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Research Article

FACE AUTHENTICATION TECHNIQUE ROBUST TO ORIENTATION USING PCA FEATURES

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ABSTRACT
This paper is aimed to analyze the performance of face recognition systems using PCA features. One of the key issues in face recognition system is selection of features from face images. Appearance based & texture based is alternative for feature extraction stage. Here appearance based PCA feature extraction method is proposed for face recognition. In this work, we proposed face identification technique which is robust to orientation of the face image under similar illumination condition. We tested our results using FERET database and our own captured database. In proposed method, efficiency obtained varies between 80-90 percent depending on the angle of orientation.

Keywords: *Histogram Equalization, Median Filter, PCA, Euclidian Distance*

INTRODUCTION
Biometrics-based person recognition is currently one of the key issues in security applications. Many biometric signals (speech, iris, fingerprint, signature, etc.) are being used in this field. Face recognition has raised extensive attention since 1990. The trend is driven by increasing demand on security application. Over the last few years, numerous algorithms have been proposed for face recognition. There are two approaches to face recognition, feature based and appearance based .The geometric feature based approach uses properties & relation (e.g. distance & angle) between facial features such as eyes, mouth, nose & chin to perform recognition (Vijaya *et al.*, 2009). Despite their economical representation & their insensitivity to variation in illumination & view point. It is not reliable enough for extraction and measurement of facial features. The other method used are appearance based which use low dimensional representation of images to perform recognition and is applied to either whole-face or specific regions in a face image. Among many approaches to the problem of face recognition, appearance-based subspace analysis, although one of the oldest, still gives the most promising results. Subspace analysis is done by projecting an image into a lower dimensional space (subspace) and after that recognition is performed by measuring the distances between known images and the image to be recognized The appearance based methods are as follows,

a) Eigen face by principal component analysis (PCA), a classical linear method for unsupervised dimensionality reduction that transforms a data set consisting of a large number of interrelated variables to a new set of uncorrelated variables (Turk and Pentland, 1991).

b) Fisher face by linear discriminate analysis (LDA) is popular for face recognition.LDA estimate transformation matrix through maximizing ratio of between class scatter to within class scatter. Discriminative features are extracted for template matching using nearest neighbor classification rule. LDA is statistical approach for classifying sample of unknown classes based on training samples with known classes (Arjun *et al.*, 2010).

Some of the challenges of facial recognition in the visual spectrum include reducing the impact of variable lighting and detecting a mask or photograph. Major benefits of facial recognition are that it is non-intrusive, hands-free, and continuous and accepted by most users. The main problems with authentication by face- recognition are as follow:

1. The facial features depend on the angle of orientation of the face, which cannot fix.
2. The features depend on the ambient.

3. And the finally it changes with age, make-up, presence or absence of glasses, and even the expression on the face, like angry, happy, sad etc.

Therefore, even though the person is same, the automatic authentication system may fail. It is said that about 75% of the authentication failure is because the angle of orientation of the probe face-image.

Actual System Implementation

The automatic Face recognition system contains Enrollment mode & Recognition mode.

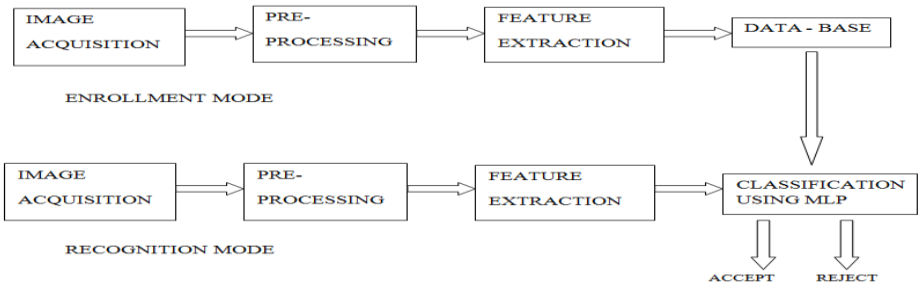


Figure 1: System Block Diagram

➢ ***Image Capture***

This block involves taking image. Image acquisition is of two type off-line and on-line. In off-line process image is taken into paper and then transferred into computer. Since it has relatively high resolution (up to 500 dpi) face matching technique can be used. In case of online acquisition of image a low resolution and fast process can be developed and online method can be used by common man on day to day basis for securing systems and work stations. But process is costly and complicated.

So for are convenience we are going to use an offline acquisition technique for image acquisition. We have captured images of 50 persons with 6 different angle orientations with resolution 120 dpi using digital camera.

