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Investigating Face Recognition Techniques for PCA and BPNN

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Abstract: Image processing plays an important role in analyzing the images. Face recognition is one of the interesting research areas in past many years. The reason behind this is its numerous ranges of applications like information security, law enforcement, access control, and smart cards etc. It is gaining so much attention in public due to network access via multimedia. The study shows that recognition system using PCA and BPNN provides high recognition rate and fast execution time. PCA is used for feature extraction and space dimension reduction. BPNN is used for image classifications. Recognition rate and execution time are two main parameters, which are measured during implementation of PCA and (PCA+BPNN).This paper focuses on highlighting the strengths and limitations of the earlier proposed classification techniques. The paper provides an insight into the reviewed literature to reveal new aspects of research in the field of image processing.

Keywords: PCA, Image Processing, BPNN, ICA, ANN

1. INTRODUCTION

Human-being can recognize and communicate with individuals faces. But advancement and improvement in computing technologies enable identical recognition and verification automatically. In the real world, face recognition has wide ranges of applications like authentication, information security, access control, and law enforcement etc. Most recognition techniques work best with well aligned, illuminated images. Small changes in size and alignment can effects the recognition rate. The motivation of face recognition is as follows:

1) Build an automatic system which can identify and recognize the face as human-being do.
2) To increase the recognition rate.
3) Rising demand for fast and highly accurate system for identification and authentication.
4) To develop methods of face recognition for machines as eyes do.
5) To provides quantities knowledge and information of human faces.

2. FACE RECOGNITION ALGORITHMS

In research of face recognition, the main aim is to acquire the high recognition rate according to recognition methods used. Extraction of face features is one of the major issues related to face recognition & verification. It affects the recognition rate. As an important issue of face recognition, extraction of face features has been paid more attention by many researchers. It has become hot topic of research in the field of face recognition. There are lots of face algorithms which can analyze the data effectively such as PCA, LDA & so on [1].

2.1 Principle Component Analysis

The core of face feature extraction is Eigen face also known as Principal Component Analysis (PCA). PCA represents face data in terms of mean square error (MSE). The samples of face data are easily handled with the help of orthogonal component analysis. PCA is a type of feature reduction method that reduce large face feature into small face feature indicators that represents the face feature effectively [2].

Let us assume there is N number of face samples. By measuring each face sample, we get K number of indicators, means total no of data is NK. It is process to find small number of face indicators called principal components from large data set. The two main property offer by principal components is that they must be independent of each other, they represents the original face information data as much as possible. There is projection of higher dimensional subspace into lower dimensional subspace with the criteria of minimum reconstruction error. The subspace created by these face feature indicators must be relevant to the largest Eigenvectors obtained by covariance matrix. For classical face feature extraction & facial data representation, PCA is widely used. It is also called dimensionality reduction technique. Starting with L number of face features, to obtain a new sample set Z, we use linear transformation procedure. In this, components of Z are uncorrelated. In next stage, we select the significant components.

Existing PCA dependent facial recognition systems have high computational cost & memory too. Because of this, it is difficult to scale up. In training stage, all the training data are prepared for calculation of projection matrix, this type of operational mode is called batch mode [3]. It stops when all the training data have been operated. There is a case, if we want to add some training data in

existing data; we have to retrain all the collected data. This means that it is difficult to scale up the recognition systems.

2.2 Linear Discriminant Analysis

Another technique for face feature extraction is Linear Discriminant Analysis (LDA). By finding suitable projection vectors, there is projection of higher dimensional subspace into lower dimensional subspace [4]. The major problem faced by LDA is small sample size. This arises when the number of face samples is smaller than dimension of the face samples which results in computational difficulty. LDA is affected by small sample size problem which is major problem in face recognition which results in low recognition rate of test data.

In face recognition, 2D face image is converted into 1D long face vector which is then transformed into high-dimensional face vector space. This face vector space results in many advantages. It also results in problems like dimensionality dilemma & sample size issue. This further result in series of problems like how to increase the accuracy, how to handle numerical instability in face recognition, how to reduce down the computational complexity, how to reduce storage requirement, how to improve image quality, how to lower down the transmission time in face image transmission and so on [5].

For moving Eigen face criteria to Fisher face criteria; two main stages are used: kernel PCA and LDA. PCA is followed by LDA. It can also be projected as input non-linearly to high dimensional space with the help of kernel function called kernel PCA and LDA [6]. The two above said methods extract face features from the image's intensity. More efficient face features can be calculated from Gabor coefficients of images. A more robust method is representation of face image using responses of Gabor filter with respect to face landmarks & then calculating a graph which describes the spatial relationship between these landmarks known as Elastic bunch graph matching. Replacing extraction of Gabor face features from the face landmarks, we can compute & extract Gabor face features from each pixel. The dimension of Gabor feature space is high. Gabor PCA & Gabor LDA is used to reduce the feature dimensions.

2.3 Independent Component Analysis

Independent component analysis (ICA) is a generalization of PCA. It minimizes the second order and higher order dependencies in the input and produces a set of statistically basis vectors. It is a method to observe high-order relationships among pixels data with linear decomposition, in such a way that it can be decomposed into independent components statistically. PCA depend only on pair wise relationships between pixels in the image database [7]. The components in ICA must not posses Gauss distribution. There are uncertainties of ICA: (a) cannot ensure of variance of components; (b) not sure about order of components. The principle of ICA algorithms are: to extract face feature vectors, to do face recognition, for face feature compression.

