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A Study on Biometric Face Recognition for Login

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ABSTRACT: A facial recognition system is a computer application which is capable of identifying or verifying an individual from a digital image or a video frame by analysing and comparing patterns.It is typically used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems.In recent years face recognition is attracting much attention in society.Training set consists of face images from which a set of Eigen faces can be generated by performing a mathematical process called principal component analysis(PCA) on a large set of images depicting different human faces.Image processing,face detection and face recognition are the main aspects.After analysing the images it select the appropriate technique to extract partial face regions and recognize individuals.Eigen faces can be used to represent both existing and new faces and we can project the new image on Eigen faces and thereby record how new faces differ from the mean face.In this way each person's input image is matched with the training set image,if a match is found only then login is possible.

KEYWORDS: Face Recognition; Image Processing; Face Detection; Eigen faces; Eigen algorithm; Principal Component Analysis(PCA).

I. INTRODUCTION

Face plays a major role in identification of a person. We human beings are capable of recognizing faces, just by seeing. We can recognize thousands of faces in our lifetime and identify familiar features. As human beings it is easy to recognize face but developing a computational model is quite difficult, because faces are multidimensional, change over time and are complex.

Face recognition is attracting a lot attention in the society of network multimedia information access.Area such as network security,content indexing and retrieval and video compression benefits in face recognition technology. Network access control via face recognition not only makes hackers virtually impossible to steal one's password but also increases user friendliness in human computer interaction.

The method proposed is to find the best match of an image for Facebooklogin. This can be done by prestored image database.Before face recognition is performed the system should determine whether there is a face in given image, this is known Face Detection.Once face isdetected then the face region has to be recognized.

There are mainly three phases as in Fig 1. for face recognition

- *Face representation*
- *Face detection*
- *Face identification*

FACE REPRESENTATIONinvolves face modelling using the algorithms of detection and identification.There are a variety of approaches under this phase, which can be classified as template based, feature based and appearance based.

a) ***Template based:***The simplest template matching approaches represents a whole face using a single template which can be a 2-D array of intensity which is the edge map of the original image. It's a simple approach but it consumes large amount of memory is required and inefficient matching.

b) ***Feature based:***In this approach geometric features such as position and width of eyes, nose and mouth, eyebrow's thickness,face breadth,etc. are extracted to represent the face. This method has smaller memory requirement and higher recognition speed than template based approach but has difficultly to extract perfect features

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c) ***Appearance based:***In this approach the face is projected on to a linear subspace of low dimensions.This subspace is first constructed by principal component analysis(PCA) on a set of training images with Eigen faces as its Eigen vectors.Later the concept of Eigenfaces were extended to Eigenfeatures such as Eigeneyes, Eigenmouth,etc. for detecting facial features.

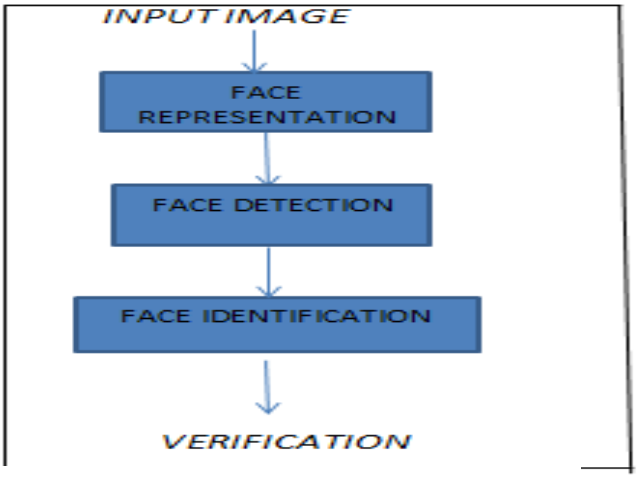

Fig 1. Face recognition phases

FACE DETECTIONis used to locate a face in a given image and to separate it from the remaining scene.There are several approaches to fulfil the task.One of them is to utilize the elliptical structure of human head.This method locates the head outline using the canny's edge finder and then fits an ellipse to mark the boundary between the head and background.This method is applicable for front views.The second approach manipulates the image into a face space .At every location in the image we have to calculate the distance between the face space and the local subimage,this distance is known as faceness.The result of calculating the distances from face space at every point in the image is a face map.If the values are low or distance is short then the face map indicates the presence of face.

