Face Recognition System by Integrating PCA, FLDA, Artificial Neural Networks and Minimum Euclidean Distance

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***Abstract*— Intensive works has been performed over the topic of face recognition from the subject of computer vision and pattern recognition .Face recognition system works on the clue of the face geometry. Over several facial expressions; face recognition system gets an argumentative effect on the recognition process.**

Principal Component Analysis is being utilized as the most common feature extraction techniques in Face Recognition. It has been extensively employed for face identification. The face recognition system functions by projecting face image onto a characteristic space .The Most commonly each face recognition system uses one algorithm for feature extraction, but here it uses the combined techniques to achieve the maximum accuracy in the results. Principal Component Analysis and Fisher Linear Discriminant Algorithm are used for feature extraction. Images could be identified by the Artificial Neural Network and Minimum Euclidian Distance.

Keywords*— Principal Component Analysis, Fisher Linear Discriminant Algorithm, Artificial Neural Network, Minimum Euclidian Distance

I. INTRODUCTION

Biometrics based human computer interfaces are widely being used for the security and the access control. Face recognition system is one of the biometric HCI systems. Biometric system recognizes the individuals by identifying their physical or behavioral manners, like fingerprint, eye or face. The scope of this system varies in the public and private sectors [12]. Further development in these systems leads into the innovation of the surveillance technology. Face recognition system make a distinction among various human faces and detects a face from an image or a video source.

This paper is designed to identify the individual using dual image face recognition system using PCA, FLDA, ANN and MED. It's quite challenging task that all information needs to be separated from the key face attributes. A natural observation finds that under different circumstances one's expressions and skin texture is moderately variant .It results in obvious change of face geometry. Citing an example yawning mouth can change the face with the prolong skin.

Face recognitions is done by comparing the selected facial features of the image with those in the available database. Feature extraction system ignores all the details other than the face. The face recognition system extracts all the basic features of the face and matches them with the available database to identify the individual.

Fig. 1 shows flow of face recognition system.

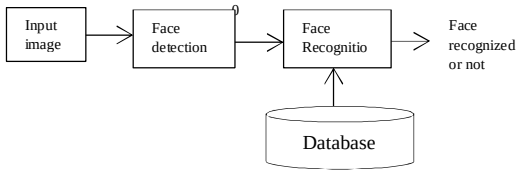

Fig. 1 Face recognition system

II. EXISTING SYSTEM

Face recognition system is always a study about the identification of face using machines. It's a common task that human beings do with ease throughout the lives. A face recognition system has the ability to identify the face automatically from the images and videos with the help of computers .And its matters with face feature extraction with the help of face geometry. Face recognition go through various stages of process such as Face detection, Facial feature extraction, and classification. Detection stage finds the information about scale of each detected face. Feature extraction is based on extracting feature vectors from the basic parts of a face such as eyes, nose, mouth, and chin, with the help of deformable templates and extensive mathematics. Then key information from the basic parts of face is gathered and converted into a feature vector. Face classification is all about the matching the distinguished input face image with the extracted features in the enrolled database. When a match is found the output would be shown otherwise could be displayed as unknown or not found in database.

Based on various applications face identification system could be working either on identification as the name implies or on verification mode. The introduced system recognizes the individual by matching the input images against the enrolled users in the database. And it finds the best match and could be provided as the result. In a face verification system a user claims an identity and the recognition system accepts or rejects the image against the matching identity which is stored either in a database or in a smart card .Face identification rather be explained like one image to many comparison and helps to find the answer " who is in the input image ? " If she is enrolled in database, but in the face verification its one to one comparison to find the answer "whether claimed identity belongs to him/her?"

