Principal Component Analysis Based Face Recognition System

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Abstract: Face recognition, as one of the major biometrics identification methods, has been applied in different fields involving economics, military, e-commerce, and security. Its touch less identification process and non-compulsory rule to users are irreplaceable by other approaches, such as iris recognition or fingerprint recognition. For the processing approach, we use principal component analysis (PCA), a data dimensionality reduction approach. The advantage of this approach is that, it enables us to detect changes in the face pattern of an individual to an appreciable extent. The recognition system can tolerate local variations in the face expression of an individual. Hence face recognition can be used as a key factor in crime detection mainly to identify criminals. The system consists of a database of a set of facial patterns for each individual. The characteristic features called 'Eigen faces' are extracted from the stored images using which the system is trained for subsequent recognition of new images The goal of this study is to understand the entire face recognition process with PCA. The proposed method is tested using FERET database

Keywords: PCA, Face Recognition, Eigen faces,LBP,Histogram.

I. INTRODUCTION

Face recognition has been studied for decades and has been applied in various areas. In 2012, Samsung released their new smart TV which incorporates face recognition by using built-in camera. This new feature allows users to log in to social network applications, such as Facebook, Twitter, or Skype without resorting to a userid and password. In addition, face recognition has also attracted the attention of governments because of its high security level and accessibility. DARPA (Defense Advanced Research Projects Agency) intends to supplant traditional digital passwords by scanning human faces [1]. Face recognition techniques even can support law enforcement. Karl Ricanek Jr. introduced an application of face recognition in detecting potential child pornography in computer storage. The results show significant progress in both detection speed and accuracy [2]. The PCA property of reducing data dimensionality without losing principal components is the key feature that makes it an object of continuing study.

Generally, an automatic face recognition system is divided into phases, face detection and face recognition. In the face detection stage, the face area is extracted from the background image, and the size of the area is also defined at the same time. In the face recognition stage, the face image will be represented with mathematical approaches to express as much information about the face as possible. Eventually, the new face image will be compared with known face images, which results in a similarity score for final verification.

The earliest principal component analysis dates back to 1901 when Karl Pearson proposed the concept and applied it to non-random variables [6]. In 1930, Harold Hoteling extended it to random variables [17] [18]. The technique is now being applied in a number of fields, such as mechanics, economics, medicine, and neuroscience. In computer science, PCA is utilized as a data dimensionality reduction tool. Especially in the age of Big Data, the data we process is often complex and huge. So reducing the computational complexity and saving computing resources are important issues.

Basically, the PCA process projects the original data with high dimensionality to a lower dimensionality subspace through a linear transformation. Nevertheless, the projection is not arbitrary. It has to obey a rule that the most representative data needs to be retained, i.e. the data after transforming cannot be distorted. Hence, those dimensionalities which are reduced by PCA are actually redundant or even noisy. Therefore, the ultimate goal of conducting PCA is to refine data so that the reduce noise.

I. LITERATURE SURVEY

Lot of the work in recognition of faces has done. Research in face recognition moreover, has shown that individual features and their immediate relationships comprise an insufficient representation to account for the performance of human face recognition. The challenge of robust face recognition remains one of the most popular research areas in computer vision.

1) Knowledge based methods are developed on the rules derived from the researchers knowledge of human faces. Problem in this approach is the difficulty in translating human knowledge into well- denned rules

2) Featured-based methods: Invariant features of faces are used for detecting texture, skin color. But features from such algorithm can be severely corrupted due to illumination, noise and occlusion.

3) Appearance-based method: In template matching methods, the templates are preened by experts. Whereas, the templates in appearance based methods are learned from examples in images. Statistical analysis and machine learning techniques can be used to the relevant characteristics of face and non-face images.

4) The Discrete Cosine Transform DCT-II standard (often called simply DCT) expresses a sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. It has strong energy compaction properties. Therefore, it can be used to transform images, compacting the variations, allowing an effective dimensionality reduction. They have been widely used for data compression. The DCT is based on the Fourier discrete transform, but using only real numbers.

5) LDA is widely used to find linear combinations of features while preserving class reparability. Unlike PCA, LDA tries to model the differences between classes. Classic LDA is designed to take into account only two classes. Specifically, it requires data points for different classes to be far from each other, while point from the same class are close. Consequently, LDA obtains differenced projection vectors for each class.

