FACE RECOGNITION USING NEURAL NETWORK WITH PCA–MBP ALGORITHM

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ABSTRACT

In this paper, a face recognition system for personal identification and verification using Principal Component Analysis (PCA) with Modified Back Propagation Neural Networks (MBPNN) is proposed. The dimensionality of face image is reduced by the PCA and the recognition is done by the MBPNN. The system consists of a database of a set of facial patterns for each individual. The characteristic features of PCA called "Eigen faces" are extracted from the stored images, which is combining with Modified Back-Propagation Neural Network for subsequent recognition of new images. Eigen faces are produced by transforming the pixels in an image to (x; y) coordinates and forming a matrix with the coordinates. The Eigen faces or the principal components of the faces are the eigenvectors of the matrix and it is the eigenvectors. These Eigen vectors are given as input to the neural networks which performs the recognition process. In this we studied the concepts, for better accuracy and minimization of errors; we introduced a Modified Back-Propagation (MBP) algorithm for Neural Network which leads an efficient and convenient result in Neural network for face recognition mechanism. Faces represent complex, multidimensional, meaningful visual stimuli and developing a computational model for face recognition is difficult. Face recognition from the images is challenging due to the wide variability of face appearances and the complexity of the image background. Neural based Face recognition is robust and has better performance.

Keywords---Eigen Values, Eigen Vector, Face Recognition, Modified Back-Propagation Neural Network, Modified Back-Propagation Algorithm, and Principal Component Analysis.

I. INTRODUCTION

Face Recognition play an important role in today scenario due to its applications, including security, person verification, internet transmission and computer entertainment. Face recognition is deified as the ability to recognize people given some set of facial characteristics. Todays, it has become a famous area of research in computer vision and image testing, mainly because we can find such recognition systems in objects of everyday life such as cellphones, security systems, laptops, PCs, etc. [1]. Face recognition is an interesting and successful application of Pattern recognition and Image analysis. Facial images are essential for intelligent vision-based human computer interaction. Face processing is based on the fact that the information about a user's identity can be extracted from the images and the computers can act accordingly. Face recognition is one of the few biometric methods that possess the merits of both high accuracy and low intrusiveness. It has the accuracy of a physiological way without being intrusive [2]. The difficulty of this problem stems from the fact that in their most common form (i.e., the frontal view) faces appear to be roughly alike and the difference between them are

quite subtle. Therefore, frontal faceimages form a very dense cluster in image space which makes it virtually impossible for traditional pattern recognition techniques to accurately discriminate among them with a high degree of success. Furthermore, the human face is not a different, rigid object. Certainly, there are various factors that cause the appearance of the face to vary. Face recognition is an efficient means of authenticating a person [3]. In this paper, a face recognition system for personal or image identification and verification using Principal Component Analysis (PCA) with Modified Back Propagation Neural Networks (MBPNN) is proposed. The dimensionality of face image is reduced by the PCA and the recognition is done by the MBPNN for face recognition. The system consists of a database of a set of facial patterns for each individual. The characteristic features of PCA called "Eigen faces" are extracted from the stored images, which is combining with Modified Back-Propagation Neural Network for subsequent recognition of new images. In this we studied the concepts, for better accuracy and minimization of errors; we introduced a Modified Back-Propagation (MBP) algorithm for Neural Network which leads an efficient and convenient output in Neural network for face recognition mechanism**.**

II. WORKING MODEL OF FACE RECOGNITION SYSTEM

The working principle of typical Face Recognition System is shown in figure 1.

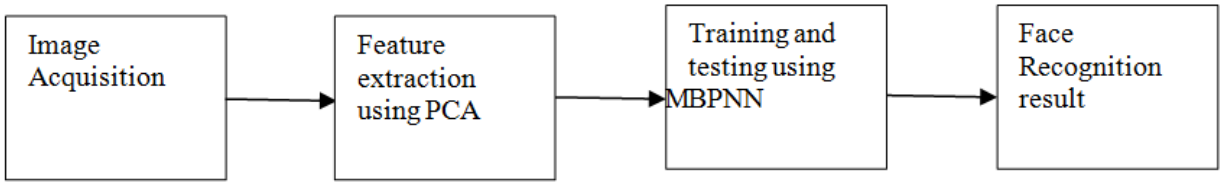

Fig.1. Generic Representation Of Face Recognition System

The Algorithm [4] & [5] for Face recognition using neural classifier is as follows:

a) Pre-processing stage –Images are made zero-mean and unit-variance.

b) Dimensionality Reduction stage: PCA - Input data is reduced to a lower dimension to Facilitate classification.

c) Classification stage - The reduced vectors from PCA are applied to train BPNN classifier to obtain the recognized image.

