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COMPARISON OF PCA AND LDA BASED FACE RECOGNITION TECHNIQUE IN NOISY ENVIRONMENT

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ABSTRACT
In the face recognition technique there are various types of noises present. In this paper I am going to detect the noise in the given faces in the face recognition using feature extractions in the two different and well know technique known as PCA and LDA technique. In this paper I am going to concentrate on only the salt and pepper type of noise in comparison. Salt and pepper noise is also known as the impulsive noise. After extracting the features of the given images by using both the PCA and LDA technique I am going to compare both the features and analyse the result.

KEYWORDS
linear discriminate analysis (LDA), Principal component analysis (PCA).

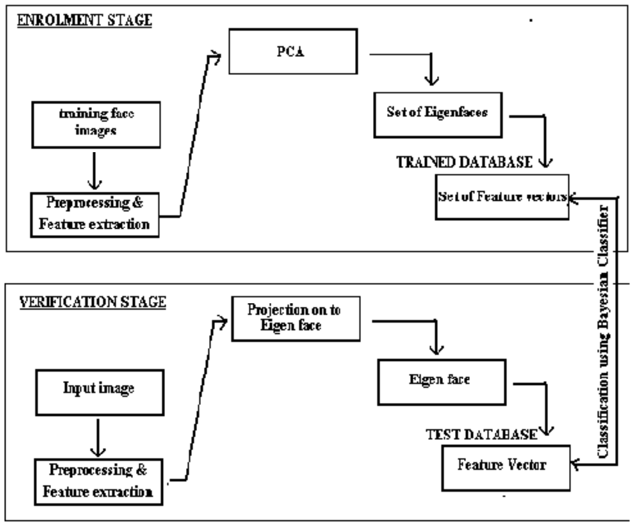
I. INTRODUCTION
From the beginning of the civilization, humans have used faces to identify known and unknown individuals. Hence, the oldest and basic characteristics used for recognition by humans are the face. The Face Recognition technique of Biometric-based authentication applications include National ID cards, airport security, workstation, network, and domain access, application logon, data protection, and remote access to resources, transaction security and Web security. Face recognition is a fairly young technology compared to other biometrics recognition techniques. The facial recognition system automatically identifies a person from a digital image. It does that by comparing selected test face image with the facial database. Aging, [1] Occlusions and makeup or cosmetics can also degrade the accuracy of a real time face recognition system. In dynamic environment many problems may arise during the development of a face recognition system. Faces are highly dynamic and can vary considerably in their orientation, lighting, scale and facial expression; therefore face recognition is considered a difficult problem to solve.
Automatic face recognition by computer can be divided into two approaches, which are as follows:-
1. Constituent-based and
2. Face-based.

In constituent-based approach, recognition is based on the Relationship between human facial features such as eyes, mouth, nose, profile silhouettes and face boundary. The success of this approach relies highly on the accuracy of the
Facial feature detection schemes. However, extracting facial features accurately is difficult. Every human face has similar facial features; a small derivation in the extraction may introduce a large classification error. Face-based approach attempts to capture and define the face as a whole. The face is treated as a two-dimensional pattern of intensity variation. Under this approach, face is matched through identifying its underlying statistical regularities.
It has already been stated that face recognition techniques have always been a very challenging task for researches because of all difficulties and limitations [2]. Human faces are not an invariant characteristic; in fact, a person's face can change very much during short periods of time (from one day to another) and because of long periods of time (a difference of months or years). One problem of face recognition is the fact that different faces could seem very similar; therefore, a discrimination task is needed. On the other hand, when we analyse the same face, many characteristics may have changed. Ones of the most important problems are changes in illumination, variability in facial expressions, the presence of accessories (glasses, beards, etc); finally, the rotation of a face may change many facial characteristics.

