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Face Recognition Using Artificial Neural Network

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***Abstract*—This paper proposed a noble face recognition algorithm which integrates the principal component analysis; back propagation neural network (BPNN) and discrete cosine transform to improve the performance of face recognition. A whole face recognition system proposed is based on PCA and DCT combination feature extraction using Artificial Neural Network. Normalization can used to eliminate the redundant information interference. Principal Component Analysis (PCA) can be used for feature extraction and dimension reduction. The recognition is done by the BPNN for efficient and robust face recognition. In this paper, the global features extraction is completed using PCA based Eigen faces computation method and the detection part is completed using multi-layered feed forward Artificial Neural Networks with back propagation process. This algorithm is implemented using MATLAB 2010 software. The learning process of neurons is used to train the input face images from training database with no. of iterations to minimize the error for recognizing face.**

***Keywords*— Artificial Neural network (ANN), discrete cosine transform (DCT), neurons, epochs, eigen faces, mean square error (MSE), face recognition, principal components analyses (PCA)**

I. INTRODUCTION

The human face plays an important role in our social interaction, conveying people's identity. The facial recognition process normally has four interrelated phases or steps. The first step is face detection, the second is normalization, the third is feature extraction, and the final cumulative step is face recognition. These steps depend on each other and often use similar techniques. Face Recognition System is a computer based digital technology and is an active area of research. The Face Recognition System has various applications like various authentication systems, security systems and searching of persons etc. These applications are cost effective and consume less time. Moreover the face database can be easily designed by using any image of the person. In last few years different face recognition techniques are purposed with successful results. As the brain of human beings create the learning ability to recognize the persons by face even when the feature characteristics of the face changes. The neurons of the human brain are trained by reading or learning the face of a person and they can identify that face quickly even after several years. This ability of training and identifying is converted into machine systems using the Artificial Neural Networks. The basic function for the face recognition system is to compare the face of a person which is to be recognized with the faces already trained in the Artificial Neural Networks and it recognized the best matching face as output. The method used for face recognition is based on Principal Component Analysis with DCT. A whole face recognition system proposed is based on PCA and DCT combination feature extraction Using Neural Network. Normalization can used to eliminate the redundant information interference. Principal Component Analysis (PCA) can be used for feature extraction and dimension reduction.

II. LITERATURE ON RELATED WORKS

Presently there are several methods for face recognition. PCA with SOM is the better technique than 2D-DCT with SOM. It has discussed the face recognition method combined with PCA and the multi-layer network which is one of the intelligent classifications was suggested and its performance was evaluated [1]. As a preprocessing algorithm of input face image, this method computes the Eigenfaces through PCA and expresses the training images with it as a fundamental vector. In this reviewed various techniques for face detection such as feature extraction. Classification schemes and databases for face recognition [2]. It gives focus on CCA was applied to the classical PCA features to form the coherent features for recognition, but it is applicable to other holistic face recognition features such as independent component analysis and discrete cosine transform features, which might improve the recognition performance further [3]. In that [4] has explored a noble face recognition algorithm which integrates the principal component analysis; back propagation neural network (BPNN) and discrete cosine transform (DCT) to improve the performance of face recognition algorithms.PCA is used to reduce the dimensionality of face image and the recognition is done by the BPNN for efficient and robust face recognition. DCT is an exact and robust face recognition system used in compression due to its compressed representation power. DCT reduce the amount of time required to recognize a face. It adopted the global features for extraction using PCA [5] based Eigenfaces computation method and the detection part is completed using multi-layered feed forward Artificial Neural Networks with back propagation process. The learning process of neurons is used to train the input face images with 1000 iterations to reduce the error. In that, face recognition task is completed with improved accuracy and success rate even for noisy face images. It [6] has given brief introduction of the PCA and the self organizing map (SOM) neural network which are the

heart for the design and implementation, these are the final algorithms used for the design of an efficient high-speed face recognition system. In that [7] given brief introduction about feature extraction Using DCT.DCT reduces the dimension of data to avoid singularity and decreases the computational cost of PCA. In this, various DCT feature extraction approaches are considered and a new efficient approach is proposed.

III. PROPOSED WORK

In this dissertation work it is proposed to carry out analysis of face recognition systems. When number of person become too large then it is become difficult to finding the optimization for such a larger entries manually it too much time consuming. It is efficient methods to solve this using MATLAB software.

