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Human Face Recognition Based on PCA Method using MATLAB

Jageshvar K. Keche **Vikas K. Yeotikar** **Manish T. Wanjari** **Dr. Mahendra P. Dhore**

Abstract **- Face recognition is very hot & bold topic from a number of years because of its application. Principle Component Analysis is a statistical method used for reducing the number of variables in feature extraction and face recognition. It is one of the most successful method in face recognition. The purpose of research work is to develop a computer system that can recognize a person by comparing the individuals. In this paper we introduce a Principal Component Analysis method for face recognition. Experimental results using PCA shows that the face recognition with the help of MATLAB software.**

Keywords **- Face recognition, Principal Component Analysis, Eigenface , Euclidean distance, Face(ORL) Database.**

I. INTRODUCTION

Human face recognition has become a popular area of research in computer vision and one of the most successful applications of image analysis and processing. It has lot of attention to the researchers in recent years. Face recognition is considered to be an important part of the biometrics technique, and meaningful in scientific research [1]. It has the potential of being a non-intrusive form of biometric identification.

Face recognition task is actively being used at airports, employee entries, criminal detection systems, etc. classifier and they shows very good performance. The challenges of face recognition lie in the inherent variability arising from face characteristics like age and gender, geometry like distance and viewpoint, image quality like resolution, illumination, and signal to noise ratio, and image content like background, occlusion and disguise[2].

It is the ability to establish a subject's identity based on his facial characteristics. Automatic face recognition has been extensively studied over the past two decades due to its important role in a number of application domains, such as access control, visual surveillance [3].

Face recognition algorithms consists of two parts: a) Face localization & normalization b) Face identification. Dimensional reduction techniques are used in reducing complexity of the recognition process such as Principal Component Analysis (PCA) [3][4][5] have now been successfully applied to this problem. The aim of this research paper is to study and develop an efficient MATLAB program for face recognition using principle component analysis and to perform test for accuracy.

In this paper, we studied and presented face recognition using Principle Component Analysis method. The rest of this paper is organized as follows: Section II extends the face recognition and detection. In Section III introduces and discusses the PCA method in detail. In Section IV, shows experiments on ORL face database. Finally, conclusions are drawn with some discussions.

II. FACE RECOGNITION AND DETECTION

Face recognition method is a kind of biometric identification technology that identifies people based on their face features. The technology uses a camera or webcam to acquire images or video streams containing human faces, automatically detects and tracks the face in the image, and then performs face recognition. The face recognition system is comprised of four parts: face image acquisition and detection, face image pre-processing, facial feature extraction, and face matching and recognition. Face detection is mainly used for pre-processing purposes, i.e. to accurately mark out the position and dimensions of a face. Face detection is used to pick out useful bits of information to detect the presence of a face.

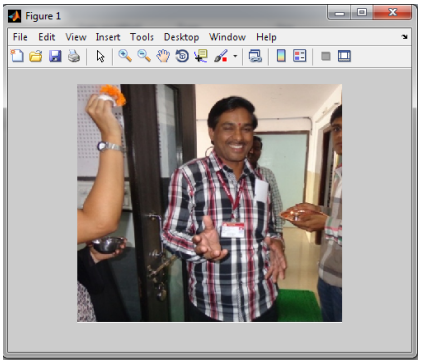

Fig.1 Original color image

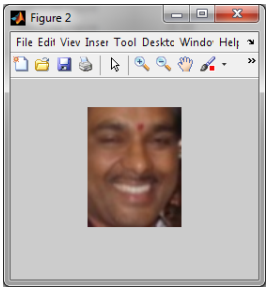

Fig.2 Extraction of face region of size 128x100 pixels

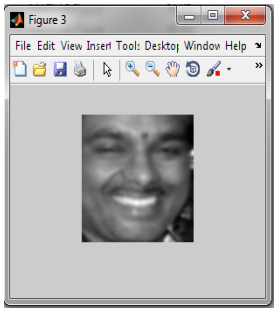

Fig. 3 Extraction of grey-scale face region of size 128x128 pixels

III. PRINCIPLE COMPONENT ANALYSIS

Principal Component Analysis is one of the most popular methods for reducing the number of variables in face recognition. It is appropriate when you have obtained measures on a number of observed variables and wish to develop a smaller number of artificial variables (called principal components) that will account for most of the variance in the observed variables. PCA is a method of transforming a number of correlated variables into a smaller number of uncorrelated variables. Similar to how Fourier analysis is used to decompose a signal into a set of additive orthogonal sinusoids of varying frequencies, PCA decomposes a signal (or image) into a set of additive orthogonal basis vectors or eigenvectors. The main difference is that, while Fourier analysis uses a fixed set of basis functions, the PCA basis vectors are learnt from the data set via unsupervised training. PCA can be applied to the task of face recognition by converting the pixels of an image into a number of eigenface feature vectors, which can then be compared to measure the similarity of two face images.

