Face Recognition using Eigen Faces

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1 Aim

Our aim is to classify the face (given image) using generated eigen faces from the training data.

2 Objectives

1. Take the mean of the input images.

2. Make a matrix 'A' of the input images.

3. Find eigen vectors.

4. Find eigen faces.

5. Find the weights of training data.

6. Find the weights of test data and compare them to clssify the test data.

3 Theory

First distribute the data into 70% (training data) and 30% (test data)
Take the image and convert it to 2-D matrix. Now convert it to 1-D arrray (Γ_i) find the mean Ψ. Now subtract the obtained mean from each vector of input image matrix and subtract from each training example. $\Phi_i = \Gamma_i - \Psi$.
Now we need to find the orthonormal eigen vectors of covariance matrix

$$C = \Sigma_{n=1}^{M} \Phi_i \Phi_i^T = AA^T$$

where $A = \begin{bmatrix} \Phi_1 & \Phi_2 & \dots & \Phi_M \end{bmatrix}$. But finding the eigen vectors of it is computationally expensive due to its large size ($N^2 \times N^2$). So we find the orthonormal eigen vectors of $L = A^T A$ which is of dimensions $M \times M$,

$$A^T A u_i = \lambda_i u_i \implies AA^T A u_i = \lambda_i A u_i \implies AA^T v_i = \lambda_i v_i$$

where $u_i = Av_i$ Now we can compute the weights (Ω_i) for training data from the equaion

$$\Omega_i = \begin{bmatrix} w_1^i & w_2^i & \dots & w_k^i \end{bmatrix}^T$$

where $w_j^i = v_j^T \Phi_i$ where $i \in [M]$
To find eigen faces, we use the equation,

$$\hat{\Gamma}_i = \Sigma_{n=1}^k w_n^i \Phi_i + \Psi$$

Now inorder to classify the test images (Γ) we need to subtract the test image and mean of training images $(\Phi = \Gamma - \Psi)$. Now multiply it with eigen faces to get its weights.

$$w_i = v_i^T \Phi$$

$$\Omega = \begin{bmatrix} w_1 & w_2 & \dots & w_k \end{bmatrix}^T$$

Now to classify, find $e = ||\Omega - \Omega_i|| \ \forall i \in [M]$ and the face can be classified as class i which has the minimum e value.

4   Observation

The accuracy obtained is 93.33%

5   Reference

1. M.A.Turk, A.P.Pentland, Face recognition using Eigenfaces, https://ieeexplore.ieee.org/document/139758

2. The Yale Face Database, http://www.face-rec.org/databases/