**Classwork 9**

**PCA**

Implement PCA face recognition using the datasets created in part 1.

Algorithm steps:

* Mean removal.
* Calculation of Covariance Matrix, its Eigen Values and Eigen Vector with dimension reduction using PCA.
* Calculation of Eigen Faces.
* Optimization of Eigen Faces.
* Classification of new faces based on resulted Eigen Faces.

**Lesson 8 presentation holds the mathematical steps.**

Mean Removal:

Assume we have training set data matrix, the first step is to calculate a mean image vector.

Each row in that matrix is a reshaped image, thus we need to add up all the rows in the training set matrix and divide the result by the number of rows.

Next, subtract the calculated row vector from each row vector in the training set matrix.

Calculation of Covariance Matrix, its Eigen Values and Eigen Vector with dimension reduction using PCA:

Calculate the small covariance matrix of the data matrix.

Calculate Eigen Values and Eigen Vectors of the resulted matrix.

Sort the Eigen Vectors in a decreasing order in accordance with their Eigen Values.

Calculate the Eigen Vectors of the correct covariance matrix.

Normalize the Eigen Vectors to the size of 1.

Create a matrix of Eigen Vectors.

Calculation of Eigen Faces:

Eigen Faces matrix is calculated by multiplying the centered data matrix by Eigen vectors matrix.

Optimization of Eigen Faces:

In the optimization step, calculate the Eigen faces of the test set.

Using Euclidean Distance, classify each face in the test set to be the same as the one with the lowest distance.

Once you classified all the faces, use label vector to calculate the success rate.

Then remove the least significant Eigen Vector from the Eigen Vector matrix and repeat the process.

Find the optimal amount of Eigen Vectors needed for the classification.

Now your Eigen Faces matrix will be the same as the one which provided optimal results.

Plot the progress of optimization.

Classification of new faces based on resulted Eigen Faces:

Use you optimized Eigen Faces Matrix to classify the Validation set classification success rate.

Plot at random pairs of faces. One which represents the person and the second is the one that was classified as that person.