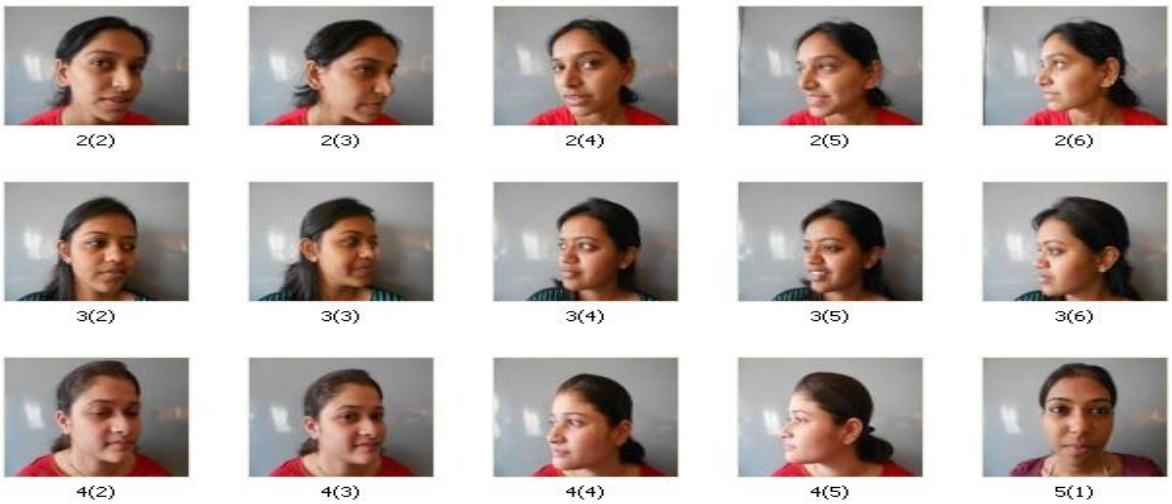


Figure 2: Captured Images

➢ ***Preprocessing***

Face recognition algorithms have to deal with significant amounts of illumination variations between gallery and probe images. For this reason, image preprocessing algorithm that compensates for illumination variations in images is used prior to recognition.

- *Rgb to Gray scale conversion-*

To convert from RGB to gray scale following formula used,

Luminance = (0.3xRed) + (0.59xGreen) + (0.11xBlue)

We don't use RGB images for processing since it will take three times more processing time

Figure 3: RGB TO GRAY Conversion

- *Noise Removal*

Medial filter is applied for noise removal from images. It removes salt & pepper noise. Such noise is represented by black & white dots in image. Median filter dose better job than mean filter by preserving useful detail in image.

Figure 5: Noise removal

➢ ***Histogram Equalization***

Histogram equalization is used to have image with approximately the same number of pixels for all luminance. Images with equalized histogram have good contrast and it is the main reason for performing this operation.

Transformation of histogram is given by,

S=T(r)

Where T(r) must be single value and monotonically increasing in the interval $0 \leq r \leq 1$

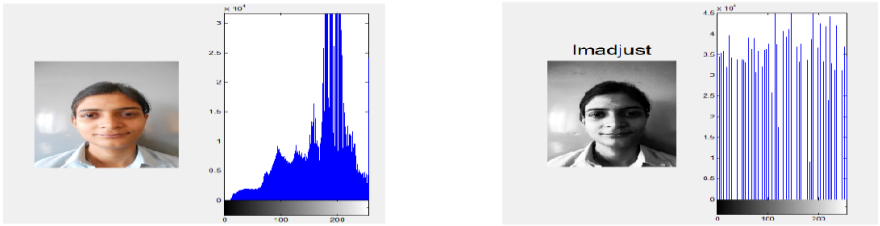
Consider a discrete grayscale image {x} and let n_i be the number of occurrences of gray level i. The probability of an occurrence of a pixel of level i in the image is

$$p_x(i) = p(x = i) = \frac{n_i}{n}, \quad 0 \leq i < L$$

L being the total number of gray levels in the image, n being the total number of pixels in the image, and $p_x(i)$ being in fact the image's histogram for pixel value i, normalized to [0,1]. Cumulative distribution function corresponding to p_x is defined as,

$$cdf_x(i) = \sum_{j=0}^{i} p_x(j)$$

,



(a) **(b)**

Figure 6: Histogram equilization

➢ ***Feature Extraction***

In prior to pattern matching stage a feature extraction stage is necessary, in order to obtain the face characteristics and to accomplish the recognition task. The result of this feature extraction stage, it would be desirable to have a simple and reliable representation of the input signal but retaining, at the same time, all the important cues for recognition.

Some features are more dependent on face view and less dependent on face identity whereas some features are less dependent on face view and more dependent on face identity.

In this approach for angle invariant face recognition, conceptually we need two sets of features:

- Angle features which would represent the pose/orientation of the face and
- Face image features which would faithfully represent the face identity of the person.

When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data, but not much information) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. In proposed method we use PCA (principal Component Analysis) to extract the features.

