International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 02, February 2016
www.ijates.com
ijates
ISSN 2348 - 7550

A STUDY OF FACE RECOGNITION TECHNIQUES

Shivani Jindal[1], Divya Gupta[2]

[1]Mtech Student, [2]Assistant Professor, Department of Computer Science and Engineering, SRM University (India)

ABSTRACT

With data and information acquire in exuberance, there is a crucial need for high security. Face recognition has been a fast growing, challenging and interesting area in real time applications. Face biometrics are useful for a person's authentication. Face Recognition is a simple and non-intrusive method that recognizes face in complex multidimensional visual model and develops a computational model for it. A large number of face recognition algorithms have been developed in last decades. In this paper an attempt is made to review a wide range of methods used for face recognition comprehensively. This include Principal Component Analysis (PCA), Linear Discriminate Analysis (LDA), Independent Component Analysis (ICA), Elastic Bunch Graph Matching (EBGM), Line Edge Map (LEM), Support Vector Machine (SVM), Self Organizing Maps (SOM), Gabor wavelet, Neural Network and various hybrid combination of these techniques. Thereafter, represent the most recent face recognition techniques listing their advantages and also improve the efficiency of face recognition under various illumination and expression condition of face images.

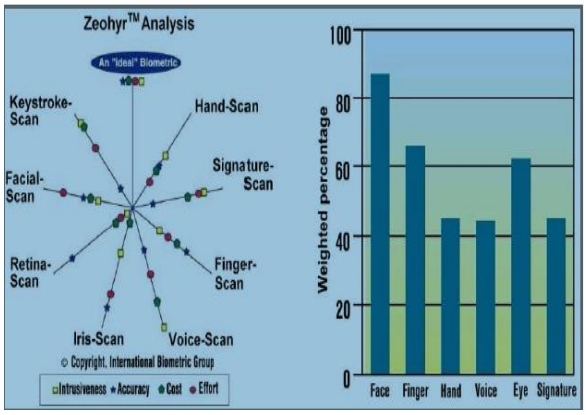
Keywords: Face Recognition; Principal Component Analysis (PCA), Linear Discriminate Analysis (LDA), Independent Component Analysis (ICA), Elastic Bunch Graph Matching (EBGM), Line Edge Map (LEM), Support Vector Machine (SVM), Self Organizing Maps (SOM), Gabor wavelet, Neural Network.

I. INTRODUCTION

In recent years face recognition has received substantial attention from researchers in biometrics, pattern recognition, and computer vision communities. The machine learning and computer graphics communities are also increasingly involved in face recognition. This common interest among researchers working in diverse fields is motivated by our remarkable ability to recognize people and the fact that human activity is a primary concern both in everyday life and in cyberspace. Besides, there are a large number of commercial, security, and forensic applications requiring the use of face recognition technologies.

Facial scan is an effective biometric attribute/indicator. Different biometric indicators are suited for different kinds of identification applications due to their variations in intrusiveness, accuracy, cost, and ease of sensing shown in Fig. 1(a). Among the six biometric indicators, facial features scored the highest compatibility, shown in Fig. 1(b), in a machine readable travel documents (MRTD) system based on a number of evaluation factors. People in computer vision and pattern recognition have been working on automatic face recognition of human faces for the last two decades and it is attracting much more attention. The main reason for the attraction of many researchers towards this has been the variety of practical applications. It is an ideal application for

security, such as, to limit employee access to sensitive data in private companies, to limit the physicians to have an access to their patient records in hospitals and the others like airport security, criminal identification, video surveillance etc[2].



(a) (b)

Figure 1: Comparison of various biometric features: (a)based on zephyr analysis (b)based on MRTD compatibility

Human can recognize and identify thousands of faces in their lives, even after years of separation or glance of meeting. Despite of changes on the faces like expression, aging, and distraction (accessories, beards, and changes in hairstyles),human still can recognize the faces, this skill is so remarkable.

Face recognition gained much attention in recent years, due to it is wide real situation, such as for securing the building, authorizing identification, crime investigation and many others. The automation of recognizing human's face is crucial and much needed to avoid human's error**.**

There are basically three approaches for face recognition[2] :

A. Feature base approach

In feature based approach the local features like nose, eyes are segmented and it can be used as input data in face detection to easier the task of face recognition.

B. Holistic approach

In holistic approach, the whole face taken as the input in the face detection system to perform face recognition.

C. Hybrid approach

Hybrid approach is combination of feature base and holistic approach. In this approach, both local features and whole face features is used as the input to face detection system.

