

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 4, April 2017

# Eigenface and PCA Based Face Recognition System

Radhanath Patra<sup>1</sup>, Abhilash Jagannath Dash<sup>2</sup>, Manisha Rajguru<sup>3</sup>, Simantini Sahu<sup>4</sup>

Associate Professor, Department of Electronics and Communication Engineering, Gandhi Institute of Engineering and Technology, Gunupur, Odisha, India<sup>1</sup>

B.Tech Student, Department of Electronics and Communication Engineering, Gandhi Institute of Engineering and Technology, Gunupur, Odisha, India<sup>2</sup>

B.Tech Student, Department of Electronics and Communication Engineering, Gandhi Institute of Engineering and Technology, Gunupur, Odisha, India<sup>3</sup>

B.Tech Student, Department of Electronics and Communication Engineering, Gandhi Institute of Engineering and Technology, Gunupur, Odisha, India<sup>4</sup>

**ABSTRACT:** A face recognition system is a computer application automated system which is capable of identifying and distinguishing between individuals. This is usually done by comparing the facial features of the individuals. The face recognition operation is done by extracting some landmarks or external facial features like the eyes, nose, lips, eyebrows etc. The person may be identified by comparing the digital image data with his stored record in the database.

In this project, the stored image in the database is compared with the captured image through MATLAB coding which is a 4<sup>th</sup> generation programming language developed by Mathworks.

Here a computational model is made to identify the face of an unknown person's by applying eigenfaces. The eigenfaces has been applied to extract the basic face of the human face images. The eigenfaces is then projecting onto human faces to identify unique feat In this study, we develop a computational model to identify the face of an unknown person's by applying eigenfaces. The eigenfaces has been applied to extract the basic face of the human face images. The eigenfaces is then projecting onto human faces to identify unique features vectors.

The ORL database for this investigation consists of 40 people with various 400 face images had been used for the learning. The eigenfaces including implemented Jacobi's method for eigenvalues and eigenvectors has been performed.

The main advantage of this technique is its high speed processing capability and low computational requirements in terms of both speed and memory utilization. Face recognition has become an important issue in many applications like security systems, credit card verification and criminal identification.

**KEYWORDS:** Eigen faces, Eigen vector, ORL database.

### I.INTRODUCTION

Automated face recognition is an interesting computer vision problem with many commercial and enforcement applications. Mughshot matching, user verification and user access control, crowd surveillance, enhanced human computer interaction all become possible if an effective face recognition system can be implemented. While research into this area dates back to the 1960's, it is only very recently that acceptable results have been obtained. However, face recognition is still an area of active research since a completely successful approach or model has not been proposed to solve the face recognition problem. The inadequacy of automated face recognition systems is especially apparent when

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 4, April 2017

compared to our own innate face recognition ability, We perform face recognition, an extremely complex visual task, almost instantaneously and our own recognition ability is far more robust than any computer's can hope to be. We can recognize a familiar individual under very adverse lighting conditions, from varying angles or view points. Scaling differences (a face being near or far away), different backgrounds do not affect our ability to recognize faces and we can even recognize individuals with just a fraction of their face visible or even after several years have passed. Furthermore, we are able to recognize the faces of several thousand individuals whom we have met during our lifetime.

In the language of information theory, the objective is to extract the relevant information in a face image, encode it as efficiently as possible, and compare one face encoding with a database of models encoded in the same way.

In mathematical terms, the objective is to find out the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images. The eigenvectors can be thought of as a set of features which together characterize the variation between face images. Each image location contributes more or less to each eigenvector, so that we can display the eigenvector as a sort of ghostly face called an eigenface.

## II. RELATED WORK

Face recognition presents a challenging problem in the field of image analysis and computer vision and as such has received a great deal of attention over the last few years because of its many applications in various domains. Face recognition techniques can be broadly divided into three categories based on the face data acquisition methodology: methods that operate on intensity images; those that deal with the video sequences; and those that require other sensory data such as 3D information or infra-red imagery. In the language of information theory, the objective is to extract the relevant information in a face image, encode it as efficiently as possible, and compare one face encoding with a database of models encoded in the same way. In mathematical terms, the objective is to find the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images. These eigenvectors can be thought of as a set of features which together characterize the variation between face images. Each image location contributes more or less to each eigenvector, so that we can display the eigenvector as a sort of ghostly face called an eigenface.