FACE DETECTIONis performed when we have to compare a new face with the face models stored in the database and classified to a known individual if a correspondence is found. The performance is affected by factors like scale, pose, illumination, facial expression and disguise.

II. RELATED WORK

TECHNIQUES USED:

a) PCA(Principal Component Analysis)-It is a standard method used for recognition of statistical design in order to reduce dimensionality and used for feature extraction. It is basically used to preserve the important information and remove redundant information. A face contains certain set of features and this set of characteristic features are called principal components or Eigen faces. The features can be extracted from the original image with the help of principal component analysis.

b) LDA (Linear Discriminant Analysis)-It is also called as fisherface method. It basically tries to improve the proportion of determinant of between classes/determinant of within school spread matrix of expected products. Fisher discriminant is used to find out a line which best separates points in order to find out the test images. We compare the test images with the database images and find out which database image is close to the test image.

c) ICA (Independent Component Analysis)-PCA does not support higher order dependencies, it is based on second order statistics of the image set. ICA is the generalization of PCA,in order to second order statistics ICA separates the higher order moments. Architecture 1 takes the image as random variable and provides outcome as pixels. Architecture 2 produces independent coding variables. By the product of individual probabilities the probability of combination of features can be obtained that provide the factorial facial code.

d) Active Appearance Model-This model is applied after collecting several face images that have different alignment features. This model is used to provide accurate alignment of the features as well as for the pose correction.

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e) LBP (Local Binary Pattern)-It provides the texture as well as the shape of the digital image, this is done by dividing a digital image into several small regions in order to extract feature. These features contain the binary patterns that provide the surrounding of pixels in the region. Image is represented by representing obtained features from the region into a single feature histogram.

III. MODULED METHODS

The input image after preprocessing is fed to a feature extraction scheme to extract features.Most frequently used techniques are Eigen Face based approach and Discrete Cosine Transform.There is another approach which is nothing but the combination of the two techniques mentioned above.

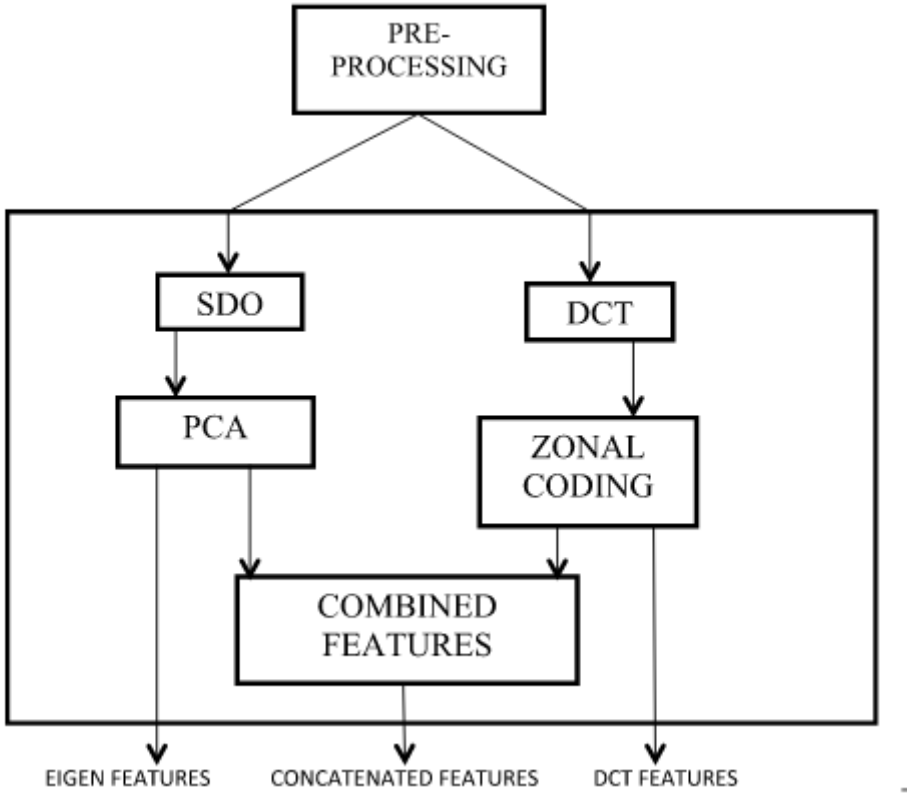

Fig 2. Techniques for extracting features

Eigen Face based approach: PCA is used to extract Eigen faces. Initially Eigen vectors are computed using covariance matrix derived from a set of training images. The probe image is projected in to the face space and the distance between the mean Eigen face and probe image is computed using spatial distance operators like Euclidian distance and cosine difference.

