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Improved Face Recognition Algorithm Using Eigen Faces

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Abstract— Face recognition is one of the major challenge and is the most popular research areas in the computer vision. The research is focused to develop the computational model of face recognition that is fast, simple and accurate in different environments. In this study, we develop an improved recognition strategy based computational model to identify the face of an unknown person. The proposed computational model makes use of the well-known eigenfaces approach. A given set of face images are processed to compute eigenfaces. The eigenfaces are then projected into a number of unique features vectors. These features vectors form a database of vectors and are used to identify an unknown face. The feature vector of the unknown face is compared with vectors in the database using the improved recognition strategy described in this paper. The proposed approach is tested on a number of face images of a database which consists of 49 images of 9 persons. The results indicate the proposed recognition strategy through eigenfaces works well.

Keywords— **Feature vector, eigenfaces, eigenvalues, eigenvector, PCA**

I. INTRODUCTION

Face recognition system is quite difficult because human faces are quite complex, multidimensional and corresponding on environment changes. The recognition of human faces is a challenging problem due the changes in the face identity and variation between images of the same due to illumination and viewing direction. The issues are how the features adopted to represent a face under environmental changes and how we classify a new face image based on the chosen representation. Face Recognition is one of the popular areas of research in Image processing. It is different from other biometric recognition because faces are complex, multidimensional and almost all human faces have a similar construction. Out of many issues some of the most important issues associated with facial recognition are the type, format and composition (different background, variant illumination and different facial expression) of the face images used for the recognition. Computers that recognize human faces systems have been applied in many applications such as security system, mug shot matching and model-based video coding. The eigenfaces is well known method for face recognition. M.A Turk and Alex P. Pentland developed the near real-time eigenfaces systems for face recognition using eigenfaces and Euclidean distance. We develop a technique to extract features from an intensity image of human frontal face to represent the features using eigenfaces.

II. LITERATURE REVIEW

Lot of the work in recognition of faces has done. Research in face recognition moreover, has shown that individual features and their immediate relationships comprise an insufficient representation to account for the performance of human face recognition. The challenge of robust face recognition remains one of the most popular research areas in computer vision.

Bledsoe [2,3] was the first to develop semi-automated face recognition with a hybrid human-computer system that classified faces on the basis of fiducial marks entered on photographs by hand.

Goldstein et all. [4] developed a vector of up to 21 features and recognized faces using standard pattern classification techniques.

Fisher and Elschlager [5] attempted to measure similar features (shade of hair, length of ears, lip thickness). They descried linear embedding algorithms that used local feature matching.

Kohonen and lahtio in and Kohonen [6,7] describe an associative network with a simple learning algorithm that can recognize and classify face images and recall a face image from an incomplete or noisy version input to the network.

Matthew A.Turk and Alex P. Pentland [8] have proposed a method to face recognition using Eigenfaces approach which tracks a subjects head and then recognizes the person by comparing characteristics of the face to those of the known individuals. Their approach treats face images as two dimensional recognition problem, taking advantage of the fact that faces are normally upright and thus may be described by a small set of 2-D characteristics views.

Zhujie and Y.L. Yu [9] developed the approach to face recognition with eigenfaces, focusing on the effects of eigenfaces used to represent human face under several environment conditions.

Kshirsagar et. all [10] proposed a methodology for face recognition based on information theory approach of coding and decoding the face image, showing an accuracy of >85% on the AT&T database which consists of 400 images with 10 images of each individual.

III. ALGORITHM FOR FACE RECOGNITION

The proposed is based on the well-known eigenfaces. In mathematical terms, we wish to find the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images, treating an image as a point (or vector) in a high dimensional space. The eigenvectors are ordered, each one accounting for a different amount of the variation among the face images. These vectors can be thought of as a set of features that together characterize the variation between face images. Each image location contributes more or less to each eigenvector, so that we can display the eigenvector as a sort of ghostly face which we call an eigenfaces.

The eigenfaces algorithm and proposed changes are described below:

A. *Eigenfaces Algorithm:*

- We assume the training sets of images are:- Γ1,Γ2 ,_,Γ*m* with each image is *I(x ,y)*. Convert each image into set of vectors and new full-size matrix (m x p) , where *m* is the number of training images and *p* is *x* x *y*.

