International Journal of Modern Engineering Research (IJMER)

www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-1366-1370 ISSN: 2249-6645

Face Recognition Using PCA-BPNN Algorithm

*Prof.Ujval Chaudhary, **Chakoli Mateen Mubarak, **Abdul Rehman, **Ansari Riyaz, **Shaikh Mazhar

*HOD department of electronics engineering, MHSS College of engineering, Byculla, Mumbai

**Student of MHSS College of engineering, Electronics branch, Byculla, Mumbai

Abstract

In this paper we will explore the concept of facial recognition using back propagating neural ntworks. Eigenfaces are produced by transforming the pixels in an image to (x; y) coordi-nates and forming a matrix with the coordinates. The eigenfaces 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.

***Keywords:** Back-propagation Neural Network, Biometric Identification, Eigen faces, Eigen vectors, Principal components analyses.*

I. INTRODUCTION

Information and Communication Technologies are increasingly entering in all aspects of our life and in all sectors, opening a world of unprecedented scenarios where people interact with electronic devices embedded in environments that are sensitive and responsive to the presence of users. Indeed, since the first examples of "intelligent" buildings featuring computer aided security and fire safety systems, the request for more sophisticated services, provided according to each user's specific needs has characterized the new tendencies within domotic research. The result of the evolution of the original concept of home automation is known as Ambient Intelligence (Aarts & Marzano, 2003), referring to an environment viewed as a "community" of smart objects powered by computational capability and high user-friendliness, capable of recognizing and responding to the presence of different individuals in a seamless, not-intrusive and often invisible way. As adaptivity here is the key for providing customized services, the role of person sensing and recognition become of fundamental importance[8][9][10]. This scenario offers the opportunity to exploit the potential of face as a not intrusive biometric identifier to not just regulate access to the controlled environment but to adapt the provided services to the preferences of the recognized user. Biometric refers to the use of distinctive physiological (e.g., fingerprints, face, retina, iris) and behavioural (e.g., gait, signature) characteristics, called biometric identifiers, for automatically recognizing individuals. Because biometric identifiers cannot be easily misplaced, forged, or shared, they are considered more reliable for person recognition than or knowledge-based methods. Others typical objectives of biometric recognition are user convenience (e.g., service access without a Personal Identification Number), better security (e.g., difficult to forge access). All these reasons make biometrics very suited for Ambient Intelligence applications, and this is specially true for a biometric identifier such as face which is one of the most common methods of recognition that humans use in their visual interactions, and allows to recognize the user in a not intrusive way without any physical contact with the sensor. We present a face recognition system based on pca features extraction and neural networks to recognize the identity of subjects accessing the controlled Ambient Intelligence Environment and to customize all the services accordingly.[2]

II. WORKING PRINCIPLE

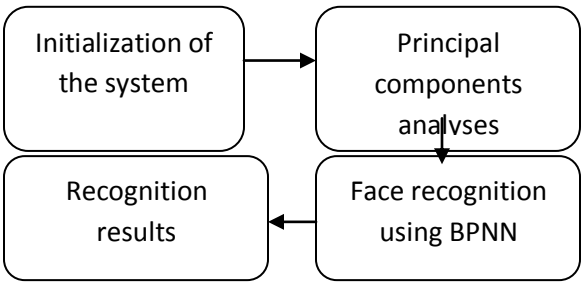


Fig 1: Generic block diagram

2.1. Initialization of the system

The Algorithm 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.

