

Facial Recognition Using EigenFaces:

Aim: To implement the eigenfaces algorithm on a training set of images and evaluate its accuracy on a testing set of images.

Procedure:

1. All the images are first arranged in the form of a row vector, and stored in an image array. Here M is the number of images in the dataset.

$$I = (\Gamma_1, \Gamma_2, \Gamma_3, \dots, \Gamma_M)$$

2. We compute the mean of all image vectors. This is called as the mean face.

$$M = (\Gamma_1 + \Gamma_2 + \Gamma_3 + \dots + \Gamma_M) / M$$

3. Then we compute the difference of each image in the dataset from the mean image Φ_i . These variances are computed and stored in the form of a list

$$\Phi_i = \Gamma_i - M$$

4. Using this value of variances we express a matrix A, which stores all the values of the variances and compute the covariance matrix.

$$A = [\Phi_1, \Phi_2, \Phi_3, \dots, \Phi_M]$$

5. Now we compute the eigenvalues of the covariance matrix of the system. This is computed as $C = AA^T$. However, this will be an extremely large system of size $N^2 \times N^2$ where N is the image size. To reduce computation we compute the eigenvectors of $A^T A$. This is $M \times M$ system, where M is the number of sample images.

6. Now we compute the eigenvectors of AA^T as $[u_1, u_2, u_3, \dots, u_n]$

$$u_i = A v_i$$

The obtained eigenvectors are normalized before further computation. We choose the best 50 eigenvectors,

7. Now we find the weights corresponding to each image in the dataset. This is obtained as a dot product of each eigenvector with each of the images in the dataset. This assigns weights to each image in the dataset. When obtain a median weight for each class.
8. When a new image is obtained we compute its weight and evaluate its difference from the median weight of every class. The closest one is assigned as the answer.

Outlier detection:

If the value of the threshold distance is greater than a certain value it is classifier as an outlier. The value has been set to 8000 in the code.

Results:

I worked on the Georgia Tech Database considering cropped images of 8 people with 15 images of each person. 12 are used for training and 3 are used for testing.

An accuracy of about 80% was obtained using $n = 50$ of all the obtained eigenvectors.

References:

1. <https://onionesquereality.wordpress.com/2009/02/11/face-recognition-using-eigenfaces-and-distance-classifiers-a-tutorial/>
2. <https://ieeexplore.ieee.org/document/139758/>