II. SPATIAL FACE RECOGNITION TECHNIQUES
Pattern recognition and matching consists of classifying, processing the input and matching it with a known pattern. Face recognition is a very complex form of pattern recognition. It consists of classifying highly ambiguous input signals, with multiple dimensions and matching them with the know 'signals'. These signals can be analysed by different techniques known as spatial face recognition techniques. In this paper we will discuss three different methods namely principal component analysis (PCA), Elastic bunch graph matching (EBGM), Independent components analysis (ICA).These techniques are explained as follows:-

A. PRINCIPAL COMPONENT ANALYSIS--PCA
Principal component analysis is a well known method used to approximate a set of data with lower dimensional feature vectors. In the case of Face Recognition the data considered is an 8-bit gray scale image which is converted into a vector in a column-wise fashion [3]. The first stage of the PCA system is the training stage. A set of facial images which is made up of classes of images of subjects that should be recognized by the system is used as a training set. The training set is used to create a covariance matrix of the training data whose strongest Eigen values will form the basis of the vector space spanned by all the training faces which is called the Face Space.

FIGURE 1: WORKING OF PCA TECHNIQUE



In the biometrics techniques, enrolment and verification are the two very important faeces in which PCA technique works. As shown in the above block diagram –First is the enrolment stage in which the face which has to be identified is taken known as training face image [5] .The features of the testing image is then considered or all the features are taken into account. Now the PCA technique is applied into the processed testing image. In the PCA technique all the features which are taken into account are break into the matrices form known as set of Eigen faces, then this all collected data is stored into the memory .Now the system is ready for the verification.

Secondly, the verification stage is applied; any random face is taken for the testing purpose. This testing image is fed to the pre-processor in which all the features of the input image are extracted. These features are then fed to the testing of the set of Eigen faces. If the features are matched or if both the data are same then the output is positive. If both the data are not matched then the system rejects the data in the negative manner. This is the basic working of the PCA technique.

B. FEATURE-BASED

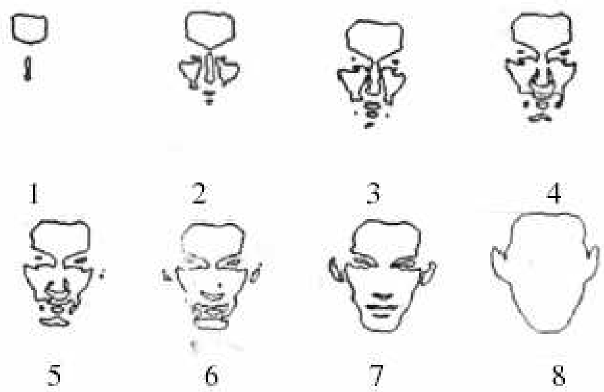
Feature-based approaches first process the input image to identify and extract (and measure) distinctive face features such as the eyes, mouth, nose, etc. as well as other fiducially marks, and then compute the geometric relationships among those facial points, thus reducing the input facial image to a vector of geometric features. Standard statistical pattern recognition techniques are then employed to match faces using these measurements.

To detect the features more reliably, recent approaches have used structural matching methods, for example, the Active Shape Model [4]. Compared to earlier methods, these recent statistical methods are much more robust in terms of handling variations in image intensity and feature shape. An even more Challenging situation for feature Extraction is feature "Restoration," which tries to recover Features that are invisible due to large variations in head poses. The best solution here might be to hallucinate the Missing features by either using the bilateral symmetry of the face or using learned information. For example [5], a View-based statistical method claims to be able to handle even profile views in which many local features are Invisible.

C. ELASTIC BUNCH GRAPH MATCHING--EBGM

Elastic bunch is a graph matching method proposed by Wiskott et al. This technique is based on Dynamic Link Structures. A graph for an individual face is generated as follows: a set of fiducially points on the face are chosen. Each fiducially point is a node of a full connected graph, and is labelled with the Gabor filters' responses applied to a window around the fiducially point. Each arch is labelled with the distance between the correspondent fiducially points. A representative set of such graphs is combined into a stack-like structure, called a face bunch graph. Once the system has a face bunch graph, graphs for new face images can then be generated automatically by Elastic Bunch Graph Matching. Recognition of a new face image is performed by comparing its image graph to those of all the known face images and picking the one with the highest similarity value.