2.4 Fourier Transform and DCT

Fourier transform and Discrete Cosine Transform both are useful spatial-frequency techniques for extracting the face feature indicators at some suitable frequency. In this process, face images are firstly converted into frequency domain and then coefficient at different frequency is calculated [8]. The coefficient at low frequency is assumed as invariant face image indicators. Invariant face image indicators are most useful indicators in many applications like palm print verification, character recognition etc. Unlike Fourier transform of entire time domain contain time-domain information about the spectral components, it cannot distinguish between different frequency distributions. So for many practical applications, FT is not suitable.

2.5 Neural Network Based Methods

ANN are used in variety of areas including optimization, adaptive control, medical diagnosis, information and signal processing, decision making, and speech processing. ANN is very useful in sensor data processing, extraction of features, automated signal recognition. Face recognition has emerged as a new area in ANN because network structure is suitable for task as same as biological systems. There are two types of ANN structure: supervised structure and unsupervised structure. Supervised learning incorporates an external teacher so that each output unit is told what it is desired response to input signals ought to be. During learning process, global information may be required. Examples are error-correction learning, reinforcement learning. The aim is designing of the weights with minimum error by using least square method. Un-supervised learning has no external teachers and based upon local information.

Back propagation neural network is the best example of supervised network. It is invented by David Parker & David Rumelhart. It is best technique for calculating the output for nonlinear type of transfer function which are made up of several continuous inputs and outputs. This network gets its name by how it operates on errors during data training. Advancement in neural networks is simultaneous optimization of network architecture & synaptic weights to obtain desirable performance. Neural network have two types of layers: (a) Single weight layer where input units are directly connected to output units; (b) Multiple layers where hidden units are used to connect input units to output units. Hidden units are used to represent the internal architecture of input units. Note that after using enough hidden units in simple network, we can implement any transfer function.

3. SUBJECTS AND METHODS

Different face recognition techniques and their advantages paired with weakness are given below in tabular form.

TABLE 1: Comparison of Different Methods

No.	Author	Year	Methods Used	Advantages	Limitations
1	A.Kharrat et al. [9]	2016	DWT-SGLDM for feature extraction. Simulated Annealing (SA) to reduce features size. Stratified K-fold Cross Validation to avoid over fitting.GA-SVM to optimize SVM parameters. SVM to construct the classifier.	Minimum number of features to classify the normal brain and Pathological brain reduces the cost of classifier.	SA and GA need more computing time which increases as the number of generation increases.
2	Ramya and Sasirekha [10]	2015	Image denoising: - fourth order Partial Differential Equation (PDE). Skull Removal: - Morphological Operators (erosion and dilation). Segmentation: - Seed point selection based region growing segmentation.	Fourth order PDE removes noise effectively and favors better edge preservation. The accuracy of detection is high in comparison to watershed segmentation.	Initial seed point selection depends on user ability.
3	S. Khare et al. [11]	2014	GA to create image segments. Curve fitting to properly segment the image without loss of information. SVM to classify extracted features.	More accurate and precise results than the method using Mahalanobis distance	Requires new training set whenever there is change in image database.
4	A. Lakshmi et al. [12]	2014	Noise removal: curvelet transform Skull removal: mathematical morphology Segmentation: spatial FCM	Curvelet transform is an efficient noise removal method that considers both faint linear and curvy linear features.	Results presented are preliminary and requires clinical evaluation.
5	Selkar and Thakare [13]	2014	Image enhancement: Noise removal Segmentation: Thresholding and watershed method Edge detection: Prewitt, Sobel, Canny edge detection operator	Thresholding algorithm detects tumor more efficiently than watershed algorithm and canny edge operator gives efficient boundary extraction results rather than and Robert operator.	Threshold selection using histogram will be inefficient if the histogram peaks are not tall, narrow, and symmetric and separated by deep valley.
6	A.Kharrat et al. [14]	2014	Image pre-processing, feature extraction via the wavelet transform-spatial gray level dependence matrix (WT-SGLDM), dimensionality reduction using GA and classification of reduced features using SVM.	Using the optimal features, the method segments benign and malignant tumors with best classification accuracy.	Applicative where the parameters must be updated.
7	Beham and Gurulakshmi [15]	2012	Image enhancement to remove outer elliptical shaped object. Morphological processing to extract the required region and K-means clustering segmentation method	Less error sensitive and can be applied to minimal amount of data with reliable results compared to supervised segmentation methods.	K-means clustering does not work well with non-globular cluster.

8	Gopal and Karnan [16]	2010	Pre-processing and enhancement using the tracking algorithm and median filter. Segmentation and classification using with FCM.	PSO with FCM has lower classification error rate and execution time and better accuracy than GA with FCM.	Median filter removes noise to a great extent but at the cost of blurring the Images which in turn makes the edges invisible

4. CONCLUSION

In this paper a number of face recognition techniques has been reviewed. After examining the above mentioned face recognition methods it has been observed that PCA with BPNN works better than the individual PCA. It provides a high accuracy rate. This method has an acceptance ratio of more than 90%.There are many other ways where the research work can be expanded. The performance of face recognition can be enhancing by using Soft computing techniques. Soft computing can be combined with artificial neural network to achieve high accurate results.

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