2.2 Principal Component Analyses:

Principal component analysis (PCA) [2] involves a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal

www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-1366-1370 ISSN: 2249-6645

components. PCA is a popular technique, to derive a set of features for both face recognition.
Any particular face can be

(i) Economically represented along the eigen pictures coordinate space, and
(ii) Approximately reconstructed using a small collection of Eigen pictures

To do this, a face image is projected to several face templates called eigenfaces which can be considered as a set of features that characterize the variation between face images. Once a set of eigenfaces is computed, a face image can be approximately reconstructed using a weighted combination of the eigenfaces. The projection weights form a feature vector for face representation and recognition. When a new test image is given, the weights are computed by projecting the image onto the eigen- face vectors. The classification is then carried out by comparing the distances between the weight vectors of the test image and the images from the database. Conversely, using all of the eigenfaces extracted from the original images, one can reconstruct the original image from the eigenfaces so that it matches the original image exactly.[5]

2.2.1 PCA algorithm:
The algorithm used for principal component analysis is as follows.[4]

(i) Acquire an initial set of *M* face images (the training set) & Calculate the eigen-faces from the training set, keeping only *M′* eigenfaces that correspond to the highest eigenvalue.
(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.[5]

Let the training set of images be G_1 ,G_2,.....G*M* . The average face of the set is defined by[5]

$$\Psi = 1/M \sum_{i=1}^{M} \Gamma_i \quad (1)$$

Each face differs from the average by vector

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

The co- variance matrix is formed by

$$C = A.A^T \quad (3)$$

where the matrix A is given by

$$A = [\Phi_1 \ \Phi_2 \ \ldots \ \Phi_M] \quad (4)$$

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 individual eigen-faces to a facial image _, the face image is transformed into its eigen-face components projected onto the face space by a simple operation.[6]

$$W_k = u^T{}_k \Phi \quad (5)$$

For k=1,.., *M′*, where *M′* £ *M* is the number of eigen-faces used for the recognition. The weights
form vector W = [$w_1, w_2, \ldots w_m$] 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 e_k

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

Where W_k 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.

2. 3. Neural Network:
A successful face recognition methodology depends heavily on the particular choice of the features used by the pattern classifier .The Back-Propagation is the best known and widely used learning algorithm in training multilayer perceptrons (MLP) .The MLP refer to the network consisting of a set of sensory units (source nodes) that constitute the input layer, one or more hidden layers of computation nodes, and an output layer of computation nodes. The input signal propagates through the network in a forward direction, from left to right and on a layer-by-layer basis. Back propagation is a multi-layer feed forward, supervised learning network based on gradient descent learning rule. This BPNN provides a computationally efficient method for changing the weights in feed forward network, with differentiable activation function units, to learn a training set of input-output data. Being a gradient descent method it minimizes the total squared error of the output computed by the net. The aim is to train the network to achieve a balance between the ability to respond correctly to the input patterns that are used for training and the ability to provide good response to the input that are similar.[1]

2.3.1 Back Propagation Algorithm:
A typical back propagation network] with Multi-layer, feed-forward supervised learning is as shown in the figure. 2. Here learning process in Back propagation requires pairs of input and target vectors. The output vector ‘o ‘is compared with target vector’t ‘. In case of difference of ‘o’

www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-1366-1370 ISSN: 2249-6645

and't'vectors, the weights are adjusted to minimize the difference. Initially random weights and thresholds are assigned to the network. These weights are updated every iteration in order to minimize the mean square error between the output vector and the target vector.

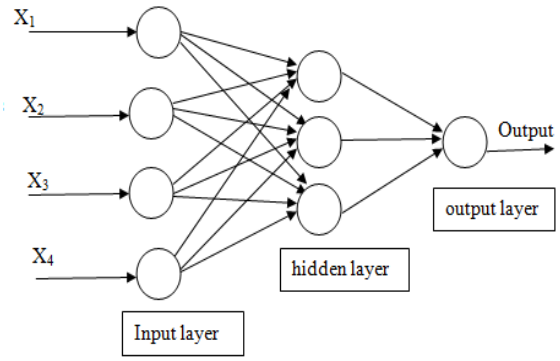


Fig 2: Multilayered neural network. [1]