- Find the Average by:-

$$\Psi = \left(\frac{1}{M}\right)\sum_{i=1}^{n}$$

- Calculated the mean-subtracted face:
  $\Phi i = \Gamma i - \psi$, i= 1,2,…….m
- And a set of matrix is obtained with
  A=[Φ1,Φ2,….Φm] is the mean-subtracted matrix vector
- Find the Covariance matrix as:-
  $C = A^T A$
- Compute the Eigen values from the Covariance matrix.
- Now Calculate
  $U_i = Av_i$
  U1=A*v1
  U= [U1 U2 U3]
- A Face image can be projected into this face space by
  $\Omega k = U^T(T^k - \Psi)$, k=1……..M
  $\Omega_1 = U^T\Phi 1$

B. *Proposed Improved Recognition Strategy*

The Test image, Γ is projected into the face space to obtain a vector Ω
$\Omega - U^T(\Gamma - \Psi)$

- The distance of Ω to each face class is defined by
- $\varepsilon k^2 = \|\Omega - \Omega_k\|^2$, k= 1……..M
- A Distance threshold $\theta c = 1/2 \max_{jk} \{\|\Omega_j - \Omega_k\|\}$, k=1……M
- Find the distance ε between the original image Γ, and its reconstructed image from the Eigen space,
- $\varepsilon^2 = \|T - T_F\|^2$, where $T_F - U = \Omega + \Psi$

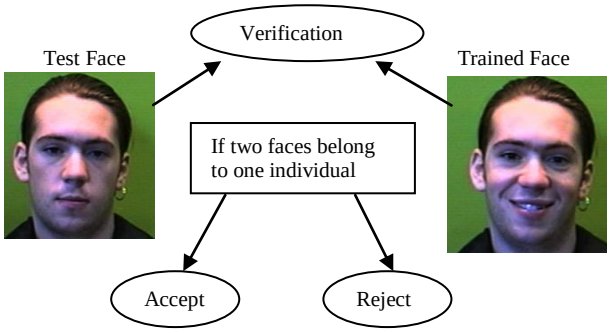
C. *Recognition Process.*

- If $\varepsilon >= \theta_c$
  Then input image is not a face image
- If $\varepsilon < \theta_c$ AND $\varepsilon_k \geq \theta_c$, for all k
  Then input image contains an unknown face
- If $\varepsilon < \theta_c$, AND $\varepsilon k = \text{mink } \{\varepsilon_k\} < \theta_c$
  Then input image contains the face of individual K.

Where θ_c is a suitable threshold based quality and noise present in the images.

IV. RESULTS AND DISCUSSION

The Code for eigenfaces is developed using Matlab. The eigenvalues and eigenvectors play a major role in producing eigenfaces.



