Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 5, May 2014, pg.780 – 787

RESEARCH ARTICLE

A Novel Approach for Face Recognition Using PCA and Artificial Neural Network

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Abstract— Face recognition is a biometric tool for verification and authentication a facial recognition based verification system can further be deemed a computer application for automatically verifying or identifying a person in a digital image. Analytic (local features based) and holistic (global features based) are the two common approaches employed for face recognition approaches with acceptable success rates. In this paper, we present a hybrid features based face recognition Technique .It combines the local and global approaches to produce a high success rate face recognition system. . Experiments are carried out on the SDUMLA-HMT face database. Principal component analysis is used to compute global features while the local feature are computed configuring the central moment and Eigen vectors and the standard deviation of the nose, eyes and mouth segments of the human face as the decision support entities of Artificial neural network.

Keywords— face recognition; analytic approach; holistic approach; hybrid features; central moment; standard deviation; eigen vectors; artificial neural network

I. INTRODUCTION

Biometrics refers to the quantifiable data (or metrics) related to human characteristics and traits. Biometrics identification (or biometric authentication) is used as a form of identification and access control. It is also used to identify individuals in groups that are under surveillance. Biometric identification is becoming more popular of late owing to the current security requirements of society in the field of military, business, information, e- commerce and etc. For our use, biometrics refers to technologies for measuring and analyzing a person's behavioral or physiological features. These features are unique to individuals hence can be used to identify or verify a person. In general, biometric systems process raw information in order to extract a template which is easier to process and store, which carries most of the information needed.

Face recognition is a nonintrusive method, and facial images are the most common biometric characteristics used by humans to make a personal recognition and verification. Human faces are complex objects with characteristics that can vary over time. However, we humans have a capability to recognize faces and indentify person at the spur of the second. Of course, our natural recognition capability extends beyond face recognition too. In Human Computer Interface (HCI), the machines are to be trained to recognize and identify and differentiate the human faces.

There is thus a requirement to simulate recognition artificially in our attempts to create intelligent autonomous machines. Now a days face recognition is attracting much attention in the field of network multimedia information access.

Basically, a face recognition system can be illustrated by the following block diagram

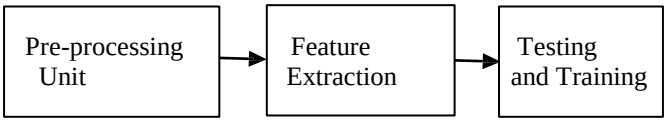

Fig. 1 Basic block diagram of a face recognition system

1) *Pre-processing Unit:* In the initial stage, the image captured in the original colour format is converted to gray scale image and then it is resized to a predefined standard and noise is removed. Further Discrete Wavelet Transform (DWT) and Histogram Equalization (HE) are carried out for expression normalization and illumination normalization respectively.

2) *Feature Extraction:* In this stage, features of face are extracted using Discrete Cosine Transform (DCT) coefficients, Principal Component Analysis (PCA) Technique, Edge Detection Techniques, DWT coefficients or combination of different techniques.

3) *Training and Testing:* In this phase, Hamming Distance, Euclidean Distance (ED), Support Vector Machine (SVM), Random Forest (RF) and Neural Network may be used for training followed by testing the new images or the test images for recognition.

The popular techniques for face recognition are based either on the shape and location of facial attributes such as the eyebrows, eyes, lips, nose and chin, and their spatial relationships, or the overall analysis of the face image that represents a face as a weighted combination of a number of canonical faces.

In the former approach the local attributes of the face are considered in training and testing while the latter approach reckons in the information derived from the whole face. The local features based approach demand a vast collection of database images for effective training thus increasing the computation time. The global technique works well with frontal view face images but they are sensitive to translation, rotation and pose changes.

Since, these two approaches do not give a complete representation of the facial image, hybrid features based face recognition system using principal component analysis and artificial neural network is designed.

This paper presents the face recognition method using PCA which extracts the geometrical features of the biometrical characteristic of the face such as nose, eyes and mouth and the overall analysis of the whole face is carried out. After the pre-processing stage, segments of the nose, eyes and mouth are extracted from the faces of the dataset. These blocks are then resized and the training features are calculated. Principal component analysis is used to compute global features of face. These facial features reduce the dimensionality by gathering the essential information and while removing all redundancies present in the segment. Besides, the global features of the total image are also calculated. These designed features are then used as decision support entities of the classifier system configured using the Artificial neural network. Experiments are carried out on the SDUMLA-HMT face database.

