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Face Recognition Based on Principal Component Analysis and Linear Discriminant Analysis

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Abstract

Face and facial feature recognition plays a significant role in different applications such as human computer communication, video surveillance, face tracking, and face recognition. Efficient face and facial feature detection algorithms are essential for applying to those tasks. Face recognition is attract much interest in the humanity of network multimedia data access. Face recognition not only makes hackers almost impossible to fetch one's "password", but also increases the customer sociability in human-computer communication. Face identification systems are now replace the need for security to survive with the present day offence .It is really realistic with the market statement which visibly depicts the rising popularity of the face recognition system. The face recognition system is prove to be very efficient in the current day market. In present networked world, the need to conserve the security of information is becoming both increasingly significant and increasingly hard. From time to time it has been notice about the crimes of credit card , computer hackings in a company or government building. Government agencies are investing a significant amount of capital into improving security systems as result of current terrorist actions that hazardously exposed and weaknesses in today's safety mechanisms.

Keywords

Face detection, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Singular Value Decomposition (SVD), Eigen-value decomposition (EVD).

Introduction

The face is our main center of attention in social interaction, playing a main role in expressing identity and feeling. Although the ability to conclude intelligence or personality from facial appearance is expect, the human talent to recognize faces is remarkable. We can recognize numbers of faces learned throughout our duration and recognize familiar faces at a glance still after years of separation. This ability is quite robust, even with large changes in the visual stimulus due to identify conditions, expression, aging, and interruptions such as glasses, beards or different hair style. Face recognition from given images is a subarea of the general entity recognition problem. Face recognition has become a significant issue in many purposes such as security systems, credit card verification and criminal reorganization. Over last few decades face recognition has been an active research area. The face is our key focus of attention in social intercourse, have a major role in expressing identity and emotion. Although the skill to infer intelligence from facial look is suspect, the human ability to identify faces is remarkable. *Face Recognition* is an main research trouble spanning many fields and disciplines. Since face recognition, having many practical functions such as bankcard recognition, access control, Mug shots searching, security observing, and inspection system, is a primary human behavior that is necessary for effective exchanges and interactions among people. Face recognition technique can be classified as characteristic based process and subspace process. Feature-based approaches remove the local features such as the location of the eyes, nose, mouth etc. Subspace process reduces the dimension of the received information, while remain the maximum separation between different classes. We produce a set of features from a set of dimensions or from a set of initially generated features. The aim is to attain new features that program the classification data in a more dense way compared with the unique features. This implies a decrease in the number of features required for a given classification job, which is also called as dimensionality reduction since the dimension of the new feature space is now compact. The aim, of course, is to attain this dimensionality decrease in some finest sense so that the overcome of information, which in common is apparent after decrease the unique number of features, it is as small as possible. "Eigen face" and "Fisher face" are the two broadly used subspace process for face identification. The "Eigen face" process uses the linear unsupervised dimensionality reduction technique Principal Component Analysis (PCA) for subspace production, whereas the "Fisher face" technique uses linear supervised dimensionality reduction technique Linear Discriminant Analysis (LDA). PCA discovers a projection on a lower dimensional representation, where along the principal component analysis most of the data variation develops in an unsupervised way. PCA suggests the perfect representation of the data with least reconstruction mistake and also discovers the best axis for projection. The chief goal of LDA is to maximize the discrimination among different classes, while minimizing the inside class distance. In classification systems, LDA is better to PCA because, it offers higher class discrimination by using the class data and so, LDA is extensively used in face recognition systems. But, when the figure of samples per class is small, PCA might outer execute LDA.

Problem Associated with Face Recognition

The problem of face recognition can be classified as follows:

1) Facial expression transform: A smiling face, a crying face, a face with closed eyes, even a small shade in the expression of face can affect facial identification system significantly.
2) Illumination transform: The way where the individual in the image has been illuminated widely effects face recognition success.
3) Aging: Images taken after time latter varying from 5 minutes to 5 years transform the system accuracy badly.
4) Rotation: Rotation of the individual image head clockwise or counter clockwise changes the performance of the system.
5) Image size: A test image of size 20x20 may be hard to organize if original class of the image was 100x100.

