



INDIAN INSTITUTE OF TECHNOLOGY  
GANDHINAGAR

EE 321 PROBABILITY AND RANDOM PROCESSES

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## Face recognition using Eigenfaces

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## 1 Task Description

Design a face recognition system using eigenfaces. Test your code on Yale Face Database.

## 2 Theory

M.A. Turk and A.P. Pentland of MIT proposed the realistic method of using eigenfaces for detection and recognition of human faces. I implemented their algorithm in this assignment.

## 3 Stepwise Algorithm Description along results

### 3.1 Mean Calculation

Firstly I calculated mean of all the images. The obtained mean is given in below figure.



Figure 1: Mean image of Yale database

### 3.2 Eigenvector Calculation

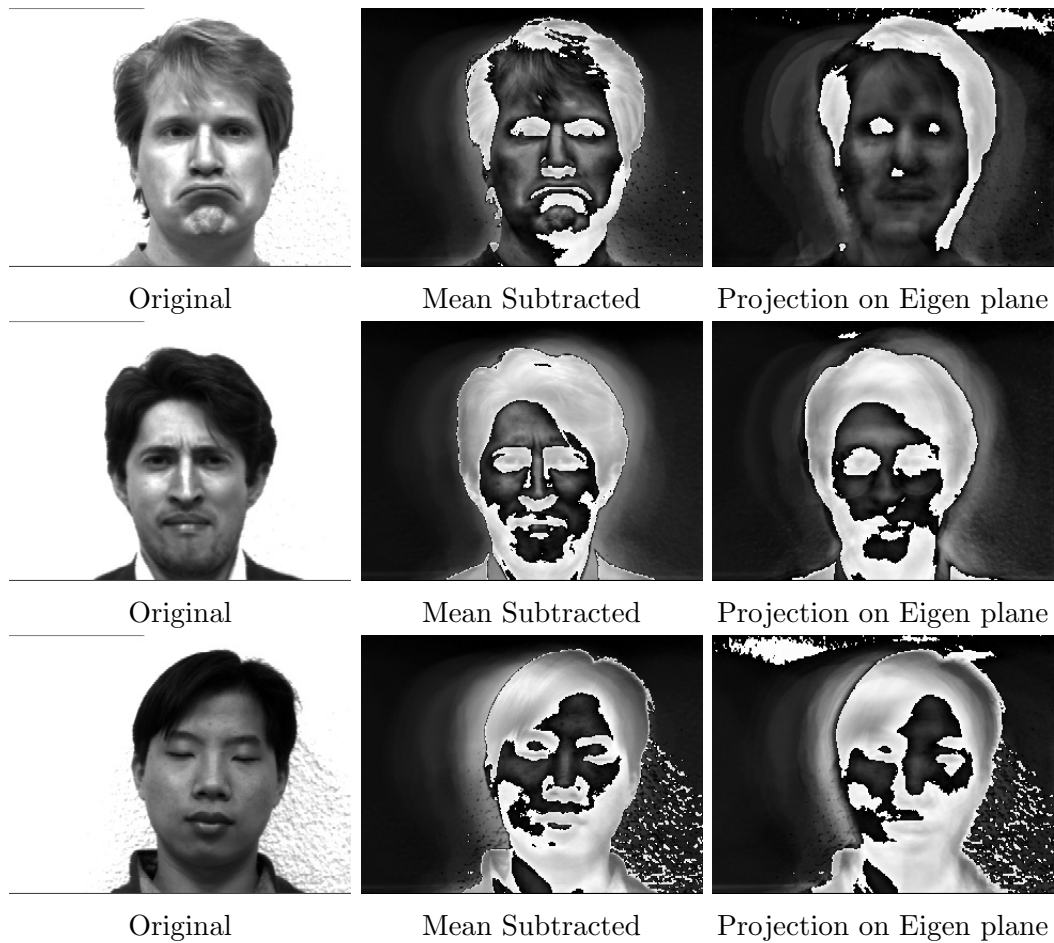
$$C = AA^T$$

$$L = A^T A$$

We will find eigen vectors of L and multiply it by A(image matrix) to find eigen vectors of covariance matrix. These eigen values we call eigenfaces.

By doing PCA I found 16 out of 105 eigenvectors sufficient to represent all the training images.

Next we project our training images onto the eigenface plane. Few examples are



depicted below.

## 4 Results on Test data

Accuracy found on the test data was 86.7%.

### 4.1 Achievements

Our dataset had 11 images for each of fifteen individuals. I took 7 images on training and tested on 4 images. With the help of PCA I reduced 105 eigen vectors to 16 major eigen vectors which contributed 85% energy. Considering the exponential reduce in terms of computational complexity this algorithm brings it can be considered champion of unsupervised algorithms.

## 4.2 Drawbacks

This algorithm will fail as the size of training data increase. As major contribution in eigen faces comes from the few eigen vectors this algorithm will not be scalable when number of eigen vectors will become large (around 500). Also like any other unsupervised algorithms it requires a lot of computation while testing, which is not good.

## 5 Reference Paper

1. M. A. Turk and A. P. Pentland, "Face recognition using eigenfaces," Proceedings. 1991 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, Maui, HI, USA, 1991, pp. 586-591. doi: 10.1109/CVPR.1991.139758
2. Yale Face Database