In PCA, faces are represented as a linear combination of weighted eigenvectors called as Eigenfaces [6][7][8]; These eigenvectors are obtained from covariance matrix of a training image set called as basis function. The number of Eigen faces that obtained would be equal to the number of images in the training set. Eigenfaces takes advantage of the similarity between the pixels among images in a dataset by means of their covariance matrix.

When a face image is projected to several face templates called eigenfaces then the difference between the images will be calculated which can be considered as a set of features that are considered as the variation between face images. When a set of eigenfaces is calculated, then a face image can be approximately reconstructed using a weighted combination of the eigenfaces.

Lets us consider a training database consists of N images which are of same size. The images are normalized by converting each image matrix to equivalent image vector Zi. The training set matrix Z is the set of images vectors with Training set.

$$Z = [Z1\ Z2\ \ldots..ZN] \quad \ldots. \quad (1)$$

$$\mu = \frac{1}{N}\sum_{k=1}^{q}(Z_k) \quad \ldots.. \quad (2)$$

The deviation vector for each image Ωi is given by:

$$\Omega i = Zi - \mu \text{ where } i = 1,2,\ldots N \quad \ldots. \quad (3)$$

Consider a difference matrix B= [Ω1, Ω2… ΩN] which having only the distinguishing features for face images and removes the common features. To find eigenfaces we have to calculate the Covariance matrix C of the training image vectors by [9]:

$$C=B.BT \quad \ldots. \quad (4)$$

Due to large dimension of matrix C, we consider matrix N of size (Nt X Nt) which gives the same effect with reduces dimension.

The eigenvectors of C (Matrix U) can be obtained by using the eigenvectors of N (Matrix V) as given by:

$$Ui=BVi \quad \ldots. \quad (5)$$

To find the weight of each eigenvector αi to represent the image in the Eigen face space, as given by [4]:

$$\alpha i = Ui\ T\ (Z - \mu)\ ,\ i=1,2,\ldots\ldots,\ N \quad \ldots \quad (6)$$

$$\text{Weight matrix } A = [\mu 1, \mu 2\ \ldots.\ \mu N]\ T \quad \ldots \quad (7)$$

The Euclidean distance is used to find out the distance between two face keys vectors and it is given by:

$$\text{Euclidean distance} = \sqrt{\sum_{i=1}^{D}(ai - bi)^2} \quad \ldots \quad (8)$$

On basis of that distance, we can say face is recognized or not.

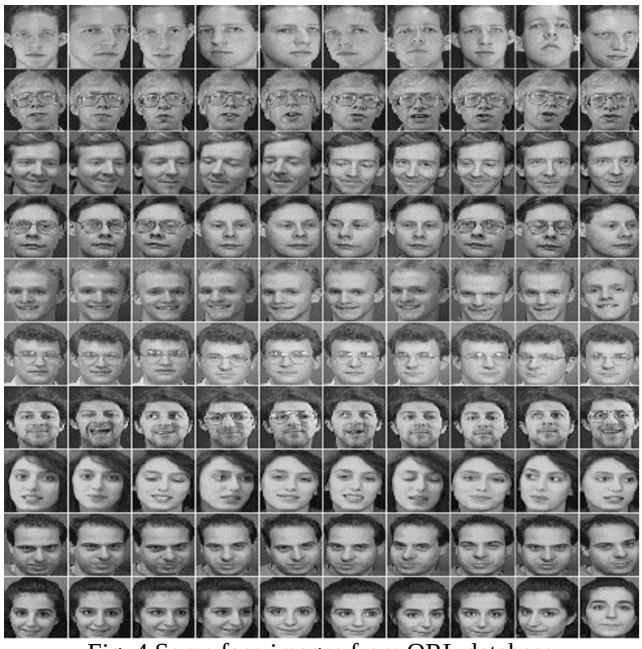

Fig. 4 Some face images from ORL database

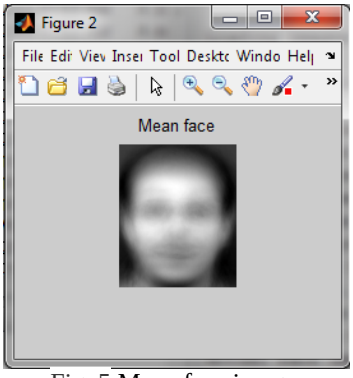

Fig. 5 Mean face image.

