ISCO630E-ASSIGNEMNT-6

Conclusion

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Question 1

We are required to perform Face Recognition using Principal Component Analysis.

The dataset consists of 5 images of 10 different people taken from varying angles.

Four of these have been used for training the model and one from each person is used for testing.

Initially all raw images are converted to grayscale equivalents of size 312*416.

Next we subtract the mean of all images from each image in the dataset.

Eigenvalues and eigenvectors are computed for the covariance matrix of the above normalised images.

$$COV(X,Y) = \frac{\sum_{i=1}^{n}\left(X_i - \bar{X}\right)\left(Y_i - \bar{Y}\right)}{n-1}$$

First k components from the sorted list of eigenvalues are chosen as principal components.

Eigen faces are obtained by projecting the normalised images to the selected eigenvector space as shown below,

$$X = \{\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_N\}, \Sigma_{k=1}^{N} \mathbf{x}_k = 0, \mathbf{x}_k \in R^d$$

PCA diagonalizes the covariance matrix:

$$C = \frac{1}{N} \sum_{k=1}^{N} \mathbf{x}_k \mathbf{x}_k^T$$

It is necessary to solve the following system of equations:

$$\lambda \mathbf{v} = C\mathbf{v} \Leftrightarrow$$

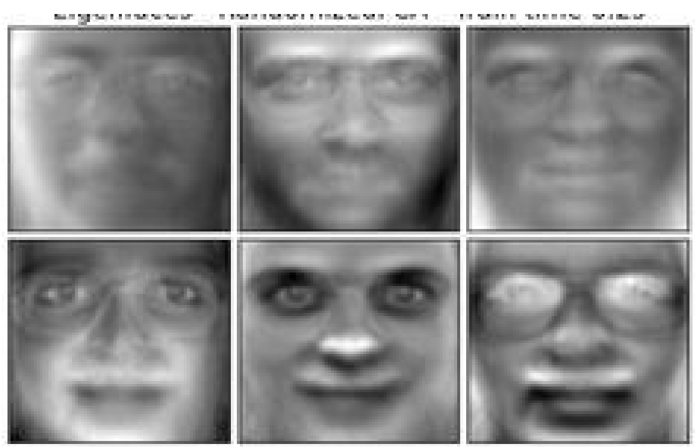
$$\lambda(\mathbf{x}_k \cdot \mathbf{v}) = (\mathbf{x}_k \cdot C\mathbf{v}), \forall k = 1, 2, \ldots, N.$$

We can define the same computation in another dot product space F:

$$\phi : R^d \rightarrow F, \mathbf{x} \mapsto \mathring{\mathbf{x}}$$

Signature of each face(weights) are computed by projecting the normalised faces to the eigenfaces.

Obtained eigen faces will look like as follows,



While testing, each test image is mean normalised and projected to the eigenfaces.

We then calculate the Euclidean distance between the projected mean aligned test images and each of the signatures. The signature which gives the minimum distance is declared as the predicted class of the test image.

For 10 test images, we get following accuracies depending on value of k,

K	Accuracy
10	70%
20	60%
30	60%

Question 2

We are required to perform Face Recognition using Linear Discriminant Analysis.

The dataset consists of 5 images of 10 different people taken from varying angles.

Four of these have been used for training the model and one from each person is used for testing.

Initially all raw images are converted to grayscale equivalents of size 312*416.

Next we subtract the mean of all images from each image in the dataset.

Following computation are done,

$$J(w) = \frac{|\tilde{\mu}_1 - \tilde{\mu}_2|^2}{\tilde{s}_1^2 + \tilde{s}_2^2}$$

The Fisher Criterion says,

$$J(\mathbf{w}) = \frac{\mathbf{w}^T \mathbf{S}_B \mathbf{w}}{\mathbf{w}^T \mathbf{S}_W \mathbf{w}}, \qquad \mathbf{S}_B = (\mathbf{m}_2 - \mathbf{m}_1)(\mathbf{m}_2 - \mathbf{m}_1)^T$$

$$\mathbf{S}_W = \sum_{n \in C_1} (\mathbf{x}_n - \mathbf{m}_1)(\mathbf{x}_n - \mathbf{m}_1)^T + \sum_{n \in C_2} (\mathbf{x}_n - \mathbf{m}_2)(\mathbf{x}_n - \mathbf{m}_2)^T$$

$$\mathbf{w} \propto \mathbf{S}_w^{-1}(\mathbf{m}_2 - \mathbf{m}_1)$$

$$S_W = \sum_{k=1}^{K} S_k$$

$$S_k = \sum_{n \in C_k} (x_n - m_k)(x_n - m_k)^T$$

$$S_B = \sum_{k=1}^{K} N_k (m_k - m)(m_k - m)^T$$

$$\boldsymbol{W} = max_{D'}(eig(S_W^{-1} S_B))$$

Where **Sw** id within class scatter and **SB** is between class scatter.

Eigenvalues and eigenvectors are computed for the covariance matrix of the above normalised images.

First k components from the sorted list of eigenvalues are chosen as principal components.

Eigen faces are obtained by projecting the normalised images to the selected eigenvector space.

Signature of each face(weights) are computed by projecting the normalised faces to the eigenfaces.

Fisher faces are obtained by projecting the signature faces to the eigenvector space.

While testing, each test image is mean normalised and projected to the eigen faces and the result is projected to the Fisher faces.

We then calculate the Euclidean distance between the projected mean aligned test images and each of the fisher faces. The fisher face which gives the minimum distance is declared as the predicted class of the test image.

For 10 test images, we get following accuracies depending on value of k,

K	Accuracy
10	70%
20	60%
30	60%