The issues of the design and implementation of the Face Recognition System (FRS) can be sub divided into two main parts. The first part is image processing and the second part is recognition techniques. The image processing part consists of face image acquisition techniques and the second part consists of the artificial intelligence which is composed by PCA and Modified Back Propagation Neural Network. Face image acquired in the first step by web cam, digital camera or using scanner is fed as an input to PCA, which converts the input image to low dimensional image and calculates its Euclidian distance. This Euclidian distance is then fed as an input to Modified Back-propagation Neural Network [6].

III. PRINCIPLE COMPONENT ANALYSIS

Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation. The PCA approach is used to reduce the dimension of the data by means of datacompression basics and reveals the most effective low dimensional structure of facial patterns. This reduction in dimensions removes information that is

not useful and precisely decomposes the face structure which involves transformation of number of possible correlated variables into a smaller number of orthogonal (uncorrelated) components known as Principal Components. Each face image may be represented as a weighted sum (feature vector) of the Eigen faces, which are stored in a 1D array. The test Image can be constructed using these weighted sums of Eigen faces. When a test image is given, the weights are computed by projecting the image upon Eigen face vectors. The distance between the weighted vectors of the test image and that of the database images are then compared. Thus one can reconstruct original image with the help of Eigen faces So that it matches the desired image [6]

IV. PCA ALGORITHM

The algorithm [7] used for principal component analysis is as follows.

(i) Acquire an initial set of *M* face images (the training set) & Calculate the Eigen-faces from the training set, keeping only *M'* Eigen faces that correspond to the highest Eigen value.

(ii) Calculate the corresponding distribution in *M'*- dimensional weight space for each known individual, and calculate a set of weights based on the input image.

(iii) Classify the weight pattern as either a known person or as unknown, according to its distance to the closest weight vector of a known person.

Let the training set of images be G1, G2, GM. The average face of the set is defined by

$$\Psi = 1/M \sum_{i=1}^{M} \Gamma_i \qquad 1$$

Each face differs from the average by vector

$$\Phi i = \Gamma i - \Psi \ (i = 1 \ldots M) \qquad 2$$

The co- variance matrix is formed by

$$C = A.A^T \qquad 3$$

Where the matrix A is given by

$$A = [\Phi_1 \Phi_2 \ldots\ldots \Phi_M] \qquad 4$$

This set of large vectors is then subject to principal component analysis, which seeks a set of *M* Orthonormal vectors *M u ....u* 1 .To obtain a weight vector W of contributions of individualEigen-faces to a facial image _, the face image is transformed into its Eigen-face componentsprojected onto the face space by a simple operation.

$$W_k = u^T_k \Phi \qquad 5$$

For k=1... *M'*, where *M'* £ *M* is the number of Eigen-faces used for the recognition. The weights form vector W = [w1, w2,….wm] that describes the contribution of each Eigen-face in representing the face image _, treating the Eigen-faces as a basis set for face images. The simplest method for determining which face provides the best description of an unknown input facial image is to find the image *k* that minimizes the Euclidean distance ek.ϵ_k

$$= \|(\Omega - \Omega_k)\|^2 \qquad 6$$

Where Wk is a weight vector describing the kth face from the training set. It is this Euclidean distance that is given as an input to the neural networks.

V. MODIFIED BACK-PROPAGATION NEURAL NETWORK

A MBP network consists of at least three layers of units: an input layer, at least one intermediate hidden layer, and an output layer. Commonly, units are connected in a feed-forward fashion with input units fully connected to units in the hidden layer and hidden units fully connected to units in the output layer.