The extensive method for feature extraction is Principal component analysis, based on the information theory concepts. In this method, information that best describes a face is derived from the entire face image. Based on the Karhunen-Loeve [2] expansion in pattern recognition, any particular face can be represented in terms of a best coordinate system termed as "eigenfaces". These are the eigen functions of the average covariance of the ensemble of faces. Later, Turk and Pentland [1] proposed a face recognition method based on the eigenfaces approach. An unsupervised pattern recognition scheme is proposed in this paper which is independent of excessive geometry and computation. Recognition system is implemented based on eigenface, PCA and ANN. Principal Component analysis for face recognition is based on the information theory approach in which the relevant information in a face image is extracted as efficiently as possible. Further Artificial Neural Network was used for classification.

At a time, all these face recognition systems using only one method for feature extraction and face recognition. Although it is successful in many cases, it fails to deliver good performance when face patterns are subject to large variations in viewpoints. And also the system's efficiency is poor.

III. PROPOSED SYSTEM

The proposed system aims to implement face recognition system with combined use of feature extraction and recognition methods. The system uses Principal Component Analysis and Fisher's Linear Discriminant Algorithm as two different feature extraction techniques and Minimum Euclidean Distance and Artificial Neural Networks as recognition systems. It then presents a comparison of all the four methodologies on a smaller database and aims to draw a conclusion as to which methodology is the more suitable techonology for the proposed database. When neural networks are aggregated with some other feature extraction algorithm such as principal component or Fisher's Discriminant Analysis, the efficiency of the system increases.

To build a face recognition system that can match humans is highly desirable yet very difficult to build. A basic face recognition system may follow a Face Detection System whose function is to identify a face in a given image and ignore all the other background details. After the face image is extracted it is given as input to the Face Recognition System, which first extracts basic features of a face that distinguishes one from the other and then classifiers are used to match images with those stored in the database to identify a person.

Existing face recognition systems are using only one method for feature extraction and face recognition. Although it is successful in many instances it breaks to deliver dependable performance when face patterns are open to great variations in viewpoints. And also the system's efficiency is poor. Face recognition system are becoming the most popular systems for security and access control and it is impotent to find method to improving the efficiency of face recognition system.

The efficiency of face recognition system can be improved by combined use of feature extraction and recognition methods. The system uses Principal Component Analysis (PCA) and Fisher's Linear Discriminant Algorithm (FLDA) as two different feature extraction techniques and Minimum Euclidean Distances (MED) and Artificial Neural Networks (ANN) as recognition systems. Proposed system contains two Face Recognition System (FRS) viz, Method1_FRS and Method2_FRS by integrating PCA, FLDA, ANN and MED. It then presents a comparison of these two FR Systems on a smaller database and aims to draw a conclusion as to which methodology is more suitable for the proposed database.

IV. METHOD1_FRS

Method1_FRS uses PCA for feature extraction and MED for face recognition. Test images and training images are stored in different databases. Feature extraction using PCA is done on both databases. Feature extracted images is given to MED recognition in order to find the existence of test image in the training image set.

A. Principal Component Analysis (PCA)

Principal Components Analysis is a powerful tool for feature extraction. This analysis identifies the patters in the data and represents them in a way of their similarities and differences. If the database has lot of images which are close to each other, means that it contains similar images but it differs slightly from each other. Face recognition on these types of images is very difficult. Principal Component Analysis can give better result in this context. PCA says about the variations on all images and points exactly what differs from each other.

If we cite an example considering an image of a "cloud" .It could be spanned about axes, which are called Principal components. To exhibit its characteristics from the data, PCA extracts and points the direction where the cloud is more extended. For an instance if the cloud is more shaped like a football, the main direction of the data could be a midline. We refer this direction as the Principal component. PCA will look then for the next direction vertical to the first one, this direction then further reduces multidimensional cloud into a two dimensional space . Thus it finds the subset of the principal components.

But in the case of face images, we project faces into the principal component space and acquires its feature vectors.

The steps involved in performing PCA [10] on a set of data are detailed below;

- Get some data
- Subtract the mean
- Calculating the covariance matrix
- Calculate the eigenvectors and Eigen values of the covariance matrix

- Choosing components and formatting a feature vector
- Deriving the new data set

An example training image set shown in Fig. 2. Success of is based on the evaluation of the eigen values and eigenvectors of images [7].