II. PRINCIPLE COMPONENT ANALYSIS

In this proposed methodology PCA is used to extract the features of the face images that are present in database. PCA, it is a dimensionality reduction procedure and it retain the majority of the variations present in the data set. It capture the variations the dataset and use this information for encoding of the face images. It calculates the feature vectors for different face points and then forms a column matrix of these vectors. Steps of PCA algorithm are shown in Fig. 2.

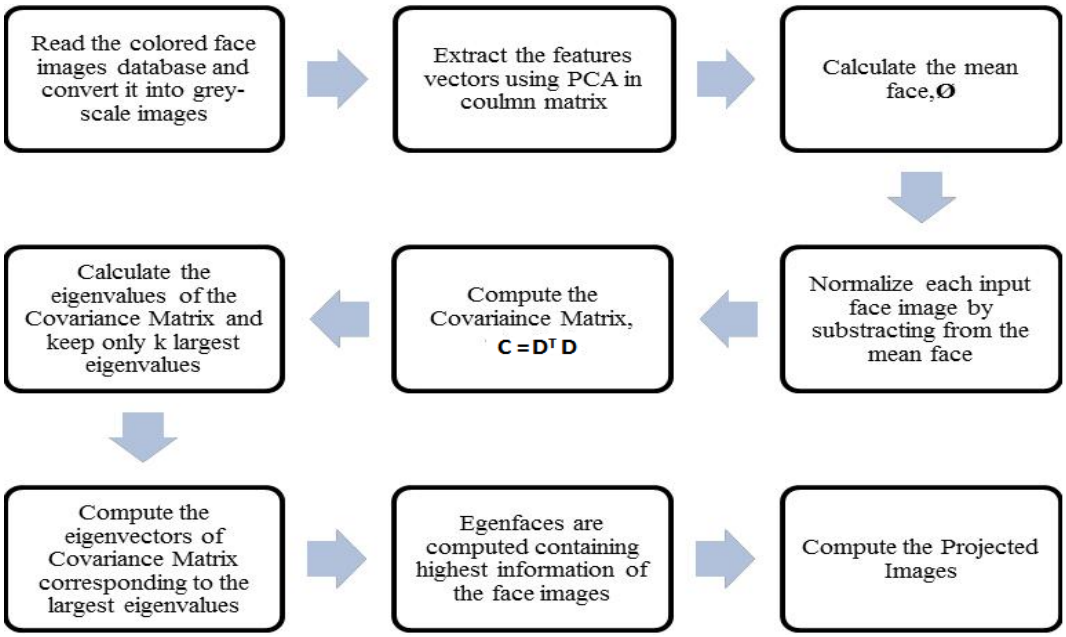

Fig. 2 Features extraction using PCA by computing eigenfaces

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

- Assume the m sample images contained in the database as $\mathbf{D_1, D_2, D_3 \ldots\ldots D_m}$.
- The average image Ø is computed, as: $\mathbf{Ø = \sum D_l / M,}$ where 1< L<M, each image will be a column vector the same size.
- The covariance matrix is calculated as by $\mathbf{C = D^T D}$ where $\mathbf{D = [O_1\ O_2\ O_3 \ldots O_m]}$.
- Calculate the eigenvalues of the covariance matrix **C** and keep only **k** largest eigenvalues for dimensionality reduction as $\lambda_k = \sum^{m}_{n=1}(U_K^T\ O_n)$.
- Eigenfaces are the eigenvectors U_K of the covariance matrix C corresponding to the largest eigenvalues.
- All the centered images are projected into face space on eigenface basis to compute the projections of the face images as feature vectors as: $\mathbf{w = U^T O = U^T (D_i - Ø)}$, where 1< i<m.

PCA method calculates the maximum variations in data with converting it to low dimensional image space from high dimensional image space. These extracted projections of images are then processed to Artificial Neural Networks for training and testing purposes.

III. EIGENVECTOR WITH HIGHEST EIGEN VALUE

An eigenvector of a matrix is defined as vector such that, if multiplied with the matrix, the outcome is always an integer multiple of that vector. This integer value is the corresponding Eigenvalue of the eigenvector. This relationship can be described by the following equation:

$M \times u = \times u$, where u is an eigenvector of the matrix. M is the matrix and is the corresponding Eigenvalue. Eigenvectors possess following properties:

- Eigenvectors can be determined only for square matrices.
- There are n eigenvectors (and corresponding Eigenvalues) in an $n \times n$ matrix.
- All eigenvectors are perpendicular to each other.