➢ *PCA*

Principal component analysis (PCA) is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of uncorrelated variables called 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 as high a variance as possible (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it be orthogonal to (uncorrelated with) the preceding components.

The purpose of PCA is to reduce the large dimensionality of the data space (observed variables) to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the data economically. The jobs which PCA can do are prediction, redundancy removal, feature extraction, data compression, etc.

Principal components are the vectors in the direction of the maximum variance of the projection samples. For given 2D data points, u1 and u2 are found as PCs

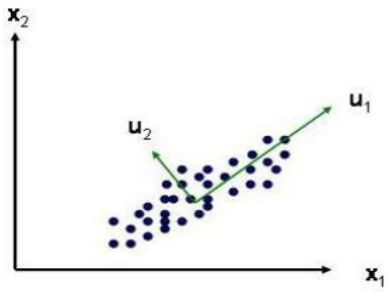


Figure 7: Principal Component

- *PCA Algorithm*

The steps in finding the principal components can be summarized as follows:

a) Collect xi of an n dimensional data set x, i=1,2, …, m

$$x_i = [p_1 \dots p_N]^T, i = 1, \dots, M$$

b) The images are mean centered by subtracting the mean image from each image vector. Let *m* represent the mean image

$$m = \frac{1}{M}\sum_{i=1}^{M} x_i$$

c) And let *wi* be defined as mean centered image

$$w_i = x_i - m$$

d) Calculate the covariance matrix:
C = (xi - m)(xi - m)T
e) Determine eigenvalues and eigenvectors of the matrix C.
f) Sort the eigenvalues (and corresponding eigenvectors) in decreasing order.
g) Select the first d ≤ n eigenvectors and generate the data set in the new representation.
h) The projected test image is compared to every projected training image by using a Euclidian distance. The result is the training image which is the closest to the test image.

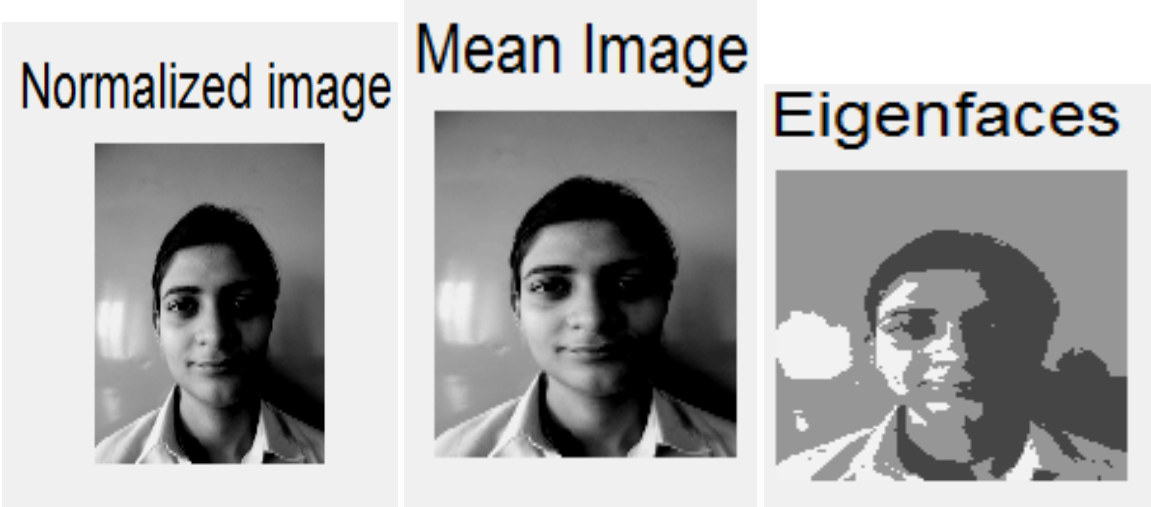


Figure 8: PCA Features

➢ ***Matching***

For Matching Euclidean Distance algorithm is used. If the value is greater than threshold then we accept it otherwise we reject it.

- Euclidean distance

Euclidean distance is the ordinary distance between two points. It is measure as the square root of the sum of the squares of the differences between the corresponding co-ordinates of the points. Set of Images of same user are taken and mean of these feature vectors is the Template. Template vector dimension must same as Input vector.

Where, d is the Euclidean distance $d = \sqrt{\sum_{i=1}^{L}(x_i - t_i)^2}$ e feature vector, Xi is the ith component of the sample feature vector, Ti is the ith c late feature vector.

RESULTS AND DISCUSSION

Results

The results were tested on standard database of FERET & also on our own captured database, which contains 100 persons each of 6 samples. Out of 6 samples 3 were taken for training and 3 were taken for testing.