Discrete Cosine Transform: This method transforms spatial domain images into decoupled frequency domain images. It means the image information is converted into DCT coefficients. These coefficients are located in the upper left corner of the DCT and are the most important to represent the image back.

Combined approach: In this approach we use both spatial and frequency domain methods. Spatial domain features are extracted using spatial differential operators which is nothing but the eigen face approach. Frequency domain features are extracted using DCT.

Each of these methods are followed by dimensionality reduction processes. PCA is used to reduce dimensionality in spatial differential operators whereas zonal coding is used in DCT.

STAGES IN IMAGE PROCESSING:

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The face recognition algorithms based in comparing the face in the picture against all the faces in the device known in advance through the images and metadata.Basically there are three stages in image processing.

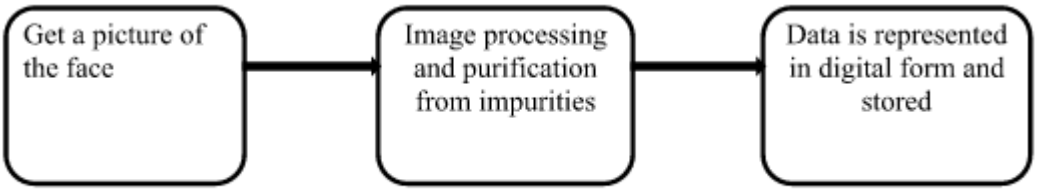

Fig 3. Stages in image processing

FIRST STAGE:It has two steps:
Acquire: this step is to get the picture and then explore it. A feature is run to help in improving the image resolution and then discover the face in the image.
Detect: this step includes the process of face determination and deduction from a big macro picture which was taken from the previous phase.
SECOND STAGE:It has four steps:
Align: It is the step where alignment and standardization of the image.
Extract: It extracts the basic features of the face of the image.
Color update: This step is concerned with the color of the image and the extent of brightening the image.
Compression: pressing the image size to the maximum size possible so that it is not a change in image quality.
THIRD STAGE: It has three steps:
Translate to digital: converts the image to digital data.
Pattern: to create a form which represents a digital image to be handled.
Save: to keep the beam data that reflects the image of the face
There are many factors which cause problems while recognizing face. Some of them are mentioned here. Illumination variation is caused by various lighting environments and is found to have larger appearance difference than the difference caused by different identities. The pose variation results from different angles and locations during the image acquisition process. This causes changes in the spatial relations among facial features and distortion on the face recognition algorithms. Expression variation not only results in spatial relation change but also facial feature shape change. The rotation, scaling and translation variation results in difficulties in face recognition and detection. Cluttering is caused by changes in environments and backgrounds around people in images. It affects the accuracy. Occlusion is one of the most difficult problem in face recognition. It means some of the parts of the face are unobserved, especially the facial features.

IV. PROPOSED SYSTEM

PCA is a statistical procedure which uses orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called the principal components.The number of principal components is less than or equal to the number of original variables.

This transformation is defined in such a way that the first principal component has the largest possible variance and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to the preceding components.The resulting vectors are an uncorrelated orthogonal basis set.The principal components are orthogonal because they are the eigenvectors of the covariance matrix which is symmetric.

