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An Analysis of Different Face Recognition Techniques

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Abstract: ***This document compare and explains about the different techniques for "Face Recognition". Face recognition comes under the research area of Image analysis. Image analysis means, to extract the meaningful information from images. So basically we compare some of the techniques for "Face Recognition" on the basis of some parameter like accuracy and execution time.***

Keywords: PCA, Linear Fisher's Discriminant Analysis Mean and Standard Deviation, Histogram Equalization.

I. INTRODUCTION

Face recognition is one of the looks into in region pattern recognition and its various viable applications in the territory of biometrics, Information security; get to control, law requirement, keen cards and observation framework. Face Recognition is used widely in different areas like commercial, government and social consumer. A human eye is the best "Face recognition System". It mostly used for providing security. Our eye first sees the face of any person than matches that face with the existing face in the database i.e. our mind. Same as human eye a computer based system also compare two images or two faces. The system also have database in which all the faces are stored.

With a specific end goal to build up a helpful and relevant face recognition framework a few components should be grasp close by.

1. The general speed of the framework from detection to recognition ought to be worthy.
2. The accuracy and efficiency ought to be high
3. The framework ought to be effortlessly refreshed and developed, that is simple to expand the quantity of subjects that can be perceived.

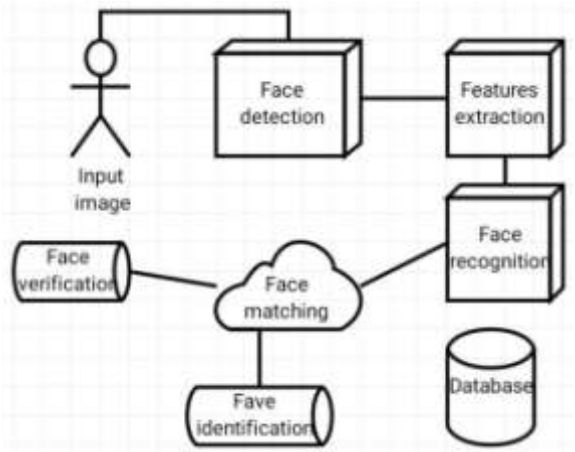

Fig. 1. Process of Face Recognition

i. Face Detection:

Face Detection refers to the process of detection of face using several facial characteristics known as nodal points. The facial features such distance between the two eyes, depth of eye socket, cheekbones and chin help in the process of face detection. Face detection is a new technology which is compatible with current existing systems and can be implemented using existing cameras or other devices which brings greater flexibility for implementation of this new technology on a broad scale.

ii. Feature Extraction:

After the process of face detection, the face image is processed and facial features are extracted from the image. Some of the most important features extracted include face colour, distance between the two eyes, width of the nose, shape of cheekbones and chin etc. These facial characteristics extracted help in facial Recognition process. Directly using these extracted facial features for face recognition have some drawbacks, primarily due to use of camera from different directions and alignments which may result varied extracted output from actual. To beat these drawbacks, feature extractions are performed using standard extraction procedures and noise clean-up.

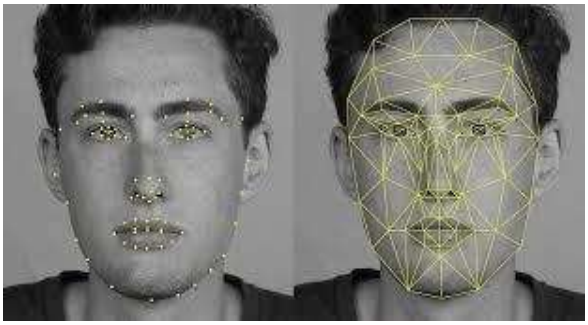

Fig. 2. Face Features Extraction

iii. Face Recognition:

After analysing the description of different faces, the last step is the process of Face Recognition. Face recognition consists of two different kinds of comparisons:

1. Verification

2. Identification

1. Verification: This comparison is process of verifying whether the face belongs to an individual is the one who he/she claims to be, by making comparison between the two.

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2. Identification: Identification is the process of comparing the individual's face with all the faces stored in the database and then producing the ranked list of identified matches as output.

