International Journal For Technological Research In Engineering
Volume 3, Issue 10, June-2016 *ISSN (Online): 2347 - 4718*

A REVIEW ON FEATURE EXTRACTION TECHNIQUES OF FACE RECOGNITION

Harpreet Kaur[1], Gurleen Kaur[2]
[1]Assistant Professor, [1,2]Computer Engineering Department, Punjabi University, Patiala

Abstract: Face recognition is the process of identification of persons by their facial images. Face recognition system takes a test image and compare this with number of trained images stored in database and then check whether the test image matches with any trained image. There are many techniques used for feature extraction. In this paper we have discussed three techniques: Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) and SIFT (Scale Invariant Feature Transform). Feature operators can transform raw pixels values of an image into a better representation. After feature extraction, classification techniques are applied which do actual face recognition process.

Keywords: Face Recognition, Feature extraction, PCA, LDA, SIFT, ORL Database.

I. INTRODUCTION

Biometric recognition refers to the automated recognition of individuals based on their biological and behavioural traits. Examples of biometric traits include fingerprint, face, iris, palm print, retina, hand geometry, voice, signature and gait. [2] Face recognition has long been and continue to be a popular topic in pattern recognition. It has become popular due to increasing demand of real world applications as border security, identity verification, video surveillance etc. Face is considered as good biometric. Biometric characteristics encompass signature, typing rhythms, eye, finger, hand, voice and face for recognition. In this paper we study three feature extraction techniques and compare them according to accuracy and computational time. PCA is one of the most popular method for dimensionality reduction and it is also known as eigenspace projection. Eigenspace is based on linear projection of image space to lower dimension feature space. [1] LDA is classical method for feature extraction and dimensionality reduction that has been used in many classification problems. The objective of LDA is to find the optimal transformation matrix so that the ratio of between class scatter is maximum and within class is minimum. [1] SIFT is a local descriptor of image feature insensitive to illumination and other variants that is usually used as sparse feature representation. SIFT features are features extracted from images to help reliable matching between different views of same object.[10]

This paper is organized as follows: Section 2 describes the literature review, Section 3 describes the three techniques namely PCA, LDA and SIFT and Section 4 describes the experimental conditions and results. Finally conclusion is stated in Section 5.

II. LITERATURE REVIEW

Yin Liu, Chuanzhen Li present, 6 feature extraction methods, have evaluated i.e., Local Binary Patterns, Histograms of Oriented Gradients, Scale Invariant Feature Transform, Speed-Up Robust Features, Fully Affine SIFT and Gabor features. Each feature was tested on 3 face databases of Yale, ORL and UMIST. The experimental recognition rate and matching time are given and compared to indicate different preferential features for different application conditions. ASIFT has the best result in recognition rate while SURF outperforms others in matching time.[1]

Soodeh Nikan, Majid Ahmadi, In this paper the effectiveness of different classification techniques is evaluated on the performance of face recognition algorithms. Gabor wavelet and its fusion with local binary pattern (LBP) are utilized as feature extractors. Dimensionality reduction approaches, principal component analysis (PCA) and Fisher's linear discriminant (FLD), are employed to reduce the size of feature vector. The performance of nearest neighbour (NN) classifier with various cost functions, sparse classification, multilayer feed-forward neural network (MFNN) and extreme learning machine (ELM) are analysed on three face databases. Simulation results show that ELM and MFNN are effective in all conditions. The performance of nearest neighbour and sparse classifier is degraded under severe illumination variation.[2]

Vinay.A, Vinay.S.Shekhar,, In this paper experimentations have been conducted on the publicly available ORL database. it demonstrate using pertinent mathematical arguments and extensive experimentations, the difference in performance between linear and nonlinear choices, and show that the GABOR-PCA variant is better suited for FR tasks when GABOR is employed as the feature extractor. The results of this study, coupled with our other works, form a series that is intended to assist developers in making prudent choices in designing proficient FR systems.[3]