The input pattern is presented to the input layer of the network. These inputs are propagated through the network until they reach the output units. This forward pass produces the actual or predicted output pattern. Because back propagation is a supervised learning algorithm, the desired outputs are given as part of the training vector. The actual network outputs are subtracted from the desired outputs and an error signal is produced. This error signal is then the basis for the back propagation step, whereby the errors are passed back through the neural network by computing the contribution of each hidden processing unit and deriving the corresponding adjustment needed to produce the correct output. The connection weights are then adjusted and the neural network has just "learned" from an experience. Once the network is trained, it will provide the desired output for any of the input patterns [8] & [9]. By using the Modified Back-Propagation Algorithm (MBP) achieve better accuracy and minimization of error in Neural Network which leads an efficient and convenient result in face recognition mechanism.

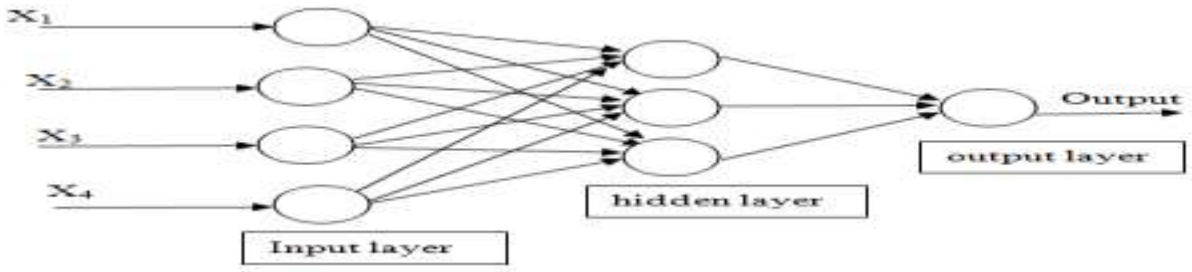

Fig.2 Multilayer Feed-Forward Neural Network

VI.MODIFIED BACK-PROPAGATION ALGORITHM

Assume a network with N inputs and M outputs. Let xi be the input to i_{th}neuron in input layer, Bj be the output of the j_{th} neuron before activation, yj be the output after activation, bj be the bias between input and hidden layer, bk be the bias between hidden and output layer, wij be the weight between the input and the hidden layers, and wjk be the weight between the hidden and output layers. Let η be the learning rate, δ the error. Also, let i, j and k be the indexes of the input, hidden and output layers respectively [8], [9]& [10].

The response of each unit is computed as:

$$Bj = \sum_{i=1}^{n} Xi*Wij \quad (7)$$

$$Yj = (1/(1+\exp(-Bj))) \quad (8)$$

Weights and bias between input and hidden layer updated as follows:

For input to hidden layer, for I = 1 to n,

$$Wij\ (t+1) = Wij\ (t) + \eta\ \delta jyi + \alpha * (wij\ (t) - wij\ (t-1)) \quad (9)$$

$$bj\ (t+1) = bj\ (t) + \eta\ \delta j + \alpha * ((bj\ (t) - bj\ (t-1)) \quad (10)$$

δj is the error between input and hidden layers and calculated as follows:

$\delta j = yj* 1-yj*\sum_k \delta k\ Wjk$ 11

Weights and bias between hidden and output layer updated as follows:

For input to hidden layer, for j = 1 to n,

$Wjk\ (t+1) = Wjk\ (t) +\eta\delta kyj+\alpha*wjk\ (t) -wjk\ (t-1)$ 12

$bk\ (t+1) = (t) +\eta\ \delta k +\alpha*(bk\ (t) -bk\ (t-1)$ 13

δk is the error between, hidden and output layers and calculated as follows:

$\delta k = yk* (1-yk) * (\delta k-yk)$ 14

VII. FLOW CHART FOR EXPERIMENTATION

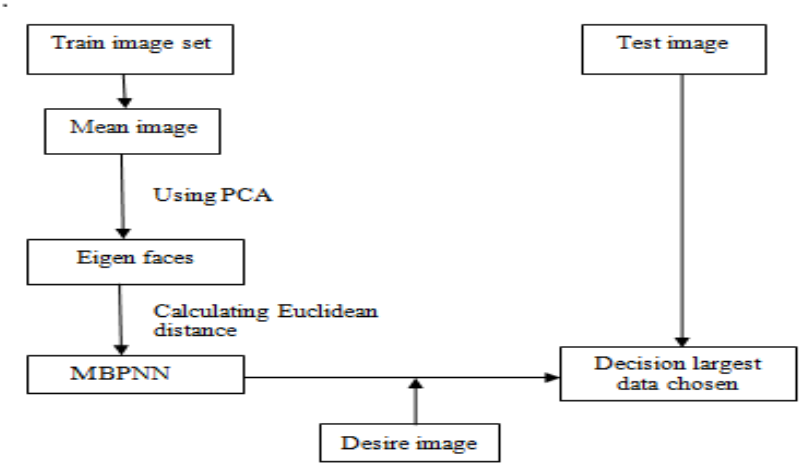

Fig.3 Complete Process of PCA And MBPNN Face Recognition System

VIII. RESULT

The effectiveness of the proposed face recognition method and the distance calculation algorithm are demonstrated using MATLAB. The face database consists of 90 images. Out of 90 images, 64 images are taken for training the networks. The number of epochs versus the squared error graph is shown in Figure 4.

Then the neural networks are tested with the remaining images. The MBPN Network accepts 2 unknown faces and it recognizes all the known faces. The combined model of PCA+MBPN recognizes all known faces and accepts 1 unknown face (false acceptance). The time consumption and the recognition rate are tabulated in Table.

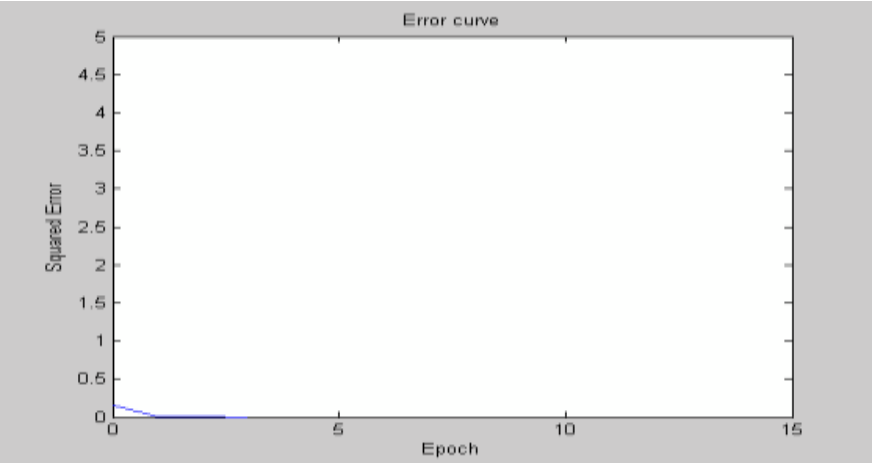

Fig. 4 Error Rate Versus Number of Epochs

COMPARISON OF PCA+MBP FRAMEWORK OVER BPN

Network	Total Images	Training +Testing time(in seconds)	False Acceptance	Recognition rate (in %)
BPN	90	3.6549	2	96.66%
PCA+MBPN	90	3.6492	1	98.88%

VIII. CONCLUSION

The result shows that the face recognition system using PCA for feature extraction and MBPNN for image classification and recognition provides a high accuracy rate and fast computation. By choosing PCA as the feature selection technique, the space dimension can be reduced. PCA combined with MBPNN works better than the individual PCA, done on the basis of the performance of the system which is measured by varying the number of faces of each subject in the training and test faces. The neural network model is used for recognizing the frontal or nearly frontal faces and the results are tabulated. A new neural network model combined with PCA and MBPN networks is developed and the network is trained and tested. This study shows that, recognition accuracy achieved by this method is very high. This method can be suitably extended for moving images and the images with varying background.

The neural networks aimed at providing artificial intelligence to the system. Neural networks using back propagation and principal component analysis is presented in this report for face recognition. It can be concludes that using the neural network approach illustrates the success of its efficient use in face recognition. The MBPNN algorithm is preferred over other neural network algorithms because of its unique ability to minimize errors. Modified Back-Propagation Neural Network (MBPNN) is found to be very accurate where recognition is required over other neural networks. Main advantage of this Modified Back-Propagation algorithm is that it can identify the given image as a face image or non-face image and then recognizes the given input image .Thus the back propagation neural network classifies the input image as recognized image.A new neural network model combined with MBPN and PCA networks is developed and the network is trained and tested. From these results, it can be concluded that, recognition accuracy achieved by this method is very high. This method can be suitably extended for moving images and the images with varying background.

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