Volume 3, Issue 5, May 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

An Introduction to a Face Recognition System using PCA, FLDA and Artificial Neural Networks

Gunjan Mehta* , **Sonia Vatta**
School of Computer Science and Engineering
Bahra University ,India

Abstract— Face recognition is a system that identifies human faces from an image database or from a video frame . The paper presents a literature review on face recognition approaches. It then explains two different algorithms for feature extraction which are Principal Component Analysis and Fisher Faces algorithm. It also explains how images can be recognized using a Backpropagation algorithm on a Feedforward neural network and Minimum Euclidean Distance.

Keywords—- eigenfaces, fisherfaces, neural network, backpropagation, minimum euclidean distance

I. INTRODUCTION

Biometrics based human computer interfaces(HCI) are becoming the most popular systems for security and access control. Face recognition system is one such biometric HCI system. It distinguishes among various human faces and identifies a face from a digital image or a video frame from a video source. This is normally done by comparing selected facial features of the image with those in a facial database that contain multiple images of people and their information. The way humans recognize faces is highly remarkable and efficient irrespective of the changes in the visual input due to lighting conditions, background, aging, glasses.[1] To build a system that can match humans in this process is highly desirable yet very difficult to build. A basic face recognition system may follow a Face Detection System whose function is to identify a face in a given image and ignore all the other background details. After the face image is extracted it is given as input to the Face Recognition System, which first extracts basic features of a face that distinguishes one from the other and then classifiers are used to match images with those stored in the database to identify a person. Therefore a basic face recognition system contains the following sub-modules[2].

- Face Detection
- Feature Extraction
- Feature Mathing/Classification

II. LITERATURE REVIEW

Pioneers of Automated Facial Recognition include Woody Bledsoe, Helen Chan Wolf and Charles Bisson. During 1964 and 1965, Bledsoe, along with Helen Chan and Charles Bisson, worked on using the computer to recognize human faces (Bledsoe 1966a, 1966b; Bledsoe and Chan 1965).

In a work proposed by **R. Chellappa, P. J. Phillips, A. Rosenfeld entitled 'Face Recognition: A Literature Survey'[3] describes** face recognition has recently received significant attention, especially during the past several years, as one of the most successful applications of image analysis and understanding. This paper provides an up-to-date critical survey of still- and video-based face recognition research. There are two underlying motivations for them to write this survey paper: the first is to provide an up-to-date review of the existing literature, and the second is to offer some insights into the studies of machine recognition of faces. To provide a comprehensive survey, they not only categorize existing recognition techniques but also present detailed descriptions of representative methods within each category. In addition, relevant topics such as psychophysical studies, system evaluation, and issues of illumination and pose variation are covered.

In the work proposed by **Matthew Turk and Alex Pentland in 'Eigenfaces for Recognition'**[4], they have developed a near real-time computer system that can locate and track a person's head and then recognize it by comparing the features of this face with those of known individuals. They treat the face recognition problem as an intrinsically two dimensional recognition problem. The system functions by projecting face images onto a feature space that spans the significant variations among known face images. The significant features are known as 'eigenfaces', because they are the eigen vectors of the set of faces, they do not necessarily correspond to features such as eyes, ears and noses. The projection operation characterizes an individual face by a weighted sum of the eigenface features, and so to recognize a face it is necessary only to compare these weights to those of known individuals. Some particular advantages of the proposed approach are that it provides for the

ability to learn and later recognize new faces in an unsupervised manner, and that it is easy to implement using a neural network approach.

In the work proposed by **Kyungnam Kim entitled 'Face Recognition using Principal Component Analysis'**[5] illustrates that the Principal Component Analysis (PCA) is one of the most successful techniques that have been used in image recognition and compression. The purpose of PCA is to reduce the large dimensionality of the dataspace to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the data economically. The main idea of using PCA for face recognition is to express the large 1-D vector of pixels constructed from 2-D facial image into the compact principal components of the feature space. This is called eigenspace projection. Eigenspace is calculated by identifying the eigenvectors of the covariance matrix derived from a set of facial images (vectors). The paper describes the mathematical formulation of PCA and a detailed method of face recognition by PCA.

In a work by **Baocai Yin Xiaoming Bai, Qin Shi, Yanfeng Sun entitled 'Enhanced Fisherface for Face Recognition'** Journal of Information & Computational Science 2: 3 (2005) 591-595[6] Fisherface is enhanced in this paper for face recognition from one example image per person. Fisherface requires several training images for each face and can hardly be applied to applications where only one example image per person is available for training. They enhance Fisherface by utilizing morphable model to derive multiple images of a face from one single image. Region filling and hidden-surface removal method are used to generate virtual example images. Experimental results on ORL and UMIST face database show that our method makes impressive performance improvement compared with conventional Eigenface methods.

In another work contributed by **P. Latha, Dr. L. Ganesan, Dr. S. Annadurai, entitled "Face Recognition using Neural Networks"** , Signal Processing: An International Journal (SPIJ) Volume (3) : Issue (5)[7] explains that Face recognition is one of biometric methods, to identify given face image using main features of face. In this paper, a neural based algorithm is presented, to detect frontal views of faces. The dimensionality of face image is reduced by the Principal component analysis (PCA) and the recognition is done by the Back propagation Neural Network (BPNN). In this project they have used 200 face images from Yale database and some performance metrics like Acceptance ratio and Execution time have been calculated. The Neural based Face recognition approach presented in this paper is robust and has better performance of more than 90 % acceptance ratio.