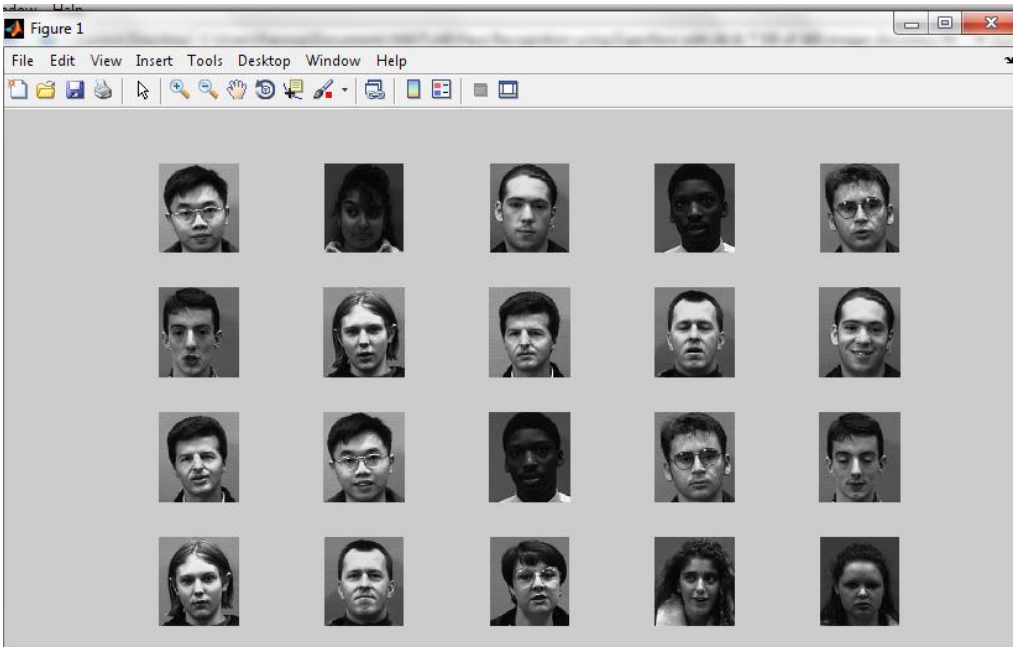


Fig. 1` Trained

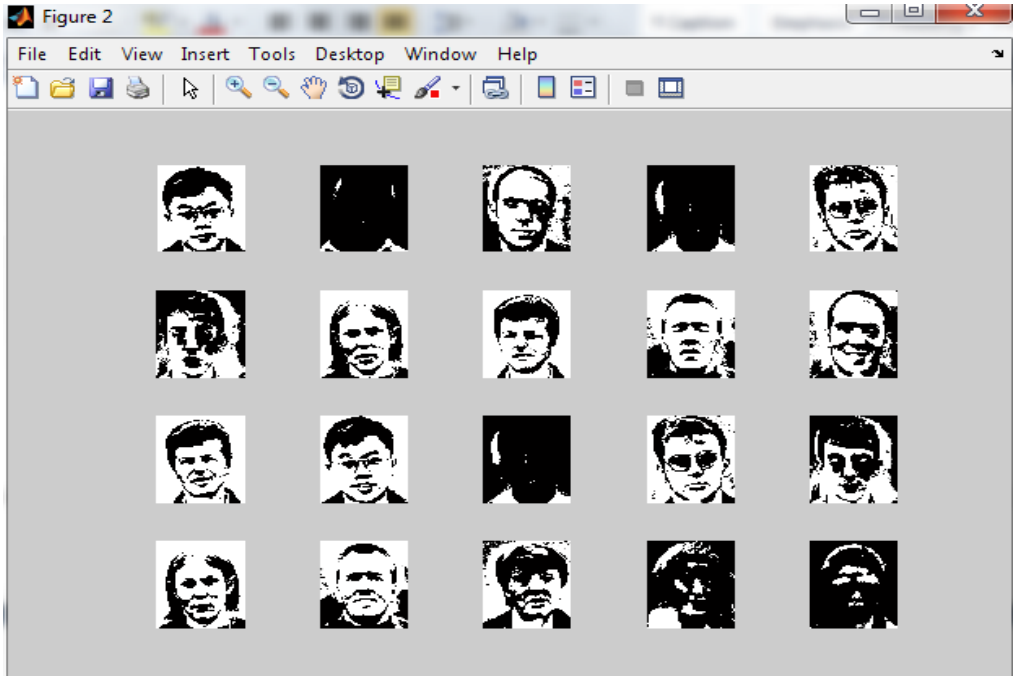


Fig. 2 Projected Images

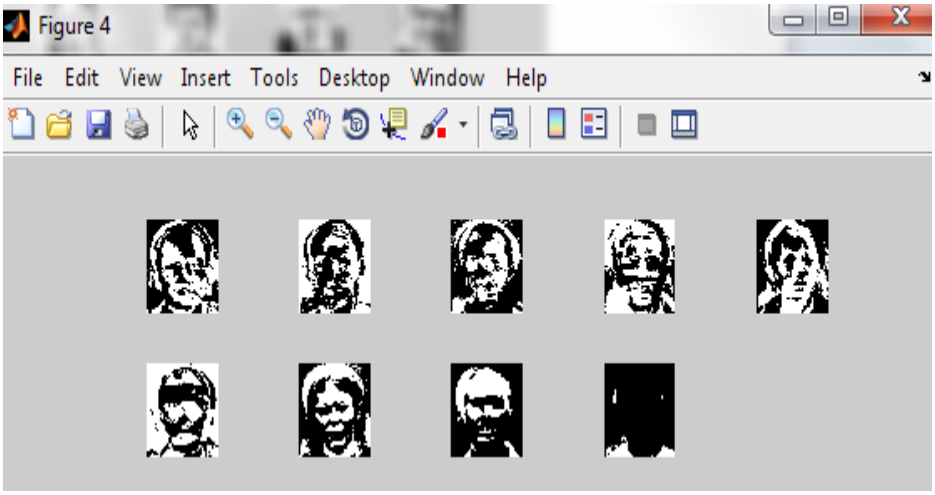
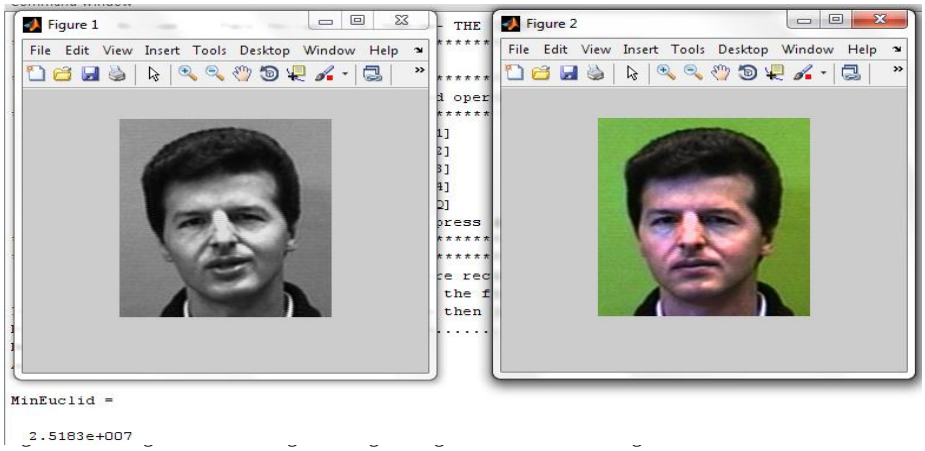


Fig. 3 Eigenfaces of Face Images U1 to U9



Experimental Results

In this work, we performed the tests on the database consists of 49 face images of nine persons. The overall accuracy of this approach is 96% on this database.

Navneet et. al [18] show an accuracy of 90.9% using PCA and 95.45% Using PCA with artificial neural network.

The threshold θ_c for the chosen data set was experimentally chosen as 3.7119e+007, where e is a Scientific notation and 3.7119e+007= 3.7119 * 10^7. The table1 shows the overall average accuracy which is an improved accuracy of 100% on the same face database . Table 2 shows an overall accuracy of 96%.

Table 1

	Recognition		
Number of images trained	***Correctly Recognized***	***Incorrectly Recognized***	***Accuracy***
49	49	0	100%

.

Table 2.

	Recognition		
Number of images trained	***Correctly Recognized***	***Incorrectly Recognized***	***Accuracy***
9	47	2	96%

V. CONCLUSIONS

In this work we introduced a slightly different solution for face recognition. The Eigenfaces approach for Face Recognition process is fast and simple which works well under constrained environment. It is one of the best practical solutions for the problem of face recognition. Many applications which require face recognition do not require perfect identification but just low error rate. So instead of searching large database of faces, it is better to give small set of likely matches. By using Eigenfaces approach, this small set of likely matches for given images can be easily obtained. By using eigenfaces approach, we try to reduce this dimensionality. The eigenfaces are the eigenvectors of covariance matrix representing the image space. The important part is making this choice of threshold θ_c which will be crucial depending on type of application and error rate acceptable. More research needs to be done on choosing the best value of threshold. This value of threshold may vary depending on the application of Face Recognition. So various methods for making best choice of threshold needs to be studied. Further, this approach can be applied to show good results on other databases as well.

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