6) The Locality Preserving Projections (LPP) was introduced by He and Neoga It's an alternative to PCA, designed to preserve locality structure. Pattern recognition algorithms usually make a search for the nearest pattern or neighbors. Therefore, the locality preserving quality of LPP can quicken the recognition.

7) Gabor Wavelate is Neurophysiological evidence from the visual cortex of mammalian brains suggests that simple cells in the visual cortex can be viewed as a family of self-similar 2D Gabor wavelets. The Gabor functions proposed by Daugman are local spatial bandpass filters that achieve the theoretical limit for conjoint resolution of information in the 2D spatial and 2D Fourier domains.

8) Independent Component Analysis aims to transform the data as linear combinations of statistically independent data points. Therefore, its goal is to provide an independent rather that uncorrelated image representation. ICA is an alternative to PCA which provides a more powerful data representation It's a discriminant analysis criterion, which can be used to enhance PCA

9) The use of Kernel functions for performing nonlinear PCA was introduced by Scholkopf e. Its basic methodology is to apply a non-linear mapping to the input and then solve a linear PCA in the resulting feature subspace.

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11) Artificial neural networks are a popular tool in face recognition. They have been used in pattern recognition and classification. Kohonen was the first to demonstrate that a neuron network could be used to recognize aligned and normalized faces.

II PROPOSED SYSTEM

The proposed disease detection system is mainly divided in four steps. Each step performs some significant task.

Step 1: Image Data Base

This is very first step for proposed face recognition system. In this step all the data base images are stored in specific location for this system FERET database is used. Total 150 images are taken in this database each person contains 10 different position images for testing. Database images are collected from net.

Step 2: Local Binary Pattern (LBP)

The collected database is then processed through the Local Binary Pattern means in this the pixel value of each point on face is calculated. The mail Principal of this is it mainly consider 3X3 matrix and center pixel is Threshold. And this center pixel will compare with all neighborhood pixel if it is greater than that pixel then it will assign 1 otherwise 0.after that we will get one binary value that we need to be convert into decimal value. The resulting decimal label value of the 8-bit word can be expressed as follows

$$LBP(xc , yc) = \sum s(ln- lc)2n$$

where lc corresponds to the grey value of the center pixel (xc, yc), ln to the grey values of the 8 surrounding the pixels, and function s(k) is defined as

$$s(k) = 1 \quad \text{if } k > 0$$
$$s(k) = 0 \quad \text{if } k < 0$$

Step 3: Image Histogram

The histogram is the tracked object's color probability map. Because in the project we focus on the face tracking, the hue channel of the face shown in the Figure 3.4.1 is used to illustrate what is the histogram. In the first step, the whole area of tracked object is scanned and the map which record how many pixels have a certain hue value in the tracked object area is built. And then, CAMshift finds out the peak the number of pixel in a certain hue value and normalizes the map into skin color probability map or histogram shown in the Figure 5. The horizontal bar of the Figure 3.4.1 is hue valueand the vertical bar is the skin probability.

Step 4: PCA

This is the main step of the system. In this step we are calculating the mean face image and the eigen face image for this purpose we need to calculate the covariance matrix of an image and the eigen vector for the same.Steps for calculation of PCA as follow

Calculate the mean of the input face images

Subtract the mean from the input images to obtain the mean-shifted images

Calculate the eigenvectors and eigenvalues of the mean-shifted images

Order the eigenvectors by their corresponding eigenvalues, in decreasing order

Retain only the eigenvectors with the largest eigenvalues (the principal components)

Project the mean-shifted images into the eigenspace using the retained eigenvectors