II. FACE RECOGNITION TECHNIQUES

1. Principle Component Analysis:

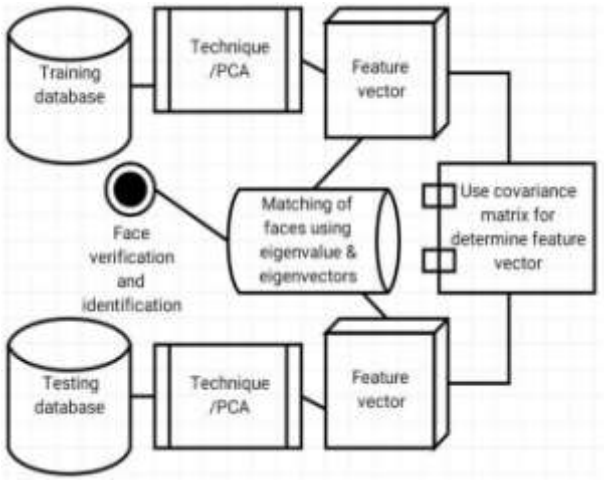

Fig. 3. Process of Principal Component Analysis

Principal Component Analysis (PCA) is a dimensionality-reduction technique using which the dimensionality of a data set can be reduced i.e. a high-dimensional dataset can be converted into a smaller-dimensional dataset before running a machine learning algorithmic rule on the information.

Principal Component Analysis can be used for the following purposes:

a) To reduce the dimensions in data

b) To find the high dimensional data patterns

c) For Visualization of high dimensionality

Principal Component Analysis as the name suggests, finds the principal components of the dataset. PCA transforms the information into a new, lower-dimensional subspace and then converts it into a new coordinate system.

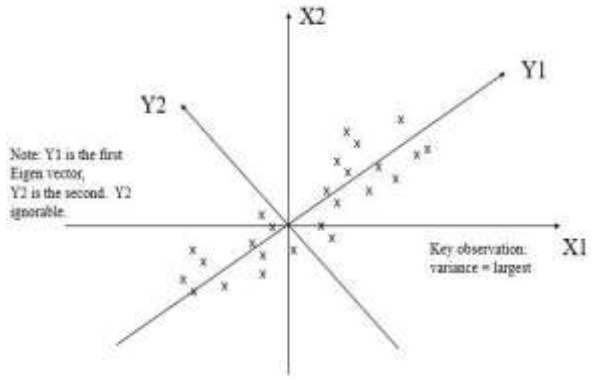

Fig. 4. Eigen Vector Analysis

Eigenvectors and Eigenvalues:

Every Eigenvector has an eigenvalue which could be scalar. Given is an n by n matrix M, where vectors x having the same direction as that of M**x** are called eigenvectors.

In the equation M**x**=λ**x**, λ is called an eigenvalue of M.

$$\begin{pmatrix} 2 & 3 \\ 2 & 1 \end{pmatrix} x \begin{pmatrix} 3 \\ 2 \end{pmatrix} = \begin{pmatrix} 12 \\ 8 \end{pmatrix} = 4x \begin{pmatrix} 3 \\ 2 \end{pmatrix}$$

2. Fisher's Linear Discriminant Analysis:

Fisher's Linear Discriminant Analysis (FLDA) is an analytical procedure for categorizing examples of faces which are not known, based on training samples with faces which are known.

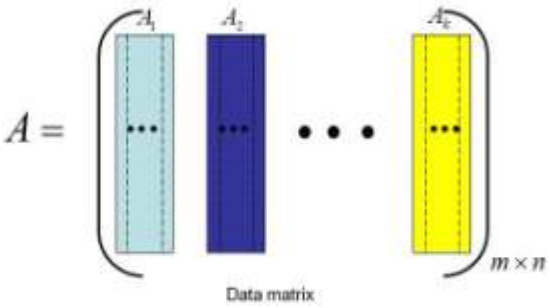

Fig. 5. Training Samples Data

The Principle component analysis projections are best suited to build from a low dimensional basis, but they are not useful from a discrimination standpoint. To overcome the drawback, Fisher Linear Discriminant (FLD) method is employed for the aim of obtaining high disconnection among the various patterns. The aim of Fisher's Linear Discriminant is to find the appropriate projection, in order to change the distances i.e. to maximize it between-class and minimize it within- class.