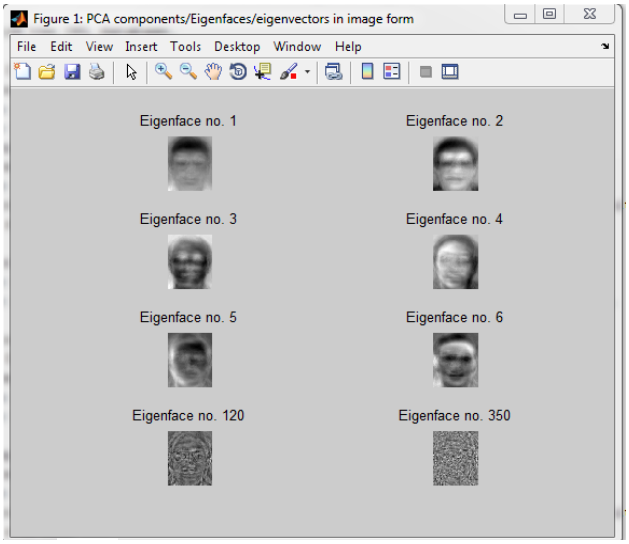

Fig. 6 Few computed eigenfaces using MATLAB

IV. Experimental Results

. We used MATLAB 7.6.0(R2008a) to implement all the experiments of Principle Component Analysis (PCA) on different face images of ORL database. We first load the images from the ORL database. After finish loading ORL images, we compute PCA subspace using the entire ORL database as training dataset. The training data comprises 400 samples (images) with 10304 variables (pixels). Then we transpose the training data matrix and finally PCA subspace constructed that is computed eigenfaces and the mean face image. The result obtained in MATLAB which is shown in fig.5 and fig.6.

Another experiment was carried for face recognition on ORL database. First loads images from the ORL database into a data matrix and then partitions this data into a training and test set. Then it computes the LDA (Linear Discriminant Analysis) subspace based on images from the training set and finally performs recognition experiments using images from the test set [10][11]. In the end, it generates a CMC (Cumulative Match Score curves) and ROC (Receiver Operating Characteristics) curves and displays them in two separate figures as shown in fig. 7 and fig.8.

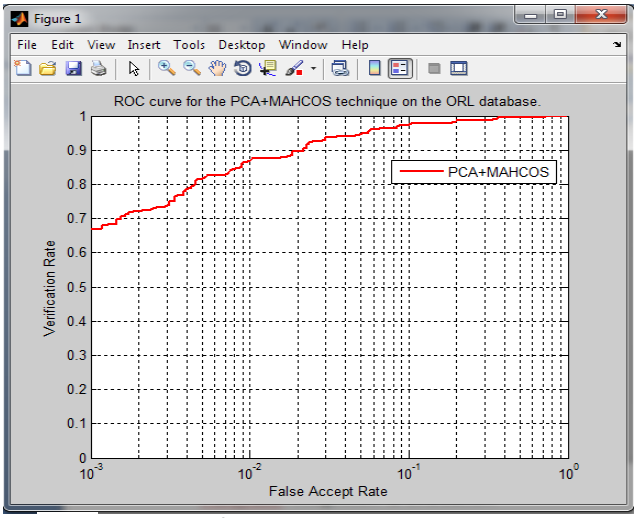

Fig. 7 Example of ROC curve generated in MATLAB

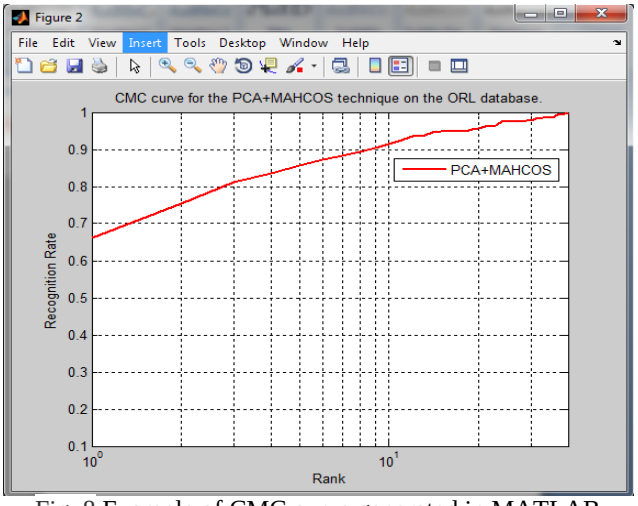

Fig. 8 Example of CMC curve generated in MATLAB

Here MAHCOS denotes matching distance. In addition to the performance curves, the outputs some performance metrics are shown in command prompt of MATLAB window.