In the work proposed by **Mayank Agarwal, Nikunj Jain, Mr. Manish Kumar and Himanshu Agrawal, in "Face Recognition Using Eigen Faces and Artificial Neural Network",** International Journal of Computer Theory and Engineering, Vol. 2, No. 4, August, 2010[8]. Face is explained to be a complex multidimensional visual model and developing a computational model for face recognition is said to be difficult. 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). A recognition score for test lot is calculated by considering almost all the variants of feature extraction. The proposed methods were tested on Olivetti and Oracle Research Laboratory (ORL) face database. The test results are said to give a recognition rate of 97.018%.

A. Conclusions from previous studies

From the study of the above papers it is clear that the proposed systems have all been tested on large databases. These databases allow neural networks to be trained efficiently and increase a system's efficiency. Also the research suggests that when neural networks are combined with another feature extraction algorithm such as Principal Component Analysis or Fisher's Discriminant Analysis the efficiency of the system increases.

B. Need of the proposed system

The proposed system aims to implement principal component analysis and fisher's discriminant analysis as two different feature extraction techniques and Minimum Euclidean distance and Artificial Neural Networks as recognition systems. It then presents a comparison of all the four methodologies on a smaller database and aims to draw a conclusion as to which methodology is more suitable for the proposed database.

III. OBJECTIVES

This paper will describe the design of a project that aims to implement a **Face Recognition System** using two different methodologies. The first methodology combines Principal Component Analysis Algorithm and Artificial Neural Networks on a database of 100 images with 80 as the training images and 20 as the test images and the other combines Fisher's Discriminant Analysis and Artificial Neural Networks as another on the same database. Also the size of the database is varied and the change in results with respect to execution time and acceptance ratio are evaluated.

IV. *RESEARCH METHODOLOGY*

The proposed system can be divided into two main modules. These with their sub modules are given below:

A) The Feature Extractor:

this includes the following sub-modules

- Data Acquisition
- Preprocessing
- Feature Extractor

I am using Principal Component Analysis (PCA) and Fishers' Linear Discriminant algorithm(FLDA) as two different feature extractor techniques in this project.

*1) Principal Component Analysis (PCA)***:** It is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into set of values of linearly uncorrelated variables called Principal Components.

In this project the Principal component analysis is applied to find the aspects of face which are important for identification. Eigenvectors (eigenfaces) are calculated from the initial face image set. New faces are projected onto the space expanded by eigenfaces and represented by weighted sum of the eigenfaces. These weights are used to identify the faces.

2) Fishers' Linear Discriminant Algorithm: Fisher's linear discriminant is a classification method that projects high-dimensional data onto a line and performs classification in this one-dimensional space. The projection maximizes the distance between the means of the two classes while minimizing the variance within each class. This defines the Fisher criterion, which is maximized over all linear projections, *w*: $\frac{J(w)=|m_1-m_2|^2}{S_1^2+s_2^2}$

where *m* represents a mean, s^2 represents a variance, and the subscripts denote the two classes. In signal theory, this criterion is also known as the signal-to-interference ratio. Maximizing this criterion yields a closed form solution that involves the inverse of a covariance-like matrix. This method has strong parallels to linear perceptrons. We learn the threshold by optimizing a cost function on the training set.

A) The Classifier Module:

this module consists of the following sub-modules

- Learning methods
- Classification

In the proposed process the learning module is implemented using two different techniques. These are Artificial Neural Networks and Minimum Euclidean distance classifier. Then a comparison of their outputs is done and is tabulated.

*1) Artificial Neural Networks***:** An artificial neuron is a computational model inspired by the natural neurons. In the proposed system Neural Network is used to create the face database and recognize the face. We build a separate network for each person. The input face is projected onto the eigenface space first to get a new descriptor. The new descriptor is used as network input and applied to each person's network. The one with maximum output is selected and reported as the host if it passes predefined recognition threshold.

2) Minimum Euclidean Distance: the classifier calculates distance D between features of test image and features of image in the training database. The image with the minimum distance is the recognized image.

The entire project will be implemented using Matlab R2009a

V. CONCLUSION

The paper presents a technique to implement a system that aims to describe four different methodologies for Face Recognition using PCA, FLDA, Minimum Euclidean Distance and Artificial Neural Networks. And how the system can be implemented on two different databases one large and one small. Later comparisons can be made of all the four technologies on the basis of database size, execution time and accuracy.

REFERENCES

[1] M. Turk and A. Pentland in '*Eigenfaces for Recognition'*,journal of cognitive neuroscience volume 3,number 1,1991
[2] T. H. Le , Applying Artificial Neural Networks for Face Recognition, Advances in Artificial Neural Systems Volume 2011 (2011), Article ID 673016
[3] R. Chellappa, P. J. Phillips, A. Rosenfeld entitled 'Face Recognition: A Literature Survey
[4] Turk M. and Pentland A. in 'Eigenfaces for Recognition',journal of cognitive neuroscience volume 3,number 1,1991
[5] Kim K., entitled 'Face Recognition using Principal Component Analysis'
[6] Yin B., Bai X, Qin S, Sun Y., entitled 'Enhanced Fisherface for Face Recognition' Journal of Information & Computational Science 2: 3 (2005) 591-595
[7] Latha P., L. Ganesan L., Annadurai S., entitled "Face Recognition using Neural Networks" , Signal Processing: An International Journal (SPIJ) Volume (3) : Issue (5)
[8] Agarwal M., Jain N, Kumar M., and Agrawal H., in "Face Recognition Using Eigen Faces and Artificial Neural Network", International Journal of Computer Theory and Engineering, Vol. 2, No. 4, August, 2010

