Literature Review on Face Recognition using Principle Component Analysis

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ABSTRACT

Face Recognition is the process of identification of a person by his facial image. The paper presents a methodology for face recognition based on information theory approach of coding and decoding the face image. Proposed methodology is connection of two stages – Feature extraction using principle component analysis and recognition using the feed forward back propagation Neural Network. *The algorithm has been tested on 400 images (40 classes). Test results gave a recognition rate of 97.018%.*

Keywords: *Face recognition, Principal component analysis(PCA), Artificial Neural network (ANN), Eigenvector, Eigenface.*

INTRODUCTION

Face recognition is a pattern recognition task performed specifically on faces. Face recognition has become an interesting research area in vision system, image analysis,pattern recognition and bio-metric technology. The face is the primary focus of attention in the society,playing a major role in conveying identity and emotion.Although the ability to infer intelligence or character from facial appearance is suspect, the human ability to recognize faces is remarkable. A human can recognize thousands of faces learned throughout the lifetime and identify familiar faces at a glance even after years of separation. Face recognition has become an important issue in many applications such as security systems, credit card verification, criminal identification etc. Developing a computational model of face recognition is quite difficult, because faces are complex, multi-dimensional visual stimuli. Therefore, face recognition is a very high level computer vision task, in which many early vision techniques can be involved.

I. RELATED WORK

There are two basic methods for face recognition. The first method 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. Another method is based on the information theory concepts viz. principal component analysis method. In this method, information that best describes a face is derived from the entire face image.

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.

II. PROPOSED TECHNIQUE

The proposed method is independent of any judgment of features (open/closed eyes, different facial expressions, with and without Glasses). The face recognition system is as follows:

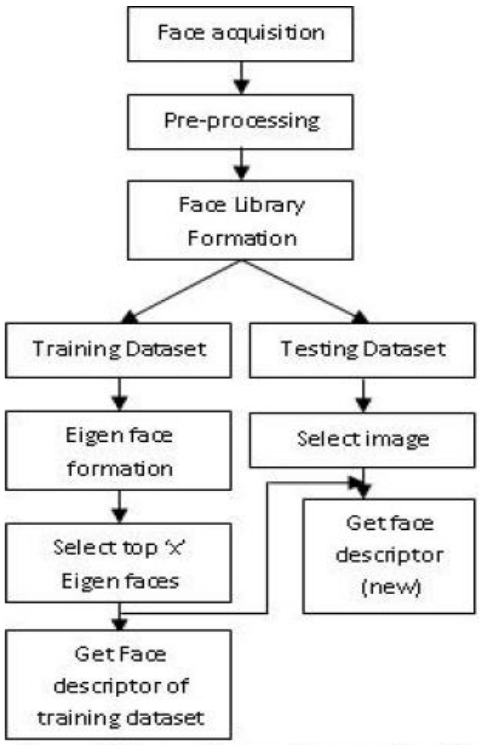


Fig. 1 – Face Library Formation and getting face

Face images are stored in a face library in the system. Every action such as training set or Eigen face formation is performed on this face library. The face library is further divided into two sets – training dataset (60% of individual image) and testing dataset (rest 40%images). The process is described in Fig. 1.

The face library entries are normalized. Eigenfaces are calculated from the training set and stored. An individual face can be represented exactly in terms of a linear combination of eigenfaces. The face can also be approximated using only the best M eigenfaces, which have the largest eigenvalues. It accounts for the most variance within the set of face images. Best M eigenfaces span an M-dimensional subspace which is called the "face space" of all possible images.

For calculating the eigenface PCA algorithm was used. It includes the calculation of the average face φ) in the face space and then further compute each face difference from the average. The difference is used to compute a covariance matrix (C) for the dataset. The covariance between two sets of data reveals how much the sets correlate.Based on the statistical technique known as PCA, the number of eigenvector for covariance matrix can be reduced from N (the no. of pixels in image) to the number of images in the training dataset.
Only M eigenfaces of highest eigenvalue are actually needed to produce a complete basis for the face space.A new face image (Γ) is transformed into its eigenface components (projected onto "face space") by a simple operation,

$$W_k = U_k^T(\Gamma - \varphi) \qquad for\ k = 1,2,\ldots\ldots M'$$

The weights Wk formed feature vector or face descriptor

$$\Omega^T = [W_1\, W_2\, \ldots\ldots W_{M'}]$$

ΩT describes the contribution of each eigenface in representing the input face image, treating the eigenfaces as a basis set for face images. The feature vector/face descriptor is then used in a standard pattern recognition algorithm. In the end, one can get a decent reconstruction of the image using only a few eigenfaces (M).

