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Face Recognition Using Pca: A Review

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Abstract
Face recognition presents a challenging problem in the field of image analysis and computer vision, and as such has received a great deal of attention over the last few years because of its many applications in various domains. The PCA has been extensively employed for face recognition algorithms. It is one of the most popular representation methods for a face image. It not only reduces the dimensionality of the image, but also retains some of the variations in the image data. The system functions by projecting face image onto a feature space that spans the significant variations among known face images. The significant features are known as "Eigen faces", because they are the Eigen vectors (Principal Component) of the set of faces they do not necessarily correspond to the features such as eyes, ears, and noses. The Eigen face approach uses the PCA for recognition of the images. The system performs by projecting pre extracted face image onto a set of face space that represent significant variations among known face images. Face will be categorized as known or unknown face after matching with the present database. If the user is new to the face recognition system then his/her template will be stored in the database else matched against the templates stored in the database. The variable reducing theory of PCA accounts for the smaller face space than the training set of face.

Keywords **–** Biometric, Face Recognition, Principle Component Analysis.

I. Introduction

1.1 Biometrics

Over the past 20 years, extensive research works on various aspects of face recognition by human and machines have been conducted by engineering scientists. Detection of the human face is an essential step in many computer vision and biometric applications such as automatic face recognition, video surveillance, human computer interaction (HCI) and large-scale face image retrieval systems. Many Biometrics is used in the process of authentication of a person by verifying or identifying that a user requesting a network resource is who he, she, or it claims to be, and vice versa .Behavioural characteristics, often called biometrics. In general, biometric systems process raw data in order to extract a template which is easier to process and store, but carries most of the information needed. Perhaps the most common biometrics is fingerprints and iris, but many other human characteristics have been studied in last year's: finger/palm geometry, voice, signature, face. Fig. 1 shows the spreading of the most popular biometrics in the last years from a commercial point of view. On the contrary, face recognition seems to be a good compromise between reliability and social acceptance and balances security and privacy well. It's true that any identification system based on face-recognition technology poses several threats to civil:

1. Impinges on the privacy of innocent people when false positives are investigated.
2. Face-template data can be stolen and cannot be replaced.

In spite of this, there are large numbers of commercial, security, and forensic applications requiring the use of face recognition technologies.

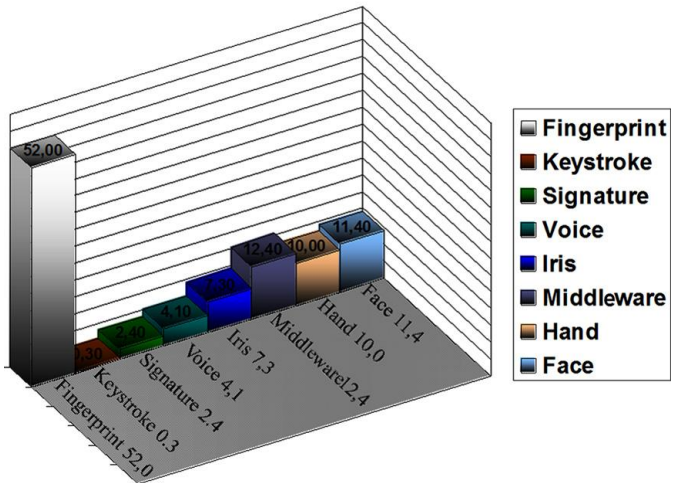

Fig. 1. The spreading of most popular biometrics

1.2 Advantage of Biometrics

Increase Security at low cost, Reduce the fraud, Saving time and attendance, Easily network accessing, Positive and accurate Identification, Highest level of security, Offers mobility, Impossible to forge, Safe & user friendly.

II. Face Recognition

Face is a complex multidimensional structure and needs good computing techniques for recognition. The face is our primary and first focus of attention in social life playing an important role in identity of individual. Computers that recognize faces could be applied to a wide variety of practical applications including criminal identification, security systems, identity verification etc. Features extracted from a face are processed and compared with similarly processed faces present in the database. In general, face recognition techniques can be divided into two groups based on the face representation they use appearance-based, which uses holistic texture features and is applied to either whole-face or specific regions in a face image and feature-based, which uses geometric facial features (mouth, eyes ,brows, cheeks etc), and geometric relationships between them .

Face Identification: Given a face image that belongs to a person in a database, tell whose image it is.

Face Verification: Given a face image that might not belong to the database, verify whether it is from the person it is claimed to be in the database.

2.1 Different methods of Face Recognition

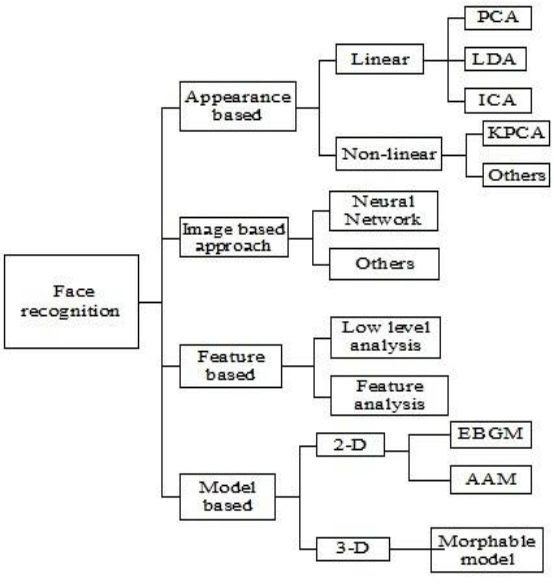

Fig. 2 Different methods of Face Recognition

2.1.2 Appearance based Eigen Face method

In Eigen face approach, after the dimensional reduction of the face space, the distance is measured between two images for recognition. If the distance is less than some threshold value, then it is considered as a known face else it is an unknown face. The approach transforms face images into a small set of characteristic feature images, called "Eigen faces", which are the principal components of initial training set of face images.Eigen face can be calculated with the help of many methods which are followings type.

