COC202 Computer Vision
Lab 7 – PCA for feature reduction/object recognition

In this lab, you will use your PCA code from Lab 6 and employ it to perform feature reduction (for CBIR) and for object recognition (in particular, face recognition).

If you have not yet finished the exercises from the previous lab, do them first.

1. Modify your QBE code from Lab 4 (the CBIR lab) to perform image retrieval (using the images from the CBIR lab), but this time not based on similarities obtained by histogram intersection but based on distances, in particular Euclidean distances, between the colour histogram vectors.

   Matlab functions that should be useful here: `norm`.

2. Use your PCA function from Lab 6 and modify the code from Exercise 1 to calculate colour histograms for the images, run PCA on the data to project it onto PCA space, and then perform retrieval using Euclidean distances in the new (full-dimensional) PCA space. Since PCA is a linear transformation and no information is lost, you should get the same results as for Exercise 1.

3. Now modify your code from Exercise 2 to perform feature reduction, i.e., select only a small number *k*, say 25, of PCs, project the histogram data onto the space spanned by these, and conduct CBIR based on the reduced feature set.

   Even though you thus significantly reduce the length of the features vectors (from 8x8x8 colour histograms bins down to 25 features, that is by >95%), you should get fairly similar retrieval results.

   You can vary *k* to see the number of PCs required to support good retrieval results.

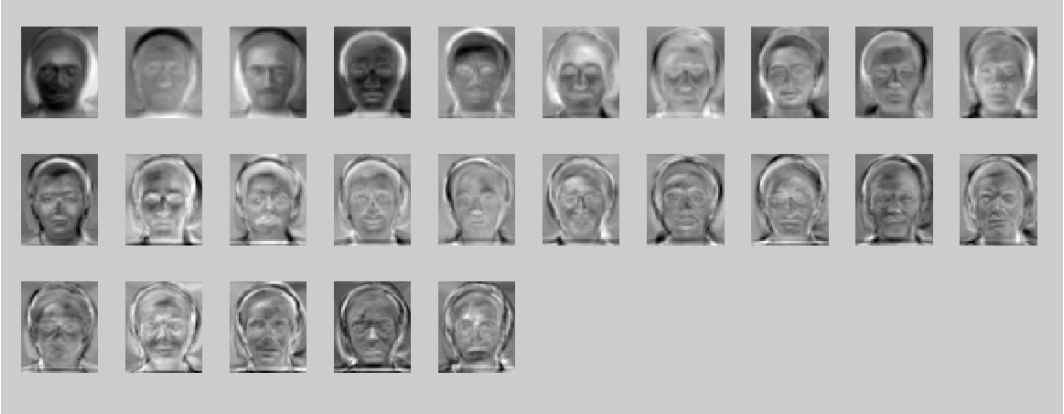
4. Download the face database from Learn and use it to perform face recognition based on eigenfaces (i.e., based on PCA).

   For this, you will proceed in a similar fashion as for the CBIR exercise based on PCA. However, here the whole images (reshaped as vectors) are used to perform PCA.

   Looking at the images contained in the database, you will see that the dataset contains (face) images of 15 individuals with 11 different expressions for each individual. Take all but one of the expressions for training, i.e. for performing PCA and obtaining the projection matrix.

   Hint: PCA is computationally expensive, so you might want to rescale the images (e.g. to a 1/4 of the original size along each dimension) first.

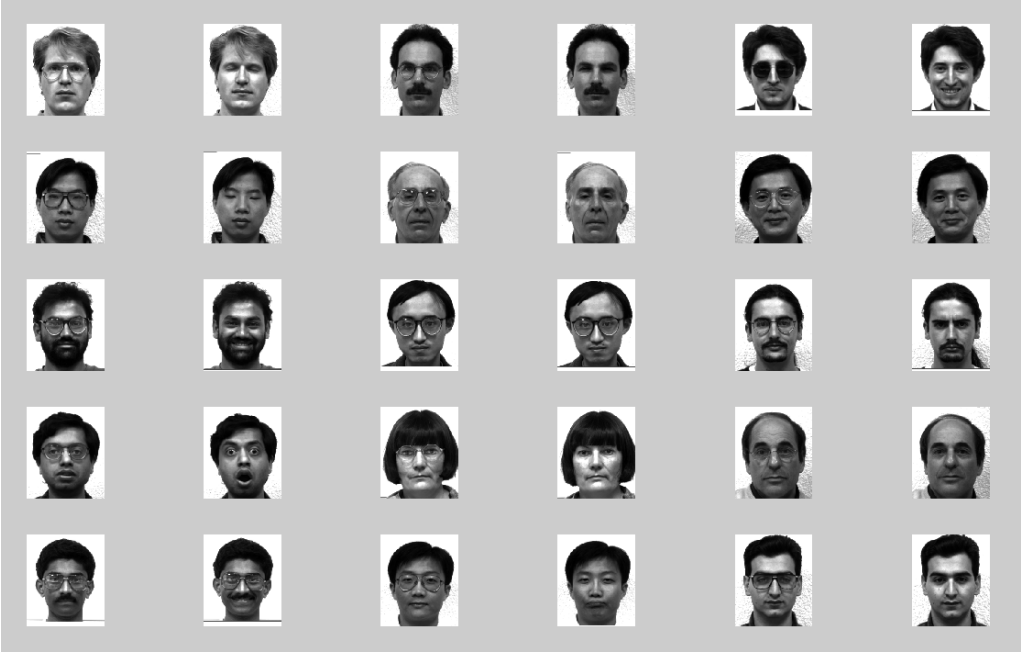
As you know, the projection matrix contains the principal components, i.e. here the eigenfaces. Choose a number k and display the k eigenfaces, which should look similar to the following:



Hint: You will need to normalise the eigenfaces to [0;1] (in double format) for display.

5. Now take the images of the remaining expression for the actual recognition experiment. Here, you will project a face image onto the (k-dimensional) PCA space and there identify the closest (by Euclidean distance) database image for classification.

   You should get very good recognition performance, e.g.:



(Above, for each of the 15 image pairs, the left image shows the input image and the right one the closest image from the database.)

Hint: As a sanity check, you might in first instance want to include the test images in the database (and PCA calculation). That way (since the distance of an image to itself will be 0), the retrieved images must be identical to the test images.

Once you have finished all exercises you may leave the lab.