The conventional motivation for selecting the Eigenvectors with the largest Eigenvalues is that the Eigenvalues constitutes the amount of variance along a particular Eigenvector. By selecting the Eigenvectors with the largest Eigenvalues, one selects the dimensions along which the images vary the most. Since the Eigenvectors are ordered from high to low by the amount of variance found between images along each Eigenvector, the last Eigenvectors find the smallest amounts of variance. Frequently the assumption is made that noise is associated with the lower valued Eigen values where smaller amounts of variation are found among the gallery images.

IV. **ARTIFICIAL NEURAL NETWORK**

In computer science and related fields, artificial neural networks (ANNs) are computational models inspired by an animal's central_nervous_systems (in particular the brain) which is capable of machine learning as well as pattern_classification and recognition. Artificial neural networks are generally presented as systems of interconnected "neurons" which can compute values from inputs.

ANNs identify and correlate patterns between input data sets and corresponding target values even when underlying data relationship is unknown. Once trained, these can predict the outcome of new independent input data. An important feature of ANNs is their adaptive nature, where 'learning by example' replaces 'programming' in solving the problem. This feature makes such computational representations very appealing in application domains where one has little or incomplete understanding of the problem to be solved but where training data is readily available.

In this work we use a Multilayer Feed-Forward Network. It consists of multiple layers. The architecture of this type of network, have the input and the output layers, also have one or more intermediary layers. These intermediary layers are called hidden layers. The computational units of the hidden layer are known as *hidden neurons*. The hidden layer does intermediate computation before directing the input to output layer. The neurons of input layer are linked to the neurons of hidden layer; the weights on these links are referred to as input-hidden layer weights. The neurons of hidden layer and the corresponding weights are referred to as output-hidden layer weights.

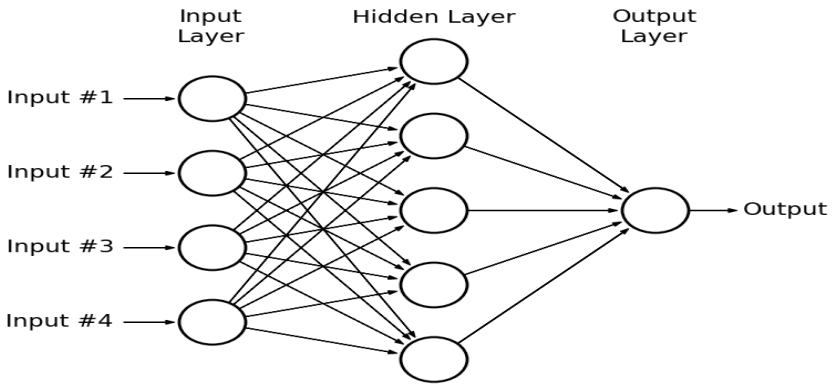

Fig. 3 Multilayered feed-forward network configuration

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In face recognition system that uses ANN, the configuration works in the following stages:-

 Input to Feed Forward Network: - In this stage, the parameters are selected to conduct required Neural Networks operation i.e. the number of input layers, hidden layers and output layers. These input neurons collect the information from the training set of face images.

 Back Propagation and Adjustment of weight: - In this stage, the input layer processes the data to the hidden layer. The hidden layer calculates the data further and then it passes processed data to the output layer. Output layer, then compares it with that of target value and obtain the error signals. These error values are sent back for weight adjustments of each layer to minimize the error as shown in Fig. 4.

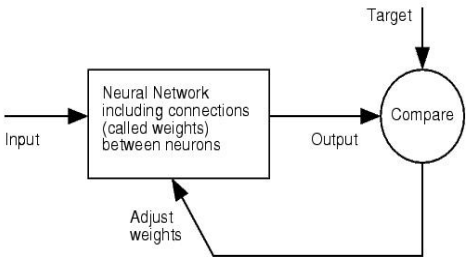

Fig. 4 Back propagation of multilayered ANN

 Mathematical Operation: - In this stage, the mathematical operation is performed on the output signal. The functions can be Tangent hyperbolic function, log-sigmoid and threshold function. If the output values of the function are same as that of the output values of the Tested face, the face is detected. Hence, the Neural Networks provides the response to the input which is same as the training data.

V. IMPLEMENTATION PROCESS

In this work, PCA technique is used to extract the features of the face images. The variations in the features of face images which contain the highest information with decomposed dimensions are extracted using PCA.

