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Face Recognition Techniques-A Review

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ABSTRACT

Face recognition has been a fast growing, challenging and interesting area in real timeapplications. A large number of face recognitionalgorithms have been developed in last decades. In thispaper an attempt is made to review a wide range ofmethods used for face recognition comprehensively.This includes PCA,ICA,LDA, ANN.In the age of rising crime face recognition is enormously important in the contexts of computer vision,psychology, surveillance, fraud detection, pattern recognition, neural network, content based videoprocessing, etc. Face is a non intrusive strong biometrics for identification and hence criminals always tryto hide their facial organs by different artificial means such as plastic surgery, disguise and dummy. Theavailability of a comprehensive face database is crucial to test the performance of these face recognition algorithms.

1. INTRODUCTION

Over a last decade face recognition has become increasingly important in the direction ofcomputer vision, pattern recognition, surveillance, fraud detection, psychology, neural network,content based video processing, etc. Rapid development of face recognition is due to combinationof the factors such as active development of algorithms, availability of large facial database andmethod of evaluating the performance of recognition algorithms [2][3]. Hence Facial RecognitionTechnology (FRT) has emerged as an attractive solution to address many contemporaryrequirements for identification and verification of identity claims. For thedevelopment of FRT face image database is needed. Several researchers have developed so manyreal face databases with a lot of covariates. New databases have been created and evaluations of recognitiontechniques using these databases have been carried out. Now, the face recognition has become one ofthe most active applications of pattern recognition, image analysis and understanding[4].

2. FACE RECOGNITION TECHNIQUES

A. Principal Component Analysis

PCA also known as Karhunen-Loeve method is one of the popular methods for feature selection anddimension reduction. The recognition method, known as eigenface method defines a feature spacewhich reduces the dimensionality of the original data space. This reduced data space is used forrecognition. PCA can outperform over many other techniques when the size of database is small. In proposed algorithm the database was subgrouped using some features of interest in faces. Only one of theobtained subgroups was provided by PCA for recognition[8]. It is a holistic approach where the input image is directly used for the process. PCA algorithm can be used to find a subspace whose basis vectors correspond to the maximum variance direction in the original n dimensional space. PCA subspace can be used for presentation of data with minimum error in reconstruction of original data [10].

B. Kernel Principal Component Analysis (KPCA)

KPCA(kernel PCA) is the reformulation of traditional linear PCA in a high dimensional space that is constructed using a kernel function. Kernel PCA computes the principal eigenvectors of the kernel matrix, rather than those of the covariance matrix [1].

A kernel principal component analysis (PCA) was previously proposed as a nonlinear extension of a PCA. The basic idea is [11] to first map the input space into a feature space via nonlinear mapping and then compute the principal components in that feature space. This article adopts the kernel PCA as a mechanism for extracting facial features. Through adopting a polynomial kernel, the principal Components can be computed within the space spanned by high-order correlations of input pixels making up a facial image, thereby producing a good performance. KPCA is a development of the PCA method [10].

C. Linear Discriminant Analysis (LDA)

The linear discriminant analysis (LDA) is a powerful method for face recognition. It yields an effective representation that linearly transforms theoriginal data space into a low-dimensional feature space where the data is well separated [8]. The main goal of LDA consist in finding a base of vectors providing the best discrimination among the classes, trying to maximize the between class differences, minimizing the within- class ones by using scatter matrices. It suffers from small sample size problem which exist in high dimensional pattern recognition task where number of available sample is smaller than dimensionality of the sample. Some of the variations of LDA are R-LDA, F-LDA and L-LDA.

a. *Regularized-LDA (R-LDA)*

R-LDA is used for extracting low-dimensional discriminant features from high dimensional training images and then these features are used by Probabilistic Reasoning Model (PRM) for classification[6].

b. *Layered Linear Discriminant Analysis (L-LDA)*

Decrease False Acceptance Rate (FAR) by reducingthe face dataset to very small size through L-LDA .It isintensive to both small subspace (SSS) and large facevariations due to light or facial

expressions by optimizingthe separability criteria. Hence it provides significantperformance gain, especially on similar face database and Small Subspace (SSS) problems[6].

c. ***Fuzzy Fisherface (FLDA) through Genetic Algorithm***
Searches for optimal parameters of membership function. The optimal number of nearest neighbors to beconsidered during the training is also found through the use of genetic algorithms[6].

D. Independent Component Analysis (ICA)
Independent component analysis (ICA) is a method for finding underlying factors or components from multivariate (multidimensional) statistical data. There is need to implement face recognition system using ICA for facial images having face orientations and different illumination conditions, for face recognition[8].

