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A Review on Comparison of Face Recognition Algorithm Based on Their Accuracy Rate

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ABSTRACT- This paper tries to present an overview of different face recognition techniques and study the characteristics of various algorithms developed for "feature selection" and "feature extraction". Study and analysis of the face recognition rate of various face recognition algorithms, used currently, is imperative for designing and developing a new Algorithm. In his paper we report performance comparison analysis of Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), ICA, SVM & SVD for face recognition. Various PCA and LD, ICA; SVM & SVD based face recognition algorithms were studied and compared in this paper. Standard public database was utilized for this purpose.

Keywords- Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA), Support Vector Machine (SVM) & Support vector Discriminate (SVD)

I. INTRODUCTION

Image analysis has many important applications and Face recognition is the most important among them. Recognizing different faces is a unique ability of human mind however this ability is restricted by the number of faces it can recognize and becomes unreliable beyond a certain number. These limitations can be easily overcome by use of automated systems involving suitable computer programs and hardware capable of high level face detection and data storage capabilities. In present scenario where both, the development as well as the access, to very high resolution and customized cameras has increased , use of face recognition, as one of the primary biometric technologies, has become more and more important and reliable source of authentication of identity. The biggest advantage of Face recognition over other biometric technologies is that it is non intrusive. Thus it is very convenient for both the user as well as the person on whom it is used. The primary aim of any face recognition system is identification of a face from multiple choices available in the database. It can be used for both recognition as well as authentication.

This Paper gives the large number of feature extraction methods reported in the literature. A newcomer to the field is faced with some question like which feature extraction method is the best for a given application? This question led us to characterize the available feature extraction methods, so that the most promising methods could be sorted out. An experimental evaluation of these few promising methods most still be performed to select the best method for a specific application. In this process, one might find that a specific feature extraction method needs to be further developed. And we also describe the performance comparison analysis of Principal Component Analysis (PCA) and Linear Discriminante Analysis (LDA), ICA, SVM & SVD for face recognition.

II. FACE RECOGNITION PROCESSING

Recognition of human face which is a visual pattern recognition. Here a face which exists as a three dimensional object is to be identified from a set of two dimensional images. Face detection, alignment, feature extraction, and their matching are the main steps through which it is achieved. How to differentiate and segmentation of face f is achieved through the process *Face Detection.* Accuracy in localization and normalization of faces is done under the process of *Face alignment* When a face is normalized geometrically and photo metrically, farther then *feature extraction process* is performed to find effective information that is useful for distinguishing between faces of different persons and pertain the geometrical and photometrical variations. *Face matching*, the extracted feature vector of the input face is matched against those of enrolled faces in the database; it outputs the identity of the face when a match is found with sufficient confidence or indicates an unknown face otherwise.

Hence face recognition results depends on mightily essential features that are extracted to represent the face pattern and classification methods used to distinguish

between faces whereas face localization and normalization are the basis for extracting effective features. These following block diagram represents the various steps that are followed:

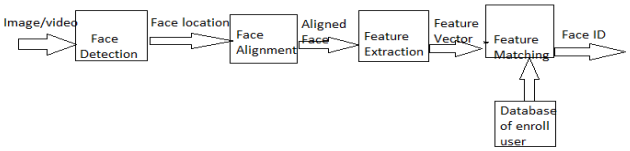

Fig 1: Face recognition Processing Flow

III. FACE DETECTION PROBLEM STRUCTURE

Face detection systems use different approaches and techniques suiting the conditions in which they are working. In Some systems detection and location of the image is carried out simultaneously whereas in others the image is first detected and location follows only if results are positive. Tracking Algorithms used for detection of faces in moving images are required at times. Certain Algorithms needs some amount of Pre Processing to make the image suitable as per Algorithm's requirement. Algorithms based on learning routine add new data to their models based on the information gathered by them during the recognition processes.

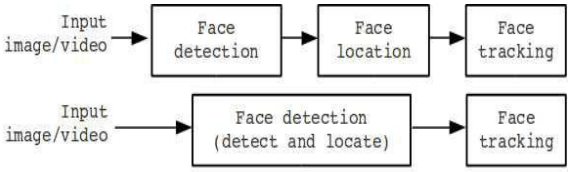

Fig 2: Face detection processes

Different scenarios in face detection

a. **Controlled environment.** It's the simplest case where Photographs are taken under controlled light, background, etc. Generally detection of face is achieved by using simple edge detection techniques. [7].

b. **Color images.** skin colors is used in finding faces however this technique has major challenge in the form of reduced ability with change in light intensity. Although establishing an efficient human skin color representation is not easy, attempts are being made in developing reliable and efficient face detection algorithms based on skin color [9].

c. **Images in motion**. Some of real time video use motion detection is used in real time videos to localize faces. Nowadays, ability of locating faces in videos is an essential requirement in all commercial systems.

Categorization of Detection Methods

Yan, Kriegman and Ahuja have presented a well accepted classification of Detection Method [17]. According to them Detection Methods can be divided into four categories. Often these categories overlap and hence an Algorithm may belong to multiple categories. This classification is as follows:

a. **Knowledge-based methods**. That type of methods encode our knowledge of human faces. which belongs to ruled-based method.

b. **Feature-invariant methods.** Algorithms that try to find invariant features of a face despite its angle or position.

c. **Template matching methods.** These algorithms compare input images with stored patterns of faces or features.

d. **Appearance-based methods.** A template matching method whose pattern database is learnt from a set of training images.