In formula Pk output signals of BPNN are determined as[7]:

$$P_k = f_k\left(\sum_{j=1}^{h2} v_{jk} \cdot f_j\left(\sum_{i=1}^{h1} u_{ij} \cdot f_i\left(\sum_{l=1}^{m} w_{li} \cdot x_l\right)\right)\right) \quad (7)$$

$$P_k = 1/\left(1 + e^{-\sum_{j=1}^{h2} v_{jk} \cdot y_j}\right) \quad (8)$$

2.3.1 Parameters Learning:

At the beginning, the parameters of BPNN are generated randomly. The parameters v_{jk}, u_{ij}, and w_{li} of BPNN are weight coefficients of second, third and last layers, respectively. Here k=1,..,n, j=1,..,h2, i=1,..,h1, l=1,..,m. To generate BPNN recognition model, the training of the weight coefficients of v_{jk}, u_{ij}, and w_{li}. s has been carried out. During training the value of the following cost function is calculated

$$E = 1/2 \sum_{k=1}^{n} (P^d_k - P_k)^2 \quad (9)$$

Here n is the number of output signals of the network and P^d_k and P_k are the desired and the current output values of the network, respectively. The parameters vjk, uij, and wli of neural network are self adjusted. The adaptive learning rate is applied in order to increase learning speed and guarantee convergence. The following strategy is applied for every given number of epochs.

2.3.2 Selection of training parameters:

For the efficient operation of the back propagation network it is necessary for the appropriate selection of the parameters used for training. Initial Weights

This initial weight will influence whether the net reaches a global or local minima of the error and

if so how rapidly it converges. To get the best result the initial weights are set to random numbers between -1 and 1.

2.3.2.1 Training a Net :

The motivation for applying back propagation net is to achieve a balance between memorization and generalization; it is not necessarily advantageous to continue training until the error reaches a minimum value. The weight adjustments are based on the training patterns. As along as error the for validation decreases training continues. Whenever the error begins to increase, the net is starting to memorize the training patterns. At this point training is terminated.

Number of Hidden Units If the activation function can vary with the function, then it can be seen that a n-input, m output function requires at most 2n+1 hidden units. If more number of hidden layers are present, then the calculation for the _'s are repeated for each additional hidden layer present, summing all

the _'s for units present in the previous layer that is fed into the current layer for which is being calculated.

2.3.2.2 Learning rate :

In BPN, the weight change is in a direction that is a combination of current gradient and the previous gradient. A small learning rate is used to avoid major disruption of the direction of learning when very unusual pair of training patterns is presented. Various parameters assumed for this algorithm are as follows.

No.of Input unit = 1 feature matrix

Accuracy = 0.001

learning rate = 0.4

No.of epochs = 400

No. of hidden neurons = 70

No.of output unit = 1

III. CONCLUSION

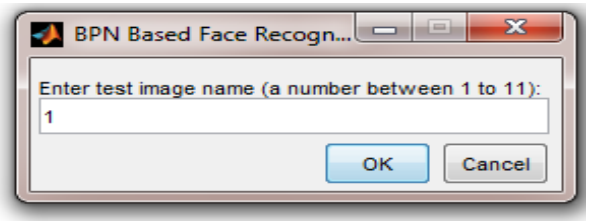
The neural networks aimed at providing artificial intelligence to the system. Neural networks using back propagation is presented in this paper for face recognition The recognition rate of BPNN system was found to be 99.25%.The identification result obtained using the neural network approach illustrates the success of its efficient use in face recognition. The BPNN algorithm is preferred over other neural network algorithms because of its unique ability to minimize errors. BPNN is found to be very accurate where recognition is required over other neural networks. Main advantage of this back propagation algorithm is that it can identify the given image as a face image or non face image and then recognizes the given

www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-1366-1370 ISSN: 2249-6645