A. PCA Algorithm

PCA was invented in 1901 by Karl Pearson.PCA is variable reduction procedure and useful when obtained data have some redundancy. This will result into reduction of variable into smaller no. of variables which are called Principal Component. The major advantage of PCA is using it in Eigenfaces approach which helps in reducing the size of the database for recognition of a test image. The images are stored as their feature vectors in the database which are found out projecting each and every trained image to the set of Eigenfaces obtained.PCA is applied on Eigenfaces approach to reduce the dimensionality of a large data set.

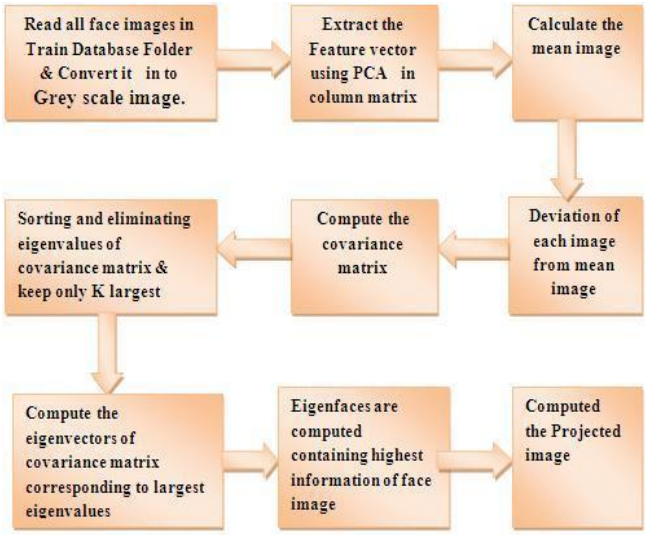

Fig.1 Computing the Eigen faces using PCA algorithm

PCA projects the data along the directions where variations in the data are maximizes. The algorithm is follows as:

- Assume the m face images contained in the database as P1, P2, P3……Pm.
- Calculate the average image, Ø, as: Ø= Σ Pl /M, where 1< L<M, each image will be a column vector the same size.
- The covariance matrix is computed as by $C = P^T P$ where P = [O1 O2 O3….Om].
- Calculate the eigenvalues of the covariance matrix **C** and carry on only k largest eigenvalues for dimensionality reduction as $\lambda k = \Sigma^{m} n=1(UK^T O_n^n)$.
- Eigenfaces are the eigenvectors UK of the covariance matrix C corresponding to the largest eigenvalues.
- All the centered images are projected into face space on Eigenfaces basis to compute the projections of the face images as feature vectors as:

$$w = U^T O = U^T(Pi - Ø), \text{ where } 1< i<m.$$

B. Artificial Neural Network

It is a computational system inspired by the formation, Processing Method, and Learning ability of a biological brain. There are a large number of different types of networks, but they all are characterized by the following mechanism: a set of nodes and connections between nodes. The nodes can be seen as computational units. They receive inputs, and process them to obtain an output. This processing might be very simple (such as summing the inputs), or quite complex (a node might contain another network...) the connections determine the information flow between nodes. They can be Unidirectional, when the information flows only in one sense and bidirectional, when the information flows in either sense.

For Face Recognition purpose, the learning process of ANN is used with back propagation algorithm. Back Propagation is a feed forward supervised learning network. Neural networks consist of the three layers as input layer, hidden layer and output layer as shown in Fig. 2. These layers of elements make independent computation of data and pass it to another layer. The computation of processing elements is completed on the basis of weighted addition of the inputs. The output is compared with the target value and the mean square error is calculated which is processed back to the hidden layer to adjust its weights. This process is having iteration for each layer to minimize the error by repeatedly adjusting the weight of each layer. Hence, it is called the back propagation. The iteration process carried on until the error falls below the tolerance level.

A multilayer neural network has a layered structure. In face recognition system using ANN, the model works in the following ways

1) Input to Feed Forward Network: Firstly, the parameters are selected for required Neural Networks operation i.e. the number of input layers, hidden layers and output layers. These input neurons get the inputs signal from the training database of face images. Each input has its own weights.