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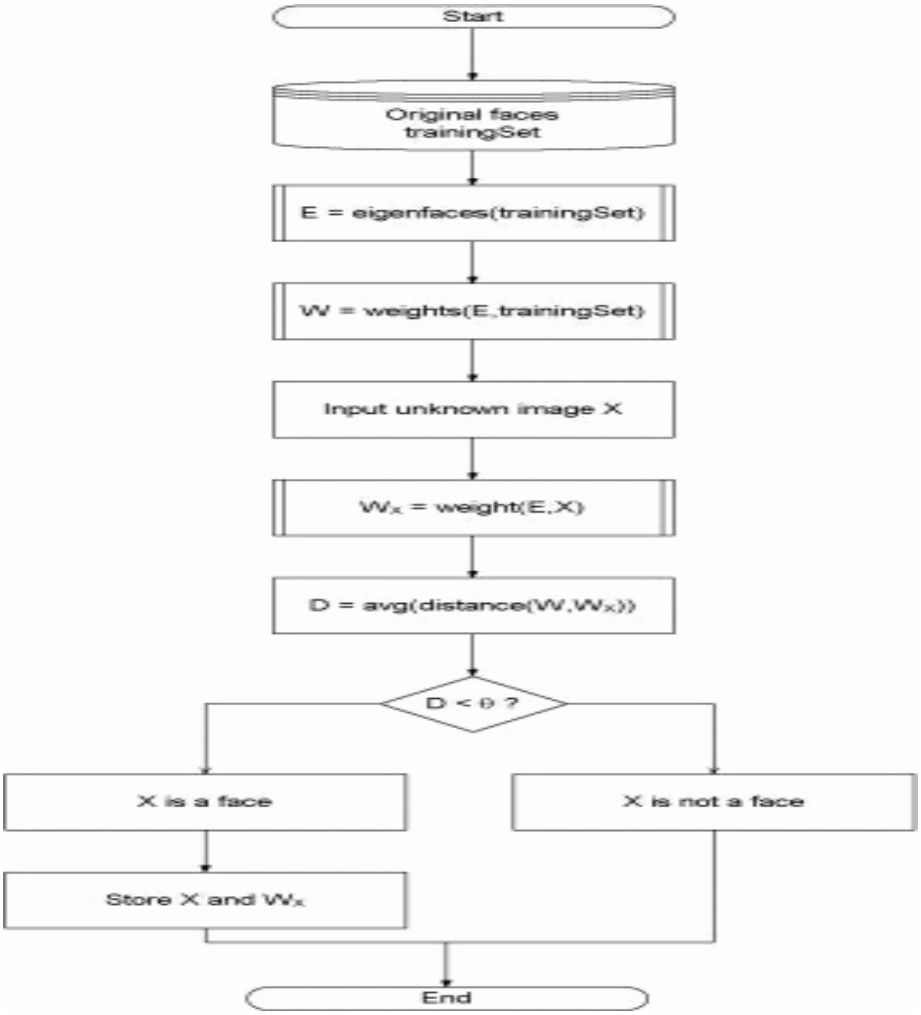

Fig 4.Flow of PCA technique in login

The objective of PCA is to take a total variation on the training set of faces and to represent the variation with just some little variables.When we have to work with a lot of images reduction of space dimension is very important.PCA reduces the dimension of a group or space so that the new base describes the typical model of the group.The image space is redundant when it describes faces.This happens because each pixel in a face is highly correlated to the other pixels.The main objective of PCA is to reduce the dimension of the work space.To reduce the dimension some principal components must be omitted.To do this we need to discard some principal components which have small quantity of data.

The key idea for PCA method is to transform the face imagesinto a small set of characteristic feature images called EIGEN FACES which are the principal components of the initial training set.In recognition process a test image is projected into the lower dimension face space spanned by Eigen faces and then classified. The PCA method was developed in 1991 by Turk and Pentland.The face features are extracted by the PCA method reducing the dimensionality of input space.

Mathematically, PCA approach treats every image of the training set as a vector in a very high dimensional space. The eigenvectors of the covariance matrix of these vectors would incorporate the variation among the face images. Now each image in the training set would have it's contribution to the eigenvectors. This can be represented as an Eigen face representing it's contribution in the variation between images. These Eigen faces look like some ghostly images.

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PCA is mathematical process performed on large set of images. We typically have a data matrix of 'n' observation on 'p' correlated variables x1,x2,…,xp .PCA looks for a transformation of xi variable into 'p' new variables yi that are uncorrelated.

There are 6 general steps in PCA:

a) Take the whole data set consisting of d-dimensional samples.
b) Compute the d-dimensional mean vector(means for every dimension of the whole data set)
c) Compute the scatter matrix
d) Compute Eigen vectors (e1,e2,……,ed) and corresponding Eigen values(λ1,λ2,….,λd).
e) Sort the Eigen vectors by decreasing Eigen values and choose k Eigen vectors with the largest Eigen values to form a d*k dimensional matrix W(every column represents a Eigen vector)
f) Use the d*k Eigen vector matrix to transform the samples onto the new subspace .This can be summarized as,$y=W^T*x$ (where x is d*1dimensional vector representing one sample and y is the transformed k*1dimensional sample in the new subspace).

EIGEN FACE APPROACH:

It is an efficient method used in face recognition due to it's simplicity,speed and learning capability.This method refers to an appearance based approach to face recognition that seeks and captures the variation in a collection of face images.This information is used to encode and compare images of individual faces in a holistic manner.