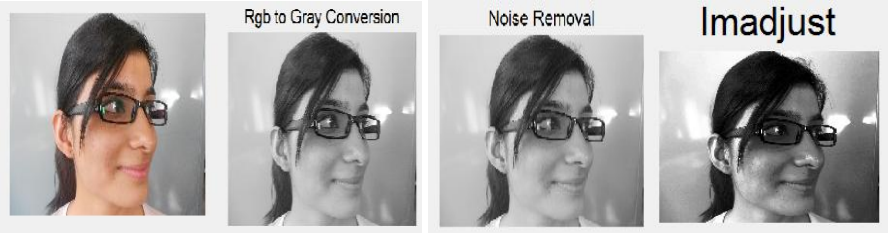


Figure 9: Pre-Processing of image

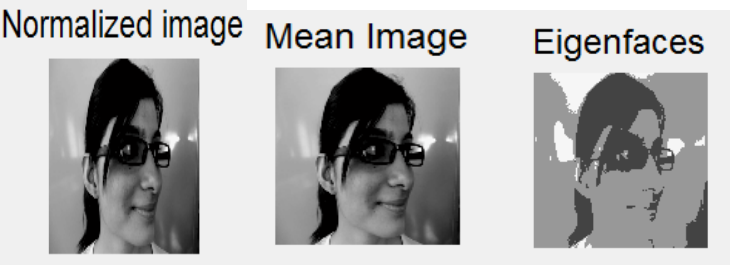
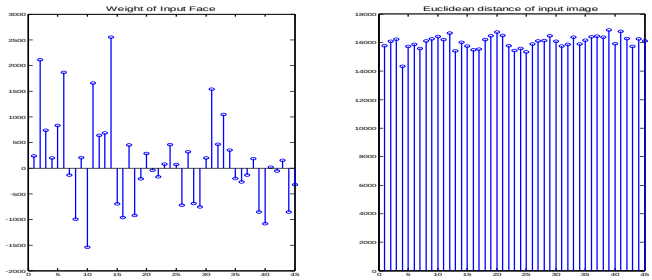


Figure 10: Feature extracted by PCA

Figure 11: Matched Image



(a) **(b)**

Figure 12: (a) Weights of input (b) Euclidian distance of input image

➢ ***Performance measurement parameters*:-**

- False Acceptance Rate :-

$$FAR = \frac{\text{Total False Acceptence}}{\text{Total False Attempts}}$$

- False Rejection Rate

$$\boxed{FRR = \frac{\text{Total False Rejection}}{\text{Total True Attempts}}}$$

- Equal Error Rate :-

Equal error rate is a point where FRR and FAR are same.

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The performance of biometric system is measured using ROC(Receiver operating Characteristics) ROC plot is a visual characterization of the trade-off between the FAR and the FRR. In general, the matching algorithm performs a decision based on a threshold which determines how close to a template the input needs to be for it to be considered a match. If the threshold is reduced, there will be less false non-matches but more false accepts. Correspondingly, a higher threshold will reduce the FAR but increase the FRR.

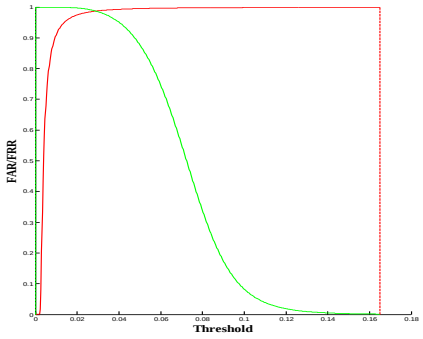

Figure 13: Curve of Threshold Vs FAR & FRR

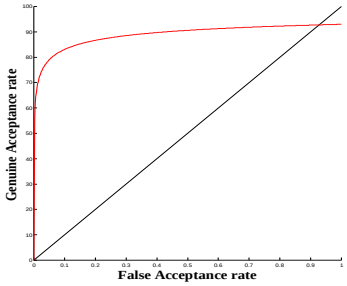

Figure 14: Curve of FAR Vs GAR for PCA

In proposed method, efficiency obtained is 88.63 percent depending on the angle of orientation. The False acceptance Rate (FAR) and False Rejection Rate (FRR) achieved is 0.81 and 1 respectively.

Conclusion

PCA is the simplest of the true eigenvector-based multivariate analyses. Often, its operation can be thought of as revealing the internal structure of the data in a way which best explains the variance in the data.

The standard database used for employing PCA algorithm and various other processes is the FERET database, it is also employed using a local database consisting of 50 images with each image of a person oriented in 6 different angles. The efficiency obtained using this algorithm varies between 80-90 percent depending on the angle of orientation. The False acceptance Rate (FAR) and False Rejection Rate (FRR) achieved is 0.81 and 1 respectively.

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