FIGURE 1: EXAMPLE OF AN EBGM LOW-RESOLUTION IMAGE



D. INDEPENDENT COMPONENT ANALYSIS—ICA

ICA is a method that can perform blind source separation. Since both the source signals and how these signals are mixed are unknown, separation is named as blind. ICA algorithm finds a linear coordinate system such that resulting signals will be statistically independent. ICA not only makes signals uncorrelated like PCA does, but also reduces higher order dependencies between the signals [6]. Compared with the classical methods, ICA is a powerful method for finding the factors that are mutually independent with the non-Gaussian distributions. In the ICA model, linear or nonlinear mixtures of the hidden factors or independent components constitute the observed data.

It is intimately related to the blind source separation (BSS) problem, where the goal is to decompose an observed signal into a linear combination of unknown independent signals. Let **s** be the vector of unknown source signals and **x** is the vector of observed mixtures. If **A** is the unknown mixing matrix, then the mixing model is written as

$$x = As$$

It is assumed that the source signals are independent of each other and the mixing matrix **A** is invertible. Based on these assumptions and the observed mixtures, ICA algorithms try to find the mixing matrix **A** or the separating matrix **W** such that is an estimation of the independent source signals.

$u = Wx = Was$

ICA can be viewed as a generalization of PCA. As previously discussed, PCA decor relates the training data so that the sample covariance of the training data is zero. Whiteness is a stronger constraint that requires both decor relation and unit variance. The whitening transform can be determined as **D-1/2RT** where **D** is the diagonal matrix of the Eigen values and **R** is the matrix of orthogonal eigenvectors of the sample covariance matrix. Applying whitening to observed mixtures, however, results in the source signal only up to an orthogonal transformation. ICA goes one step further so that it transforms the whitened data into a set of statistically independent signals.

E. LDA FACE RECOGNITION TECHNIQUE

The LDA face recognition technique is the most popular method used in the image processing techniques. In this paper we are analysing the detailed LDA technique to get the result in the various feature parameters. Firstly the whole process of LDA is explained and then the description of the features are taken into account .After all the analysis a new algorithm is proposed to calculate those features.

6. LINEAR DISCRIMINANT ANALYSIS—LDA

Linear discriminate analysis (LDA) method which is also known as fisher faces method is another example of appearance-based techniques which encodes discriminatory information in a linear separable space of which bases are not necessarily orthogonal. Linear discriminate analysis has been one of the technical techniques employed in the face recognition. The basic idea of the linear discriminate analysis is to calculate the optimal discriminator vector so that the ratio of with- in the class and between the class scatter matrices is maximised. The primary purpose of the Linear Discriminated Analysis is to separate samples of distinct groups by maximising their between-class reparability while minimising their within-class variability [7]. Although LDA does not assume that the populations of the distinct groups are normally distributed, it assumes implicitly that the true covariance matrices of each class are equal because the same within-class scatter matrix is used for all the classes considered.

Let the between-class scatter matrix S_b be defined as-

$S_b = \sum_{i=1}^{g} N_i(\bar{X_i} - \bar{X})(\bar{X_i} - \bar{X})^T$ (1)

And the within-class scatter matrix *Sw* be defined as

$S_W = \sum_{i=1}^{g}(N_i - 1)S_i = \sum_{i=1}^{g}\sum_{j=1}^{N_i}(\bar{X_i} - \bar{X})(\bar{X_i} - \bar{X})^T$ (2)

Where *j i x*, is the *n*-dimensional pattern *j* from class *i* p , *i N* is the number of training patterns from class *i* p , and *g* is the total number of classes or groups. The vector *xi* and matrix *Si* are respectively the unbiased sample mean and sample covariance matrix of class *i* p. The grand mean vector *x* is given by-