II. LITERATURE SURVEY

This section provide an overview of various face recognition techniques that has been applied till now with their advantage and disadvantage:

A. Principal Component Analysis (PCA): Recognition of human faces using PCA was first done by Turk and Pentland and reconstruction of human faces was done by Kirby and Sirovich . PCA also known as

Karhunen-Loeve method is one of the popular methods for feature selection and dimension reduction. Eigen faces are the principal components divide the face into feature vectors. The feature vector information can be obtained from covariance matrix. These Eigenvectors are used to quantify the variation between multiple faces. The faces are characterized by the linear combination of highest Eigen values. Each face can be considered as a linear combination of the eigen faces. The face can be approximated by using the eigenvectors having the largest eigen values. The best M Eigen faces define an M dimensional space, which is called as the "face space". Principal Component Analysis is also used by L. Sirovich and M. Kirby to efficiently represent pictures of faces. They defined that a face images could be approximately reconstructed using a small collection of weights for each face and a standard face picture. The weights describing each face are obtained by projecting the face image onto the eigen picture. PCA reduces the dimension size of an image in a short period of time. There is a high correlation between the training data and the recognition data[2].

B. Independent Component Analysis (ICA): Independent component analysis (ICA) is a method for finding underlying factors or components from multivariate (multidimensional) statistical data. There is need to implement face recognition system using ICA for facial images having face orientations and different illumination conditions, which will give better results as compared with existing systems. What distinguishes ICA from other methods is that, it looks for component that are both statistically independent and non Gaussian . The ICA is similar to blind source separation problem that boils down to finding a linear representation in which the components are statistically independent. It seeks a set of vectors that reduces the dimensionality of input images .However, ICA does not require the ortho normalization of vectors, which allows higher-order dependencies in image pixels to be exploited. ICA removes the first and second-order statistics by "sphering " the data. Each image (with the mean subtracted) is stored as a row vector in X ,which is multiplied by the whitening matrix $W_z = 2cov(X) - 1/2$. ICA finds statistically independent images, represented by the rows in matrix U, that are mixed together with matrix W such that U=WX. In comparison to PCA, the rows of are analogous to Eigen faces and the columns of W^{-1} are the weights of each image. ICA can account for more variations in the input images, but suffers from slower performance[5].

C. Gabor Wavelet: Gabor features have been recognized as one of the best representations for face recognition. Gabor filter, named methods to represent images-At one extreme, images can be represented by placing the wavelets at each pixel and other is to place a face graph where the nodes of the graph lie on facial features. Gabor wavelet technique has recently been used not only for face recognition but also for face tracking and face position estimation. Gabor wavelets (filters) characteristics for frequency and orientation representations are quite similar to those of human visual system. These have been found appropriate for texture representation and discrimination. This Gabor-wavelet based extraction of features directly from the gray-level images is successful and widely been applied to texture segmentation, and fingerprint recognition[6].

In recent years, Gabor wavelets have been widely used for face representation by face recognition researchers, because the kernels of the Gabor wavelets are similar to the 2D receptive field profiles of the mammal cortical simple cells, which exhibits desirable characteristics of spatial locality and orientation selectivity. Typical methods include the dynamic link architecture (DLA) elastic bunch graph matching (EBGM) Gabor Fisher classifier (GFC), and Ada Boosted GFC (AGFC) . It was observed that though Gabor phases are sensitive to local variations, they can discriminate between patterns with similar magnitudes, i.e. they provide more detailed

information about the local image features. Therefore, the Gabor phases can work comparably well with the magnitudes, as long as its sensitivity to misalignment and local variations can be compensated carefully. In previous work, authors proposed to represent face images using the local Gabor binary patterns (LGBP), which combines Gabor magnitudes with local binary patterns (LBP) operator. Improved results were achieved when compared with the LBP and the GFC. Since face representation with LGBP based on local histograms, which were insensitive to local variations, similarly local histograms of LGBP can be used to suppress the sensitivity of Gabor phases to local variations. By encoding Gabor phases through LBP and local histograms, a very impressive recognition rates comparable with those of Gabor magnitudes-based methods were achieved, which shows effectiveness of Gabor phases in the discrimination of different faces.

