COMPARISON OF FACE RECOGNITION METHODS

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ABSTRACT: : *Face recognition has gained its popularity because of its uniqueness among the other biometric methods. It has all the features of an effective security system. But when looking closer we come to know that, there are some limitations in the face recognition system that needs to be researched and studied upon. There are challenges such as variation in illumination, problem of posing, expression and age. In order to eliminate these challenges, we have to use specific algorithms. Combination of one or more algorithms will help in solving these challenges to an extent. The algorithms that will be used in this paper are Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), and Independent Component Analysis (ICA) and classification performed using Support Vector Machine (SVM). We will be using Matlab codes for implementing the algorithms. We will be comparing the performance of the systems on the basis of the accuracy.*

Key Words: *Face Recognition, Feature extraction, PCA, LDA, Viola Jones algorithm, SVM*

INTRODUCTION

Face recognition is currently one of the most widely used biometric identification technique. Many active researches are going on in this biometric method. It is one of the widest applications of image processing and pattern recognition. Compared to other existing biometric methods such as, finger print, iris, retina, voice etc, face recognition stands out because of its various advantages. One of the prominent advantages is that in all the other existing biometric methods, the user has to perform some action in order to trigger the system, whereas in face recognition method the used need not perform any sort of actions or procedures to initiate the system. [1]

The certain uniqueness of the face recognition system has largely dominated the other biometric methods. If we compare the existing methods on their uniqueness, performance and acceptability we can see that face recognition is much efficient that other existing methods. Table 1 shows the comparison of few of the biometric systems.

Table1. Comparison of Biometric Methods

Biometric Methods	Performance	Uniqueness	Acceptability
Face Recognition	Medium	Medium	High
Finger print	Medium	High	Medium
Iris	High	High	low
Signature	Low	Low	High
Voice Recognition	Low	Low	High

II FACE RECOGNITION

Face recognition by definition can be explained as the computer application that can be used for identifying or verifying an individual using their faces. There are various steps involved in the face recognition system. Figure 1, shows us the different steps or components involved in designing a typical face recognition system.

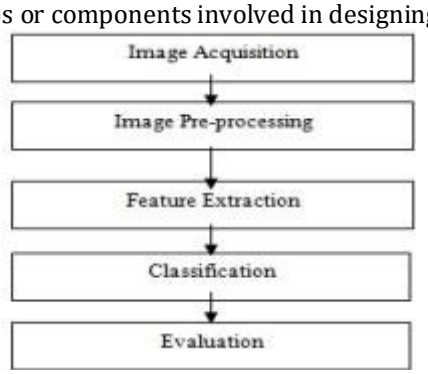

Fig. 1 Components of a typical Face recognition

2.1 Image Acquisition

There are two sets of database used here. One is the standard ORL databases with 40 subjects and 10 images each for each subject, which is a collection of faces with different illumination, poses, expression [15]. The second database is a database created exclusively for this project. It consists of people with similar faces, different facial expressions and poses. It consists of 10 subjects with 10 images each. Figure 2 shows the ORL database that we are using in this project.

2.2 Image Pre-processing

After a face is detected in the image, the face is extracted and converted into gray image for easy processing. To make the system less complicated, gray images are used. Other pre-processing techniques like image equalization, image restoration etc need not be done as the database is a standard database.

2.3 Feature Extraction

Feature extraction is one of the important procedures in face recognition. The importance of this step is that, storing a whole image is space consuming [4]. In order to save space, only unique features of the face image are extracted out of the image. In order to face the challenges in face recognition system, we are experimenting different algorithms in to the system. These algorithms are mainly for dimensionality reduction. The algorithms such as PCA, LDA, and ICA etc are implemented here. [3]

2.4 Classification

There exist various methods for classification, both linear and non-linear. Here we will be using support vector machine (SVM), a machine learning technique to classify the face images. It performs both classification and regression. A threshold is set, which will help in performing the function of accepting or rejecting the input, the face image.

Fig 2. ORL database used

2.5 Evaluation

Evaluation step basically involves, accepting or rejecting the face template given as input. On the level of accepting and rejecting, the recognition rate can be figured out. Along with recognition rate few other parameters such as accuracy.

III FACE RECOGNITION APPROACH

There are various face recognition approaches that are present. Based on the still images there are basically three approaches that will be discussed here.