$\bar{X} = \frac{1}{N}\sum_{i=1}^{g} N_i \bar{X_i} = \frac{1}{N}\sum_{N}^{g}\sum_{i=1}^{N_i}\sum_{j=1} X_{ij}$ (3)

Where *N* is the total number of samples, that is,

N = *N* + *N* + + *Ng*...... 12. It is important to note that the within-class scatter matrix *Sw* defined in equation (2) is essentially the standard pooled covariance matrix multiplied by the scalar (*N* – *g*), that is *p*

$$S_W = \sum_{i=1}^{g}(N_i - 1)S_i = (N - g)S_p \qquad (4)$$

The main objective of LDA is to find a projection matrix P_{lda} that maximizes the ratio of the determinant of the between-class scatter matrix to the determinant of the Within-class scatter matrix (Fisher's criterion), that is

$P_{ida} = \frac{argmax}{P}\left|\frac{P^T S_h P}{P^T S_W P}\right|$ (5)

Devijver and Kittler [5] have shown that P_{lda} is in fact the solution of the following Eigen system problem:

$S_h P - S_W PL = 0$ (6)

Multiplying both sides by S_W^{-1}, equation (6) can be rewritten as-

$S_W^{-1} S_h P - S_W^{-1} S_W PL = 0$

$S_W^{-1} S_h P - PL = 0$

$(S_W^{-1} S_h)P = PL$ (7)

Where *P* and L are respectively the eigenvectors and Eigen values of $s_w^{-1} s_b$. In other words, equation (7) states That if S_w is a non-singular matrix then the Fisher's criterion Described in equation (5) is maximised when the projection matrix P_{lda} is composed of the eigenvectors of $S_W^{-1}S_b$ - with at most (*g* -1) nonzero corresponding Eigen values. This is the standard LDA procedure[7].

The within class scatter matrix signifies how face images are disseminated closely within classes and between class scatter matrix depicts how classes are alienated from each other. When face images are projected into the discriminated vectors W, face images ought to be distributed closely within classes and should be separated between classes, as much as probable [9]. In other words, these discriminated vectors diminish the denominator and maximize the numerator in Equation (3). W can therefore be constructed by the eigenvectors of S_W^{-1} S_b. These eigenvectors are also referred to as the fisher faces. There are various methods to solve the problem of LDA such as the pseudo inverse method, the subspace method, or the null space method.

III NOISY IMAGES

The noise in the image can be defined as the undesirable product in the captured image which result to the false or unauthentic and not essential information.

The noise as we use technically stands for "unwanted signals", similarly in the face recognition the noise is unwanted things came in the image. The image become noise or sometimes due to the brightness.

When noisy images come then, it's a new task for the recognizer to recognise the correct image with accuracy. For the further studies of the noise first we have to see the basic and the very very important noises.

There are following three main types of noise:-

1. Salt and pepper noise
2. Gaussian noise
3. Poisson noise.

Now we are going to explore the salt and pepper noise in detail.

SALT AND PEPPER NOISE

The alternative name of the salt and pepper noise is impulsive noise as the name says is caused due to the sudden and sharp disturbance in the image signal.

The appearance of this typical noise is, as the randomly occurrence of white and black pixels into the image. The random white pixel over the image is called as the salt noise and the random black pixels over the image are known as pepper noise. On combining these two when both (white and black) pixels occurs over the image then it is known as salt and pepper noise.

IV PROPOSED METHODOLOGY

The approach to face recognition involves the following operations

- Acquire an initial set of N face images (training images).
- Calculate the Eigen face from the training set keeping only the M images that correspond to the highest Eigen values. These M images define the "face space". As new faces are encountered, the "Eigen faces" can be updated or recalculated accordingly.
- Calculate the corresponding distribution in M dimensional weight space for each known individual by projecting their face images onto the "face space".

