Performance Analysis of FDA Based Face Recognition Using Correlation, ANN and SVM

Mahesh Goyani
Department of Computer Engineering
GCET, Sardar Patel University
Anand, INDIA
e- mail : mgoyani@gmail.com

Akash Dhorajiya
Department of Computer Engineering
GCET, Sardar Patel University
Anand, INDIA
e- mail : akashdhorajiya@gmail.com

Ronak Paun
Department of Computer Engineering
GCET, Sardar Patel University
Anand, INDIA
e- mail : ronak_paun@yahoo.com

***Abstract*–Since last decade, face recognition has replaced almost all biometric authentication techniques available. Many algorithms are in existence today based on various features. In this paper, we have compared the performance of various classifiers like correlation, Artificial Neural Network (ANN) and Support Vector Machine (SVM) for Face Recognition. We have proposed face recognition based on discriminative features. Holistic featuresbased methods Fisher Discriminant Analysis (FDA) ususedto extract outdiscriminative features from the input face image respectively. These features are used to train classifiers like Artificial Neural Network (ANN) and Support Vector Machine (SVM). Results in the last section describe the accuracy of proposed scheme.**

***Keywords*-Face Recognition, Fisher Discriminant Analysis, Artificial Neural Network, Support Vector Machine.**

I. INTRODUCTION

Face recognition means to identify the person from still image or from video based on facial features from the processed and stored face dataset [1]. Authentication is required in all the way, everywhere. Biometrics is automated method ofidentifying a person or verifying the identity of a person based on a physiological orbehavioral characteristic [2].Many biometric techniques like Ear recognition, Finger print recognition, Iris recognition, face recognition etc have left their footprints in the area where authentication or security is the prime concern. Each of the techniques has some pros and cons. Idea of swipe card has been outdated as there is lots of risk is involved in it. It could be lost, theft, wore out or forgotten but biometric are the feature, which always be with the person and its life long.The necessity for personal identification in the fields of privateand secure systems made face recognition one of the main fields amongother biometric technologies. The importance of face recognition risesfrom the fact that a face recognition system does not require thecooperation of the individual while the other systems need suchcooperation [3].Face is very rich with facial features like eyes, eyebrow, lips, nose tip and many more. Of course, there are many dimensions of difficulties in employing face for the system. Facial features also change with the age, race, illumination, occlusions, face pose etc. Many algorithms have been suggested for face recognition.

Most of the face recognition techniques fall any of the four categories: holistic method, feature-based method, model based method and hybrid method[1]. Feature based methods only exploit facial features like eyes, eyebrow, nose tip, lip etc and their geometric relations. Whereas, holistic methods encode entire face and represent face as a code point in higher dimensional image space [4].Hierarchy of various face recognition techniques is shown in fig. 1.

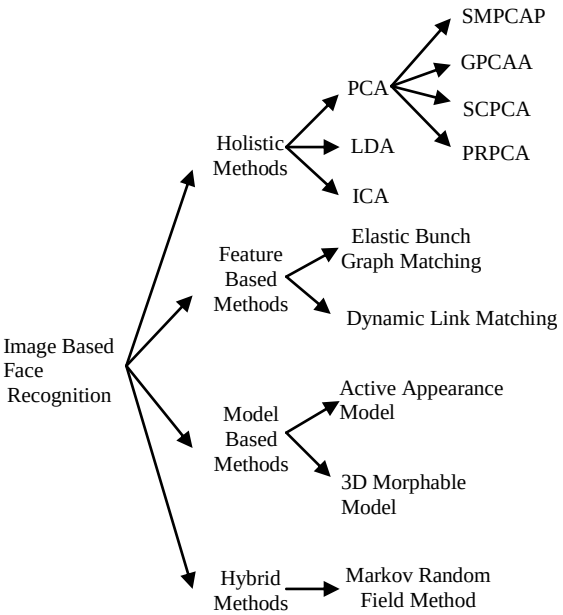

Figure 1. Taxonomy of face recognition methods

PCA and FDA are the holistic methods which projects N x N image into some less number of key features. These features are used to train classifiers like neural network and support vector machine. As holistic methods are exploiting entire face region for the training, it is quite complex to train classifier against it compared to straightforward facial features. Neural network has strong root in pattern recognition. Moreover, it is widely accepted as an ideal tool for it. In recent years, SVM has been emerged as successful application in pattern recognition. SVM tries to find out optimum decision boundary that separates the data points with maximum margin based on Structural Risk Minimization [5].