The covariance matrix is calculated using following formula

$$\Gamma = \frac{1}{R}\sum_{i=1}^{R}(X_i - \overline{X})(X_i - \overline{X})^T$$

$$= \Phi\,\Phi^T$$

where $\Phi = (\Phi_1, \Phi_2, \ldots, \Phi_R) \subset \Re^{D\times R}$ and

$$\overline{X} = \frac{1}{R}\sum_{i=1}^{R} X_i$$

Which is the mean image of the training set. The dimension of the covariance matrix Γ is DxD. Then, the eigenvalues and eigenvectors are calculated from the covariance matrix Γ. Let $\mathbf{Q} = (\mathbf{Q}1, \mathbf{Q}2, \ldots, \mathbf{Q}r) \subset \Re D\times R$ (r<R) be the r eigenvectors corresponding to r largest non-zero eigenvalues. Each of the r eigenvectors is called an eigenface. Now, each of the face images of the training set **Xi** is projected into the eigenface space to obtain its corresponding eigenface-based feature $Zi \subset \Re^{r\times R}$, which is defined as follows:

$$\mathbf{Z}_i = \mathbf{Q}^T\mathbf{Y}_i\ ,\ i = 1, 2, \ldots, R$$

Where $\mathbf{Y}_i$ is the mean-subtracted image of $\mathbf{X}_i$.

III SYSTEM RESULTS

The goal of our proposed system is to develop the Face recognition system using LBP and PCA only Image database is of 150 images. Some database images are shown below Fig.1

Fig. 1 Database Images

Fig. 2 LBP of an Image

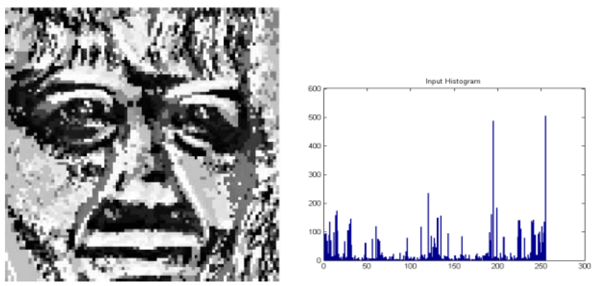

Fig. 3 Histogram of an Image

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Fig. 4 Mean image of an Image

Fig. 5 Eigen Face image of an Image

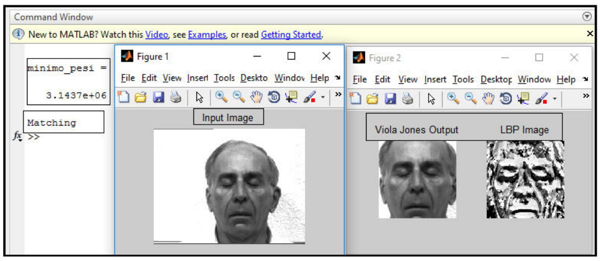

Fig. 6 Final output of face recognition.

Recognition Accuracy

For the best recognition system, Recognition accuracy should be high. It is calculated in ratio as follows: Both are shown in Fig. 7 in form of graph.

Face Acceptance Ratio (FAR):-

(Match count/ (No Of face*Images Per face))*100

Face Rejection Ration (FRR):-

(Mismatch count/ (No Of face*Images Per face))*100

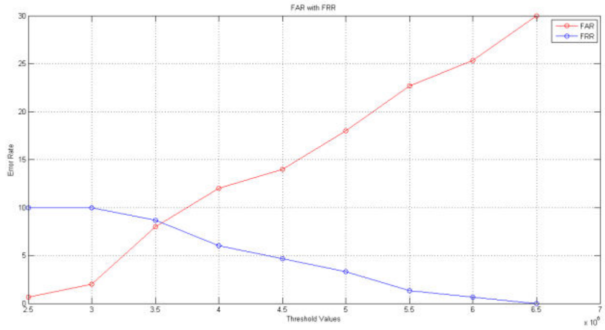

Fig. 7 Graphical representation of FAR and FRR.

The performance for the system is evaluated using FAR and FRR, Face sample images whose matches are not in database with minimum elucidiean distance the results are as follows.

TABLE I % RECOGNITION ACCURACY

Sr. No.	Face	Distance
1		100%
2		90%
3		60%
4		100%
% Recognition Accuracy		**87.5%**

IV CONCLUSION

From literature, the study of face recognition with PCA is done. The proposed system is tested on FERET database of 150 face images. The performance of the proposed method in terms of Face Acceptance ration and Face Rejection ration with threshold on that specific threshold it will give maximum accuracy. It shows that the proposed method has high recognition accuracy which illustrates the robustness of the proposed system. The performance of overall recognition accuracy obtained for the system is 87.5%

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BIOGRAPHIES

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