- Calculate a set of weights projecting the input image to the M "Eigen faces".
- Determine whether the image is a face or not by checking the closeness of the image to the "face space".
- If it is close enough, classify, the weight pattern as either a known person or as an unknown based on the Euclidean distance measured.
- If it is close enough then cite the recognition successful and provide relevant information about the recognized face from the database which contains information about the faces.
- Repeat the above classification with noisy images.

V EXPEIMENTAL SETUP

The experimental results are shown below for face recognition with PCA and LDA technique over noisy channel Salt Pepper.

The results are analyzed in the MATLAB according to the methodology written above.

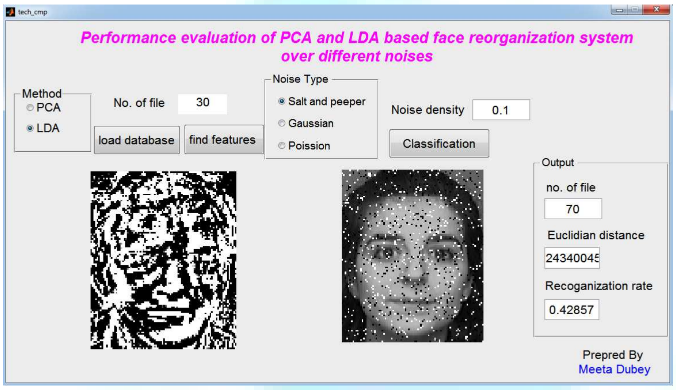
These two above images contains 50 files through which the tested image has been recognized on the bases of the minimum possible Euclidean distance or the Eigen distance.

VI RESULT

Now the graphs has been drawn between the training samples and the Eigen distance for the PCA and LDA technique by considering various values. On the basis of the graph below the result is analyzed as:-

In the salt and pepper noise as explained earlier in this paper shows the random occurrence of the white and black pixels in the images. The following output of the salt and pepper noise using LDA technique is:-

OUTPUT OF LDA WITH SALT AND PEPPER NOISE



The Euclidean distance and the recognition rate has been calculated using LDA technique. Each face has some features on the bases of which is has been recognized. The above figure also shows the feature extraction of the tested images.

Similarly, the output of the salt and pepper noise using PCA technique has been shown below:-

OUTPUT OF PCA WITH SALT AND PEPPER NOISE

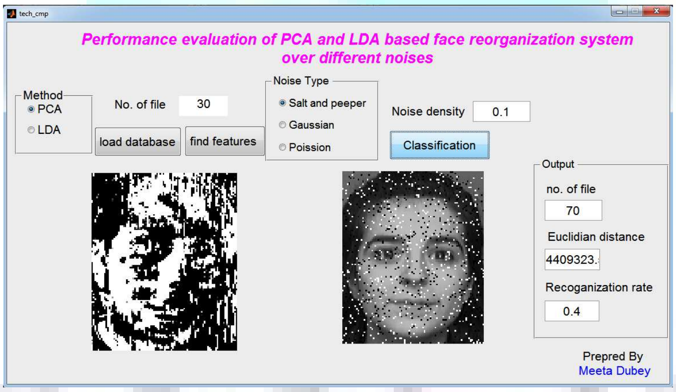
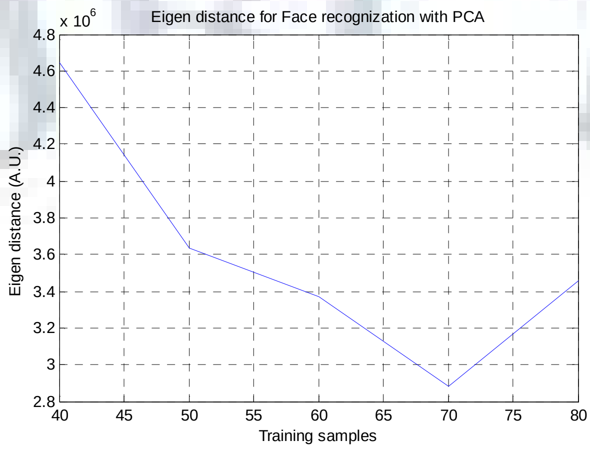
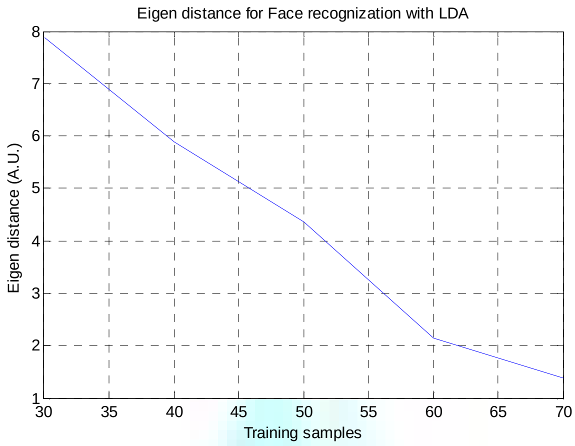