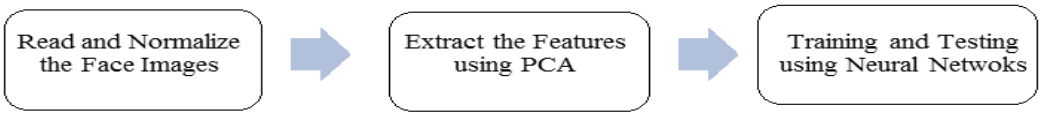

Fig. 5 Basic blocks for face recognition

Extracted features calculate the eigenfaces. These eigenfaces are then fed as input to the Artificial Neural Networks in order to train the neural networks. For testing basis, the eigenface of the tested image is provided as input to the neural networks that are trained and these neural networks finds the best match considering the threshold value for rejecting the unknown face images.

VI. RESULTS

We applied PCA for feature extraction with Artificial neural network as classifier. The experiment is carried on the SDUMLA-HMT face database. We extracted feature vectors using PCA with an application program coded using Matlab 7.0.

In this study, standard SDUMLA-HMT database images (10 poses for each of 40 people) were converted into JPEG image format without changing their size. For both feature extraction methods a total of six train-ing sets were composed that include varying pose counts (from 1 to 6) for each person and remaining poses are chosen as the test set. Our training sets include 40, 80, 120, 160, 200 and 240 images according to chosen pose count. For each person, poses with the same indices are chosen for the corresponding set.

The results obtained are tabulated in Table 1 which shows that the proposed method is more efficient compared to that of face recognition technique using PCA and Support Vector Machine (SVM)

TABLE I
IMPROVEMENT from the FACE RECOGNITION SYSTEM USING PCA and SVM

Type of technique	Recognition rate (in %)	Error rate on the evaluation set (in %)	Half total error rate on the evaluation set (in %)	Verification rate at 1% FAR in %):	1% FAR on the test set equals (in %)
PCA and SVM	85.52	6.64	6.12	50.00	54.14
PCA and ANN	92.99	3.03	2.70	95.49	94.95