Turk and Pentland [6] were first to employ eigen face based method for face recognition. Original work is based on K-L expansion. It treats the faceimages as 2-D data, and classifies the face imagesby projecting them to the eigenface space, which iscomposed of eigenvectors obtained by the varianceof the face images. Eigenface recognition derives itsname from the German prefix *eigen*, meaning ownor individual [7]. The eigenface approach works well aslong as the test image is similar to the trainingimages used for obtaining the eigenfaces.

Etemad and Chellappa [1] proposed a method onappliance of Linear/Fisher Discriminant Analysis forthe face recognition process. LDA is carried out viascatter matrix analysis. The aim is to find theoptimal projection, which maximizes between classscatter of the face data and minimizes within classscatter of the face data. As in the case of PCA,where the eigenfaces are calculated by the eigenvalue analysis, the projections of LDA arecalculated by the generalized eigenvalue equation.

II. Materials and Methods

A. *Dataset Discription*

We have carried out our experiments on Cambridge Olivetti Research Lab (ORL) face dataset. It contains total 400 images, 10 expressions of each of 40 individual. Each image contains different face gesture and constant illumination environment in gray scale mode. Size of each image is 112 X 92 pixels. Variable numbers of images are chosen for training and testing. Fig. 2 shows second expression of all forty subjects.

Figure 2. OLE dataset samples

B. *Fisher Discriminant Analysis*

When substantial changes in illumination and expression are present, much of the variation in the data is due to these changes. The PCA techniques essentially select a subspace that retains most of that variation, and consequently the similarity in the face space is not necessarily determined. PCA projections are optimal for reconstruction from a low dimensional basis; they may not be optimal from a discrimination standpoint [8]. FLD finds the projection of data in which the classes are most linearly separable. LDA is a method for high dimensional data analysis, as class labels are available in dataset. It finds an optimal low dimensional space such that when data points are projected, classes are well separated. In [9], Belhumeur et al. analyzedeigenanalysis of two inverted matrix products and used classspecific information for finding the projection that bestdiscriminates among classes for face recognition. Features for FDA could be derived as shown in fig 3.

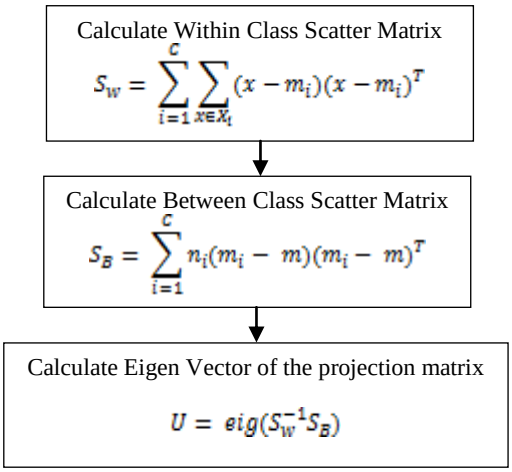

Figure 3. Derivation of FDA features

Where, C is number of classes,
is mean of i_{th} class data
is the mean of all
X is set of training images,
is number of images in i_{th}class.
is within class scatter matrix
is between class scatter matrix
U is eigen vector

is the sum of C matrices of rank or less and mean vectors are constrained by . There for will be of rank or less. This means only of the eigenvalues will be nonzero [10]. The projections with maximum class separability information are the eigenvectors corresponding to largest eigenvalues of .The linear transformation is given by a matrix *U* whose columns are the eigenvectors of the above problem(i.e., called *Fisher faces*).Because in practice S_w is usually singular, the Fisher faces algorithm first reduces the dimensionality of the data with PCA and then applies FLD to further reduce the dimensionality to *C-1*. PCA smears the classes together, so it is no longer linearly separable. With FLD classification job is simplified as it achieves better between class scatter compare to PCA, though PCA achieves greater total scatter [8].