Training of Neural Networks

One ANN is used for each person in the database in which face descriptors are used as inputs to train the networks [3]. During training of the ANN's, the faces descriptors that belong to same person are used as positive examples for the person's network (such that network gives 1 as output), and negative examples for the others network (such that network gives 0 as output). Fig.2 shows schematic diagram for the networks training.

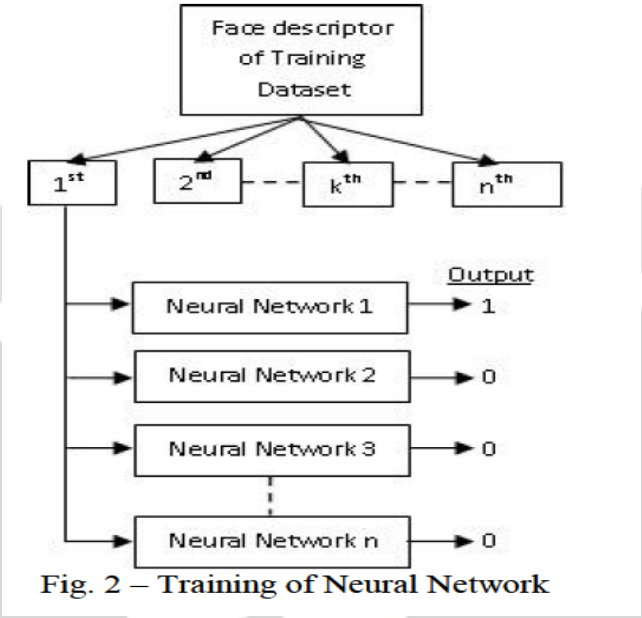


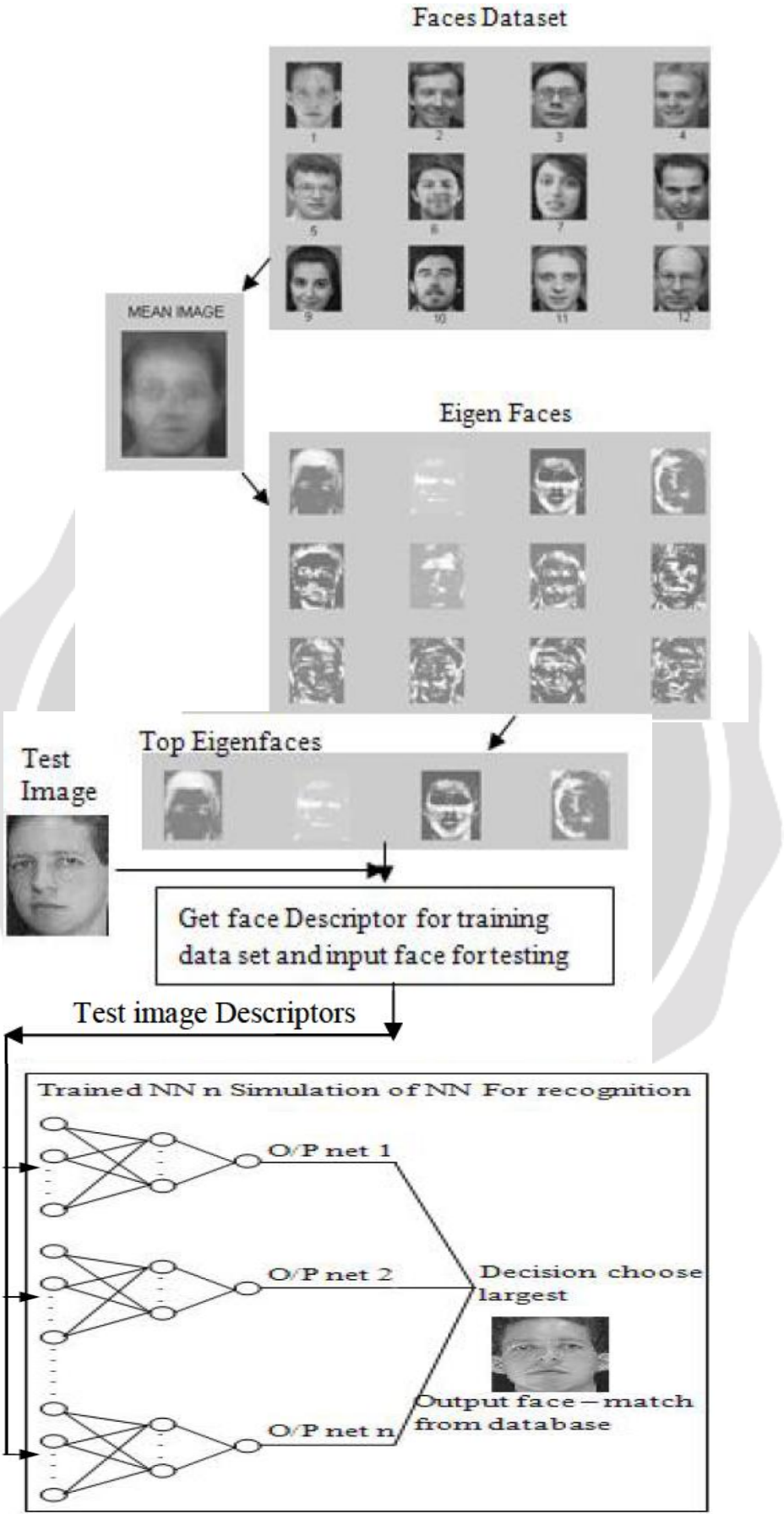
Fig. 2 – Training of Neural Network

The proposed method is tested on ORL face database. Database has more than one image of an individual's face with different conditions. (expression, illumination, etc.). There are ten different images of each of 40 distinct subjects. Each image has the size of 112 x 92 pixels with 256 levels of grey. For some subjects, the images were taken at different times, varying the lighting, facial expressions (open / closed eyes, smiling / not smiling) and facial details (glasses / no glasses). All the images were taken against a dark homogeneous background with the subjects in an upright, frontal position (with tolerance for some side movement). The original pictures of 112x92 pixels have been resized to 56 x 46 so that the input space has the dimension of 2576.

The numbers of network used are equal to number of subjects in the database. The initial parameters of the Neural Network used in the experiment are given below:

Type: Feed forward back propagation network
Number of layers: 3 (input, one hidden,output layer)
- Number of neurons in input layer : Number of eigenfaces to describe the f aces
- Number of neurons in hidden layer : 10
- Number of neurons in output layer : 1

Since the number of networks is equal to the number of people in the database, therefore forty networks, one for each person was created. Among the ten images, first 6 of them are used for training the neural networks, then these networks are tested and their properties are updated. The trained networks would be used later on for recognition purposes. For testing the whole database, the faces used in training, testing and recognition are changed and the recognition performance is given for whole database.


