

## A Matlab based Face Recognition GUI system Using Principal Component Analysis and Artificial Neural Network

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**Abstract**—Today, Face recognition has an important application in artificial intelligence of biometrics. The research continues to develop an efficient Face recognition system. The goal of this paper is to develop a Face recognition system which is less sensitive to variations in pose, illumination and facial expressions. The Face recognition system mainly consists of two steps: the extraction of feature and the recognition. In the proposed technique, feature extraction is being done with the help principal component analysis and back-propagation neural network has been used for the recognition step. An unknown face has been taken from the test database and then PCA and ANN techniques are used to recognize the test face image from our train database face images. The system has been examined on Olivetti and Oracle Research Laboratory (ORL) face database and the results have been shown.

**Keywords**—Face Recognition; Eigenface; Principal Component Analysis (PCA); Artificial Neural Network (ANN); Back Propagation

### I. INTRODUCTION

With the advances in use of face recognition techniques for the security and surveillance system, it has become a challenging task to develop a system of face recognition which is highly efficient in use. Face images are similar in overall configuration and so face recognition is difficult. Humans are very powerful in recognizing the faces that they see often. With the advent of very high performance computing, a computer can be made to mimic large amount of interconnections and networking that exist between all the nerve cells in a human brain. This can be done by implementing a network of artificial neurons which functions in the same way as of actual neural network of human brain. Of all the biometrics applications face recognition is more important as it does not require any physical interaction of the person to be recognized. Face recognition system can be used and developed in two ways: the identification or the verification. Identification corresponds to one to many recognition i.e. the unknown face is matched with the many faces given in the database and the matched one is displayed as the output. Verification corresponds to one to one interaction i.e. the unknown face is verified as whether it is face of the specified person or not. In this paper, we have dealt with the identification of the unknown faces using ORL database.

Face recognition techniques can be approached in two ways. (i) Appearance based (ii) Feature based. In the appearance based techniques, the whole face image is considered and the features are extracted through it. In the feature based technique, some of the features of face (like eyes, nose, mouth etc) are being considered for feature extraction. The feature based approaches include elastic bunch graph etc. The appearance based includes PCA, LDA, ICA etc. Compared to appearance based, feature based techniques of face recognition are less sensitive to variations in illumination. The eigenface approach or the Principal component analysis is the appearance based technique.

### II. METHODOLOGY

#### A. Preprocessing

Image resizing, histogram equalization and rgb to gray scale conversion are used for pre processing of the images. The image resizing has been done to make the system free from specific

dimension of face image. The intensity has been equally distributed by using histogram equalization to improve the performance of face recognition system.

## B. PCA Algorithm

The Principal Component Analysis (PCA) is among the most affluent algorithms that have been used in any image recognition and compaction. The motive of PCA is to reduce the big sized dimensionality of the face data space to the smaller useful dimensionality of feature space, which is needed to describe the data. PCA comprises of a mathematical stages that transforms a large number of correlated variables into a smaller number of uncorrelated variables called principal components. In order to do this, a face image is being projected to several face templates called eigenfaces, which is being considered as a set of features that characterizes variations among the face images [9].

**The various steps involved in calculating eigenface are as follows:**

- Acquire an initial database of M face image each of size N\*N.
- Each face image is converted into a vector form so as to form a face vector space, represented as  $\Gamma_i$ .
- The mean is calculated as
$$\psi = \frac{1}{M} \sum_{i=1}^M \Gamma_i$$
- Now the mean is subtracted from each image,  $\phi = \Gamma_i - \psi$ .
- A Matrix  $A = \{\Phi_1, \Phi_2, \Phi_3, \dots, \Phi_{M-1}, \Phi_M\}$  has been formed and find the covariance matrix,  $C = A^T A$ .
- The eigenvector,  $v_i$  and eigenvalues,  $\lambda_i$  of the covariance matrix has been calculated.
- The eigenvalues are arranged in decreasing order along with their eigenvectors and the small eigenvalues has been eliminated.
- Represent each face image as a linear combination of all the k eigenvectors. Weight vector has been represented as  $\Omega$ . Or the  $\Omega^T = [W_1, W_2, \dots, W_k]$ . where W are the weights of selected k eigenvectors, given by  $W_k = V_k^T (\Gamma - \psi)$ . Thus the centered image vectors have been projected onto eigenspace.

