Project Title: ***Face Recognition Using Principal Component Analysis***

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The topic of face recognition has received considerable concentration in recent years and has become one of the sophisticated parts of image analysis and pattern recognition research. In image processing, the face recognition is a classical problem and has various applications. There are numerous methods that had been implemented for the face recognition. However, in this project, the Principal Component Analysis (PCA) based image recognition has been studied and implemented in MATLAB work-space according to given guidelines. Recently, the PCA has been extensively employed for face recognition algorithms that not only reduces the dimensionality of the image, but also retains some of the variations in the image data. The implementation has also been tested on the given data set of faces that was captured during the lectures. The overall accuracy for the detection of the unknown face is 55.84 percent for the given set of face image. The results reflect acceptable accuracy of the PCA based implementation.

Objectives of the Projects:

1. Understandings and Implementations of PCA and SVD for dimension reduction.
2. Implementations of Face recognition system in MATLAB.
3. Findings out the accuracy of recognitions of the face.

Methodology

The implemented method for the project on PCA based face recognition systems are described below-

The captured data set of different faces of various subjects has been resized to 240×320. Five different views of each subject are captured. Then five points are selected and their x and y locations are extracted from each image as features. These five points are located as: *two points from the center of eyes*, *one point from the center of the nose* and *two points are extracted from the ending edges of the lips*. After that, Singular Value Decomposition (SVD) was used for getting a mapped matrix of 64×64 with predetermined locations of all the features in the data set. Upon applying transformation, each image in the data set is converted into single vector and then each vector is placed into a matrix such that each vector is acted as a row of the matrix as given in the Eq. 1

$$D = \begin{bmatrix} I_1(1,1) & I_1(1,2)..... & I_1(M,N) \\ I_2(1,1) & I_2(1,2)..... & I_2(M,N) \\ . & & \\ . & & \\ . & & \\ . & & \\ I_n(1,1) & I_n(1,2)..... & I_n(M,N) \end{bmatrix} \quad (1)$$

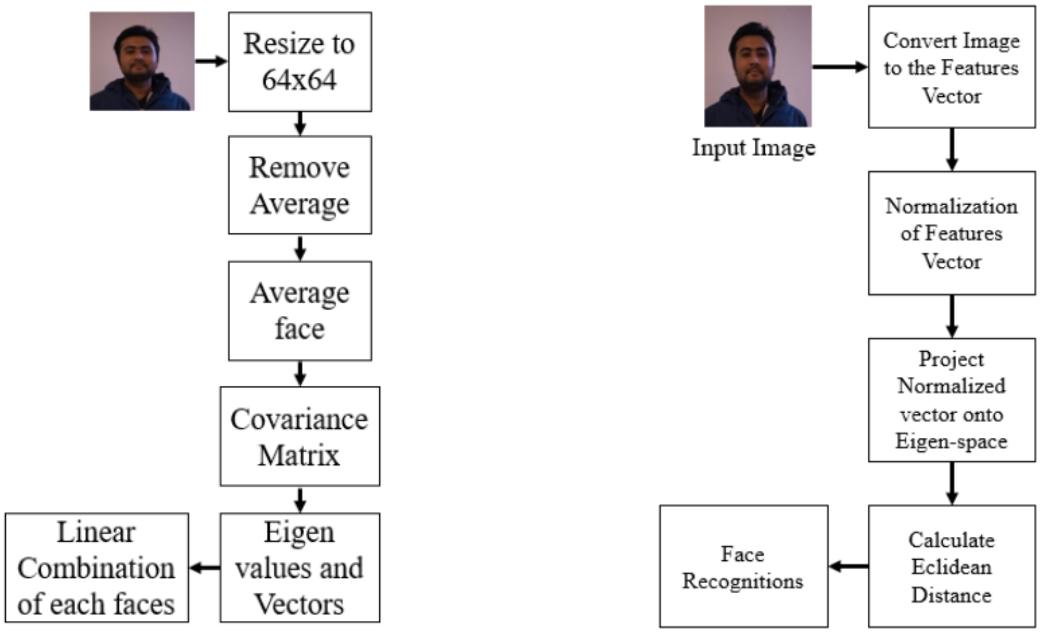
Now the co-variance of the matrix D is determined by using the Eq. 2, where N is number of images in the data set and D is given in Eq. 3. The overall process for the training of data set for recognition of face is shown in Fig. 1 (a). Due to symmetric nature of the co-variance matrix C, the diagonalization is applied to it. Then the eigenvectors are obtained that are called principal components of matrix C.

$$C = \frac{1}{N}\tilde{D}\tilde{D}^T \quad (2)$$

$$\tilde{D} = D - mean(D) \quad (3)$$

$$\phi_i = \Phi.X_i \quad (4)$$

As each principal component is representing an image in the data set, therefore, each image can be obtained back by converting the principal component. The conversion is a reverse process of concatenation and converted images are called eigenfaces. The k principal components are put into d projection matrix Φ, here d is the size of matrix D and each column in Φ matrix represents a principal component. Therefore, any image I_i can be represented as a vector X_i and can be projected in PCA space by computing φ_i as given in Eq. 4. At the final stage, the images are trained by projecting them to the PCA space. Then in the testing part, the test image is passed through the implemented algorithm to get the its match from the trained database. The overall implemented method is described graphically in Fig.1 (b).

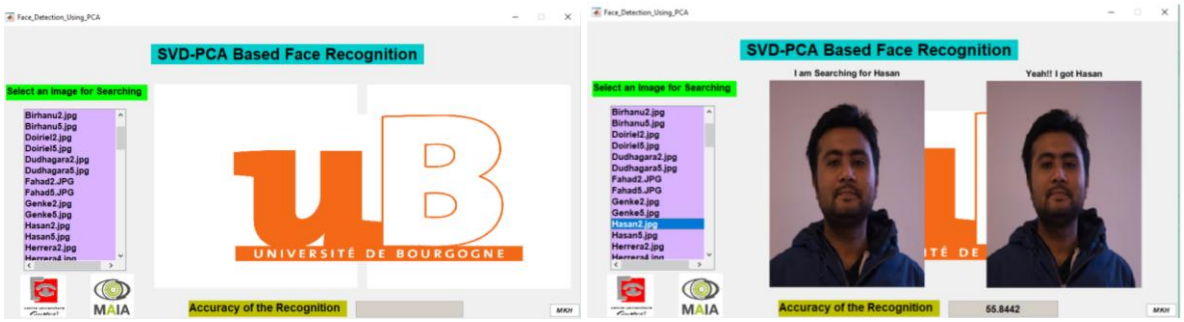


(a) (b)

Fig. 1: The block diagram of a) training process b) implemented algorithm

Results and Discussion

Fig. 2 (a), shows the implemented Graphical User Interface (GUI). From this GUI, the user can select the search image from the generated list of the GUI on the left-hand side as given in Fig. 2 (a). Then selected image is compared within the trained data set and exact match can be shown in GUI display area and at the same the calculated recognition accuracy of the algorithm is prompted on the bottom of the GUI as shown in Fig. 2 (b). As from the reflected results, the implemented algorithm shows an accuracy of 55.84 percent. However, on some images within the data set the recognition results are not acceptable. The reason that has been analyzed during the testing phase that brings unacceptable results. The reason is simple that PCA recognition is based on only the Euclidean distance among feature set.



(a) (b)

Fig. 2: A preview of a) developed GUI b) Recognized face

Project Partner: Amjad Khan and Zafar Toshpulatov