The Eigen faces are principal components of a distribution of faces.The coding and encoding of face images may give information of face images emphasizing the significance of features.These features may or may not be related to facial features such as eyes,nose,lips and hairs.

EIGEN FACES: Eigen faces is the name given to a set of Eigen vectors when used in a computer vision problem of human face recognition. This approach was developed by Sirovich and Kirby in 1987 and used by Turk and Pentland. The Eigen vectors are derived from covariance matrix of the probability distribution over the high dimensional vector space of face images. The Eigen faces form a basis set of all images used to construct a covariance matrix, this produces dimensional reduction.

A set of Eigen faces can be generated by performing principal component analysis(PCA) on a large set of images depicting different human faces. Facial recognition was the source of motivation behind the creation of Eigen faces. Eigen face is primarily a dimension reduction method.

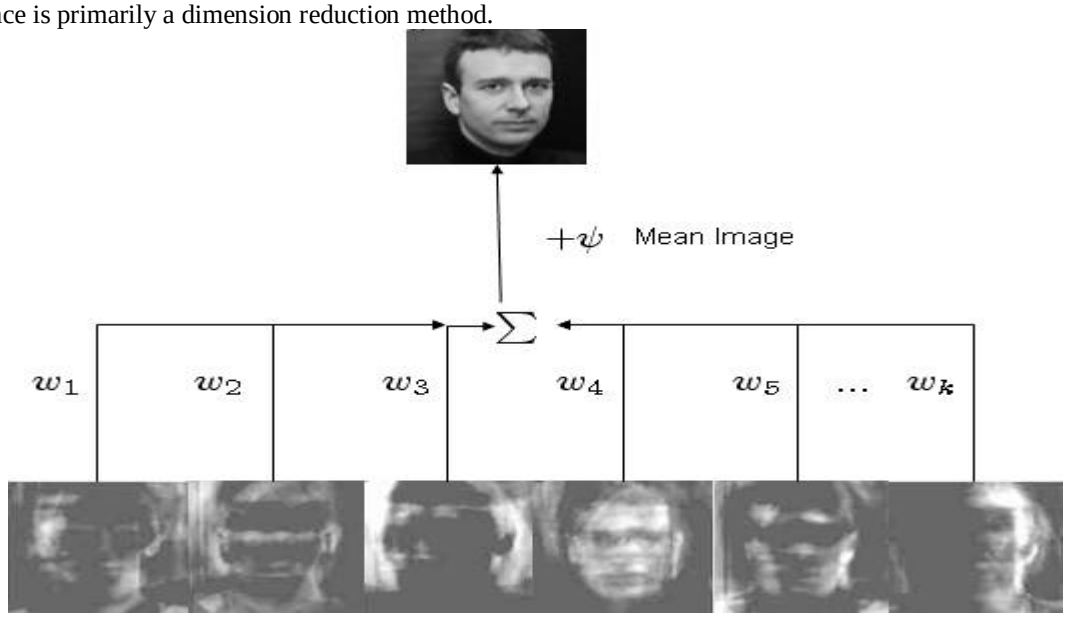

Fig 3. Face Matchingusing EIGEN algorithm

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The images seen by the system are saved as collections of weights, describing the contribution each Eigen face has to that image. When a new face is presented to the system for classification, its own weights are found by projecting the image onto the collection of Eigen faces. This provides a set of weights describing the probe face. These weights are then classified against all weights of the stored images to find the closest match. A nearest neighbor method is a simple approach for finding the Euclidean distance between two vectors.
Various extensions have been made to the Eigen face method such as Eigen features. This method combines facial metrics with the Eigen face representation.

V. CONCLUSION AND FUTURE WORK

Among the different biometric techniques facial recognition may not be most reliable and efficient. However one key advantage is that it does not require the cooperation of the test subject to work.Face recognition systems have the capability of identifying individuals among a crowd,without passersby even knowing about it,but the other biometric systems like iris scans,fingerprints and speech recognition cannot perform mass identification.
An Eigen face based face recognition approach is implemented in MATLAB. This method represents a face by projecting original images onto a low dimensional sub space. A new face is compared to known face classes by computing the distance between the projections onto the face space. Eigen face approach for face recognition is fast and simple which works well under constraint environment. One of the major advantage of this approach is easy implementation.

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