IV. FEATURE EXTRACTION

Ability to identify unique features of a face enables us to differentiate a face from others even in case of modification due to addition of physical objects like Hat, Normal Makeup etc. We can recognize faces even after age related changes in appearance occur. This unique ability is the primary requirement of any automated system if it is to be of any practical relevance. The process of identification and extraction of relevant unique features of a face is defined as Feature Extraction. The usefulness of information gathered in identification of face at later stages and efficiency of feature extraction process in terms of computing time and memory usage are the chief concern of design process. Dimensionality reduction, feature extraction and feature selection are the chief component of the process where dimensionality reduction could be seen as a consequence of the feature extraction and selection algorithms. The process of feature Extraction can be suitably described by the following diagram:

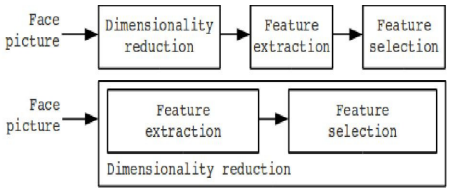

Fig 3: Feature extraction processes.

V. FEATURE EXTRACTION AND SELECTION METHODS

Number of feature extraction algorithms have been developed and are in use today. Many of these were developed for different purposes but found use in face recognition techniques after certain modifications. For example, Karl Pearson developed invented PCA 1901[8], but proposed it for pattern recognition after 64 years [13]. It found application in face representation and recognition only in the early 90's [10, 5, 11]. Table 1 presents a list of feature extraction algorithms usually used for face recognition:

Method	Notes
Principal Component Analysis. (PCA)	Eigenvector-based, linear map
Kernel PCA	Eigenvector-based , non-linear map, kernel methods used
Weighted PCA	PCA weighted coefficients used
Linear Discriminant Analysis (LDA)	Eigenvector-based, supervised linear map
Kernel LDA	LDA-based, uses kernel methods
Semi-supervised Discriminant Analysis (SDA)	An adaptation (Semi-supervised) of LDA
Independent Component Analysis (ICA)	Linear map, separation of non-Gaussian distributed features
Neural Network based methods	Diverse neural networks using PCA, etc.
Multidimensional Scaling (MDS)	Nonlinear map, sample size limited, noise Sensitive.
Self-organizing map (SOM)	Nonlinear, based on a grid of neurons in the feature space

Table 1: Algorithms for Feature extraction

B. Incremental Two-Dimensional Two-Directional Principal Component Analysis (I(2D)2PCA) Benefits of both Two-Directional Principal Component Analysis (2D) 2PCA and Incremental PCA (IPCA) are combined in this method. Computational load consumed by I (2D) 2PCA is lesser less than IPCA also the memory wastage is lesser than (2D) 2PCA [7].

C. Infrared Face Recognition based on the Compressive Sensing (CS) and PCA After Normalizing the Facial Image fast compressive sensing is performed. PCA is used for non-adaptive linear projections from CS which then classifies the image using 3-nearest neighbor method [8].

LDA algorithms analyzed

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 [15].

B. Multi-Feature Discriminant Analysis (MFDA) combines the advantages of both the Two-Directional Principal Component Analysis (2D) 2PCA and Incremental PCA (IPCA).

C. Layered Linear Discriminant Analysis (L-LDA) the face dataset is reduced to very small size through L-LDA which helps in decreasing False Acceptance Rate (FAR). It is exhaustive to both small subspace (SSS) and large face variations due to light or facial expressions by optimizing the reparability criteria. Hence it provides convincing performance, mostly on similar face database and Small Subspace (SSS) problems [23].

SVM algorithms analyzed

A. PCA based Eigen faces approach using SNM algorithm size of each feature vector is determined by the size of eigen face space. As the training set grows, this size reaches up to 240 (6 pose for each person). For a simpler and more feasible classification process we utilize only first 40 elements of each feature vector. Hence, we use these 40 features for SVM

B. SVM based on Boolean kernel function SVM is proposed. First the representation basis of an image set of face is achieved by Karhunen-Loève transform , After this the extracted characteristics are transformed to "0" and "1" format, Next, classification is achieved by using the Boolean kernel function based on SVM. The experiment conducted for face recognition with ORL face databases showed that the proposed method resulted in better accuracy, compared to PCA and linear SVM.

Independent component analysis (ICA) algorithms analyzed

Generalization View of the PCA is known as ICA. It minimizes the second order and higher order dependencies

in the input and determines a set of statistically independent variables or basis vectors. Here we are using architecture I which finds statistically independent basis images [2].

Basic steps for ICA [12]:

Collect X_i of n dimensional data set X, i = 1, 2, 3,…M.

Mean correct all the points: calculate mean M_x and substract it from each data point, $X_i - M_x$

Calculate the covariance matrix:

$C=(X_i - M_x)(X_i - M_x)^T$

The ICA of X factorizes the covariance matrix into the following form: $C = F\Delta F^t$ where Δ is a diagonal real positive matrix. F transforms the original data X into Z such that the components of the new data Z are independent: X = FZ.

VII. CONCLUSION

Developing a comprehensive Face Recognition Database faces many challenges and the ability to take high quality, consistent, repeatable images is the most difficult among them. In order to compare the performance of some face recognition algorithms on faces we have prepared as well as presented a database and tested the matching accuracy of PCA, LDA, etc face recognition algorithms. Selection of Feature Extraction methods is probably the most important factor in achieving highly reliable recognition performance. The last two decades have witnessed a large scale development in recognition methods. Still a lot of research is needed to tackle the challenges in face recognition so that commercially viable software solutions can be made readily available. It is hoped that this comprehensive discussion will provide insight into various concepts involved, and boost further advancement in this field.

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