D. Elastic Bunch Graph Matching(EBGM): Face recognition using elastic bunch graph matching is based on recognizing faces by estimating a set of features using a data structure called a bunch graph. This approach is totally different to Eigen face and Fisher face. It uses elastic bunch graph to automatically locate the fudicial points of the face such as eyes, nose, mouth, etc and recognize the face according to these face features. Elastic Bunch Graph Matching (EBGM) uses the structure information of a face which reflects the fact that the images of the same subject tend to translate, scale, rotate, and deform in the image plane. It uses the labeled graph, edges are labeled the distance information and nods are labeled with wavelet coefficients in jets. After that this model graph can be used to generate image graph. The model graph can be rotated, scaled, translated and deformed during the matching process. The Gabor wavelet transformation is used to produce the local features of the face images.

Gabor wavelets are biologically motivated convolution kernels in the shape of plan waves restricted by a Gaussian envelop function, the set of convolution coefficients for kernels of different orientations and frequencies at one image pixel is called a jet. A relative set of jets can be selected from the Gabor wavelet transform of the image. The image jets initially have the same relative spatial arrangement as the graph jets, and each image jet relatives to one graph jet. The similarity of the graph with the image then is simply the average jet similarity between image and graph jets. For increase similarity it allows some translation, rotation and distortion up to some extent. The advantage of this is that change or missing any one feature it does not mean that the person will not recognized. The stored data can be easily extended to a database for storage. When a new face images is added, no additional effort is need to modify templates, as it already stored in the database. It is possible to recognize person up to rotation of 22 degrees. There are various disadvantage of this algorithm as it is very sensitive to lightening conditions and a lot of graphs have to be placed manually on the face. When the changes in lighting are large, the result will have a significant decrease in the recognition rate.

E. Linear Discriminate Analysis (LDA): The linear discriminate analysis (LDA) is a powerful method for face recognition. It yields an effective representation that linearly transforms the original data space into a low-dimensional feature space where the data is well separated. In LDA the goal is to find an efficient or interesting way to represent the face vector space. However, the within-class scatter matrix (SW) becomes singular in face recognition and the classical LDA cannot be solved which is the under sampled problem of LDA (also known as small sample size problem). A subspace analysis method for face recognition called kernel discriminate locality preserving projections (MMDLPP) is based on the analysis of LDA, LPP and kernel functions. A nonlinear subspace which can not only preserves the local facial manifold structure but also emphasizes discriminate

information. Combined with maximum margin criterion (MMC) new method called maximizing margin and discriminate locality preserving projections (MMDLPP) was proposed to find the subspace that best discriminates different face change and preserving the intrinsic relations of the local neighborhood in the same face class according to prior class label information[1].

F. Line Edge Map (LEM): Edge information is a useful object representation feature that is insensitive to illumination changes to certain extent. Though the edge map is widely used in various pattern recognition fields. A Line Edge Map approach, extracts lines from a face edge map as features. This approach can be considered as a combination of template matching and geometrical feature matching[9]. The LEM approach not only possesses the advantages of feature-based approaches, such as invariance to illumination and low memory requirement, but also has the advantage of high recognition performance of template matching.

Line Edge Map integrate the structural information with spatial information of a face image by grouping pixels of face edge map to line segments. After thinning the edge map, a polygonal line fitting process is applied to generate the LEM of a face. Also, LEM is expected to be less sensitive to illumination changes due to the fact that it is an intermediate-level image representation derived from low level edge map representation. The basic unit of LEM is the line segment grouped from pixels of edge map. A face prefilering algorithm is proposed that can be used as a preprocess of LEM matching in face identification application. The prefilering operation can speed up the search by reducing the number of candidates and the actual face (LEM) matching is only carried out on a subset of remaining models[8].

G. Support Vector Machine (SVM): SVM is a learning technique that is considered an effective method for general purpose pattern recognition because of its high generalization performance without the need to add other knowledge . Intuitively, given a set of points belonging to two classes, a SVM finds the hyper plane that separates the largest possible fraction of points of the same class on the same side, while maximizing the distance from either class to the hyper plane, this hyper plane is called Optimal Separating Hyper plane (OSH) which minimizes the risk of misclassifying not only the examples in the training set but also the unseen example of the test set. The advantage of SVM classifier over traditional neural network is that SVMs can achieve better generalization performance. The main characteristics of SVMs are: (1) that they minimize a formally proven upper bound on the generalization error; (2) that they work on high-dimensional feature spaces by means of a dual formulation in terms of kernels; (3) that the prediction is based on hyper planes in these feature spaces, which may correspond to quite involved classification criteria on the input data; and (4) that outliers in the training data set can be handled by means of soft margins[10].