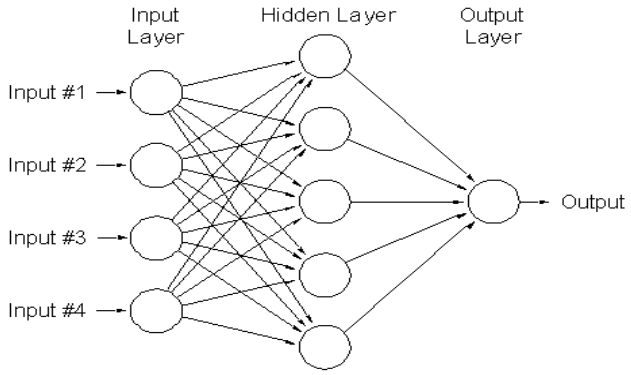

Fig. 2 Architecture of Neural Network

2) Back Propagation Algorithm and weight Adjustment: The input layer processes the data to the hidden layer which computes the data further and passes it to the output layer. Output layer compare it with the target value and obtain the error signals. These errors are sent back for updating the weights of each layer to minimize the error as shown in Fig. 3.

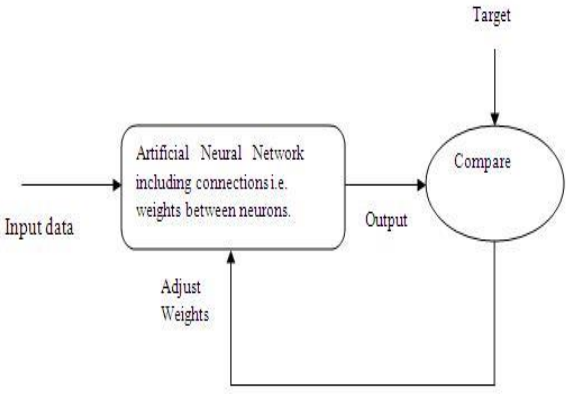

Fig.3 Back Propagation of Multilayered ANN

C. Implementation Process

In this work, the features of the face images are extracted using PCA which extracts the variations in the features of face images which contains the highest information with decomposed dimensions.

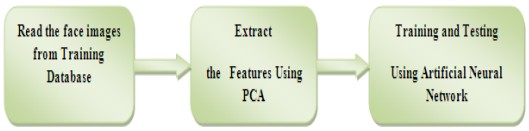

Fig.4 Basic Blocks for Face Recognition

D. Training Neural Network with Input face images

Back Propagation feed forward Artificial Neural Network is used for training the input face images. The computed Eigenfaces of the input face images are fed to the neural networks. The parameters selected for the ANN are mentioned in Table I. After setting the parameters of neural networks are trained with Eigenfaces of the input images via input layer, hidden layer and output layer. Each Eigenfaces image distance is compared with each other. In this work, the mathematical function Log-sigmoid is used which is mentioned in the Table I. The errors at the output layer are sent back to the previous layers that are hidden layer and update the weights of these layers which minimize the error. The momentum and learning rate parameters counts the updates from previous iterations and recalculates the new updated output. The iteration used is 50000 and the errors are minimized to value 0.0001.

E. Testing the ANN with Tested Face Image

For face recognition, the eigenfaces images of the test face image is intended by feature extraction based on PCA. This Eigenfaces image is given to the trained neural network. The tested Eigenfaces is compared with the Eigenfaces of the trained neural network for finest match result using the Log-sigmoid function values. The minimum distance between the tested Eigenfaces image and the trained input Eigenfaces image is not as much of as the threshold value.

F. Experimental Approach

Here, we have used the database of 84 face images with different face images of 21 user persons. The images are cropped and resized to 180×200 pixels having 36000 dimensional image space. For testing purpose 42 images are used which are unknown face images. Fig. 5 shows the colored face images of some users and their grey-scale converted images. The simulation method is completed by using MATLAB2010 software coding.

Fig.5 Color face images converted in to grey scale

Fig.6 Projection of face images

In training part, Artificial Neural Networks are trained with the projected face images that are Eigenfaces and the

following parameters are set for input, hidden and output layered artificial neural network for complete training and testing purpose.

