the input image is shifted. After that taking the inverse fourier transform of image the correlation output for sharp peaks are looking, and the location of the peak will shift depending in the shift of the input image shift. The sharpness of the peak is a direct indicates that how well the reconstructed phase spectrum matched the phase spectrum of the test image. But the limitation of this method that it does not handle the pose variation.

G. Kernel Discriminative Common Vector method

Xiaoyang Tan and Bill Triggs[12] has proposed, The Kernel Discriminative Common Vector method, Gabor wavelets and Local Binary Patterns (LBP),In this method combing the two local appearance descriptor Gabor wavelets and Local Binary Patterns (LBP). LBP is basically a fine scale descriptor that captures small texture details. Local spatial invariance is achieved by performing local histogram on the resulted texture codes. LBP is a good for coding fine details of facial appearance and texture. And Gabor features encode facial shape and appearance information over a range of coarser scales although they have also been used as a preprocessing stage for LBP feature extraction. First the face image is captured, and its Gabor and LBP representations are extracted, projected into their PCA subspaces, it normalized separately and integrated into a combined feature vector, which is then projected into the optimal discriminant space, after that the optimal projection matrix is calculated and each training vector entry is mapped into training samples. The projected test feature vector test is then classified using the nearest neighbor rule and the cosine distance where template is a face template in the gallery set. Other similarity metrics such as Mahalanobis distances could be used, but found that the cosine distance and performed best among the metrics it tested on this database. Both methods give more information and computational efficiency is good. But neither scalable to large numbers of individuals nor easy to extend to additional feature sets.

H. Likelihood Ratio Based Biometric Score Fusion

Likelihood Ratio Based Biometric Score Fusion is proposed by Karthik Nandakumar[13], The combination of match scores that is based on the Likelihood ratio test. Fusion can be performed at four different levels of information, namely, sensor, feature, match score, and decision levels. Score level fusion is generally preferred because it offers the best trade-off in terms of the information content and the free in fusion. Combining match scores is a difficult task because the scores of different matchers can be either distance or similarity measure; it follows different probability distributions, or provides different accuracies and may be correlated. Score fusion techniques can be divided into the three categories: Transformation-based score fusion, classifier-based score fusion, Density based score fusion. The match scores are first normalized to a common domain and then combined. This approach is based on the likelihood ratio test and it requires explicit estimation of genuine and impostor match score densities. the finite Gaussian mixture model(GMM) is quite effective in modeling the genuine and impostor score densities, fusion based on the resulting density estimates achieves consistently high performance.

I. Fisher's linear discriminant (FLD)

Fisher Linear Discriminant method has been proposed by Yu Su, Shiguang Shan, X. Chen, and W. Gao[16], It is a novel face recognition method which works on both global and local discriminative features. In this method, global features are extracted from the whole face images by keeping the low-frequency coefficients of Fourier transform, which encodes the holistic facial information, such as facial contour. For local feature extraction, Gabor wavelets are exploited considering their biological relevance. After that, Fisher's linear discriminant(FLD) is separately applied to the global Fourier features and each local patch of Gabor features. After that multiple FLD classifiers are obtained, each classifier works on different facial evidences for face recognition. Finally, all these classifiers are combined to form a hierarchical ensemble classifier. ensemble is applied in two stages: the combination of the local classifiers and the combination of the global and local classifiers. After that the Gabor + FLD method is used for face recognition. Gabor wavelet and FLD have been recognized as two valuable pearls for face recognition. But the Global feature extraction is not that much effective for face recognition.

J. Haar like features

Haar like features method is proposed by Seunghoon Park, Bohyung Han[17], This method has describes the detection and reorganization of faces under different pose and real-time base on haar-like features. The input image is capture across the different locations and scale using a scaling factor .At each location an independent decision is made regarding the presence of a face. This discuss about very large number of classifier are evaluated. Each classifier is having function made up of rectangular sums followed by the threshold values. In each round one feature is selected, that with the lowest weight error. The final classifier is assign using the confidence rated procedure. In every round the incorrectly labeled examples are given a higher weight and correctly labeled examples are given a lower weight. After achieving very low false positive rate, a large number of examples are required. To remove that haar basis function uses rectangle features, each rectangle feature is binary threshold function which is constructed from some threshold value and rectangle filter which is linear function of the image. There are different rectangular functions are used such as two-rectangular filter, three-rectangular filter, four-rectangular filter using that filters they calculate the different classifiers. After detection of faces, each person face should be train in face recognition step and face size for training is chosen, then using one person face under different conditions as positive sample and other persons' faces as negative sample. In face recognition step here they consider only detected face region of complete picture. To decrease the false positive rate, the threshold of final classifier is increased. This automatically reduces the recognition rate and to increase the recognition rate classifier layers are removed from . This is done simultaneously for all the classification stages of the recognition system.

K. Hybrid Fourier Feature

Wonjun Hwang, Haitao Wang, Hyunwoo Kim[18] has proposed, Hybrid fourier feature based system, In this method the hybridization of three different methods are done such as in preprocessing method they have used Integrated Normalize gradient Image(INGI) algorithm, for feature extraction **a** hybrid Fourier-based is used, and for face recognition a score fusion scheme is used. **I**n the preprocessing stage, a face image is transformed into an illumination-insensitive image, called an "integral normalized gradient image," by normalizing and integrating the smoothed gradients of a facial image, and removes the uncontrolled illumination from the image. After that in feature extraction of complementary classifiers, multiple face models based upon hybrid Fourier features are applied. The hybrid Fourier features are extracted from different Fourier domains in different frequency bandwidths and then each feature is individually classified by linear discriminant analysis. In addition, multiple face models are generated by plural normalized face images that have different eye distances. This feature extraction framework is introduced in order to remove unnecessary frequency parts as the occasion demands for face recognition. There are three types of Fourier feature domain, concatenated real and imaginary components, Fourier spectrums, and the phase angle, are represented. Three different frequency bandwidths are also designed to extract more complementary frequency features, for those complementary features random sampling of feature vectors and training samples are provided after getting complementary classifiers, a unified classifier combining these complementary classifiers. The purpose of combining classifier is to construct a strong classifier by combining the suitable a set of classifiers. Combining the classifiers can be achieved by processing the set of scores produced by component classifiers and generating a new single score value this process is called score fusion Finally, to combine scores from multiple complementary classifiers, a log likelihood ratio-based score fusion schemes applied [17][18].

The above discussed methods have some limitations which have solved by many researchers, but there are still some other issues in face recognition like computational time and efficiency of recognizing the faces from large databases. Also, to overcome the problem of uncontrolled environmental problem, a hybrid DWT (Discrete Wavelet Transform) will be used for feature extraction which reduces the computational complexity,

because work in both frequency and time domain, DWTs also have higher flexibility, better compression ratio and performance, This approach combines multiple classifiers with complementary features instead of improving the accuracy of a single classifier. Illumination insensitive preprocessing and density based score fusion technique is combine into the proposed face recognition system which will give efficient face recognition performance.

IV. CONCLUSION

Face recognition is a challenging and important recognition technique, among all the biometric techniques. The computational time, accuracy and the performance of the face recognition system under uncontrolled illumination with different posses is important issue in multiple face model recognition system. The various methods and issues in multiple face model recognition are discussed in this paper. There is need of efficient method for face recognition system which will reduce computational time and increase efficiency.

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