Lih-Heng Chan, Sh-Hussain Salleh , In this paper, Artificial Neural Networks (ANN) is proposed as an alternative to replace Euclidean distances in classification of human face features extracted by PCA and LDA. ANN is well recognized by its robustness and good learning ability. The algorithms were evaluated using the Database of Faces which comprises 40 subjects and with a total size of 400 images. Experimental results show that ANN reasonably improves the performance of PCA and LDA method. LDA-NN achieves an average recognition accuracy of 95.8%[4]

Firoz Mahmud, Mst. Taskia Khatun, In this paper,two techniques are discussed: Principal Component Analysis

(PCA) and Linear Discriminant Analysis (LDA). Both of these techniques are linear. PCA applies linear projection to the original image space to achieve dimensionality reduction. LDA applies linear projection from the image space to a low dimensional space by maximizing the between class scatter and minimizing the within class scatter. These methods will be discussed here based on accuracy and percentage of correct recognition.[5]

Soninder Singh Garcha, Harpreet Kaur, This paper presents a Robust Technique implementation for facial recognition under Eigen feature extraction and further matching with testing image. During training are front postures of face images is taken and in testing section various methods are applied on image of human example noise, left poses, right poses, blurriness etc on these effects results are calculated to recognise the face on bases of Eigen values and calculation is done on basis of distance and time and accuracy. [6]

Mayank Agarwal, Nikunj Jain, Mr. Manish Kumar , Himanshu Agarwal 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. [7]

Yogesh Tayal, Pramod Kumar Pandey, D. B. V. Singh To recognize an image from a database is typical task due to the image of a face changes with facial expression, age, viewpoint, illumination conditions, noise etc. Facial expression carries crucial information about the mental, emotional and even physical states of the conversation. This paper proposes an Eigen based face recognition algorithm for recognize an image from the database. Eigen face has proven to be a useful and robust cue for face recognition, localization and tracking.[8]

Patrik Kamencay , Martin Breznan . Presents an example of face recognition using SIFT-PCA method and impact of graph based segmentation on recognition rate. They used ESSEX database and concluded that test results gave the recognition rate of 92 %. [9]

Sanket Panda, Shaurya Nigam, Rohit Kumar, Mamatha HR. In this paper performance of SIFT-PCA and SIFT-LDA. It shows that these two are better than regular SIFT as they can recognize faces with lesser number of key points and also cpable of removing noise. [10]

III. PROPOSED TECHNIQUES

Pre-processing

Image size normalization, histogram equalization and conversion into grey scale are used for pre-processing of the image. This module automatically reduce every face image to X*Y pixels(based on user request), can distribute the intensity of face images (histogram equalization) in order to improve face recognition performance. 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 and testing dataset. The process is described in Fig. 1.

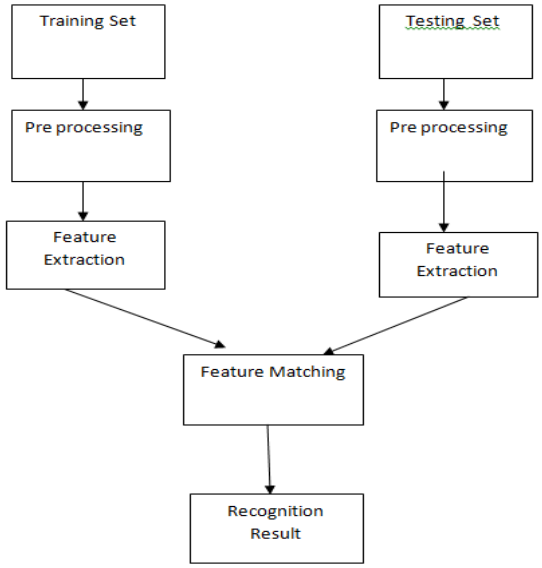

Fig 1. Face Recognition Procedure

Feature Extraction

The aim of feature extraction is to extract a compact set of interpersonal discriminating geometrical and photometrical features of the face. Methods for feature extraction include PCA, LDA, LBP, SIFT etc.