It counts the 500 iterations or epochs having learning rate of 0.03 and the training continuous up to the mean square error reaches at a performance goal set at 0.0001. For the testing purpose these trained neural networks are used. After simulation process, the performance of trained neural network is shown below Fig.7

TABLE I
PARAMETERS SELECTED FOR TRAINING PURPOSE

SN	Parameters selected for ANN	Specifications
1.	ANN layers	3
2.	Input layer contains	Eigenfaces column Matrix having values of eigenvectors of 84 different images
3.	Output layer having	Column Matrix contain 84 target elements for each face image
4.	Neurons in input layer	45
5	Neurons in output layer	1
6.	No. of Iterations	500
7.	No. of validation checks	6
8.	Gradient value	1.00e-10
9.	Mathematical function used at output layer	Sigmoid function
10.	Learning rate	0.03
11.	Performance goal	0.0001

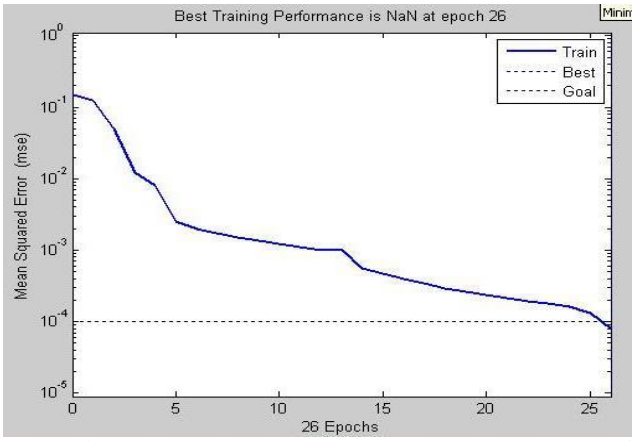

Fig.7 Performance plot with respect to Mean Square Error and number of Iterations of Artificial Neural Networks

Fig. 7 shows the performance graph as the MSE is reduced to 0.0001 by using back propagation neural network which is updating the weights of hidden layer.

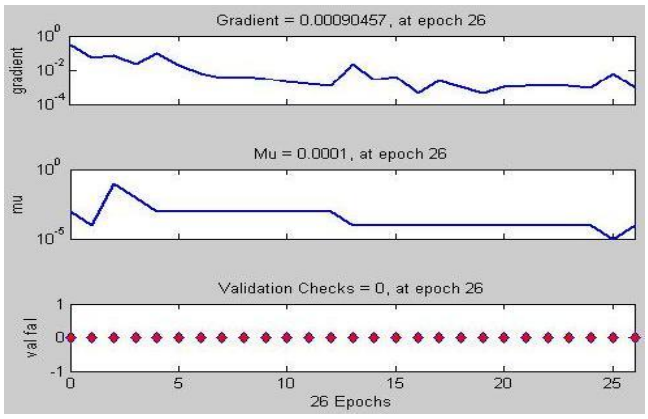

Fig. 8 Training State plot of Gradient, Learning rates and Validation checks with number of Iterations of ANN

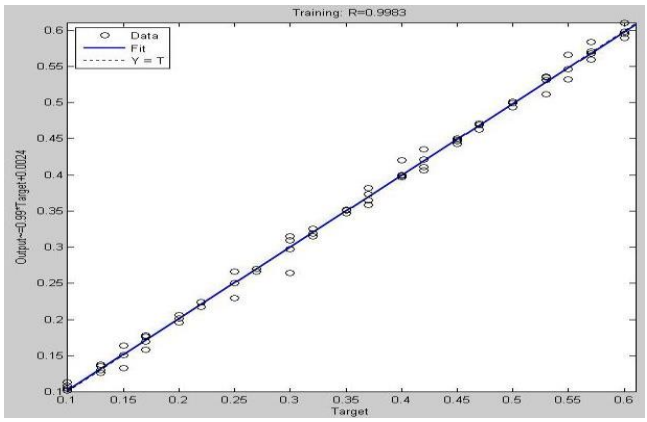

Fig .9 Regression plot for Training state

Regression plot shows correlation between Target and actual output.

Fig.10 shows that equivalent image is almost similar to test image. The test image is matched with the database of trained images and the equivalent output image is generated as a result of the use of the proposed algorithm.

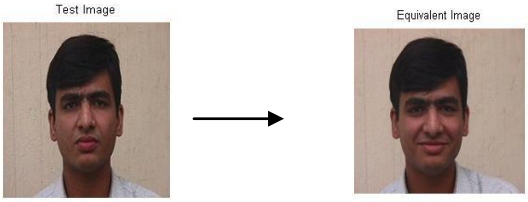

Fig. 10 Applied Test image and it's equivalent output image

IV. CONCLUSION

The purpose of this study was to investigate and implement an artificial neural network for face recognition. The objective was to develop an artificial neural network based feature extractor or classifier that can be used for authorized user verification in a practical work environment using PCA. Specifically, a back propagation neural network algorithm was implemented .We have applied test image for recognition of face using trained neural network.

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