H. Self Organizing Map(SOM):SOM also known as Kohonen Map has the property of clustering the data that preserves the topology of the input vector that means even the data with the minor changes gets clustered in closer zones. Because of this property it better classify the facial expression data , as similar data with the small changes gets clustered .SOM ordinary mapping of an input high dimensional space in much lower dimensional space. It is less computationally expensive and perform better with large complex data. Since that time, it has been used most widely for data analysis in some areas such as economics physics, chemistry or medical applications. The SOM provides an orderly mapping of an input high-dimensional space in much lower dimensional spaces, usually one or two dimensions. As it compresses information while preserving the most important topological and metric relationships of the primary data items, it can be thought to produce

some kind of abstractions of information. So it can be utilized in a number of ways in complex tasks such as pattern classification, process analysis, machine perception, control, and communication . It is an unsupervised learning process, which learns the distribution of a set of patterns without any class information. It has the property of topology preservation. There is a competition among the neurons to be activated or fired .The result is that only one neuron that wins the competition is fired and is called winner-takes all neuron. SOMs may be one dimensional, two-dimensional or multidimensional, but the most common ones are either one-dimensional or two-dimensional maps. The number of input connections depends on the number of attributes to be used in the classification. The neuron with weights closest to the input data vector is declared the winner during the training. Then the weights of all of the neurons in the neighborhood of the winning neuron are adjusted by an amount inversely proportional to the distance. It clusters and classifies the data set based on the set of attributes used.

I. Neural Networks: The attractiveness of using neural networks could be due to its non linearity in the network. Hence, the feature extraction step may be more efficient than the linear Karhunen-Loève methods. One of the first artificial neural networks (ANN) techniques used for face recognition is a single layer adaptive network called WISARD which contains a separate network for each stored individual. The way in constructing a neural network structure is crucial for successful recognition. It is very much dependent on the intended application. For face detection, multilayer perception and convolutional neural network have been applied a hybrid neural network which combines local image sampling, a self-organizing map (SOM) neural network, and a convolutional neural network. Neural networks have also been used successfully for face recognition problem. The advantage of using the neural networks for face recognition is that the networks can be trained to capture more knowledge about the variation of face patterns, and thereby achieving good generalization . The main drawback of this technique is that the networks have to be extensively tuned to get exceptional performance. Among the neural networks approaches for face recognition, multilayer perceptron (MLP) with back propagation (BP) algorithm has been mostly used . However, the convergence of the MLP networks is slow and the global minima of the error space may not be always achieved . On the other hand, the RBF neural networks have fast learning ability and best approximation property.

III. COMPARISON

Face recognition with variant pose, illumination and expression is a challenging problem. Robust face recognition requires the ability to recognize identity despite many variations in appearance the face can have. Today there exist many well known techniques for face recognition, each with its own inherent limitations. The Gabor Image representation simulates the function of the human visual system, a design feature which may be important in the field of robotics and computer vision. The Gabor wavelets approach appears to be quite perspective and has several advantages such as invariance to homogenous illumination changes, small changes in head poise and robustness against facial hair, glasses. A Gabor Wavelet technique achieved higher recognition rate and better classification efficiency when feature vectors had low dimensions[7].

Number of Principal Components	Accuracy in %
5	53.5
10	69
15	75
20	80
25	80.75
30	81
35	81.75
40	82.25
45 to 100	82.25

Table 1: RECOGNITION ACCURACY FOR GABOR JET - PCA

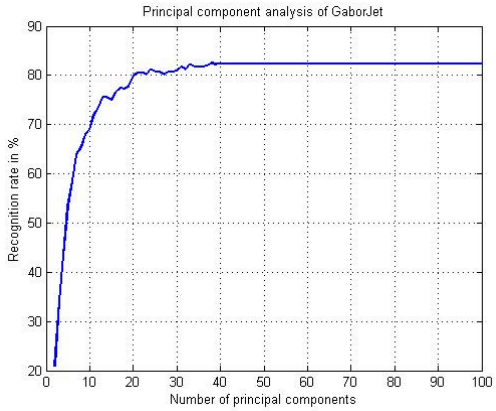


Figure2: Plot number of principal components vs. recognition accuracy.

There are some methods with corresponding to their recognition rate that vary with number of classes and sub block size. The results corresponding to SOM are the best among all the techniques that are shown by using figure (3 and 4) and table (2 and 3)[7] .

Recognition Rate (%)			
Method	Number of Classes		
	10	20	40
SOM (5 × 5)	94.06	90.72	89.92
SOM (10 × 10)	94.06	91.86	90.82
PCA	93.39	90.25	89.51
SOM+PCA (1)	77.75	72.08	62.64

.