Feature Matching

Feature matching is the actual recognition process. The feature vector obtained from testing set is matched with training set. The matching algorithm vary from fairly obvious Nearest Neighbour to advanced schemes like Artificial Neural Networks.

A. Principal Component Analysis

PCA is one of the most successful techniques that have been used in image recognition and compression. PCA is a statistical approach. The main purpose of PCA is to reduce the dimensionality of the data space or image space to the similar intrinsic dimensionality of the feature space. PCA transforms a number of correlated variables into a number of uncorrelated variables called principle components or eigen faces such that the first eigen face has the greatest amount of variance among images and the last has least amount of variance. PCA can perform prediction redundancy removal ,feature extraction ,data compression etc because PCA is a classical technique which can do something in the linear domain such as signal processing ,image processing ,system and control theory ,communication etc. PCA has the potential to perform feature extraction , that able to capture the most different data components of samples and select the number of important individuals from all feature components. It is also known as eigenfaces technique. [4]

Total M images

Step 1: $\bar{x} = \frac{1}{M}\sum_{i=1}^{M} x_i$

Step 2: subtract the mean: $\Phi_i = x_i - \bar{x}$

Step 3: form the matrix $A = [\Phi_1\ \Phi_2 \cdots \Phi_M]$ (NxM matrix), then compute:

$$C = \frac{1}{M}\sum_{n=1}^{M} \Phi_n \Phi_n^T = AA^T$$

(sample **covariance** matrix, NxN, characterizes the *scatter* of the data)

Step 4: compute the eigenvalues of C: $\boldsymbol{\lambda}_1 > \boldsymbol{\lambda}_2 > \cdots > \boldsymbol{\lambda}_N$

Step 5: compute the eigenvectors of C: $u_1, u_2, \ldots, u_N$

B. Linear discriminant Analysis

Linear Discriminant Analysis (LDA) is an attractive choice for face recognition. LDA is a statistical approach for classifying samples of some unknown classes based on training samples with known classes. LDA refers to as a categorical variable that is it has some continuous independent variable and categorical dependent variable. LDA uses PCA for low dimensional representation and project them onto a lower dimensional space where the ratio of between classes scatter matrix and within class scatter matrix. LDA uses class based on the database. It divides the databases into some classes. Based on these classes LOA performs the operation. These classes are created randomly based on the samples of the database.

- Suppose there are C classes
- Let $\boldsymbol{\mu}_i$ be the mean vector of class i, $i = 1, 2, .., C$
- Let M_i be the number of samples within class i, $i = 1, 2, .., C$,
- Let $M = \sum_{i=0}^{C} M_i$ be the total number of samples. and

Within-class scatter matrix:

$$S_w = \sum_{i=1}^{C}\sum_{j=1}^{M_i}(y_j - \boldsymbol{\mu}_i)(y_j - \boldsymbol{\mu}_i)^T$$

Between-class scatter matrix:

$$S_b = \sum_{i=1}^{C}(\boldsymbol{\mu}_i - \boldsymbol{\mu})(\boldsymbol{\mu}_i - \boldsymbol{\mu})^T$$

$$\boldsymbol{\mu} = 1/C \sum_{i=1}^{C} \boldsymbol{\mu}_i \quad \text{(mean of entire data set)}$$

$$\text{maximize } \frac{det(S_b)}{det(S_w)}$$

C. Scale invariant feature transform

SIFT is a feature descriptor method developed by David Lowe in 1999. Earlier it was used for object recognition but now it is effectively implemented for faces. It can works with variations in scale, zoom, rotation, lighting etc. SIFT works in four stages.