## III. PROBLEM STATEMENTS

In security system, many type of password are used to access the private and confidential data. Such password can be as insert characters (key in pin) and touch smart card using RFID technology. Passwords and PINs are hard to remember and can be stolen or guessed; cards, tokens, keys and the like can be misplaced, forgotten, purloined or duplicated; magnetic cards can become corrupted and unreadable. By developed face recognition it more secure because facial image had been used as the ID. It also helps to avoid any duplicated identification.

Other problem is to indentifying certain criminals especially in identification technique used by the police. Face recognition helps to recognize the facial image in more efficient and accurate in order to match with the identity stored in the database.

## IV. EIGEN FACES METHOD

The basic idea of eigenfaces is that all face images are similar in all configurations and they can be described in its basic face images. Based on this idea, the Eigen faces procedures are as follows:

- A. Obtain the face images  $I_1, I_2, \dots, I_M$  (training faces). The face images must be centered and shall be of the same size.
- B. Represent every image  $I_i$  as a vector of  $\Gamma_i$ .
- C.  $\therefore$  Compute the average face vector  $\Psi$ :

$$\Psi = \frac{1}{M} \sum_{i=1}^M \Gamma_i$$

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 4, April 2017

D<sub>2</sub>: Subtract the mean face:

$$\Phi_i = \Gamma_i - \psi$$

E. Compute the covariance matrix C:

$$C = \frac{1}{M} \sum_{n=1}^M \phi_n \phi_n^T = AA^T \quad (N^2 \times N^2 \text{ matrix})$$

$$\text{Where } A = [\phi_1 \ \phi_2 \ \dots \ \phi_M] \quad (N^2 \times M \text{ matrix})$$

F. Compute the eigenvectors  $u_i$  of  $AA^T$ .

The matrix  $AA^T$  is very large--> not practical!!

Consider the matrix  $A^T A$  ( $M \times M$  matrix)

Compute the eigenvectors  $v_i$  of  $A^T A$

$$A^T A v_i = \mu_i v_i$$

$$A^T A v_i = \mu_i v_i \Rightarrow AA^T A v_i = u_i A v_i \Rightarrow$$

$$C A v_i = \mu_i A v_i \text{ or } C \mu_i = \mu_i u_i$$

where  $u_i = A v_i$

Thus,  $AA^T$  and  $A^T A$  have the same eigenvalues and their eigenvectors are related as follows:

$$u_i = A v_i$$

Compute the M best Eigenvectors of  $AA^T$  :  $u_i = A v_i$

Keep only K eigenvectors (corresponding to the k largest eigenvalues)

### V. FORMULA FOR FACE RECOGNITION USING EIGEN FACE

Given an unknown face image  $\Gamma$  (centered and of the same size like the training faces) follow these steps:

A<sub>2</sub> Normalize  $\Gamma$ :  $\phi = \Gamma - \psi$

B. Project on the Eigenspace

$$\Phi = \sum_{i=1}^K w_i u_i \quad (w_i = u_i^T \phi)$$

$$w_1$$

C: Represent  $\phi$  as  $\Omega = w_2$

$$w_3$$

D. Find  $e_r = \min_i \|\Omega - \Omega_i\|$

$E_r$ : If  $e_r < T_r$ , then  $\Gamma$  is recognized as face I from the training set. The distance  $e_r$  is called as the distance within the face space (difs)

### VI. OUTLINE OF A TYPICAL FACE RECOGNITION SYSTEM

The There are six main functional blocks, whose responsibilities are given below:

#### a) The acquisition module

This is the entry point of the face recognition process. It is the module where the face image under consideration is presented to the system. Another word, the user is asked to present a face image to the face recognition system in this module. An acquisition module can request a face image from several different environments. The face image can be an image file that is located on a magnetic disk, it can be captured by a frame grabber or it can be scanned from paper with the help of a scanner.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 4, April 2017

## b) The pre-processing module.

In this module, by means of early vision techniques, face images are normalized and if desired, they are enhanced to improve the recognition performance of the system.

## c) The feature extraction module

After performing some pre-processing (if necessary), the normalized face image is presented to the feature extraction module in order to find the key features that are going to be used for classification. Another word, this module is responsible for composing a feature vector that is well enough to represent the face image.

