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Face Recognition using Eigen faces method

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ABSTRACT: Persons Authentication plays an important role in finding the identity of a person of any industry. There are many techniques used for finding the identity of a person, out of which the Face Recognition is the predominant Biometric technique used by most of the Humans. Face Recognition technique needs sophisticated computing techniques for recognition as it is a Complex Multidimensional Structure. The purpose of the paper is to recognize the Faces using the PCA (Principal Component Analysis) algorithm. The Original Image is converted to Grayscale Image to reduce the two dimensional problem of an image. The system data base contains a set of images for which the Eigen values and Eigen vectors are determined. The Eigen vectors are chosen to form the Eigen faces, these Eigen faces are then transformed, from which the PCA features are extracted. The features extracted may not correspond to the facial features like Nose, Mouth, and Eyes. The PCA features of the test images are evolved and this test image is now projected on to the data set of images. The Euclidean distance is used to find the similarity between the test image projected and each and every individual image of the data set. The low value of the Euclidean distance shows the recognised image from the data set. Experimental results for 21 Face Images of 10 persons of various postures and illumination show 90 Percent of successful recognition of test image.

Keywords- Eigenvalue, Eigenvector, Eigen face, Pca, Face recognition.

I. INTRODUCTION

Over a recent couple of decades, facial recognition has been considered as a standout compare to other biometric systems like passwords, PINs, cards, keys etc. Because these different kinds of biometric systems can be stolen, copied and lost. However, to overcome these problems some examples have been included of a personcharacteristics such as facial images, fingerprints, iris etc., which are strategies for personal identification especially for security systems. In face recognition the face features for individual identification are considered as a major method of the biometric system areas. Nowadays, if a person can appear in front of the digital image that particular person can be identified automatically by face recognition system.

In facial recognition, person's security is a crucial part in any industry. Therefore, there are many techniques used as a purpose, face recognition is one of them. Hence, there are several approaches for recognizing a face in facial recognition system which PCA and neural networks have been incorporated. The system consists a database of set of facial patterns for each individual person, those characteristic features called as Eigen faces. Most approaches for facial recognition based on the location and shape of facial features like eyes, mouth, nose, lips etc. Popular recognition algorithms includes Eigen face, Fisher face etc., and also implementing the other type algorithms like correlation, template matching, normalized cross correlation to overcome the recognition problems

In face recognition system the one of the most efficient method is PCA approach. This approach transforms the faces into a small set of Eigen faces, which are the initial set of training set images. Face recognition can be done by several algorithms like PCA, LDA and ICA. There are two

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major problems. First one is due to significant intrapersonal variations. Captured face images from the same person may have different appearances under different conditions. The lighting and the pose changes can leads to complex distribution of faces. Second, there are not enough samples to capture all kinds of face variations of a person in different situations. So, the face recognition system design should be focusing to reduce the intrapersonal variation using training data

Used technique: **PCA**abbreviates Principal Component Analysis. PCA was firstly invented by Karl Pearson in 1901. PCA is commonly used technique for the Face recognition. The main purpose of PCA is to remove the low beneficial feature values.

PCA is a statistical technique and is used to perform orthogonal transformation that is used to convert a set of observations of correlated variables into a set of values of uncorrelated variables which are called as principal components.

Principal Component Analysis also called as dimensionality reduction technique because it is used to reduce the dimensions of large dataset, on transforming the large set of variables into small set of variables without loss of the original information.

The dimensions of the dataset can be reduced by involving the below two categories

a) Feature Selection:

Feature selection is the process of selecting the subset of a feature of face from the dataset without transforming the features of it.

b) Feature Extraction:

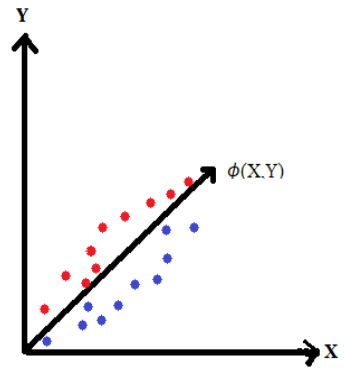
Feature extraction is the method which involves the transformation of features of face from the dataset into a low dimensional space.

Mathematically, PCA can be calculated by extracting the Principal components of the Multidimensional data. The first principal component is the linear combination of the actual or original dimensions that has the highest variability. The Nth principal component is the linear combination with highest variability, which is orthogonal to the N-1 First Principal components. The largest variation of the any Projection of data lies in the First Principal component. . The Nth coordinate is the direction of the Nth maximum variance to the Nth principal component. Generally, the mean M is extracted from the data based on the Karhunen-Loeve Transform (Klt). So, Let Mnxm be the data matrix, where M1, M2, ……., Mm. are the image vectors Known to be vector columns, and N is the number of pixels per image. The Klt transform is calculated by solving, the Eigen value problem

$C_x = \phi \Delta \phi^T$

Where, C_x is the Covariance matrix of the data$C_x = \frac{1}{m}\sum_{i=1}^{m} x_i x_i^T$

Figure **a)**Principal component Analysis(PCA)



$\phi = [\emptyset_1, \ldots\ldots\ldots\ldots, \emptyset_n]$ is the Eigen vector Matrix of C_x.

Δ is the Diagonal matrix, the Eigen values are $\Delta 1, \ldots\ldots\ldots, \Delta n$ of C_x are located on its main diagonal.Δi is the variance of the data projected on ϕ_i.

In the above figure **a**, X and Y are orthogonal and ϕ is the First Principal component

Used methodology:

Steps for PCA:

Step 1: Making the training set:

In the present paper we are using the Orl database of 24 images of 200*200 pixels and are in jpg format. For simple computation, reshape all images and create a matrix where each column of matrix corresponds to face vector.