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Identification experiments:

The rank one recognition rate equals (in %): 66.07%

Verification/authentication experiments:

The equal error rate equals (in %): 5.03%
The minimal half total error rate equals (in %): 4.72%
The verification rate at 1% FAR equals (in %): 86.79%
The verification rate at 0.1% FAR equals (in %): 66.79%
The verification rate at 0.01% FAR equals (in %): 45.00%

Conclusion

From many years the research in face recognition is an exciting area to come and will keep many researchers, scientists and engineers busy. So we are using the most flexible and efficient method for face recognition, Principal Component Analysis. In this

paper we have given concepts of face recognition methods in MATLAB. The system receives the input face from ORL database and it is recognized from the training set. Recognition is done by finding the Euclidean distance between the input face and our training set. The results were simulated using MATLAB. The said approach is definitely simple, easy and faster to implement identification, verification and authentication.

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REFERENCES

[1] Jiarui Zhou, Zhen Ji, Linlin Shen, Zexuan Zhu and Siping Chen, "PSO Based Memetic Algorithm for Face Recognition Gabor Filters Selection", IEEE Conference Memetic Computing (MC), 2011, pp.1- 6.

[2] Anil K. Jain, Brendan Klare and Unsang Park, "Face Recognition: Some Challenges in Forensics", in IEEE International Conference Automatic Face & Gesture Recognition and Workshops (FG 2011), 2011, pp. 726-733.

[3] Jageshvar K. Keche, Vikas K. Yeotikar and Dr. Mahendra P. Dhore, "Human Face Recognition using Wavelet Transform based Approach", International Journal of Computer & Mathematical Sciences (IJCMS), ISSN: 2347 – 8527, Volume 3, Issue 9, November 2014, pp. 81-88.

[4] M. Turk and A. Pentland "Eigenfaces for Recognition", J. Cognitive NeuroScience, vol. 3, pp. 71-86, 1991.

[5] Liton Chandra Paul and Abdulla Al Sumam, "Face Recognition Using Principal Component Analysis Method", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) ISSN: 2278 – 1323, Volume 1, Issue 9, November 2012.

[6] M.A.Turk and A.P. Pentaland, "Face Recognition Using Eigenfaces", IEEE conf. on Computer Vision and Pattern Recognition, pp. 586-591, 1991.

[7] B.Poon , M. Ashraful Amin , Hong Yan "Performance evaluation and comparison of PCA Based human face recognition methods for distorted images" International Journal of Machine Learning and Cybernetics, , Vol 2, No. 4,pp. 245–259, July 2011. Springer-Verlag 2011.

[8] G. J. Alvarado , W. Pedrycz ,M. Reformat ,Keun-Chang Kwak "Deterioration of visual information in face classification using Eigenfaces and Fisherfaces" Machine Vision and Applications, Vol.17, No. 1, pp. 68-82. Springer-Verlag 2006.

[9] Manal Abdullah et.al, "Optimizing face recognition using PCA" . International Journal of Artificial Intelligence & Applications (IJAIA), Vol.3, No.2, March 2012

[10] S. Bengio, J. Mariethoz. The expected performance curve: a new assessment measure for person authentication. Proceedings of Odyssey 2004: The Speaker and Language Recognition Workshop, 2004.

[11] V. ˇ Struc. The matlab inface toolbox for illumination invariant face recognition. Website, 2012.
http://luks.fe.uni-lj.si/sl/osebje/vitomir/face_tools/INFace /index.html.

AUTHOR'S PROFILE

Jageshvar K. Keche is a Research Scholar Pursuing Ph. D. in Computer Science. He is currently working as Lecturer in Department of Computer Science, SSESA's, Science College, Congress Nagar Nagpur.
Email Id- jkkeche@gmail.com, jkkres@gmail.com

Vikas K. Yeotikar is a Research Scholar Pursuing Ph. D. in Computer Science. He is currently working as Lecturer in Department of Computer Science, SSESA's, Science College, Congress Nagar Nagpur.
Email Id- vkyeotikar@gmail.com

Manish T. Wanjari is a Research Scholar pursuing Ph. D. in Computer Science. He is currently working as Project Fellow under UGC Sponsored Major Research Project in the Department of Computer Science, SSESA's, Science College, Congress Nagar Nagpur.
Email Id- mwanjari9@gmail.com

Dr. Mahendra P. Dhore is Associate Professor in Computer Science, Department of Electronics & Computer Science, RTM Nagpur University, Nagpur. He is having teaching experience of more than 18 years at UG & PG level. His research areas include Digital Image Processing, Document Image Analysis, Mobile Computing & Cloud Computing. He is Member of IEEE, IAENG, IACSIT, IETE, and ISCA.
Email Id- mpdhore@ieee.org, mpdhore@rediffmail.com