## C. Artificial Neural Network

An artificial neural network, is a technique based on the process of biological neural networks, or we can say, it is mirroring of biological neural system. It consists of simple processing element (known as neuron), processing in parallel and interacting with each other using weighted interconnection. It is a system that has a structure which receives an input, processes the input data, and provides the output. Once the input is introduced to the neural network, and the desired response is set at the output layer, an error is collected from the difference of desired output and the real system output. For an artificial neuron, weight is a number that represents the synapse.

The Back-Propagation is known as the best and extensively used learning algorithm for training multilayer perceptrons. The MLP refer to a network that consists of a set of sensual units (source nodes) to constitute the input layer, one or more hidden layers of computation nodes, and an output layer of computation nodes [5]. The data is first propagated to hidden layer and after that to the output layer; this is known to be the forward pass of the BPNN algorithm. In the forward pass, each node of hidden layer get the input from all nodes of the input layer, which are then multiplied with appropriate weights and there after summed. The output of the hidden node occurs as a non-linear transformation of the resulting sum. Similarly every node of output layer gets input from all the nodes of hidden layer, which are then multiplied with the appropriate weights and there after summed. The output of this node also occurs as a non-linear transformation. The output value of output layer is analyzed with the targeted output values. The targeted output values are the values that we require to teach the network.

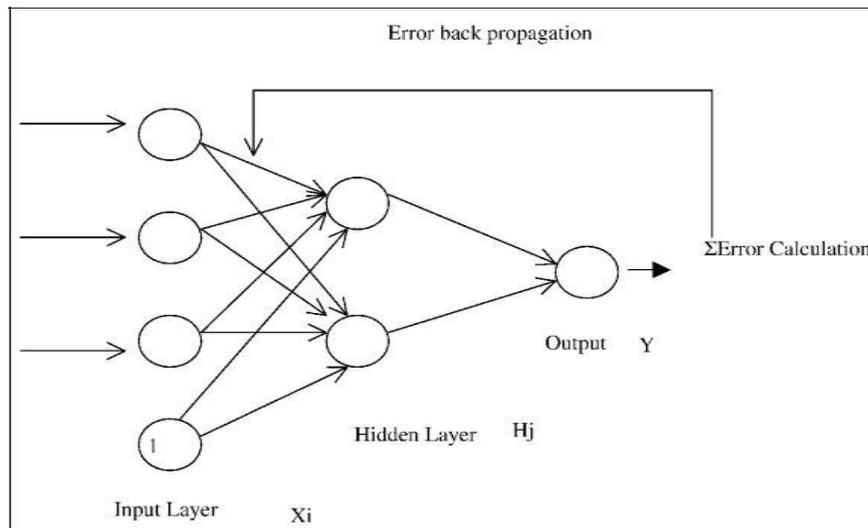


Fig. 1. Back propagation neural network

The difference between actual output values and targeted output values is evaluated and propagated back towards the hidden layer. This is known to be the backward pass of the BPNN algorithm. The difference error is used to update the connection strengths among the nodes, i.e. weight matrices updated among input layers- hidden layers. Also hidden-output layers are updated. During the testing period or phase, no learning takes place (weight matrices are not altered). Each test vector is supplied to the input layer.

