**EIGENFACES IN DIGITAL IMAGE PROCESSING**

**AIM OF THE EXPERIMENT:**

To find the eigenfaces of the image in digital image processing

**MATHEMATICAL BACKGROUND:**

Eigenfaces refers to an appearance-based approach to face recognition that seeks to capture the variation in a collection of face images and use this information to encode and compare images of individual faces in a holistic manner i.e. Eigenfaces is the name given to a set of eigenvectors when they are used in the computer vision problem of human face recognition.  Specifically, the eigenfaces are the principal components of a distribution of faces, or equivalently, the eigenvectors of the covariance matrix of the set of face images, where an image with N pixels is considered a point (or vector) in N-dimensional space.

To create a set of eigenfaces, one must:

1. Prepare a training set of face images. The pictures constituting the training set should have been taken under the same lighting conditions, and must be normalized to have the eyes and mouths aligned across all images. They must also be all resampled to a common pixel resolution (r × c). Each image is treated as one vector, simply by concatenating the rows of pixels in the original image, resulting in a single row with r × c elements. For this implementation, it is assumed that all images of the training set are stored in a single matrix T, where each column of the matrix is an image.
2. Subtract the mean. The average image a has to be calculated and then subtracted from each original image in T.
3. ***Calculate the eigenvectors and eigenvalues of the covariance matrix S***. Each eigenvector has the same dimensionality (number of components) as the original images, and thus can itself be seen as an image. The eigenvectors of this covariance matrix are therefore called eigenfaces. They are the directions in which the images differ from the mean image. Usually this will be a computationally expensive step (if at all possible), but the practical applicability of eigenfaces stems from the possibility to compute the eigenvectors of S efficiently, without ever computing S explicitly, as detailed below.
4. Choose the principal components. Sort the eigenvalues in descending order and arrange eigenvectors accordingly. The number of principal components k is determined arbitrarily by setting a threshold ε on the total variance. Total variance v = n \cdot (\lambda_{1}+\lambda_{2}+...+\lambda_{n}), n = number of data images by
5. k is the smallest number satisfies :\frac{n(\lambda_{1}+\lambda_{2}+...+\lambda_{k})}{v} > \epsilon  

These eigenfaces can now be used to represent both existing and new faces: we can project a new (mean-subtracted) image on the eigenfaces and thereby record how that new face differs from the mean face. The eigenvalues associated with each eigenface represent how much the images in the training set vary from the mean image in that direction.



Matrix=[

**MATLAB CODE:**

*clc*

*clear all*

*a=[ ];*

*disp(‘enter covariance matrix’);*

*for i=1:3*

*b=[ ];*

*for j=1:3*

*x=input(‘enter matrix element’);*

*b=[b x];*

*end*

*a=[a;b];*

*end*

*disp(a)*

*eig(a)*

*[V,D]=eig(a)*

*disp(V)*

**OUTPUT:**

enter matrix

enter matrix element4

enter matrix element7

enter matrix element-7

enter matrix element3

enter matrix element8

enter matrix element55

enter matrix element22

enter matrix element4

enter matrix element-32

    4    7   -7

    3    8   55

   22    4  -32

ans =

  -23.491

  -17.229

   20.720

   0.32689   0.39782  -0.30659

  -0.82772  -0.84195  -0.93090

   0.45610   0.36451  -0.19857

Eigenvector=

0.32689 0.39782 -0.30659

-0.82772 -0.84195 -0.92090

0.45610 0.36451 -0.19857

**ENGINEERING INTERPRETATION:**

Eigenfaces are most widely used in real time face detection and recognition systems.

Eigenface provides an easy and cheap way to realize face recognition because:

* Its training process is completely automatic and easy to code.
* Eigenface adequately reduces statistical complexity in face image representation.
* Once eigenfaces of a database are calculated, face recognition can be achieved in real time.
* Eigenface can handle large databases