1. Holistic Approach
2. Feature-based Approach
3. Hybrid Approach

3.1 Holistic Approach

In holistic approach, the whole face region is taken in as the input face. In this project we are mainly focusing on holistic approach. The techniques such as Principle component analysis (PCA), Eigen faces, Fisher faces, Support vector machine (SVM), Independent component Analysis (ICA) etc can be considered as holistic approaches.[2]

3.2 Feature- based Approach

In this approach, we would specifically focus on certain features on the face, such as nose, eyes, etc, which will be considered as the features and will be extracted as unique features from the face and stored in the database [5]. The techniques such as Pure Geometry, dynamic link architecture and hidden Markov model

will come under this approach.

3.3 Hybrid approach

This approach basically is the combinational approach. Here we can see along with the basic techniques, latest techniques such as artificial neural network (ANN) like systems are combined together.

IV METHODOLOGY

The algorithms used in the system are responsible for eliminating the challenges mentioned previously. The feature extraction or dimension reduction algorithms implemented in this project will reduce these challenges to an extent. Here we shall discuss the major algorithms used in this system.

4.1 Principle Component Analysis (PCA)

Principle component analysis is a widely used face recognition algorithm. This is basically used for dimensionality reduction. Mathematically, the main components of the face distribution are eigenfaces. They are also called as eigenvectors as they are the covariance matrix of the face images [13]. The main aim of using PCA is to get the eigenvectors as known as eigenfaces. Each of the faces in the image set can be considered as the linear combinations of the eigenfaces. Each of the MxN matrixes of the image is converted in to Mx1 column matrix [14]. The mean of each of the column matrix is taken and a normalized matrix is created by subtracting the mean from each of the column matrix. Covariance of the matrix is calculated from which the Eigen vectors are found. The best of the Eigen faces are define the face space. Re-expressing the data is the main objective of principle component analysis. PCA can be effectively used for reducing noise and redundancy. [2]

PCA basis vectors are taken in from a set of training images **I.** After finding the average and subtracting it from the training set, the data samples are created,

$$i_1, i_2, \ldots\ldots, i_n \in I\text{-}\bar{I}$$

These data samples are arranged in a matrix,

$$X = \begin{bmatrix} \begin{bmatrix} \vdots \\ i_1 \\ \vdots \end{bmatrix} & \cdots & \begin{bmatrix} \vdots \\ i_n \\ \vdots \end{bmatrix} \end{bmatrix}$$

The covariance matrix will be $\mathbf{XX^T}$ for the training images, and the principle components of this covariance matrix can be calculated using the following equation,

$$\mathbf{R^T (XX^T) = A}$$

Here **A** is the diagonal matrix of Eigen values and R represents the matrix of orthonormal eigenvectors. Only the eigenvectors associated with larger eigenvalues are considered for the face space.

4.2 Linear Discriminant Analysis (LDA)

R A Fisher designed Fisherface or the Linear Discriminant Analysis (LDA) in the year 1930 [12]. Linear Discriminant Analysis (LDA) is used to find a set of basis images which provides the help to maximize the ratio of between-class scatter to that of within-class scatter. An issue with the algorithms is that the scatter matrix always tends to be single within the class, and the reason would be that the number of pixels in the image is much greater than the number of images in the dataset [6-11]. According to previous researches LDA can be effectively used in conditions of variation in illumination. The main objective of LDA is to increase the distance between the classes and this feature is of great help when it comes to face recognition.

4.3 Independent Component analysis (ICA)

Independent Component analysis is a recently developed statistical technique which can be considered as the better version of PCA in some aspects. It is mostly used for blind source separation and blind convolution. There are basically two fundamentally different ways to apply ICA to face recognition. Architecture I and II, the architecture I considers the input images as a linear combination of statistically independent basis images combines by an unknown matrix [16]. The coefficients obtained are not statistically independent where as architecture II has coefficients that are statistically independent. The basis images of architecture II displays global properties.