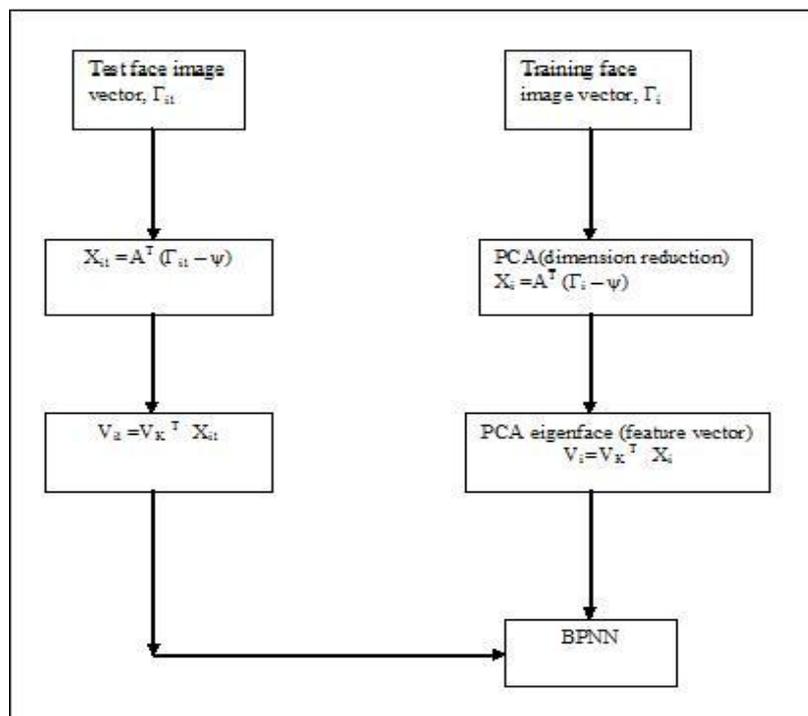


Fig. 2. Methodology Flow diagram

### III. SIMULATION ENVIRONMENT

Any image can be best represented in the matrix form. Also arithmetic and various other operations can be easily performed on matrix. Matrix Laboratory (MATLAB) is the software which effectively performs operations on matrix. It is a software package for high performance numerical computation and visualization. MATLAB 7.9.0 has been used as a simulation environment. There

are several optional toolboxes available, out of which Image Processing Toolbox, Neural Network Toolbox and Statistics Toolbox have been used to create Face Recognition system.

#### IV. EXPERIMENTATION

The face recognition system has been tested on 80 images of ORL database. The original size of the images was 92\*112, which has been resized to 180\*200 so as to make the system dimension independent. A sample of ORL database on which the experiment is performed is shown in fig3



*Fig. 3. Sample of face images from ORL database*

The images of the database have been converted to the feature vector (column vector) and then the PCA algorithm has been applied to them. Firstly in the first phase recognition is done using only PCA algorithm and the results are checked. In the second phase the eigenfaces calculated using PCA has been given as the input to the back propagation neural network. The back propagation neural network has been trained with the following parameters.

No. of Input unit = 1 feature matrix  
Accuracy = 0.001  
Learning rate = 0.2  
Transfer function: logsig  
Training Function: Traingd  
Back propagation weight/bias learning function: learngdm  
Performance function: mse  
No. of epochs = 10000  
No. of output unit = 1

The graphical user interface shown in fig.4 has been built to analyze the face recognition system performance. The GUI of Face recognition has only been built for the system combining both the techniques, BPNN and PCA as a whole. Two axes have been used to display input image and neural network recognition. Several tabs are given for different functions. Tabs are given to select the training and testing databases. Clicking on the create database creates the database (eigenfaces of the database). Now the test data is selected from the right tab. PCA is applied to create the eigenface. Back propagation is then used to recognize the test face to the database. The BPNN starts searching for the recognition with several epochs (1000). The fig.5 shows the Back-propagation neural network training.

