CPEG 585 (Computer Vision) - Assignment #6

Face Recognition by Principle Component Analysis

In this assignment, you will program Principle Component Analysis (PCA) and test it on the ATT face dataset which consists of 400 images (40 persons with 10 images per person). You will use the 5 images for each person (total of 40x5=200 images) to prepare the 30 basis vectors (called Eigen Faces) i.e., you will reduce the dimensionality to 30 by keeping the top 30 Eigen values and the corresponding Eigen vectors. Once the projections of the 200 training dataset images have been computed on the 30 basis vectors, you will test the accuracy of the system on the remaining 200 images.
The set of training and testing images from the ATT dataset are provided to you in two separate folders in a zip file.

For implementing the PCA first read the tutorial given in the following link:
http://kiwi.bridgeport.edu/cpeg585/PrincipalComponentAnalysis_Tutorial.pdf

You can either use C# or Python for this assignment.
If you are using C#, using the Mapack library for computing the Eigen values, the Eigen vectors, and any matrix computations. For Python, use the Numpy library.

Here are the recommended steps for implementing the above assignment.
Training Phase:

1. **Read all training images, convert them to a gray scale, and then convert them to a vector. Each image in the ATT dataset is 98x112, so the vector size will be 10976x1.**
2. **Find the mean image vector of all 200 training images and subtract the mean image from the vector of each image. Assemble the mean adjusted image vectors into an I' matrix of size 10976x200.**
3. **Compute the 200x200 covariance matrix for the 200 mean adjusted training images.**
4. **Compute the Eigen values for the covariance matrix. Sort these by magnitude, then keep the top 30 Eigen values.**
5. **Compute the Eigen vectors corresponding to the top 30 Eigen values, and assemble these Eigen vectors into an EV matrix. The size of this EV matrix will be 200x30.**
6. **Compute the EF matrix by multiplying the I' matrix of size 10976x200 with EV. The EF matrix size will be 10976x30. Each column of this EF matrix is called an Eigen Face. If you scaled each value in the Eigen face between 0 and 255, and displayed it in a picture box, it will appear as a ghost image. The 30 Eigen faces are the principle**

components i.e., basis vectors that are orthogonal to each other. Every image now can be projected on to these 30 basis vectors and be represented as a linear combination of these 30 basis vectors.

7. **Create a projection i.e, representation of all 200 training images in terms of the 30 basis vectors by multiplying each mean adjusted image vector's transpose with the EF matrix resulting in a 1x30 projection.**

<u>Testing Phase</u>:

1. **Read an image from the testing folder. Convert it to a 10976x1 vector and subtract the mean image vector from it.**
2. **Compute the projection of the test image onto the 30 basis vectors by multiplying the transpose of the mean adjusted test image with the EF matrix.**
3. **Compute the correlation of the test image projection with each of the 200 training images to see with which image, it produces the highest correlation – this image is the match to the test image.**

Determine the percentage accuracy of the PCA based face recognition for the entire 200 test images. How does this accuracy change, if 10, 30, 50 and 100 Eigen Faces are used?