FIGURE 3: EIGEN DISTANCE FOR PCA BASED FACE RECOGNITION



From the graph it is clear that for the PCA base feature, as the training samples increases the Eigen distance is decreases.

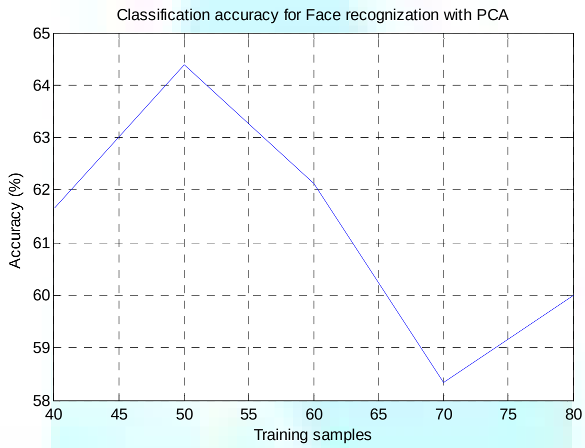
FIGURE 4: EIGEN DISTANCE FOR LDA BASED FACE RECOGNITION



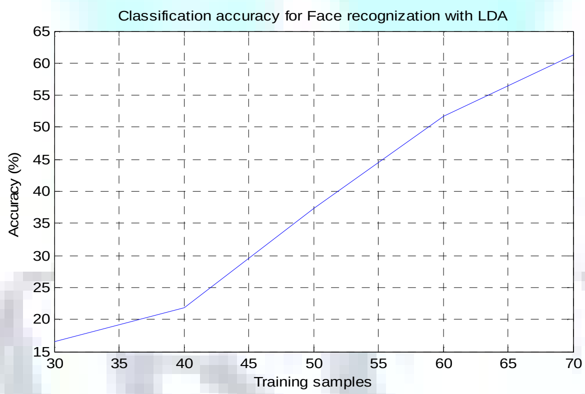
From the graph it is clear that for the LDA base feature, as the training samples increases the Eigen distance is decreases

The accuracy of the experiments is now analysed .The graph is drawn between the training samples and the accuracy for the face recognition for the PCA and LDA technique respectively:-

FIGURE 5: CLASSIFICATION ACCURACY OF PCA BASED FACE RECOGNITION



From the graph it is clear that for the PCA base feature, as the training samples increases the Accuracy is increases till 50 samples, when training sample increases over 50 accuracy get reduces in the salt & pepper noise.



From the graph it is clear that for the LDA base feature, as the training samples increases the Accuracy is increases in the case of salt & pepper noise.

VII CONCLUSION

From all the above results we can conclude that performance of PCA is better than LDA in presence of salt & pepper noise because PCA technique provide greater accuracy as compare to the LDA technique at same sample rate.

We can also conclude that if an image having salt and pepper noise and if the number of samples are less then we can use the LDA technique with the good accuracy, but if the number of samples are in ample then LDA will not work we have to use PCA technique for getting greater accuracy and efficiency.

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