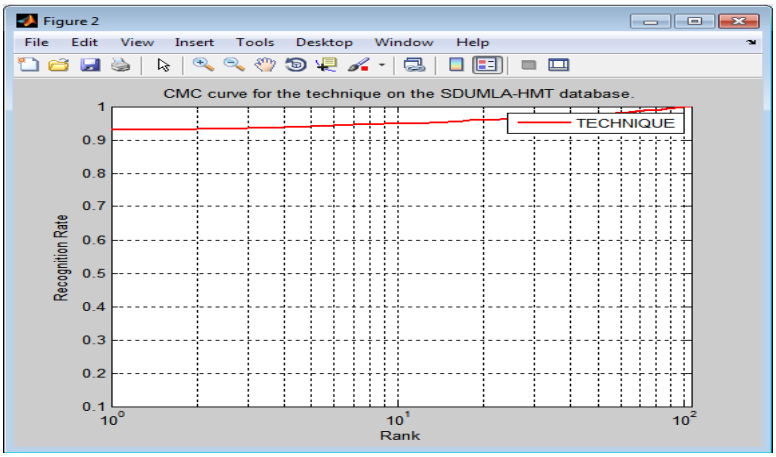

Fig. 6 Recognition rate

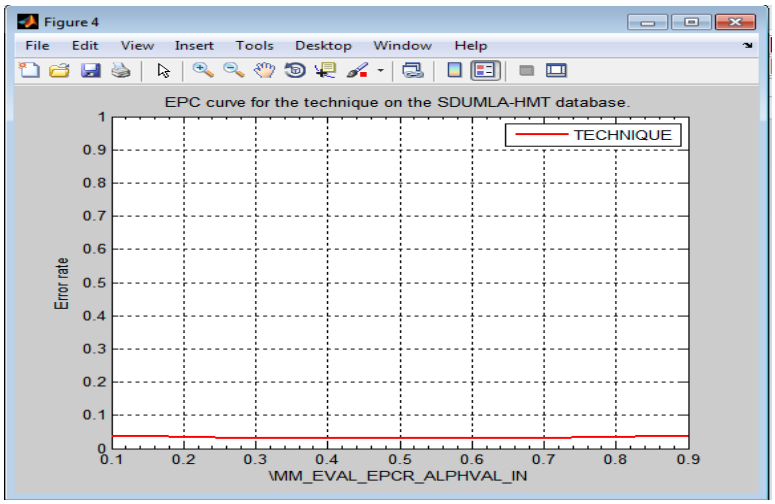

Fig. 7 Error rate

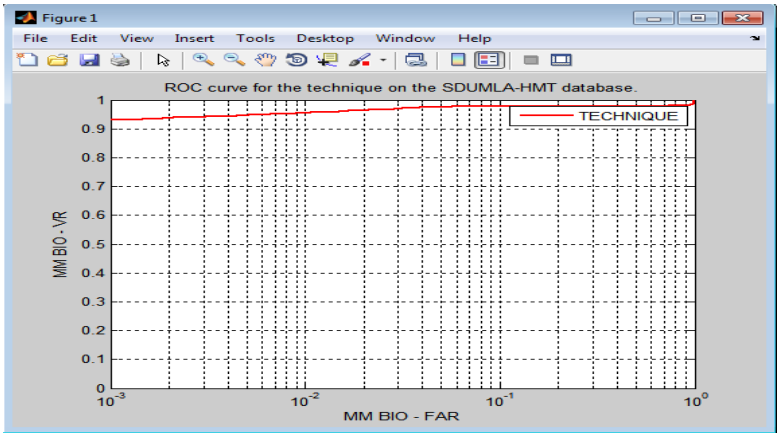

Fig. 8 Verification rate

VII. CONCLUSION

In this paper, a new Face recognition technique is presented. The new technique was considered as a combination of PCA and Artificial neural network. We used these algorithms to construct efficient face recognition technique with a high recognition rate. Proposed method consists of following parts: image pre-processing that involves histogram equalization, normalization and mean centering, dimension reduction using PCA that main features that are important for representing face images are extracted, and artificial neural network algorithm is employed to train the database. The ANN receives the features vector as input, and trains the network to learn a complex mapping for classification. Simulation results using SDUMLA-HMT face datasets demonstrated the ability of the proposed method for optimal feature extraction. Hence it is concluded that this method has the recognition rate more than 90 %.

ACKNOWLEDGMENT

I take this opportunity to express my profound gratitude and deep regards to my guide Mr. Sateesh Kumar H C for his exemplary guidance, monitoring and constant encouragement throughout the course of this thesis. The blessing, help and guidance given by him time to time shall carry me a long way in the journey of life on which I am about to embark.

REFERENCES

[1] K. Ramesha and K. B. Raja, "Dual transform based feature extraction for face recognition," International Journal of Computer Science Issues, 2011, vol.VIII, no. 5, pp. 115-120.G. Eason, B. Noble, and I. N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955.
[2] Khashman, "Intelligent face recognition: local versus global pattern averaging", Lecture Notes in Artificial Intelligence,4304, Springer-Verlag, 2006, pp. 956 – 961.
[3] Abbas, M. I. Khalil, S. Abdel-Hay and H. M. Fahmy,"Expression and illumination invariant preprocessing technique for face recognition," Proceedings of the International Conference on Computer Engineering and System, 2008, pp. 59-64.
[4] S. Ranawade, "Face recognition and verification using artificial neural network," International Journal of Computer Applications, 2010, vol. I, no. 14, pp. 21-25.
[5] Bernd Heisele, Y Purdy Ho, and Tomaso Poggio, "Face recognition with support vector machines: global versus component-based approach", in Proc. 8th International Conference on Computer Vision, pages 688–694, 2001.
[6] Peter Belhumeur, J. Hespanha and David Kriegman, "Eigenfaces versus Fisherfaces: Recognition using class specific linear projection," IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), 1997, vol. XIX, no. 7, pp.711-720.
[7] K. Ramesha , K. B. Raja, K. R. Venugopal and L. M. Patnaik, "Feature extraction based face recognition, gender and age classification," International Journal on Computer Science and Engineering, 2010, vol. II, no. 01S, pp. 14-23.
[8] Albert Montillo and Haibin Ling, "Age regression from faces using random forests," Proceedings of the IEEE International Conference on Image Processing, 2009, pp.2465-2468.
[9] H. Murase and S. K. Nayar, "Visual learning and recognition of 3-D objects from appearance," Journal of Computer Vision, vol. XIV, 1995, pp. 5-24.
[10] M. Turk and A. P. Pentland, "Face recognition using Eigenfaces," Proceedings of IEEE Conference on Computer Vision and Pattern Recognition, 1991, pp. 586-591.
[11] Peter Belhumeur, J. Hespanha and David Kriegman, "Eigenfaces versus Fisherfaces: Recognition using class specific linear projection," IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), 1997, vol. XIX, no. 7, pp.711-720.

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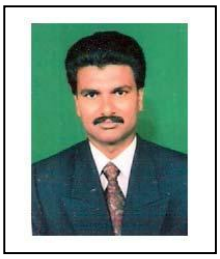

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