Fig. 2 Original training images

Fig 3 Feature extracted image by using PCA

Feature extracted image using PCA is shown in Figure 3 which contains only face part of the image and, removed all other background details.

B. *Minimum Euclidean Distance*

PCA feature extracted images given to an MED recognition system. The recognition system calculates distance between features of test image and features of image in the training database. The image with the minimum distance is the recognized image [4]. The distance is calculated by the equation

$$D = Y - X_i$$

Where Y represents the matrix correspondents to the test image and X_i represents matrix correspondents to training image.

Figure 4 explains face recognition by using minimum Euclidian distance. The first image shows tested image and second part shows distance with the stored images.

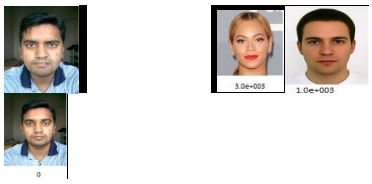

Figure 4: Minimum Euclidian Distance Recognition

Here the minimum distance is found in the second training image with distance zero. So an accuracy of 100% is obtained in this test image. Different image of same person is considered for better result.

V. METHOD2_FRS

Method2_FRS uses Fisher's Linear Discriminant Algorithm for feature extraction and Artificial Neural Network for face recognition. Test images and training images are stored in different databases. Feature extraction using FLDA is done on both databases. Feature extracted images is given to ANN recognition in order to find the existence of test image in the training image set.

A. *Fishers' Linear Discriminant Algorithm*

Fisher's linear discriminant is a recognition method in which multidimensional image is transformed to a one dimensional data and recognition process is done on this line space [6]. This projection is done in a way that maximizes the distance between the means of the test and train images while minimizing the variance between each image sets [14]. This is called the Fisher criterion, which is maximized over all linear projections,

$$w: J(w)=|m_1-m_2|^2 /(S_1^2+S_2^2).$$

Where m_1 and m_2 represents mean of two images and S_1 and S_2 represents variance between them. In signal theory, this criterion is called as the signal-to-interference ratio. Maximizing this criterion yields a closed form solution that involves the inverse of a covariance-like matrix. This method has strong parallels to linear perceptions. We learn the threshold by optimizing a cost function on the training set.

An example training image set shown in Fig. 2. Success of is based on the accuracy of mapping images to the fisher space [6].

Feature extracted image using PCA is shown in Fig. 5 which contains only face part of the image and, removed all other background details.

Fig. 5 Feature extracted image by using FLDA

The mapped fisher space image is given to ANN for recognition process.

C. *Artificial Neural Networks*

An artificial neuron is a computational model, and its idea inspired by the neural system of human [2]. A man can easily recognize a face with his/her neural system. In the proposed system Neural Network is used to face recognition.

Separate neural network is created for each person. Mapped fisher space images are the input to ANN and it creates a new descriptor [13]. The new descriptor is used as network input and applied to each person's network. The one with maximum output is selected and reported as the recognized image if it passes predefined recognition threshold.

Network training is done nntraintool of MATLAB and it is shown in Fig 6.

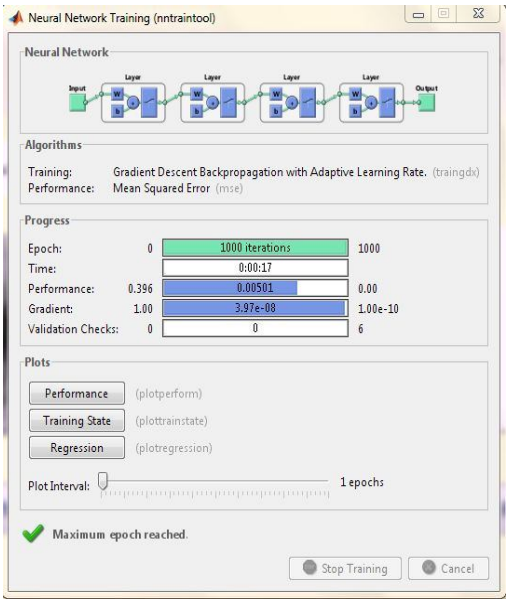

Fig.6 ANN image training

Performance graph for ANN training is shown in Fig.7. Fig. 8 shows training state and Fig.9 shows regression respectively.