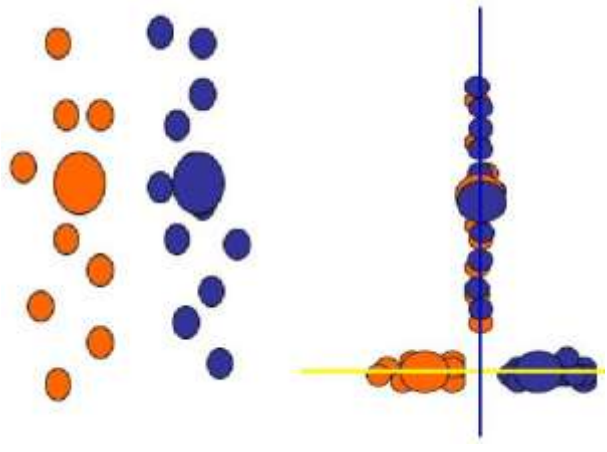

Fig. 6. Maximized Distance Fig. 7. Minimized Distance

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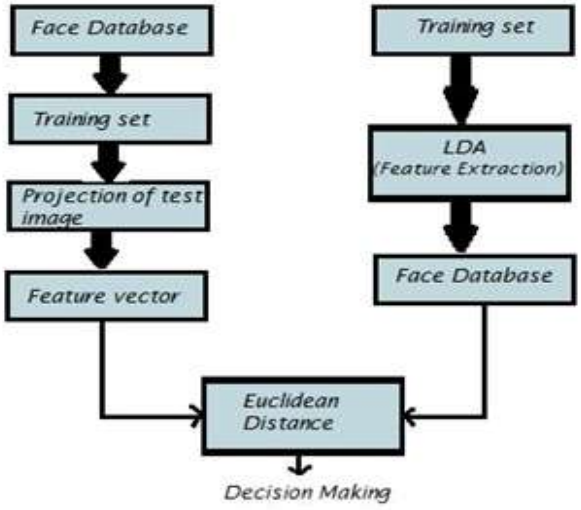

Fig. 8. Process of FLDA

Fisher's Linear Discriminant technique is a projection using which between class scatter is maximized and within class scatter is minimized.

The FLDA algorithm can be used on all the face images by implementing the following mentioned steps:

Step 1: Obtain the training sample and test sample of face images and create its feature vector representation.

Step 2: Calculate the covariance matrices Sw and Sb for both within class and between-class using the following formulas:

$$S_b = \sum_{k=1}^{k} N_k(\mu_{xk} - \mu_x)(\mu_{xk} - \mu_x)^T$$

$$S_w = \sum_{k=1}^{k} \sum_{X_i C_k} (X_i - \mu_{xk})\,(X_i - \mu_{xk})^T$$

Step 3: Using the following formula, the transformation matrix for higher separability can be formed

$$J = \frac{\det(W^T,\ S_b,\ W)}{\det(W^T,\ S_w,\ W)}$$

Fig. 9. Transformation Matrix Formula

Step 4: Categorize the given face image based on its Euclidean distance and threshold values.

3. Histogram Normalization:

In Image Processing Normalization is a technique that undergoes a change in the range of pixel intensity values. Contrast stretching or histogram stretching are the other names used for normalization.

If a uniform histogram A is to be made for a different image I, this is called histogram equalization. The Normalize module expands an image's element worth so as to hide the complete element value that varies from 0-255. The function consists of each colour band i.e. RGB and identifies the minimum and maximum value in all of the three colour bands.