## d) The classification module.

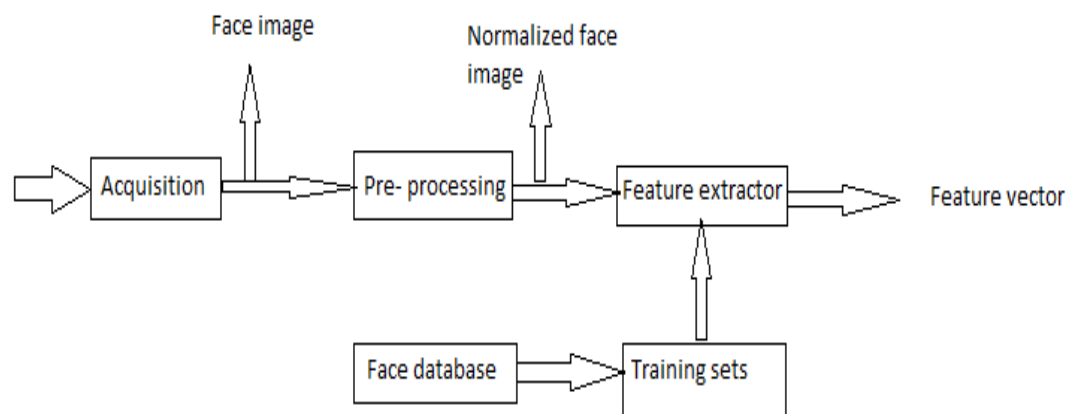
In this module, with the help of a pattern classifier, extracted features of the face image is compared with the ones stored in a face library (or face database).

After doing this comparison, face image is classified as either known or unknown.

## e) Training set.

Training sets are used during the "learning phase" of the face recognition process. The feature extraction and the classification modules adjust their parameters in order to achieve optimum recognition performance by making use of training sets.

Face library or face database. After being classified as "unknown", face images can be added to a library (or to a database) with their feature vectors for later comparisons. The classification module makes direct use of the face library



**Fig1: Outline of a Typical Face Recognition System**

## VII. OUTLINE OF THE PROPOSED FACE RECOGNITION SYSTEM

The proposed face recognition system passes through three main phases during a face recognition process. Three major functional units are involved in these phases and they are depicted in Figure 2.2. The characteristics of these phases in conjunction with the three functional units are given below:

### A. Face Library Formation Phase

In this phase, the acquisition and the preprocessing of the face images that are going to be added to the face library are performed. Face images are stored in a face library in the system. We call this face database a "face library" because at the moment, it does not have the properties of a relational database. Every action such as training set or eigenface formation is performed on this face library. Face library is initially empty. In order to start the face recognition process, this initially empty face library has to be filled with face images. The proposed face recognition system

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 4, April 2017

operates on 128 x 128 x 8, HIPS formatted image files. At the moment, scanner or camera support is unavailable. In order to perform image size conversions and enhancements on face images, there exists the "pre-processing" module. This module automatically converts every face image to 128 x 128 (if necessary) and based on user request, it can modify the dynamic range of face images (histogram equalization) in order to improve face recognition performance. Also, we have considered implementing a "background removal" algorithm in the pre-processing module, but due to time limitations, we have left this for future work. After acquisition and pre-processing, face image under consideration is added to the face library. Each face is represented by two entries in the face library: One entry corresponds to the face image itself (for the sake of speed, no data compression is performed on the face image that is stored in the face library) and the other corresponds to the weight vector associated for that face image. Weight vectors of the face library members are empty until a training set is chosen and eigenfaces are formed. .

### B. Training Phase

After adding face images to the initially empty face library, the system is ready to perform training set and eigenface formations. Those face images that are going to be in the training set are chosen from the entire face library. Because that the face library entries are normalized, no further pre-processing is necessary at this step. After choosing the training set, eigenfaces are formed and stored for later use. Eigenfaces are calculated from the training set, keeping only the M images that correspond to the highest eigenvalues. These M eigenfaces define the M-dimensional "face space". As new faces are experienced, the eigenfaces can be updated or recalculated. The corresponding distribution in the M-dimensional weight space is calculated for each face library member, by projecting its face image onto the "face space" spanned by the eigenfaces. Now the corresponding weight vector of each face library member has been updated which were initially empty. The system is now ready for the recognition process. Once a training set has been chosen, it is not possible to add new members to the face library with the conventional method that is presented in "phase 1" because, the system does not know whether this item already exists in the face library or not. A library search must be performed.