The most common method for generating spatially localized features is to apply independent component analysis (ICA) to produce basis vectors that are statistically independent (not just linearly decorrelated, as with PCA).It is a statistical and computational for enlightening the hidden factors that underlie sets or random variables, measurement or signals. ICA is superficially related to principal component analysis (PCA) and factor analysis. The ICA algorithm aims at finding S component as independent as possible so that set of observed signals can be expressed as a linear combination of spastically independent components[10].

ICA can also be used to create feature vectors that uniformly distribute data samples in subspace. This conceptually very different use of ICA produces feature vectors that are not spatially localized. Instead, it produces feature vectors that draw fine distinctions between similar images in order to spread the samples in subspace.

E. ANN(Artificial Neural Network)
An artificial neural network (ANN), also called as simulated neural network (SNN) or commonly just neural network (NN) is an interconnected group of artificial neurons that uses a mathematical or computational model forinformation processing based on connectionist approach to computation. In most cases an ANN is an adaptive system thatchanges its structure based on external or internal information that flows through the network. In more practical termsneural networks are non-linear statistical data modeling tools. They can be used to model complex relationships betweeninputs and outputs or to find patterns in data. The original inspiration of the technique was from the examination of thecentral nervous system and the neurons. In a neural network model, simple nodes (called variously "neurons", "neuroses",processing elements", or units) are connected together to form a network of nodes- hence the term neural network. Whilea neural network does not have to be adaptive, its practical use comes with algorithms designed to alter the strengths(weights) of the connections in the network to produce a desired signal flow. These networks are also similar to thebiological neural networks in the sense that the functions are performed collectively and in parallel by the units, rather thanthere being a clear delineation of sub-tasks to which various units are assigned.

Table 1. Linear Methods of feature extraction

Methods	Advantages	Limitations	Recognition rate
PCA	• It reduces the dimensionality of the original data space. • The best algorithm to recognize image without disturbance is PCA • It is used to find the patterns in the data and reducing the number of dimensions without loss of information • Recognition is simple and efficient compared to other matching approaches. • No knowledge of geometry and reflectance of faces is required • Data compression is achieved by the low dimensional subspace representation. • PCA is completely nonparametric: any data set can be plugged in and an answer comes out,requiring no parameters to tweak and no regard for how the data was recorded	• Identifies the linear combinations of variables and ignore the high order correlation value • The method is very sensitive to scale, therefore, a low-level preprocessing is still necessary for scale normalization. • Due to its "appearance-based" nature. First, learning is very time-consuming, which makes it difficult to update the face database.	• PCA and minimum distance classifier gives a recognition rate of 96.7% on ORL database
KPCA	• It allows us to generalize traditional PCA to nonlinear dimensionality reduction. • KPCA gets an eigen vectors with higher variance.	• It is computational intensive and takes a lot more time compare to PCA	• The highest recognition rate is 90%
LDA	• Linear mapping dimensionality of the subspace is limited by the number of classes of the data •	• Cannot handle data in which individual classes are far from Gaussian, suffer from small sample size problems • LDA implicitly assumes that the mean is the discriminating factor, not variance • An intrinsic limitation of classical LDA is the so called singularity problem, that is, it fails when all scatter matrices are singular.	• The accuracy for LDA is 74.25%
ICA	• It captures the high order statistics of the data • ICA provides a more powerful data representation than PCA as its goal was that of providing an independent rather than uncorrelated image decomposition and representation.	• If the data sources are independent then it works well	• The recognition rate of ICA is 92.3%
ANN	• It has high learning abilities	• Complex and difficult to train • Difficult to implement • Sensitive to lighting variation	• The accuracy of ANN is 96.2%

4. CONCLUSION

PCA isbetter than LDA and ICA under differentillumination variations but LDA is better than ICA.LDA is more sensitive than PCA and ICA onpartial occlusions, but PCA is less sensitive topartial occlusions compared to LDA and ICA. PCAis used as a dimension reduction technique in and for modeling expression deformations.Comparisons between PCA and ICA are complex, because differences in tasks, architectures, ICA algorithms, and distance metrics must be taken into account.For the face recognition test we see the best results being generated by PCA, followed by ICA and then by KPCA. But these outperforms the learner without any preprocessing by a huge margin. The main reason being that the original learner had 1850 attributes with most of the data as useless noise due to image being clicked outside and from various angles. So the learning is not exactly out of images. PCA filters out important characteristics of the face that can be best used in the classification of the images and the learner performance is improved dramatically due to that reason.

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