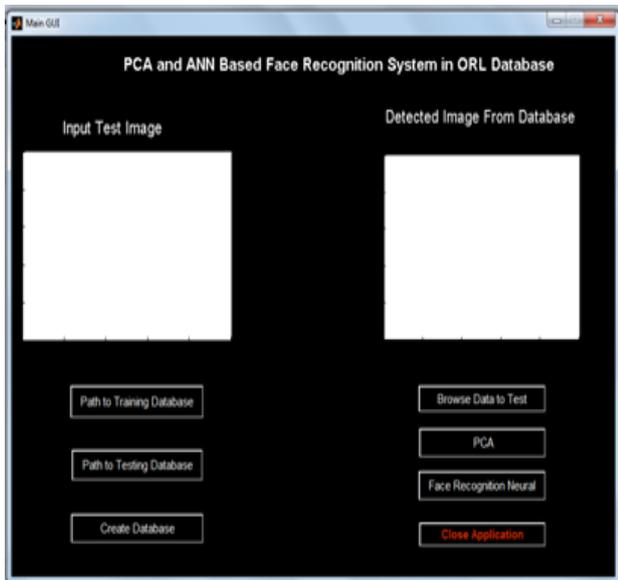


Fig. 4 GUI of the face recognition system

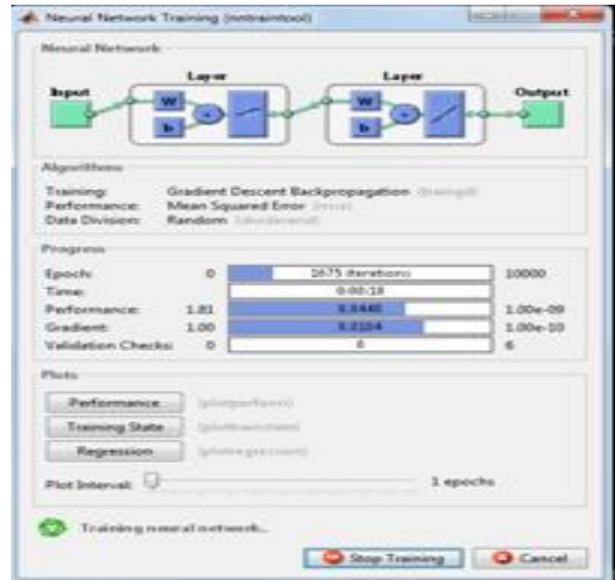


Fig. 5 BPNN running

## V. RESULT

The following results were being analyzed during the test on the face recognition system. It has been seen that the performance of PCA and ANN as a combined technique is better as compared with PCA only when seen for the images with variations in lighting conditions, expressions and head orientations. The results have shown that the proposed technique gives an accuracy of approx. 95 percent.

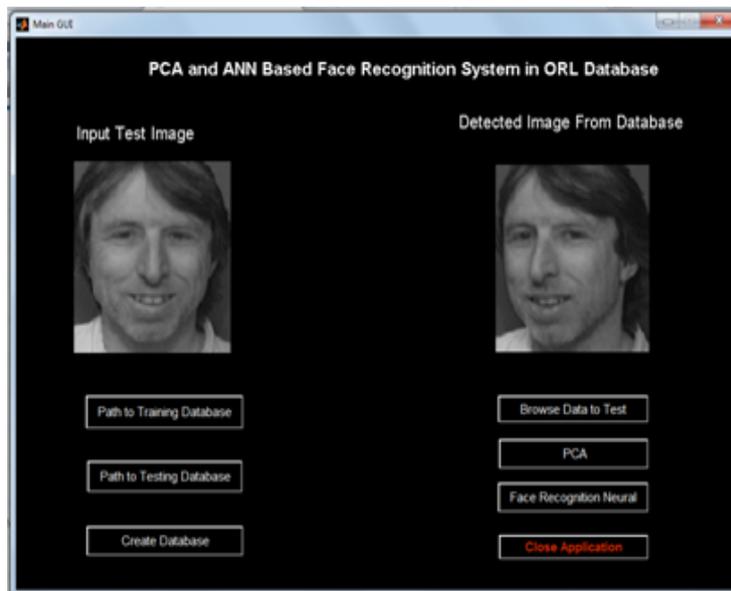


Fig. 6. Recognized face using PCA and ANN

TABLE(1): Success rate (in %) of Face Recognition on ORL image database in different conditions