Detection of scale space extrema- In this first search is for location of scale and image and then it uses difference of Gaussian to locate interest points.

$$G(x, y, \sigma) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\frac{x^2+y^2}{\sigma^2}}$$

Convolution of image with Gaussian filters:

$$L(x, y, \sigma) = G(x, y, \sigma) * I(x, y)$$

The different of Gaussian(DOG) images is then performed and the maxima or minima of this DOG are used to locate the key points as:

$$\begin{aligned} D(x, y, \sigma) &= (G(x, y, k\sigma) - G(x, y, \sigma)) * I(x, y) \\ &= L(x, y, k\sigma) - L(x, y, \sigma). \end{aligned}$$

Key point localization- In this location and scale is calculated from key points.

Orientation assignment- It is done according to the image gradient. Smoothed image L at a scale of σ is used for scale calculation.

Image gradient m and orientation θ:

$$m(x,y) = \sqrt{(L(x+1,y) - L(x-1,y))^2 + (L(x,y+1) - L(x,y-1))^2}$$

$$\theta(x,y) = \tan^{-1}((L(x,y+1) - L(x,y-1))/(L(x+1,y) - L(x-1,y)))$$

Key pint descriptor computation- In this matching is done with the descriptors of key points of test and trained images based on a defined threshold. If the distance is less than the threshold then test image is considered as matched and if it exceeds threshold then the key point undergoes removal. After that , the face the face in training set that has maximum number of key points matches is considered as a match.

IV. EXPERIMENT CONDITIONS AND RESULTS

A. Database

In this paper we used ORL database. There are ten different images of each of 40 distinct subjects. 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).

