Eigenfaces

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1 Introduction

I implemented the Eigenfaces algorithm described in the paper by Turk and Pentland. First PCA is performed on the training matrix to obtain representative eigenfaces. The eigenfaces are then used to project the training and testing vectors into PCA subspace in order to obtain the reduced dimensionality training and testing feature vectors. Finally, classification is performed using the reduced training and testing feature vectors to match faces. The MATLAB code used to perform these steps is based in part on a submission by University of Illinois on the MathWorks file exchange.

2 Implementing Eigenfaces

2.1 Obtaining Average Face

Once the training matrix is assembled, the algorithm finds the mean face (seen in Fig 1).

Figure 1: Average Face From Training Images

2.2 Performing PCA

PCA is performed in the following ways: first the eigenvectors of XX^T are found, where X is the data set matrix. Next SVD is performed. Finally the eigenvectors of X^TX are found and the method described in the Turk and Pentland paper is used. Using the *tik* and *tok* MATLAB functions it is observed that SVD takes the least amount of time to perform. After PCA is performed, the n significant eigenvectors with the largest associated eigenvalues are found (n is taken in as in input for the eigenfaces algorithm).

2.3 Image Reconstruction

Weights are calculated by subtracting the average face off of each image and projecting the resulting image onto the basis spanned by the top n eigenvalues. A reconstruction of the faces can be seen in Fig 2. Images started to become recognizable with an n of 5.

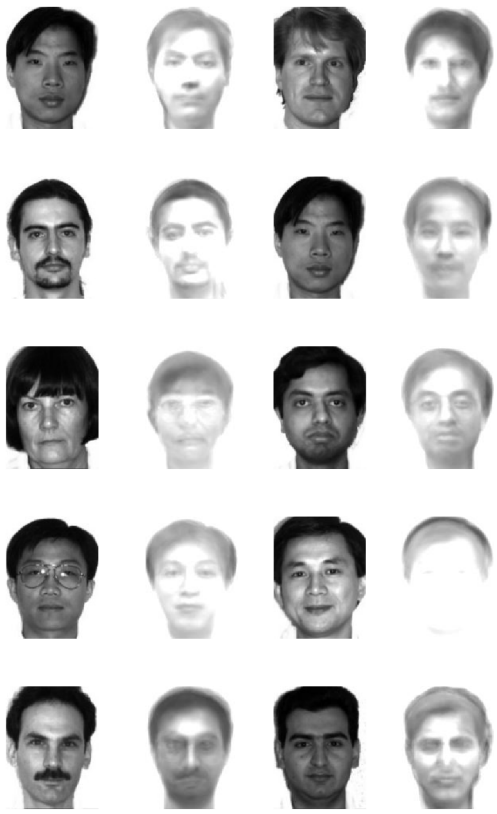

Figure 2: Facial Reconstruction, n = 25

2.4 Testing Recognition

Using twenty test images, seventeen were correctly identified. This creates a recognition rate of eighty-five percent. When glasses were removed from the dataset, the accuracy of the model increased. This is likely because glasses are a strong classification indicator and removing them got rid of false matches where a subject wearing glasses in one image would be matched to a different subject wearing glasses. Ten of the matches can be seen in Fig 3.

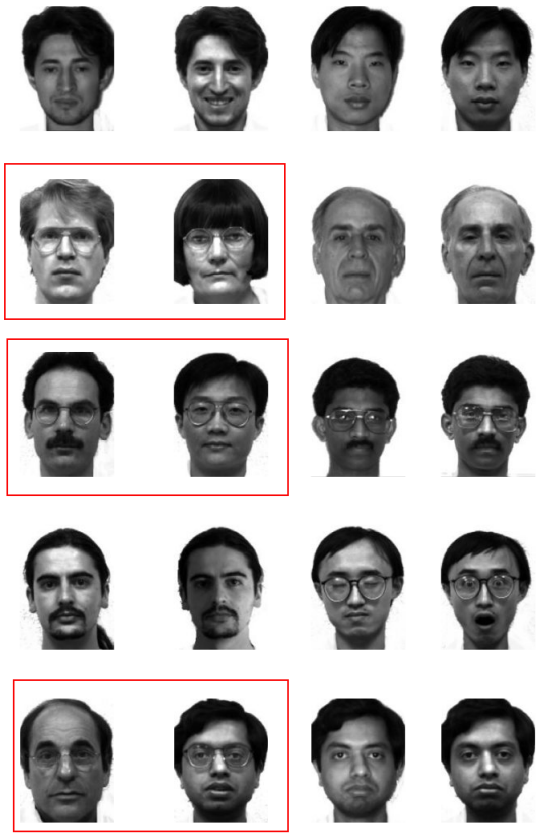

Figure 3: Facial Recognition, False Matches Highlighted