- PCA
- LDA
- ICA

There are four key factors that can significantly affect system face recognition performances**:**

1. Illumination variations due to skin reflectance properties and due to the internal camera control. Several 2D methods do well in recognition tasks only under moderate illumination variation, while performances noticeably drop when both illumination and pose changes occur.
2. Pose changes affect the authentication process, because they introduce projective deformations and self-occlusion. Even if methods' dealing with up to 320 head rotation exists, they do not solve the problem considering that security cameras can create viewing angles that are outside of this range when positioned. On the contrary, with exception of extreme expressions such as scream, the algorithms are relatively robust to facial expression.
3. Another important factor is the time delay, because the face changes over time, in a nonlinear way over long periods. In general this problem is harder to solve with respect to the others and not much has been done especially for age variations. At last, occlusions can dramatically affect face recognition performances, in particular if they located on the upper-side of the face, as documented in literature. This problem is defined as, given a set of images of faces of different people we need to recognize a new face.

III. Principal Componentan Alysis (Pca)

Principal component analysis (PCA) was invented in 1901 by Karl Pearson .The Principal Component Analysis (PCA) is one of the most successful techniques that have been used in image recognition and compression. PCA is a statistical method under the broad title of factor analysis. 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.PCA techniques, also known as

Karhunen- Loeve methods, choose a linear projection that reduces the dimensionality while maximizing the scatter of all projected samples. It not only reduces the dimensionality of the image, but also retains some of the variations in the image data. The system functions by projecting face image onto a feature space that spans the significant variations among known face images. The significant features are known as "Eigen faces", because they are the Eigen vectors (Principal Component) of the set of faces they do not necessarily correspond to the features such as eyes, ears, and noses. The Eigen face approach uses the PCA for recognition of the images. The system performs by projecting pre extracted face image onto a set of face space that represents significant variations among known face images. Face will be categorized as known or unknown face after matching with the present database. If the user is new to the face recognition system then his/her template will be stored in the database else matched against the templates stored in the database. The variable reducing theory of PCA accounts for the smaller face space than the training set of face.The first principal component is the linear combination of the original dimensions that has the highest variability. The n-th principal component is the linear combination with the maximum variability being orthogonal to the n-1 first principal components.The greatest variance of any projection of the data lies in the first coordinate. The n-st coordinate will be the direction of the n-th maximum variance - the n-th principal component.

IV. Eigen Faces For Recognition

In mathematical terms, we wish to find the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images. Each face image in the training set can be represented exactly in terms of a linear combination of the eigen faces. The number of possible eigen faces is equal to the number of face images in the training set. However the faces can also be approximated using only the "best" eigenfaces - those that have the largest eigen values, and which therefore account for the most variance within the set of face images. The primary reason for using fewer eigen faces is computational efficiency. The best M' eigen faces span an M'-dimensional subspace ~ "face space" ~ of all possible images. As sinusoids of varying frequency and phase are the basis functions of a fourier de= composition (and are in fact eigen functions of linear systems), the eigen faces are the basis vectors of the eigen face decomposition. The idea of using eigen faces was motivated by a technique developed by Sirovich and Kirby for efficiently representing pictures of faces using principal component analysis. They argued that a collection of face images can be approximately reconstructed by storing a small collection of weights for each face and a small set of standard pictures. It occurred to us that if a multitude of face images can be reconstructed by weighted sums of a small collection of characteristic images, then an efficient way to learn and recognize faces might be to build the characteristic features from known face images and to recognize particular faces by comparing the feature weights needed to (approximately) reconstruct them with the weights associated with the known individuals. The following steps summarize the recognition process:

1. Initialization: Acquire the training set of face images and calculate the eigen faces, which define the face space.
2. When a new face image is encountered, calculate a set of weights based on the input image and the *M* eigenfaces by projecting the input image onto each of the eigenfaces.
3. Determine if the image is a face at all (whether known or unknown) by checking to see if the image is sufficiently close to "face space."
4. If it is a face, classify the weight pattern aseither a known person or as unknown.
5. (Optional) If the same unknown face is seen several times, calculate its characteristic weight pattern and incorporate into the known faces(i.e., learn to recognize it).

2. Recognition using PCA analysis As seen above, the latter method is clearly not a correct way of pixel to pixel image recognition. Thus what we need is to allow for some disturbance in the test. This can be achieved by PCA as described mathematically above. Here we explain the concept step by step going through a set of images and processing them. The following is the set of images which were taken as training images. Note that the data set was not kept large as the larger the data set the concept understanding is not that good though the recognition rate may increase due to more training images.

There are 12 persons with each having 4 training images. First these images are cropped to the same size. Now to build the correct covariance matrix, an average vector is formed out these image vectors whose corresponding two dimensional image is shown below:

Fig.3 TRAINING FACES Application of PCA

Principal Component Analysis finds many applications in data analysis because of its ability to capture the variance in the data and represent it in the lower dimesions making the storage as well as processing an easier task.

V. Conclusion

In this paper we implemented the face recognition system using Principal Component Analysis and Eigen face approach. The system successfully recognized the human faces and worked better in divergent conditions of face orientation. The biometric techniques, face recognition possess one great advantage, which is its user-friendliness (or non-intrusiveness).The eigenface approach to face recognition was motivated by information theory, leading to the idea of basing face recognition on a small set of image features that best approximate the set of known face images, without requiring that they correspond to our intuitive notions of facial parts and features.

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