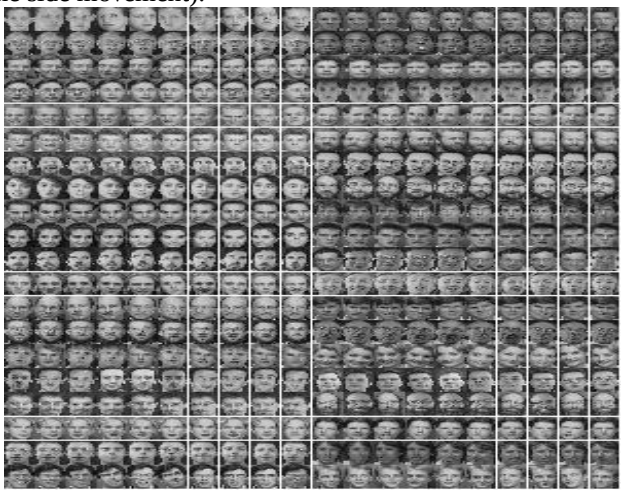

Fig 2. ORL Database

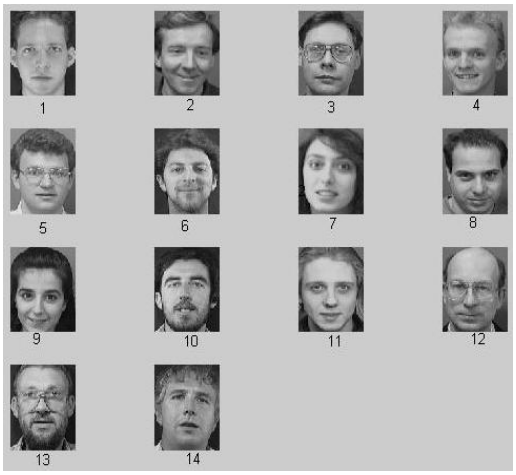

Fig 3. Sample training images

Fig 4. Mean image

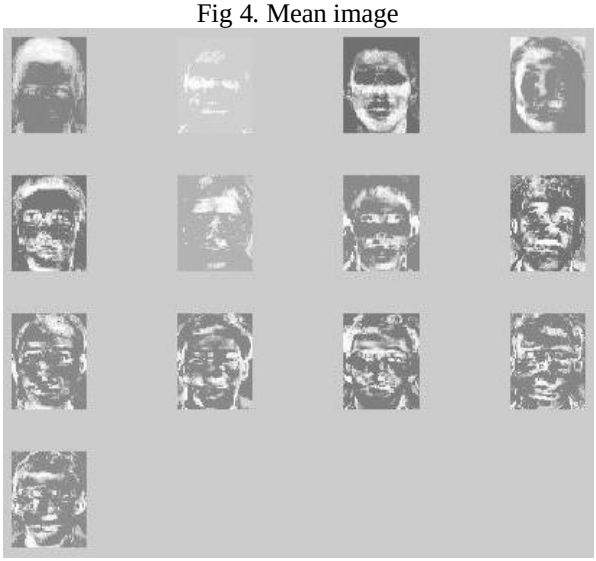
Fig 5. Eigen faces


Fig 6. Image from database with SIFT features

Results using ORL database with less number of training images

	Accuracy Rate(%)	Computational Time(s)
PCA	66.67	1.638
LDA	84.44	1.891
SIFT	93.75	1.911

V. CONCLUSION

In this paper we reviewed the works done in facial feature extraction. There are different types of feature extraction methods. Among them we have measured the performance of PCA, LDA and SIFT in terms of accuracy and computational time. From our experiment we see that recognition rate of SIFT is greater than both PCA and LDA. PCA is fast and eigen faces in PCA are used as the compact storage because it performs quick comparison between test images and learned train images. However, LDA and SIFT takes more time for recognition process but gives more accuracy using less number of training images.

REFERENCES

[1] Yin Liu, Chuanzhen Li, Bailiang Su, Hui Wang, "Evaluation of feature extraction methods for face recognition", IEEE, Sixth International Symposium on Computational Intelligence and Design, pp 313-316, 2013.

[2] Soodeh Nikan, Majid Ahmadi "Effectiveness of Various Classification techniques on Human Face Recognition", IEEE, pp 651-655, 2014.

[3] Vinay.A,Vinay.S.Shekhar,K.N.Balasubramanya Murthy, S.Natarajan „"Face Recognition using Gabor Wavelet Features with PCA and KPCA - A Comparative Study", Science direct, Elsevier ICRTC-2015, pp 650-659, 2015.

[4] Lih-Heng Chan, Sh-Hussain Salleh , Chee-Ming Ting , "PCA, LDA and Neural Network for Face Identification", IEEE, ICIEA, pp 1256-1259, 2009.

[5] Firoz Mahmud, Mst. Taskia Khatun, Syed Tauhid Zuhori, Shyla Afroge, Mumu Aktar, Biprodip nal, "Face Recognition using Principle Component Analysis and Linear Discriminant Analysis",IEEE, ICEEICT, pp 1222-1226, 2015.

[6] Soninder Singh Garcha, Harpreet Kaur, "A robust technique implementation for facial recognition under eigen feature extraction" , Journal of global research in computer science, vol 4, no 8, August 2013.

[7] Mayank Agarwal, Nikunj Jain, Mr. Manish Kumar , Himanshu Agarwal August, "Face Recognition Using Eigen Faces and Artificial Neural Network", International journal of computer theory and engineering, vol 2, no 4, 2010.

[8] Yogesh Tayal, D. B. V. Singh, "Face Recognition using Eigenface ", International journal of advance research in computer engineering, vol 1, issue 8, 2010.

[9] Patrik Kamencacy, Martin Breznan, Dominik

Jelsovka and Martina Zachariasova, " Improved face recognition method based on segmentation algorithm using PCA-SIFT" , IEEE, 2012.

[10] Sanket Panda, Shaurya Nigam, Rohit Kumar, Mamatha HR, "A performance study of SIFT, SIFT-PCA and SIFT-LDA for face recognition", IJSCE, vol-5 issue-3, July 2015.