Table 2 :Recognition Rate Of The Face Recognition System With Varing Number Of Classes

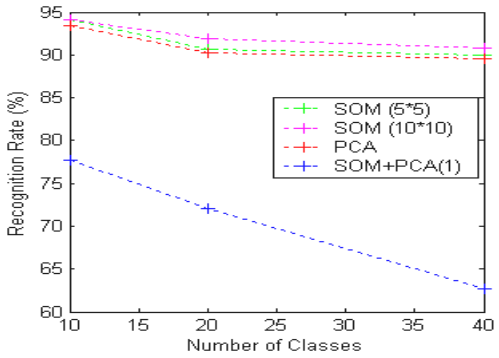


Figure 3:Recognition rate as a function of number of classes

Recognition Rate (%)			
Method	Size of sub block		
	(4 × 4)	(8 × 8)	(16 × 16)
SOM (5 × 5)	94.06	94.06	95.95
SOM+PCA (1)	77.75	77.17	72.83
SOM+PCA (2)	68.29	62.17	54.89

Table 3: Recognition Rate of The System With Changing Sub Block Size

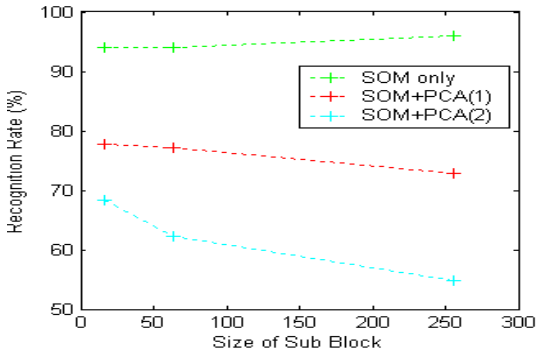


Figure 4: Recognition rate as a function of changing sub block size

Conclusion and Future Work

Among the whole types of biometric, face recognition system is the most accurate. This paper has attempted to review a significant number of papers to cover the recent development in the field of face recognition as (PCA, LDA, ICA, LEM SOM, Neural Network and SVM) with their advantages and disadvantages.

As a future work, we would like to explore this research area more deeply with the combination of different hybrid algorithms i.e. Gabor wavelets and SOM and give more information about face detection, face extraction and classification.

REFERENCES

[1] Sneha R. Madane, Prof. S.T. Khandare, A Survey on Face Recognition in Present Scenario, International Journal of Modern Communication Technologies & Research (IJMCTR) ISSN: 2321-0850, Volume-3, Issue-4, April 2015.

[2] Riddhi Patel, Shruti B. Yagnik, A Literature Survey on Face Recognition Techniques, International Journal of Computer Trends and Technology (IJCTT) – volume 5 number 4 –Nov 2013

[3] R. Hietmeyer, "Biometric identification promises fast and secure processing of airline passengers," The Int'l Civil Aviation Organization Journal, vol. 55, no. 9, pp. 10–11, 2000.

[4] Dian Retno Anggraini, Face Recognition Using Principal Component Analysis and Self Organizing Maps 2014 Third ICT International Student Project Conference (ICT-ISPC2014)

[5] Parul Jain, Nilay Jain and Rohit Raja, A Survey on Face Recognition in Present Scenario, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 3 Issue 12, December 2014

[6] Vinay Kumar. B, Shreyas B. S, Face Recognition Using Gabor Wavelets PROCEEDINGS OF THE IEEE ASILOMAR CONFERENCE ON SIGNALS, SYSTEMS AND COMPUTERS, IEEE ISBN: 1-4244-0785-0/06/$20.00

[7] Dinesh Kumar, C.S. Rai, and Shakti Kumar, An Experimental Comparison of Unsupervised Learning Techniques for Face Recognition, International Journal of Computer, Electrical, Automation, Control and Information Engineering Vol:1, No:4, 2007

[8] A. S. Tolba, A.H. El-Baz, and A.A. El-Harby, Face Recognition: A Literature Review, International Journal of Signal Processing 2;2 2006

[9] B. Takács, "Comparing face images using the modified hausdorff distance," Pattern Recognition, vol. 31, pp. 1873-1881, 1998.

[10] Wenchao Zhang , Shiguang Shan, Laiyun Qing, Xilin Chen, Wen Gao, "Are Gabor phases really useless for face recognition?",Springer-Verlag London Limited 2008