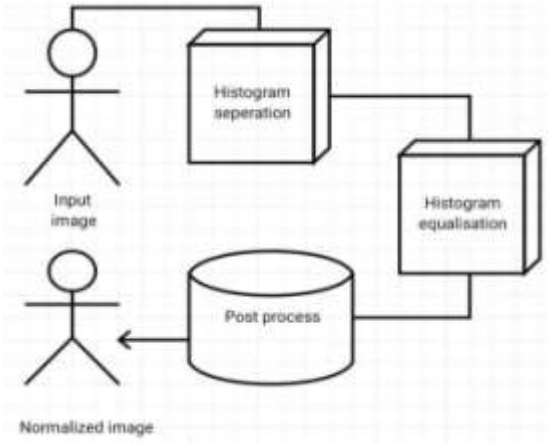

Fig. 10. Histogram Equalization Process

4. Distance Based Approach Using Mean And Standard Deviation:

In this approach we used two parameters mean and standard deviation. First we need to calculate the mean and standard deviation of each image which are already stored in training database then we need to calculate the mean and standard deviation of the test image.

After that we compare the differences of mean and standard deviation of all images to our test image. And then the difference which is lesser among all the differences that image we will select as a equivalent image. This is the simple concept of MS (mean & standard deviation) based approach for face recognition.

We have also used threshold in this approach, means if the difference is higher than the threshold then the face is not present in the training database.

The formulas for mean and standard deviation are:

$$\mu = \frac{\sum_{i=1}^{n} x_i}{n}$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \mu)^2}{n}}$$

Fig. 11. Mean and Standard Deviation Formulas

III. RESULT

We have implemented different face recognition techniques in MATLAB 2014, which require some configurations like 2GB RAM, 500 GB ROM etc. On the basis of parameters i.e. accuracy and execution time we have found that PCA do not require any previous knowledge of data set and its class as compare to FLDA. So it proves that PCA is unsupervised learning technique and FLDA comes under the supervised learning technique. May be the efficiency and accuracy of PCA and FLDA is same sometimes.

But somehow PCA is better than FLDA because it don't require any kind of initial knowledge of class and labels. And if we talk about other two techniques i.e. Histogram equalisation and distance based approach then histogram equalisation is only efficient for face comparison not for face recognition system. And distance based approach using mean and standard deviation is also used for only small size of database not for large size of database so this is also not that much useful.

Table 1. Observation Table

Parameter	PCA	FLDA	HE	MS
Accuracy	88%	80%	40%	60%
Execution Time (Sec)	25.256	27.45	31.48	33.19

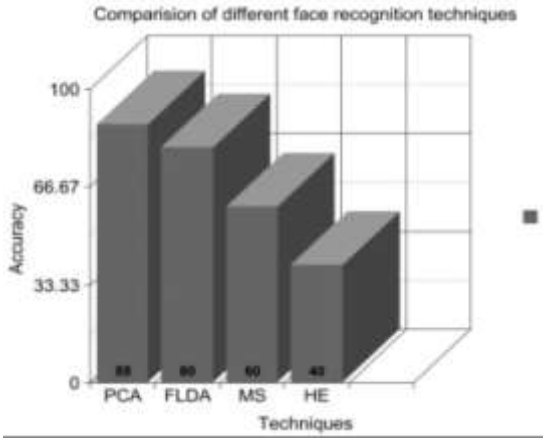

Fig. 12. Comparison of Different Face Recognition Techniques Based on Accuracy

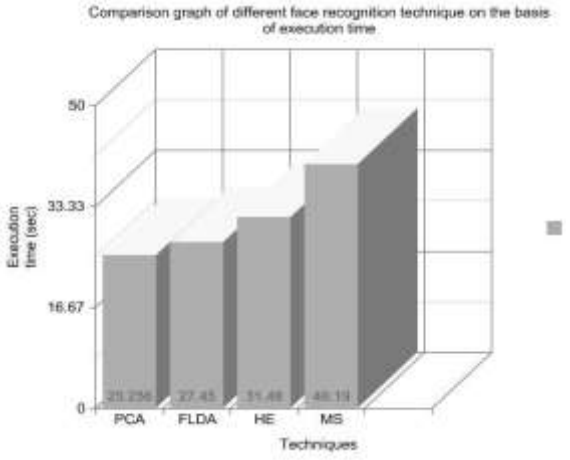

Fig. 13. Comparison of Different Face Recognition Techniques based on Execution Time

IV. CONCLUSION

These graphs show that the accuracy and execution time of PCA (principle component analysis) is better than the other techniques means this approach is most favourable and useful technique for face recognition.

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