4.4 Support Vector Machine (SVM)

A Support Vector Machine (SVM) is formally defined by a separate hyperplane as a discriminatory classifier. When given the labeled training data, an optimal hyperplane is produced by the algorithm that categorizes n ew examples.A Support Vector Machine (SVM) performs classification by building an Ndimensional hyperpl ane that divides data into two categories in an optimal way. SVM is very closely linked to neural networks, in Matlab as well we will be separately making use of neural networks toolbox for performing this function using in this project and . We will be combining the classifier with different feature extraction algorithms

used in this paper.
The primary objective of SVM data analysis is to find the ideal hyperplane that divides vectorclusters in a wa y that instances with one classification of the specified variable are on one side ofthe plane and instances wit h the other category are on the other side of the plane.The support vectors are the vectors near the hyperpla ne. The figure shows the function of SVM classifier. In the figure 2, we can see that the different classes are being separated using the lines [17]. In the second part of the figure we can see how the classifier has computed the optimum hyperplane and the maximum margin. This can be effectively used in face recognition system.

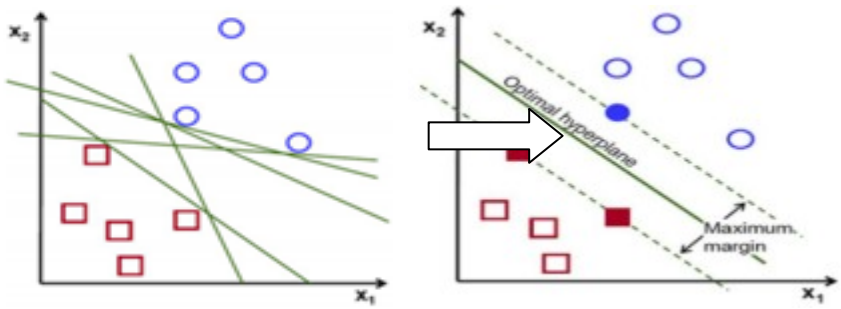

Fig.2 SVM classification

V DESIGN

The proposed project focuses on comparing the existing face recognition algorithms and creating an efficient hybrid face recognition system from the existing algorithms. The algorithms that will be used are discussed in the previous sections. Based on the algorithms used we will find the recognition rate and accuracy of the system. The flow chart in the figure 3 shows how the system works.

