Face Recognition with Eigenfaces

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1 Introduction

Eigenfaces is a technique used in computer vision based on the principal component analysis, where the goal is to achieve a low dimensionality representation of a multi-dimensional space by means of computing the principal components that can recreate every object in that space as their linear combination. In this project, we implement the eigenfaces algorithm which takes as input a set of images (train and test), computes the eigenfaces of that set and the descriptors of each image, which denote the weight of each eigenface in the image formulation. Then, the algorithm classifies each of the test images to a train image.

2 Implementation

To run the program, run *CV_2.m.* This class loads the datasets and creates two subsets: train and test. Then, it calls the function *EigenAn.m* to perform the eigenfaces analysis on the train set and returns the eigenfaces. Continuing, the algorithm calls the *GetDescriptors.m* function two times, one for the training and one for the testing set, and finally calls *NN_Classify.m* for each test image to classify according to the training image set.

3 Experiments & Discussion

In Figure 1 we see the 50 principal components of the entire image space (400 images). It is clear that after the first 20 to 30 eigenfaces, much detail is lost where at the last row of faces it is not so clear what feature is captured by each eigenface. As a result, we can assume that it is probably not optimal to increase the number of principal components any further as we will not get better information, whereas the dimensionality of the space basis will increase and so will the complexity.

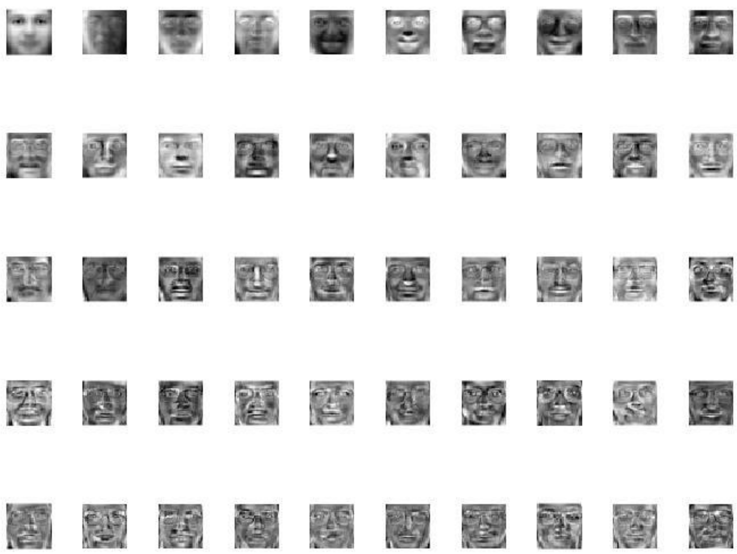

Figure 1: 50 eigenfaces of a 400 image set

Figure 2 shows how an image is reconstructed by its descriptors (numbers) and the eigenfaces (pictures) of the dataset . Although the reconstruction is not completely accurate (for example result face wears glasses) we can see that the produced face is to a certain degree close to the original image. For this space, 40 principal components were computed.

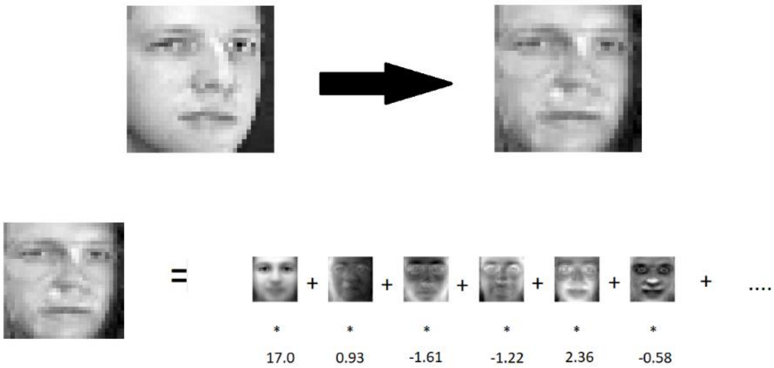

Figure 2: Reconstruction of an image

Next, we see the relation between the k component in the eigenface analysis and the error in classification. The error was computed as the average Euclidean distance between the test image and its calculated classification in the training image set. As expected, the larger the k the smallest the error, as we have a better description of the data space with more eigenfaces. In all three cases, for k's larger than 30-40 the error decrease is not that dramatical anymore. Examples of image classification are depicted in Figure 4, where k=40 was used, while the classification was successful in all cases, thus coming in agreement with the data acquired.

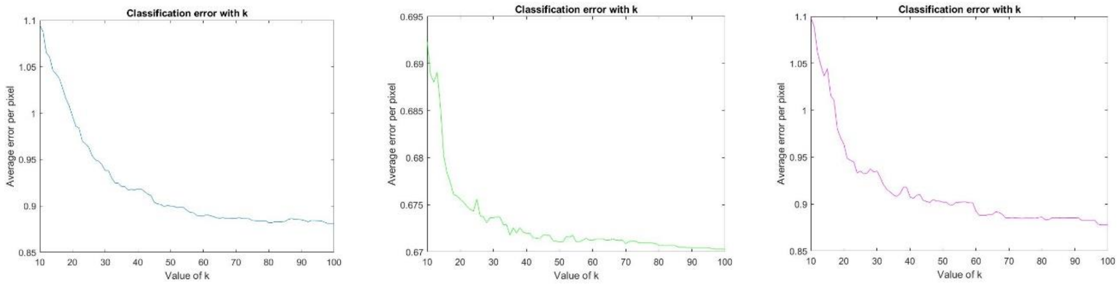

Figure 3: Error per pixel for different k's

Datasets: 3.mat(left), 5.mat(middle), 7.mat(right)

Figure 4: Classification examples

Original images (left), Classes (right)