Condition	PCA	PCA with BPNN
Normal	90	97
Light variations	70	95
Expression variations	70	95
Slight Head orientation	65	93

## VI. CONCLUSION

**The conclusions that have been drawn using the proposed technique are:**

1. The contemplated approach gives the accuracy of approximately 95percent.
2. Back-propagation neural network algorithm gives better result than PCA.
3. Back-propagation when combined with PCA reduces the size of input given to the Neural Network.
4. Contemplated approach has minimal sensitivity to lighting conditions, facial expressions and head orientation.

## REFERENCES

- [1] M.A. Turk and A.P. Pentland, "Face Recognition Using Eigenfaces", IEEE Conf. on Computer Vision and Pattern Recognition, pp. 586-591, 1991.
- [2] M. Agarwal, N. Jain, M. Kumar and H. Agrawal, "Face Recognition Using Eigen Faces and Artificial Neural Network", International Journal of Computer Theory and Engineering, Vol. 2, No. 4, , pp624-629, August, 2010.
- [3] Prof V.P. Kshirsagar, M.R. Baviskar, M.E. Gaikwad "Face Recognition Using Eigenfaces" , IEEE Conference, 2011.
- [4] P.Latha, Dr.L.Ganesan & Dr.S.Annadurai." *Face Recognition using Neural Networks*" Signal Processing: An International Journal (SPIJ) Vol.3 : Issue (5). 153-160, 2009.
- [5] M.A.Turk and A.P.Pentland, "Eigenfaces for Recognition ," Journal of Cognitive Neuroscience. Volume. 3, pp.71-86.
- [6] Kirby, M., and Sirovich, L., "Application of the Karhunen- Loeve procedure for the characterization of human faces", IEEE PAMI, Vol.12, 103-108, 1990.
- [7] Prof. Y. Vijaya Lata, Chandra Kiran Bharadwaj Tungathurthi, H. Ram Mohan Rao, Dr.A. Govardhan, Dr.L.P. Reddy, "Facial Recognition using Eigenfaces by PCA" International Journal of Recent Trends in Engineering, Vol. 1, No. 1, May 2009
- [8] Kailash J. Karande Sanjay N. Talbar "Independent Component Analysis of Edge Information for Face Recognition" International Journal of Image Processing, Volume (3): Issue (3) pp: 120 -131.
- [9] Prasa1, S.S. Panda2, G. Deepthi and V. Anisha," Face Recognition Using PCA and Feed Forward Neural Networks",International Journal of Computer science and Telecommunications, Volume 2, Issue 8, pp 79-82, Nov 2011.
- [10] Zhujie Y. L. Y ., "Face Recognition with Eigenfaces", Proc. IEEE International conference Industrial Technology, pp. 434-438,1994
- [11] M. Nandini, P. Bhargavi, G.Raja Sekhar, "Face Recognition using Neural Networks", IJSRP, Vol.3, Issue 3, pp 1-5, March 2013
- [12] Suhas S Satonkar, Vaibhav M Pathak, Dr Prakash B Khanale "Face Recognition Using Principal Component Analysis and Artificial Neural Network of Facial images Database using Soft Computing ",IJETTCS, Vol.4,Issue 4, pp.110-116 ,August 2015.
- [13] Prachi Agarwal, Naveen Prakash, "An Efficient Back Propagation Neural Network Based Face Recognition System Using Haar Wavelet Transform and PCA",IJCSMC, pp 386-391, 2013.
- [14] R. C. Gonzalez and R. E. Woods, "Digital Image processing", 3rd Edition, Pearson International Edition.