### C. Recognition and Learning Phase

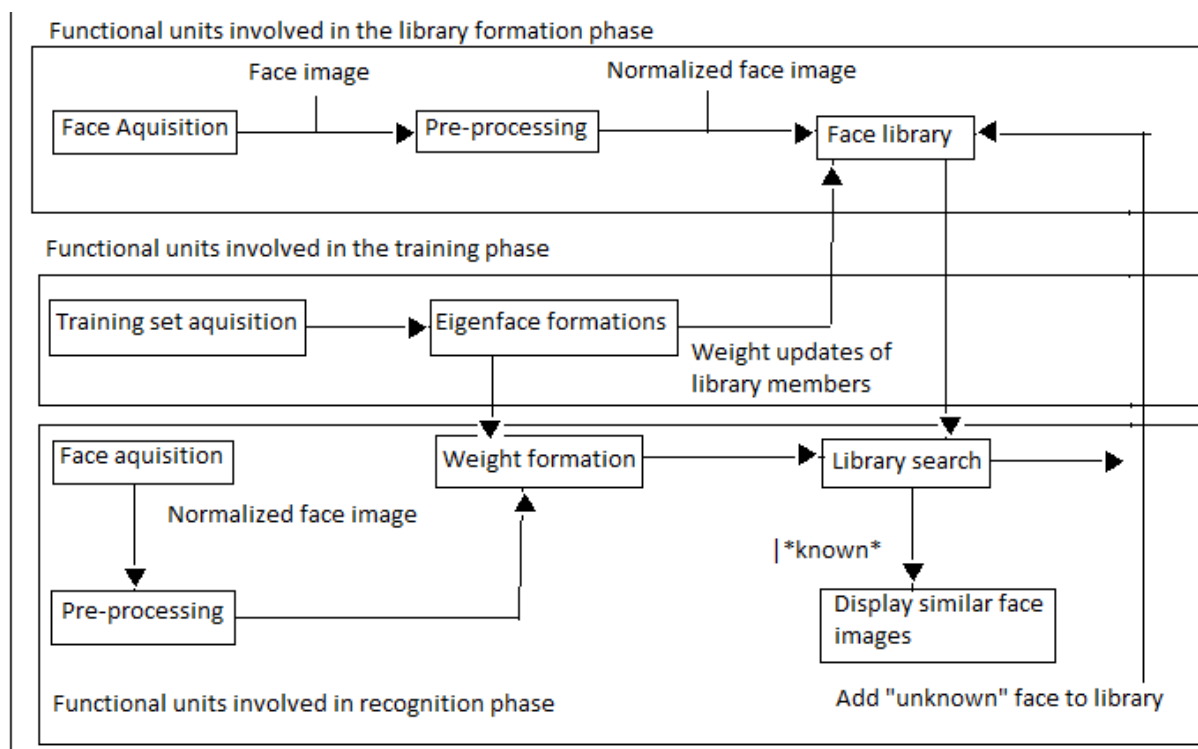
After choosing a training set and constructing the weight vectors of face library members, now the system is ready to perform the recognition process. User initiates the recognition process by choosing a face image. Based on the user request and the acquired image size, pre-processing steps are applied to normalize this acquired image to face library specifications (if necessary). Once the image is normalized, its weight vector is constructed with the help of the eigenfaces that were already stored during the training phase. After obtaining the weight vector, it is compared with the weight vector of every face library member within a user defined "threshold". If there exists at least one face library member that is similar to the acquired image within that threshold then, the face image is classified as "known". Otherwise, a miss has occurred and the face image is classified as "unknown". After being classified as unknown, this new face image can be added to the face library with its corresponding weight vector for later use (learning to recognize)

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 4, April 2017



**Fig2: Functional units involved in different phases**

### VIII. WHY CHOOSE FACE RECOGNITION?

Face recognition appears to offer several advantages over other biometric methods, a few of which are outlined here. Almost all these technologies require some voluntary action by the user, for examples, the user needs to place his hand on a hand-rest for fingerprinting or hand geometry detection and has to stand in a fixed position in front of a camera for iris or retina identification .

However, face recognition can be done passively without any explicit action or participation on the part of the user since face images can be acquired from a distance by a camera. This is particularly beneficial for security and surveillance purposes.

### IX. CONCLUSION

The face recognition system uses eigenfaces approach is quite simple, fast and off low cost. For medium level industries having less than 1000 employees it can be proved to be very handy and efficient. It is just a stepping stone on the field of artificial intelligence. In future we can use this approach to differentiate genders.

However eigenfaces based recognition is very much vulnerable to variations in light, facial expression.etc. In the end, we also implemented the eigenfaces based face recognition on Matlab and the working was satisfactory

### X. ACKNOWLEDGEMENT

I sincerely believe that I was fortunate enough to have come across a group of human beings whose mere mode of living can inspire someone to work wonders. My project guide Mr. Radhanath Patra, Assistant Professor, Department of Electronics, GIET, Gunupur, is paradigm of that suit. He not only encouraged me to pursue my studies but also instilled the self-belief and confidence, which helps me to take on various trivial, serious and inevitable hassles of life.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 4, April 2017

I am very much thankful to the Head, Department of Electronics Engineering, GIET, Gunupur, Prof Subhrajit Pradhan for his valuable suggestions and supports during the project periods.

