PROBLEM 1

This problem is about eigenimages and Principal Component Analysis. The accompanying document PCA.pdf provides a nice, thorough explanation of the brief summary of PCA and eigenvectors we discussed in class. Please read through the whole document to solidify your understanding of eigenimages and PCA.

In this exercise, you have to apply PCA to find eigen-space of face images (or eigen-faces), and then use these eigen-faces to reconstruct the original faces using fewer features.

Training Data: You will use the faces image data set from here.

As for execution, you only have to implement Section 4 of the PCA.pdf. Please keep in mind that **you have to execute this exercise using the faces image data set given above (and NOT the characters image data set mentioned in PCA.pdf)**

1. Vectorize the training data as explained in Section 4.1

2. Compute the eigenvalues and eigenvectors of the image covariance

3. Reconstruct the first four persons using only *m* eigenvectors, as explained in section 4.

PROBLEM 2

(a)

For data X with covariance matrix C_x, C_x has an eigen-decomposition such that $C_x = U\Lambda U^T$, find a transformation $Y = f(X)$ such that C_y is a diagonal matrix. [Also known as PCA whitening]

(b)

For data X_1 with covariance matrix C_{x1}, each image is now scaled such that $X_2 = 3X_1$, how is C_{x2} related to C_{x1}? How is U_{x2} related to U_{x1}?

Report must include:

1. **First 12 eigenimages**
2. **Projection coefficients vs. eigenvector numbers**
3. **Resynthesized versions of the original image with different *m***
4. **Hand-written or typed solution of problem 2**

PLEASE NOTE THAT YOU ONLY NEED TO IMPLEMENT ABOVE MENTIONED PARTS AND IGNORE THE REST.