Step 2:Calculating the normalised face vector:

1. The average face vector of matrix M is calculated as $\Psi = \frac{1}{m} + \sum_{i=1}^{n} \Gamma_i$ where $\Gamma_1, \Gamma_2, \Gamma_3, \ldots$ are face vectors.

2. Subtract the average face vector from all the individual face vectors i.e.; normalised face vector equation is given by$\phi_i = T_i - \Psi$ here ϕ_i represents how each of the image in the data base differ from average face vector.

Step 3: Calculation of Eigen vector:

1. To calculate Eigen vector we need to calculate Eigen values and covariance matrix. Where covariance matrix is obtained by C= AA^T

2. The Eigen values are given by **eigenvalue= det(C-λI)=0** where $\mathbf{\lambda I}=\begin{bmatrix}\boldsymbol{\lambda} & \mathbf{0}\\ \mathbf{0} & \boldsymbol{\lambda}\end{bmatrix}$

3. Now for calculating Eigen vectors=Eigen values □ covariance matrix.

Step 4: Choosing Eigen faces: The Eigen values determine the magnitude of the pixel values and

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Eigen vectors define the direction of the pixel arrangement so to have the pixel values arranged in positive forward direction the Eigen vectors greater than 1 are taken as Eigen faces.

II. RESULTS AND DISCUSSIONS

Matlab 2017 is used for the coding. The original image is converted into gray scale image for easy computation. The gray scale image is taken of the pixel value 200*200. These images are used to perform the face recognition.

TRAINING SET OF IMAGES:

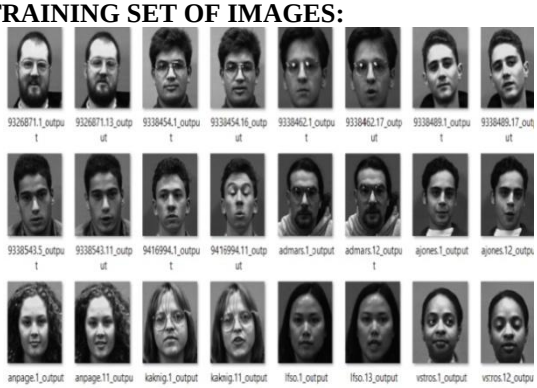
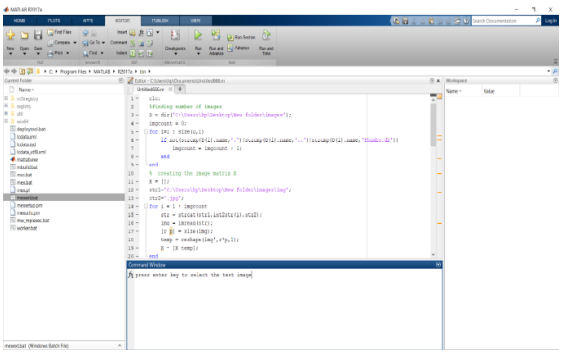
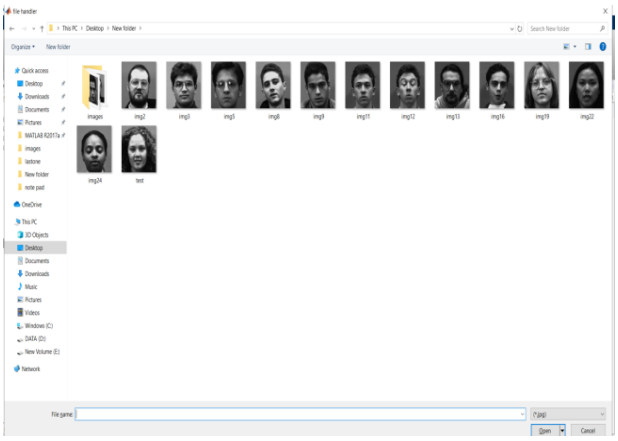


Fig 3: The Training set of images.

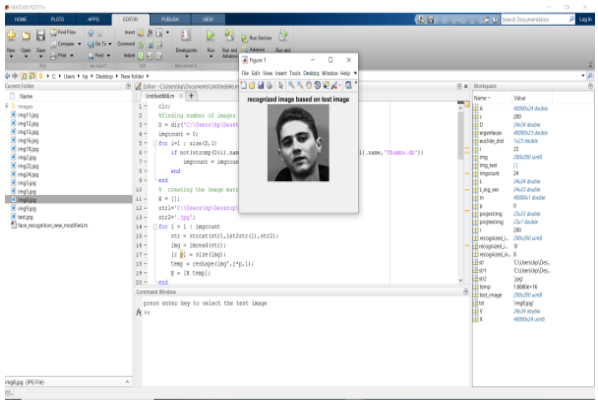
After performing all the operations of the above mentioned algorithm the command window opens and asks to select a test image for recognition.



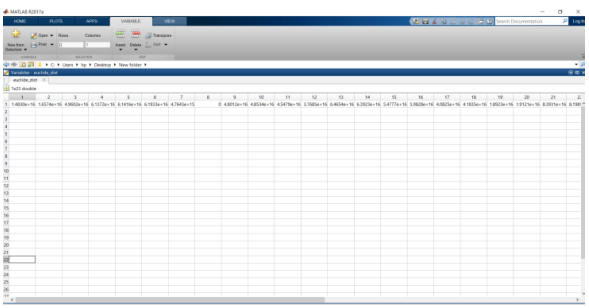
After pressing enter a the test images folder opens with 12 images for recognition. Choose a image from the set of the test imag



The test image provided as input image for recognition gets displayed on the screen saying that test image is matching the test image.



The Euclidean distance between the test image and the each individual image is shown in the workspace as below



when we input the test image in the command window the matched image from the data set is displayed ,saying that the provided image is recognized.

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