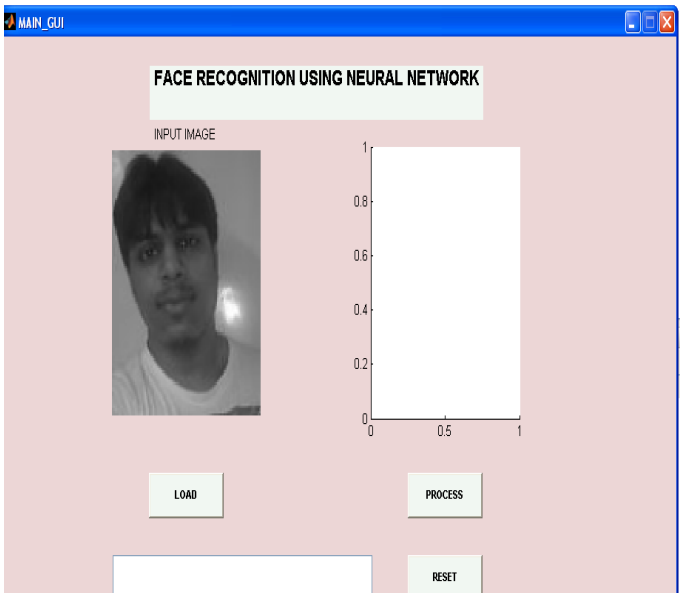
input image .Thus the back propagation neural network classifies the input image as recognized image.

IV. RESULTS AND DISCUSSION

Step1: Testing of image



Step2: Selected image is displayed



Step3: Recognized Image

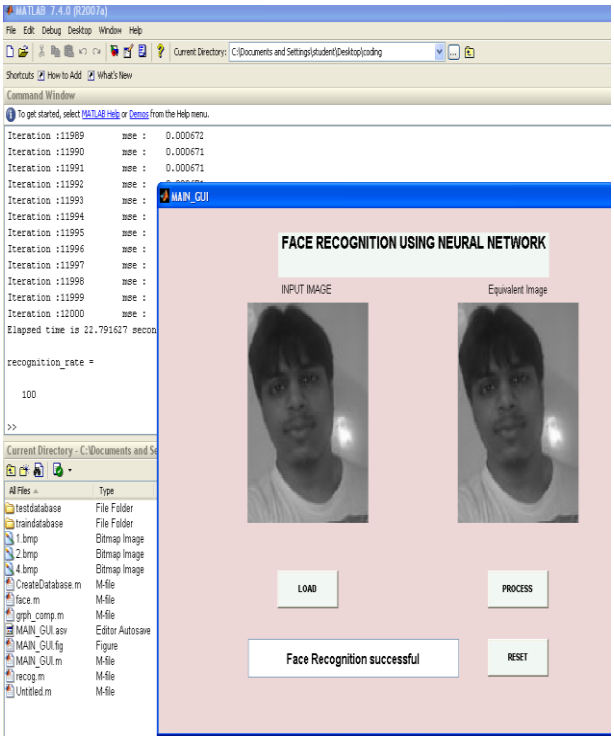


Fig 3: The obtained result on MATLAB

The first step consists of a basic input step where we need to give the input image to be recognized. This is done by pressing the push button"load" .This is shown in the step 1 in the above figure. The second step shows the image selected for recognition in the left hand side box. After this we start the recognition process by pressing on the push button"process".

The final step shows the recognized image in the right hand side box. In workspace of the MATLAB we even got the elapse time needed in the entire recognition process. For the above example the elapse time was 22.9secs.

Performance Comparisons: In this section we found that as we increase the number of subjects in the recognition process,the execution time goes on increasing and the efficiency of recognition also decreases. Also graphical results shows that the BPNN algorithm with PCA is more accurate and quick then PCA alone.