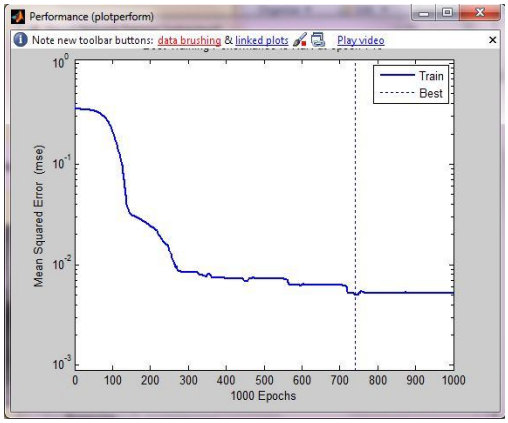

Fig. 7 ANN Performance

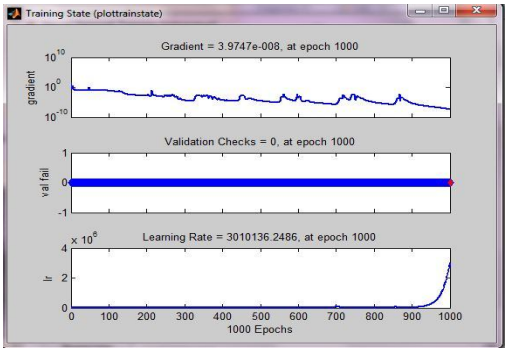

Fig. 8 ANN Training State

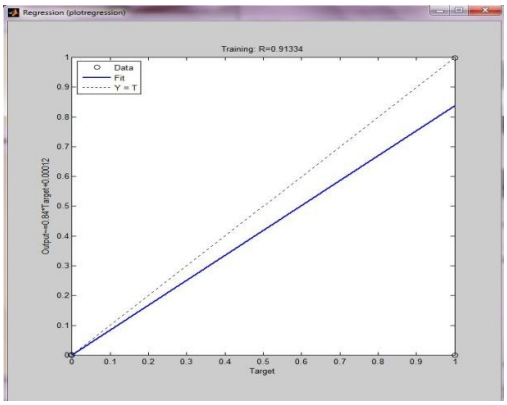

Fig.9 ANN Regression

VI RESULT

Table I shows the accuracy in percentage for Method1_FRS and Method2_FRS in 20 test images.

TABLE I

COMPARISON OF TWO FR SYSTEMS

Test image index	Method1_FRS	Method1_FRS
1.	95	99
2.	96	98
3.	97	95
4.	94	98
5.	93	97
6.	96	98
7.	99	99
8.	93	96
9.	94	97
10.	94	96
11.	97	98
12.	99	96
13.	93	94
14.	95	99
15.	98	99
16.	96	97
17.	95	97
18.	94`	96
19.	97	99
20.	98	99

VII CONCLUSION AND FUTURE ENHANCEMENT

Face recognition can used in Security measure at Airports, Passport verification, Criminals list verify police department, Visa Processing, Verification of Electoral identification and Card Security measure at ATM's.

The project presents a technique to implement a system that aims to describe four different methodologies for Face Recognition using PCA, FLDA, Minimum Euclidean Distance and Artificial Neural Networks. Two face recognition systems is made by using these techniques, Method1_1 FRS and Method2_FRS. Two image set is created, test image set and training image set. Existence of test image set is checked against training set images by using Method1_FRS and Method2_FRS. Accuracy of these two FRS is calculated and from the result it is clear that Method2_FRS makes more accurate result. A better result is achieved when artificial neural network is combined with another feature extraction method.

As future works, the test image can be proceeding with video images. So that face recognition system can apply in more real time applications.

VIII ACKNOWLEDGMENT

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