Faces Dataset
MEAN IMAGE
Eigen Faces
Top Eigenfaces
Test Image
Get face Descriptor for training data set and input face for testing
Test image Descriptors
Trained NN n Simulation of NN For recognition
O/P net 1
O/P net 2
O/P net n
Decision choose largest
Output face – match from database

ANALYSIS

The proposed techniqueis experimented and analyzed by varying the number of eigenfaces used for feature extraction and recognition rate was recorded. Further the same experiment is repeated three times to get the more accurate result. Finally the average of the three experiments has been taken results are shown in the Table 1.

Table I: Recognition score of Face recognition using PCA and ANN.

No of Eigen Faces	Recognition Rate (%)			
	Result 1	Result 2	Result 3	Average of Result 1-3
20	98.037	96.425	96.487	96.983
30	96.037	96.581	96.581	96.399
40	96.506	96.45	97.012	96.656
50	**96.525**	**97.231**	**97.3**	**97.018**
60	94.006	94.987	95.587	94.860
70	94.643	96.031	95.556	95.410
80	94.950	94.837	95.212	95
90	93.356	94.431	93.439	93.742
100	95.250	93.993	93.893	94.379

The result derived from proposed method is compared with the other techniques which are 1. K-means [2], 2. Fuzzy Ant with fuzzy C-means.[2] Comparison of the result has been tabulated in Table II.

Table II: Comparison of the result

Method	Recognition Rate
K-means	86.75
Fuzzy Ant with fuzzy C-means	94.82
Proposed	**97.018**

CONCLUSION

The paper presents a face recognition approach using PCA and Neural Network techniques. The result is compared with K-means, Fuzzy Ant with fuzzy C-means and proposed technique gives a better recognition rate then the other two. In the Table I one can see the recognition rate by varying the eigenfaces and the maximum recognition rate obtained for the whole dataset is 97.018.

References

[1] Yuille, A. L., Cohen, D. S., and Hallinan, P. W., "Feature extraction from faces using deformable templates", Proc. of CVPR, (1989)

[2] S. Makdee, C. Kimpan, S. Pansang, “Invariant range image multi - pose face recognition using Fuzzy ant algorithm and membership matching score” Proceedings of 2007 IEEE International Symposium on Signal Processing and Information Technology,2007, pp. 252-256