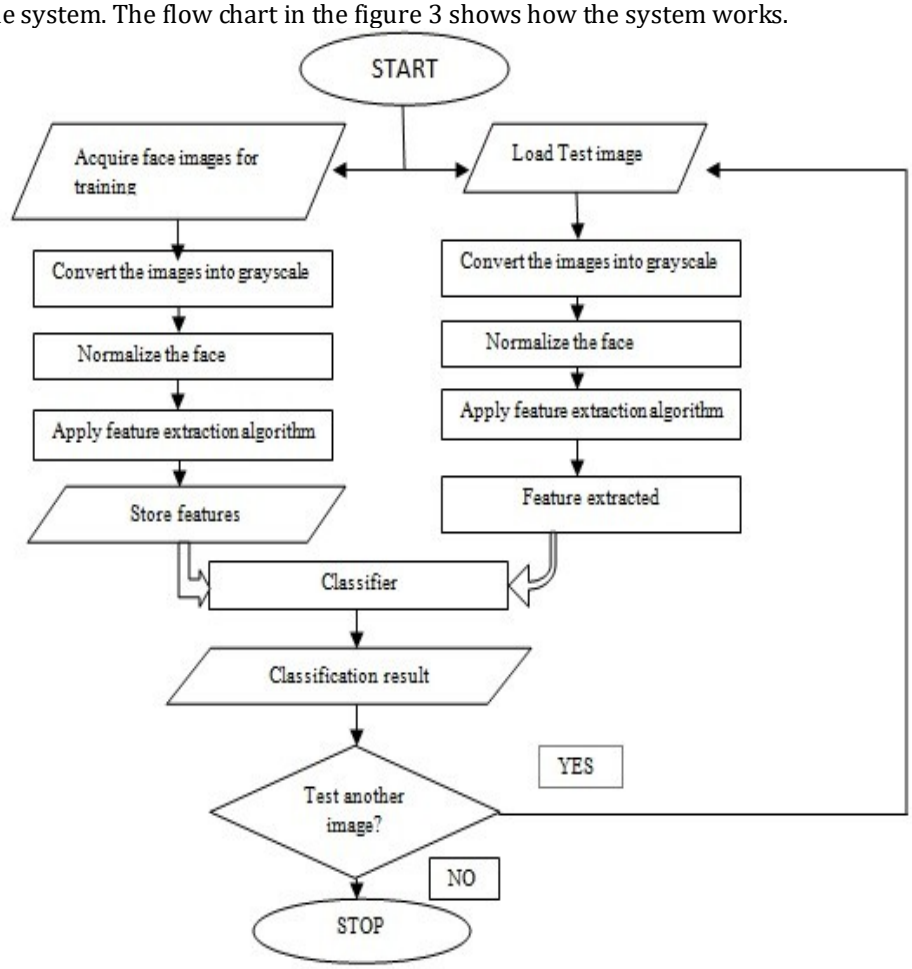

Fig. 3. Flowchart of the face recognition system

After completing the face recognition using all the algorithms mentioned, we will be considering a hybrid system consisting of PCA and LDA, PCA with SVM. We will be comparing the accuracy of the system.

VI RESULT

The accuracy of each of the system is computed using Matlab code using ORL database and table 2 shows the accuracy of each of the systems. The bar chart also shows the comparison between the algorithms.

TABLE 2. Result running the algorithms in ORL database

ALGORITHMS USED	NUMBER OF SUBJECTS	CORRECT	INCORRECT	RECOGNITION ACCURACY (%)
PCA	20	286	34	89.4
LDA	20	292	28	91.25
ICA	20	283	37	88.4375
PCA+LDA	20	298	22	93.125
PCA+SVM	20	305	15	95.3125

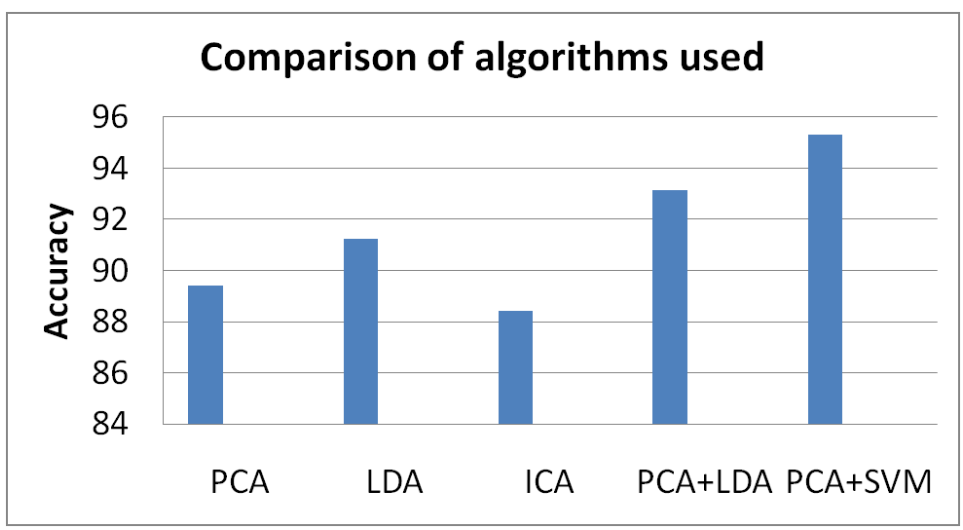

Fig. 4 Algorithm accuracy comparison

When we compare the rate at which the algorithms solve the challenges mention in the previous sections in this paper, we see that the algorithms individually cannot solve all the challenges, but when used together can solve the issues to an extent. Especially when combining PCA and LDA together, we find that the system can solve variation in illumination, pose and expression challenges. The age challenge has always been a very difficult one to solve as the problem with age is that, a person's face features may or may not vary in 10 years duration. ORL database used could only provide the faces with pose , illumination and expression variation.

VII CONCLUSION

The main objective of this paper was to compare as well as to design an efficient face recognition system using the existing algorithms used for face recognition. We saw that, if the algorithms are used individually, the output produced is much less and if used in a combined form, we get much better output. The remaining issue we have to work on is the age problem which is still an unsolved problem in face recognition system. Using the advanced methods such as neural networks and artificial intelligence can solve this issue as well. In this paper we found that, the combination of PCA and SVM is comparatively an efficient system. It solves majority of the challenges mentioned in the previous section.

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