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An Efficient Approach for Face Recognition using PCA Algorithm

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Abstract—*The current paper shows the working of Principal Component Analysis (PCA) for Face Recognition. PCA is one of the most popular approach to represent a face image. It helps to reduce the dimensionality of an image and retains some of the variations in the image data as well. In this technique, training set, consist of images are defined as a linear combination of weighted eigenvectors (Principal Components) which are known as eigenfaces. These eigenvectors do not necessarily correspond to the face features like- eyes, nose, ears etc.*
Each face from training data set can be represented a weighted sum of K eigenfaces. It calculates distance between input weight vector and all the weight vectors of training set and then decides that the face is known or unknown.
In this paper, we conducted various simulations to verify our algorithm and considered the best accuracy through the same.

Key Terms*: Face recognition, Principal Component Analysis, Eigen Vectors, and Eigenfaces.*

1. INTRODUCTION

The Human face plays a major role in conveying identity and emotions. It is the central organ of sense and is also very central in the expression of emotion among humans and among numerous other species. We can easily recognize many of faces during our lifetime and identify familiar faces at a single moment even after long time. This is a quite robust skill, despite some big changes in the visual stimulus due to, expression, aging, viewing conditions and distraction such as beards, glasses or changes in hairstyle. Face recognition considered as an important process in many applications such as verification of credit cards, criminal identification, security systems etc. For example, the technique to recognize a particular face easily from a huge data base can improve criminal identification. Although it is clear that human brain is good to recognize a face, but it is not at all obvious how faces are encoded or decoded by the human brain. Unfortunately to build a computational model of face recognition is tough. Because it is a very high-level computer vision task, in which there are many early vision techniques can be involved. Although there are different approaches to the face recognition problem. The PCA (Principal Component Analysis) is one of the best approach in them. The PCA also Known as eigenfaces or eigenvectors. It converts a matrix form image into vector format and reduces its dimensionality. The eigenface approach helps to create ghost-like faces that represent the majority of variance in a face image database.

2. FACE RECOGNITION PROCESS

Today face recognition is being used in various fields such as criminal identification, Support law enforcement, missing children identification, minimize identify fraud etc.

"Face Recognition" is a very active area in the Biometrics fields and Computer Vision, as it has been studied strongly for 25 years.

"Face Recognition" generally follows two stages:

1. Face Detection: In which a face image is searched to find any face, then image processing method finds the facial image for recognition.

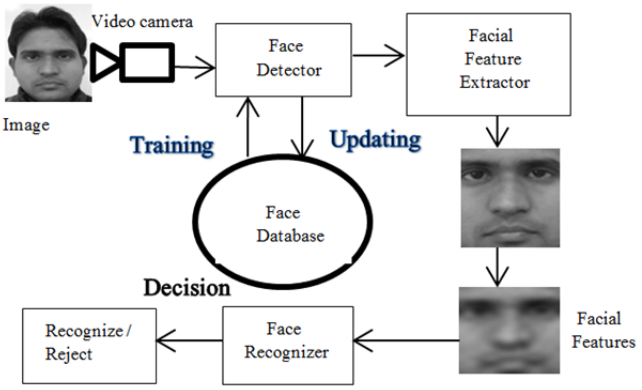

Fig. 1: Framework for Face Recognition System.

2. Face Recognition: In this step the detected face is compared to a database of known faces, to decide who that person is.

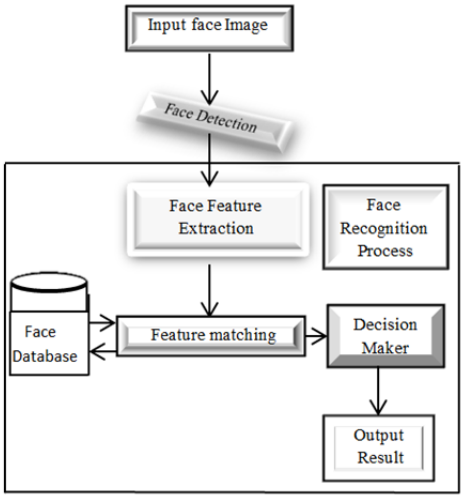

Fig. 2: Work Flow Model

3. PRINCIPLE COMPONENT ANALYSIS (PCA) ALGORITHM

The Eigenface approach convert a high image content into low dimension data, that is easy to process and store in less space as well. When a new image in the eigenface subspace is projected, the recognition process takes place, after which the person is classified by comparing its position in eigenface space with the position of known individual. The main advantage of this process is its speed, simplicity and efficiency to small or gradual changes on the face. PCA several steps are undertaken:

Step 1: Initialize the training dataset of images.

$S = \{I_1, I_2, I_3, I_4, \ldots\ldots\ldots, I_m\}$.

Step 2: Calculate the Average face vector and find out the mean image.

$$\Psi = \frac{1}{M}\sum_{n=1}^{M}\Gamma_n .$$

$\Phi i = Ii - \Psi$

After mean subtraction, we get the image like this:

Step 3: Calculate Eigenvectors and Eigenvalues from the covariance Matrix.

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

This step helps to find out the features of an image.

Here we have an eigenface No. 0 and a last eigenface No. 119. First face is able to see but last face is only the extracted features of the face. It is mainly a noisy image.

Step 4: Now convert the lower dimension K eigenvector to the original face dimensionality.

$Ui = Avi$

Step 5: Calculate distance between input weight vector and all the weight vector of the training set. If the distance is less than threshold the face is known otherwise unknown.

4. RESULTS AND ANALYSIS

4.1 Explanation of PCA algorithm

Explanation Of Eigen faces (Principal Component Analysis) in simple terms, Eigenfaces figures out the main differences between all the training images, and then how to represent each training image using a combination of those differences. So for example, one of the training images might be made up of: (Average Face) + (13.5% of eigenface0) - (34.3% of eigenface1) + (4.7% of eigenface2) + ... + (0.0% of eigenface199).

Out of the whole 200 training images that above images were supplied.

4.2 Accuracy Graph

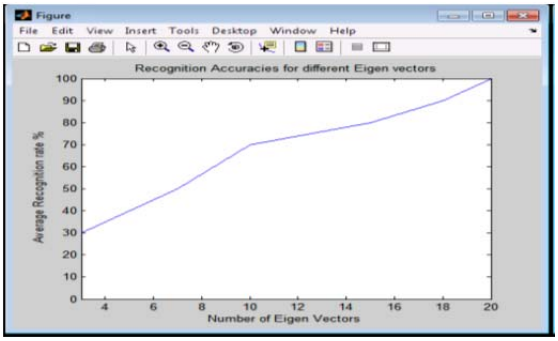

Fig. 1: Graph shows the relationship between Eigen vectors and the Average Recognition Percent (%).

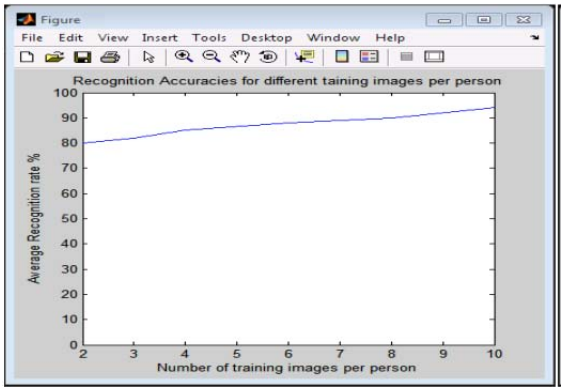

Fig. 2: Graph shows the relationship between No. of Training images per person & Average Recognition rate Percent (%).

5. CONCLUSION

In this paper, we drive the technique of PCA Algorithm for face recognition, which is a best approach to convert the dimensionality of an image and helps to save the storage space. In this experiment we used the ORL database with pgm images and implemented in Matlab. This method gave better result though it has limitations over the variations in size of images. Thus, this approach is a good solution for face recognition challenge. It is a simple and fast technique, which shown work well in constrained environment.

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