I would also grab the opportunity to thank entire faculty group for their moral support and cooperation to make this thesis success.

My family has been the axis of my mental strength and their support leaves me with irreparable debt and honest gratitude.

## REFERENCES

- [1] S. Branson, G. V. Horn, S. Belongie, and P. Perona. Bird species categorization using pose normalized deep convolutional nets. In Proc. BMVC, 2014.
- [2] J.-C. Chen, V. M. Patel, and R. Chellappa. Unconstrained face verification using deep CNN features. CoRR, abs/1508.01722, 2015
- [3] K. Simonyan and A. Zisserman. Very deep convolutional networks for large-scale image recognition. CoRR, abs/1409.1556, 2014.
- [4] . Grother and M. Ngan. Face recognition vendor test (FRVT): Performance of face identification algorithms. In NIST Interagency report 8009, 2014.
- [5] Hariharan, P. Arbelaez, R. Girshick, and J. Malik. Simul- ´ taneous detection and segmentation. In Proc. ECCV, 2014.
- [6] . Taigman, M. Yang, M. A. Ranzato, and L. Wolf, —Deepface: Closing the Gap to Human-Level Performance in Face Verification!, Computer Vision and Pattern Recognition (CVPR), IEEE Computer Society Conference on, (2014), pp.1701-1708
- [7] PriyankaWagh, JagrutiChaudhari, RoshaniThakare, ShwetaPatil, “Attendance System based on Face Recognition using Eigen face and PCA Algorithms”, ICGIoT, IEEE conference, 2015.
- [8] Prabhjot Singh1 and Anjana Sharma, “Face Recognition Using Principal Component Analysis in MATLAB”, International Journal of Scientific Research in Computer Science and Engineering, vol. 3, issue 1.
- [9] Elena Alionte, Corneliu Lazar, “A Practical Implementation of Face Detection by Using Matlab Cascade Object Detector, ICSTCC, pp. 785790, 2015.
- [10] Dong Li, Huiling Zhou and Kin-Man Lam, (2015) High Resolution Face Verification Using Pore-Scale Facial Features IEEE transactions on image processing, Vol. 24, No. 8, pp 2317-2327
- [11] Priyanka, Dr. Yashpal Singh, (2014) A Study on Facial Feature Extraction and Facial Recognition Approaches International Journal of Computer Science and Mobile Computing, Vol. 4, pp 166-174
- [12] R.C. Gonzalez, R.E. Woods, S.L. Eddins, (2004) Digital Image Processing Using Matlab, Prentice Hall, Upper Saddle River, New Jersey.
- [13] Shemi P M, Ali M A, A Principal Component Analysis Method for Recognition of Human Faces: Eigenfaces Approach, International Journal of Electronics Communication and Computer Technology (IJECCT), Volume 2 Issue 3 (May 2012).
- [14] M. Turk, A. Pentland: Face Recognition using Eigenfaces, Conference on Computer Vision and Pattern Recognition, 3 – 6 June 1991, Maui, HI , USA, pp. 586 – 591.
- [15] Prof. Y. VijayaLata , Chandra KiranBharadwajTungathurthi , H. Ram Mohan Rao , Dr. A. Govardhan , Dr. L. P. Reddy, Facial Recognition using Eigenfaces by PCA, Department of Computer Science and Engineering, GokarajuRangaraju Institute of Engg&Tech, Jawaharlal Nehru Tech. University.
- [16] Parvinder S. Sandhu, Iqbaldeep Kaur, Amit Verma, Samriti Jindal, Inderpreet Kaur, ShilpiKumari, Face Recognition Using Eigen face Coefficients and Principal Component Analysis, International Journal on Electrical and Electronics Engineering 3:8 2009.
- [17] R. Jafri, H. R. Arabnia, “A Survey of Face Recognition Techniques”, Journal of Information Processing Systems, Vol.5, No.2, June 2009.
- [18] C. A. Hansen, “Face Recognition”, Institute for Computer Science University of Tromso, Norway.
- [19] M. D. Kelly. Visual identification of people by computer. PhD thesis, Stanford University, Stanford, CA, USA, 1971.
- [20] T. Kanade. Computer Recognition of Human Faces, 47, 1977.
- [21] W. Zhao, R. Chellappa, P. J. Phillips & A. Rosenfeld, “Face recognitions literature survey”, ACM Computing Surveys, Vol. 35, No. 4, December 2003, pp. 399–458.