

EE 779 Advanced Topics in Signal Processing
PCA for Face Recognition
Assigned: 08/10/16, Due: 24/10/16
Indian Institute of Technology Bombay

Note

- Please complete this PCA assignment before starting the NMF part.
- This is an individual assignment. Please post your doubts on moodle.
- Relevant files including the article [1] are posted in moodle.
- Code and data were adapted from the code provided by [2].

Description The objective of this assignment is to understand the application of Principal Component Analysis (PCA) in face recognition. We are more interested in the PCA representation than the recognition itself. You are provided with the Matlab code for a PCA implementation based on [1]. This includes a data base of face images, first to obtain the principal components (PCs) and then later to use the PCs to represent faces. You will have to understand the algorithm and test it with few sample images (e.g., your face image). You will have to submit a two-page (maximum) writeup of your analysis and observations. Follow the steps and get started on PCA.

1. Download the file `pca_nmf_proj.zip` and extract its contents into a folder `pca_nmf_proj`.
2. Go through the file `pca_orl.m` and understand how it implements the PCA algorithm discussed in [1]. Read the comments and code to understand the MAT files it creates.
3. In the `pca_orl.m` provided, a subset of the images (40×5 using `orl_train.m`) is used to obtain the PCs. Write your own code and name it `facerecog1_<firstname>.m`. Call `pca_orl` without reducing the number of components (i.e., use all 200) and obtain the output MAT files. Verify the performance of the PCA implementation and record your observations for the following three cases.
 - (a) Use one of the original images (and name it `orlImgTrain`) from the training images. Reconstruct this image using PCs and name it as `orlImgTrainEst`. Obtain the mean-square error `trainMSE` by comparing these two. Include this value and images in your report.
 - (b) Use one of the test images (and name it `orlImgTest`) by using `orldata_test.m`. Reconstruct this image using PCs and name it as `orlImgTestEst`. Obtain the mean-square error `testMSE` by comparing these two. Include this value and images in your report.
 - (c) Create an image of your face so that it matches the dimension of the data used in the `orl` data. i.e., 46×56 and grey-scale image. Crop it so that it only has your face and name this image `myImg`. Reconstruct this image using PCs and name it as `myImgEst`. Obtain the mean-square error `myImgMSE` by comparing these two. Include this value and images in your report.Compare and comment on the results obtained for the three cases.
4. Repeat (3), but for reduced components and create a file similar to the one in (3) and name it `facerecog2_<firstname>.m`. Try for various number of PCs. In the report, include the results you obtained using 100 PCs.
5. In addition to the specific results required in parts (a) and (b), include other objective results.
 - Plots of eigen values to indicate their relation to number of components.
 - Images of Eigenfaces corresponding to few of the significant components.
6. Write your own PCA algorithm (without using any modifications suggested in [1]). Create a file similar to the one in (3) and name it `facerecog3_<firstname>.m`. Repeat the experiments in (3) and (4), but the number of PCs need not be same. Compare the performance of your implementation with that in (3) or (4). Is there any difference in performance ? Justify.

Matlab tips

1. One way to display a vector as a grayscale image in Matlab.

```
>> imshow(reshape(img, 46, 56), [min(img) max(img)])
```

References

1. Matthew Turk and Alex Pentland., “Eigenfaces for Recognition,” *J. Cognitive Neuroscience*, Vol. 3, no. 1, 1991, pp.71–86.
2. Delac K., Grgic M., and Grgic S., “Independent Comparative Study of PCA, ICA, and LDA on the FERET Data Set,” *International Journal of Imaging Systems and Technology*, Vol. 15, no. 5, 2006, pp. 252–260.