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Pattern Recognition

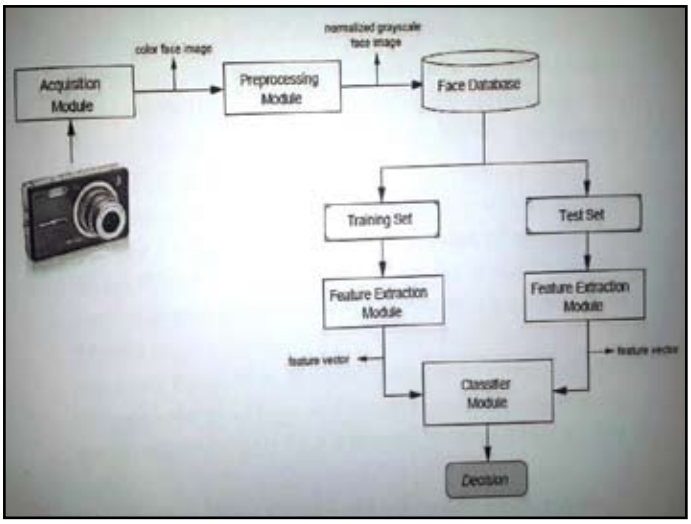
Pattern recognition is a scientifically precise field with the function of classifying objects into one of a various classes. The pattern recognition method is generally applied in a way that allows automatic identification without human intervention. Pattern identification is the science of production inferences from perceptual information, applying tools from statistics, probability, calculation geometry, machine knowledge, signal processing, and algorithm design. Thus, it is of essential importance to artificial cleverness and computer visualization, and has far-reaching functions in engineering, science, medicine, and business.

Predominant Approaches

Face Recognition have different approaches to solve pattern recognition problems:
GEOMETRIC (it is based on face feature) and PHOTOMETRIC (it is based on view) . In Face recognition different types of algorithms were developed : PCA (principal component analysis) and LDA (linear discriminant analysis) .

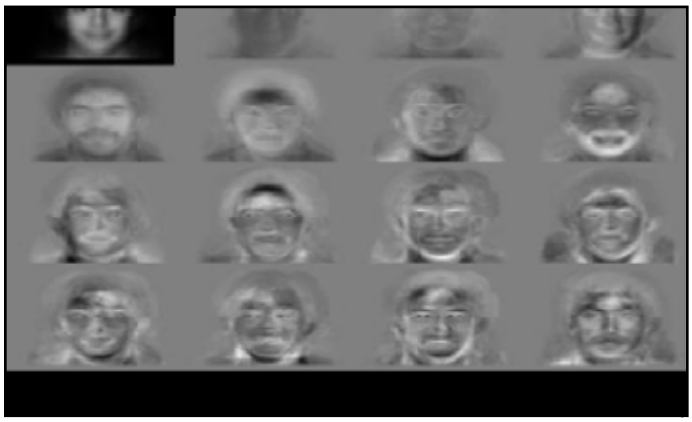
Face Recognition System steps

The recognition system initial start with the Acquisition Module where the images are captured with a digital camera or any image capturing device. Second phase, captured images are sent through the Preprocessing Module to meet the principles necessary by a given recognition system. The Preprocessing Module executes tasks such as color-to-grayscale conversion, resizing of image, and illumination and background removal of image in order to normalize the input image. Then the normalized images are inserted to the Face Database. Some of the images in the face database are utilized as the Training Set of the system and the remained will be the Test Set. The Feature Extraction Module gets as input a normalized image and outputs an arithmetical model of that input image that convey the most important characteristics in that image, there by reducing its dimensionality. For example, method such as Principal Components Analysis (PCA) and the Linear Discriminant Analysis (LDA) can be utilized as feature extractors. Finally, the Classifier Module evaluates the feature vectors among a test image and all the training images and decides which training image is nearest to that test image. A face recognition system consist the following modules:



Principal Component Analysis

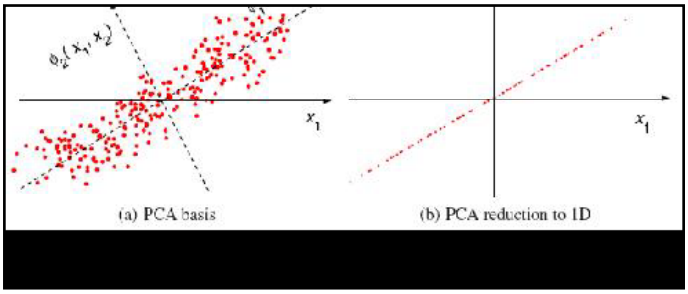
Principal component analysis (PCA) is a dimensionality reduction method, which generate the optimal linear least-square decomposition of a training set. PCA is a helpful for statistical method that has generate application in area like recognition of face and compression of image, and is a popular method for finding patterns in figures of high dimension. PCA usually make use of Eigen faces. With PCA, the test image and gallery images must be the equal size and it first to normalized line up the eyes and mouth of the face within the images. The PCA approach is applied for reduction in dimension of image by use of data compression, and reveals the most efficient low dimensional configuration of facial patterns. This decrease in dimensions removes information that is not helpful and specifically decomposes the face structure into orthogonal components known as Eigen faces. Every face image may be shows as a weighted sum (feature vector) of the Eigen faces, which are save in a 1D array. A test image is compared against a gallery image by calculating the distance between their individual feature vectors. The PCA approach usually needs the full frontal face to be offered every time; if not the image results in poor presentation .The main advantage of this method is that it can minimize the data required to identify the entity to1/1000th of the data presented



This figure shows standard eigen faces

PCA technique uses Eigenvectors and Eigen values to represent face images. Eigenvectors can be use as a set of features which jointly characterize the dissimilarity between face images. Each image location donates more or less to each Eigenvector, so that we can exhibit the Eigenvector as a kind of ghostly face which is known as an Eigen face.

Graphical Example of PCA



Linear Discriminant Analysis

LDA is a information separation method. The aim of LDA is to get the directions that can divide the unlike classes of the information once estimated .Let the data matrix X which represent the various set of human faces , where each row represents a different human face. In data matrix each image X, characterize by a (n, m) matrix of pixels, is symbolize by a high dimensional vector of (n*m) pixels. The first who used this representation for face recognition were Turk and Pentland. In 2-dimensional Principal Component Analysis (2dPCA) which directly calculate the Eigenvectors of the covariance matrix from data matrix instead of matrix to vector conversion. In 2-dimensional Linear Discriminant Analysis, it directly evaluate the directions which will divide the classes without matrix to vector conversion. Both technique reported the higher recognition rate. PCA and LDA algorithms process in batch mode. The technique PCA/LDA for face recognition systems bear from the scalability difficulty. To avoid this drawback, an incremental approach is used which is a natural solution for this problem. The major complexity in developing the incremental approach PCA/LDA is to evaluate covariance matrix and to handle the inverse of the within class scatter matrix. When the measurement of the image is high, both the calculation and storage difficulty increases radically. Thus, the technique of implementing a real time process becomes very resourceful in order to calculate the principal components for explanation (faces) arriving in order.

Conclusions

Face recognition process has arrived a extended way in the last twenty years. Today, machines are capable to automatically confirm identity information for safe transactions, for surveillance and secure tasks, and for access control to buildings, houses etc. These functions usually process in a controlled surroundings and recognition algorithms can take benefit of the environmental constraints to acquire high recognition accurateness. However, coming generation of face recognition systems are going to have extensive purpose in smart environments, where computers and machines are more like a facilitate assistant. To attain these goals computers must be capable to constantly recognize nearby people in a way that fits as expected within the pattern of normal human interactions. They should not need any special relations and should identify to human intuitions about when recognition is require to formed. This implies that next smart generation should use the similar modalities as humans, and have approximately the same boundaries. These objectives are now seems to be accomplish, however some important research stay to be done to make person recognition technique and that should process reliably in extensively varying conditions using data from single or multiple modalities.

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