Test face is projected on face space and its features are compared with stored features either using L2 norm, or test face features are given as an input to ANN or SVM classifiers, which find outs the most similar class for it.

III. Experimental Results

We have used two layer feed forward back propagationneural network (FFBPNN) with input, hidden and outputlayer as shown in fig 4. Two layers FFBP is perhaps thebest choice for classification [11]. In ourexperiment, we have used 9 neurons in input layer as there are C-1 features are available (in our case C is 10),15neurons in hidden layers and 1 neurons in output layer.Numbers of neurons in hidden layer are found throughexperiments. We have trainednetwork for 5000 epochs with goal 0.00001. We have employedMATLAB functions *'trainscg'* for training and *'learnwh'*for learning. By testing, we found out that this combinationgives the best and fastest convergence.

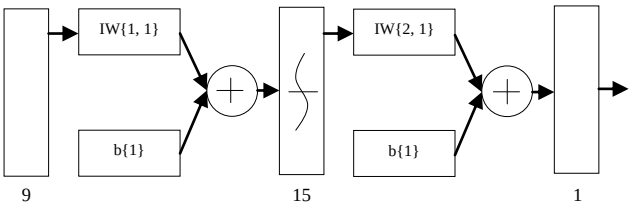

Figure 4. Structure of Neural Network Used

SVM were originally proposed by Boser, Guyon and Vapnik in 1992 and gained increasing popularity in late 1990s.Nowadays, SVM has been proved a good classifier over Neural Network. In SVM, a model is first created based on training samples. This model is then used to classify unknown data. We have used SVM – Light Multiclass tool (version 2.20) for classification. We have used linear kernel for training purpose. Goal of SVM is to find out a hyper plane with largest class margin, which best separate out given data.

Table II describes the results of the experiment carried out. As we have 10 classes (10 persons), with FDA we will have 9 features. These 9 features are used to classify the unknown data against three different classifiers, neural network, Support vector machine and L2 norm.

TABLE I: Results of FDA

No. of face per subject	Accuracy(%)			
	Neural Network	SVM	L2 Norm	Average
01	63	86	91	80.00
02	70	94	97	87.00
03	72	95	98	88.33
04	82	96	99	92.33
05	90	98	99	95.67
06	92	98	99	96.33
07	93	99	99	97.00
08	97	100	100	99.00
09	97	99	100	98.67
10	100	100	100	100.00

Fig. 5 describes the performance comparison between all three measures.

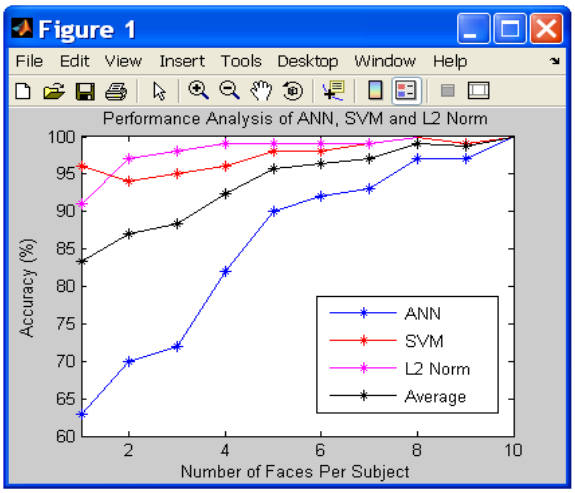

Figure 5. Performance Graph of FDA

IV. Conclusion

Illumination and facial expression varies every time face is scanned and so face recognition is difficult task. However, FDA features are quite discriminative compare to other holistic features like PCA, illumination would not affect much on the result. Neural network separates classes through only single lines, while SVM separates classes through fuzzier boundary and hence SVM has less chance of miss classification compared to neural network. Moreover, with 40 classes, neural network is not able to find generalized mapping function, which can classify all the data correctly. From results, we can conclude that SVM out weights the performance of Neural network, with improvement of more than 10 %.

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