www.ijmer.com Vol.2, Issue.3, May-June 2012 pp-1366-1370 ISSN: 2249-6645

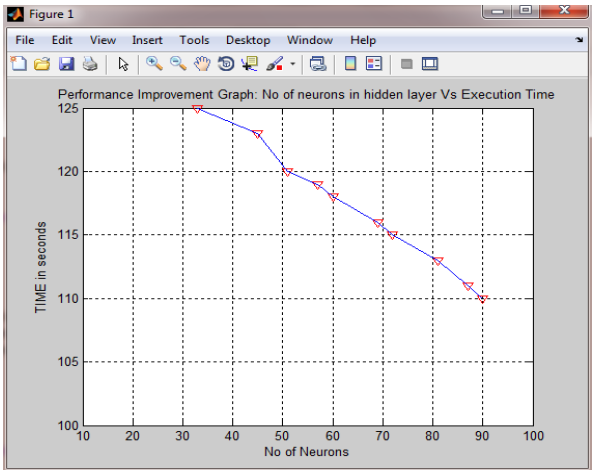


Fig 4:Graph of execution time versus no. of neurons

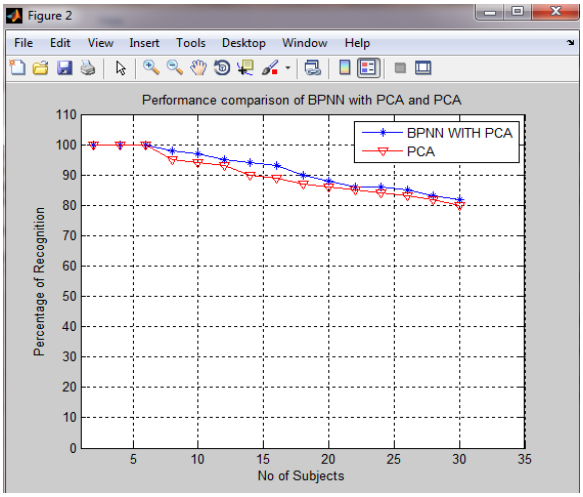


Fig 5 :Graphical comparison between BPNN with PCA and PCA in terms of recognition rate

VI. REFERENCES

BOOKS:

[1] S.N.Sivanandam Introduction *To Neural Network Using Matlab* 6.0 –, 2nd edition Tata McGraw Hill publications.

[2] Rafael C. Gonzalez, Richard E. Woods *Digital Image Processing*, 2nd edition — PHI publication.

[3] Simon Haykin *Introduction to Neural Network* –, 2nd edition, McGraw Hill Publication.

JOURNAL PAPERS:

[4] R. Rojas(1996), *Neural Network An Introductions*, Springer-Verlag, Berlin,"IEEE Transactions of Neural Networks. vol.8, no.1,pp158-200

[5] 'Pattern Recognition and Neural Networks'by B.D. Ripley Cambridge University Press, 1996, ISBN 0-521-46086-7

[6] Xiaofei He, Shuicheng Yan, Yuxiao Hu, Partha Niyogi, and Hong-Jiang Zhang, "*Face Recognition Using Laplacianfaces*" IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, VOL. 27, NO. 3, MARCH 2005

[7] Igor Aizenberg, Naum Aizenberg, Constantine Butakov, Elya Farberov*," Image Recognition on the Neural Network based on Multi-Valued Neurons"* Neural Networks Technologies Ltd., Hashmonaim str., 3, Bnei-Brak, 51264, Israel

[8] Henry A. Rowley, Shumeet Baluja, and Takeo Kanade *Neural Network-Based Face Detection*(PAMI, January 1998) pp 4-20

[9] Santaji Ghorpade, Jayshree Ghorpade, Shamla Mantri, Dhanaji Ghorpade *"NEURAL NETWORKS FOR FACE RECOGNITION USING SOM*",Dept. of Information Technology Engineering, Pune University, India, IJCST Vol. 1, Iss ue 2, December 2010

[10] 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.

[11] Jawad Nagi, Syed Khaleel Ahmed, Farrukh Nagi "*A MATLAB based Face Recognition System using Image Processing and Neural Networks*" Department of Electrical , Electronics and Mechanical Engineering Universiti Tenaga Nasional, Malaysia, 4th International Colloquium on Signal Processing and its Applications, March 7-9, 2008,.