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A Review on Face Recognition Algorithms

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***Abstrac*t –**
Face recognition has been challenging and interesting area in real time applications. Face recognition is a form of biometric identification that relies on data acquired from the face of an individual. A large number of face recognition along with their modifications, have been developed during the past decades.

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. In real world applications, it is desirable to have a stand-alone, embedded facerecognition system. The reason is that such systems provide a higher level of robustness,hardware optimization, and ease of integration.

In this paper an attempt is made to review a wide range of methods used for face recognition comprehensively. This include PCA, ICA, LDA, SVM, Gabor wavelet soft computing tool like ANN for recognition, LBP and various hybrid combination of this techniques. This review investigates all these methods with parameters that challenges face recognition like pose variation, facial expressions and illuminations.

***Keywords*:- Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Face Recognition, Independent Component Analysis (ICA), Artificial Neural Networks (ANN), Local Binary Pattern (LBP).**

I. INTRODUCTION

As we all know that almost the security system in the airports, huge hotel and especially in the police led depend on the use of advanced protection system that based on the computer programs. A facial recognition system is a computer application for automatically identifying a person digital image that its source is already sorted in the database.

Actually, it works by comparing the selected facial features from the image and a facial database.

The earliest work on face recognition can be traced back at least to the 1950s in psychology and to the 1960s in the engineering literature. Some of the earliest studies include work on facial expression emotions by Darwin [1]. But research on automatic machine recognition of faces started in the 1970s [2] and after the seminal work of Kanade [3]. In 1995, a review paper [4] gave a thorough survey of face recognition technology at that time [5]. At that time, video-based face recognition was still in a nascent stage. During the past decades, face recognition has received increased attention and has advanced technically. Recently, significant research efforts have been focused on video-based face modeling/tracking, recognition and system integration. New databases have been created and evaluations of recognition techniques using these databases have been carried out. Now, the face recognition has become one of the most active applications of pattern recognition, image analysis and understanding.

The system measures the overall face structure, including distances between eyes, nose, mouth and chicks. With the use of these unique features face recognition-system stores face templates into its database for further classification. There are several challenges associated with facial feature detection and can be attributed by the factors like intensity, illumination conditions, occlusion, unnatural intensities etc., The research on face recognition categorizes it into the following approaches:

1. Feature-based approach
2. Holistic or global approach

3. Hybrid approach

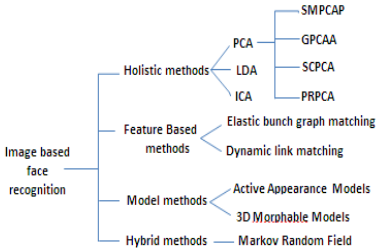

Figure 1. Approaches to face recognition

The system consists of two modules: pre-processing part and recognition part. Pre-processing part is used to remove various unwanted background information and make the picture ready for proceeding. Recognition part is carried out using various algorithms in various stages and classification of the face image is done.

The input of a face recognition system is always an image or video stream. The output is an identification or verification of the subject or subjects thatappear in the image or video. Some approaches define a face recognitionsystem as a three step process - see Figure 2.

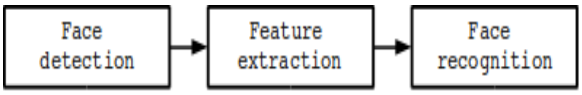

Figure 2. A generic face recognition system

II. BACKGROUND IDEA

There are numerous application areas in which face recognition can be exploited. Face recognition is also useful in human computer interaction, virtual reality, database recovery, multimedia, computer entertainment, information security e.g. operating system, medical records, online banking., Biometric e.g. Personal Identification - Passports, driver licenses , Automated identity verification - border controls , Law enforcement e.g. video surveillances , investigation , Personal Security - driver monitoring system, home video surveillance system.

Figure 3. Digital Photography

- Security system wherecomputer/ network security is done.
- Face Identification
- Surveillance (CCTVs to monitor criminals, drug offenders).
- Imageinvestigations such as searching images of missing children, police bookings and immigrants.
- In Criminal justice systems.
- General identification that includes, banking, passports,Electoral registration, national IDs, identifying newborns, employee IDs.
- Image database investigations (searching image databases of licensed drivers, benefit recipients, missing children, immigrants and police bookings).
- In Smart Cards
- All Multi-media environments that uses adaptive human computer interfaces.
- Video indexing.
- Face Access Control such as office access or computer logon, frontal faces and indoor illumination.

Figure 4. Application- Surveillance

Figure 5. Application- Access Control

III. FACE RECOGNITION ALGORITHMS

A. Principal Component Analysis (PCA)

*PCA is one*of the popular methods for feature selection and dimension reduction.Recognition of human faces using PCA was first done by Turk and Pentland [6] and reconstruction of human faces was done by Kirby and Sirovich [7]. The recognition method, known as eigenface method defines a feature space which reduces the dimensionality of the original data space. This reduced data space is used for recognition. But poor discriminating power within the class and large computation are the well known common problems in PCA method. This limitation is overcome by Linear Discriminant Analysis (LDA).

B. *Linear Discriminant Analysis (LDA)*

LDA is the most dominant algorithms for feature selection in appearance based methods [8]. But many LDA based face recognition system first used PCA to reduce dimensions and then LDA is used to maximize the discriminating power of feature selection. In the proposed method [9] Gabor filter is used to filter frontal face images and PCA is used to reduce the dimension of filtered feature vectors and then LDA is used for feature extraction. A recursive algorithm for calculating the discriminant features of PCA-LDA procedure is introduced in [10]. This method concentrates on challenging issue of computing discriminating vectors from an incrementally arriving high dimensional data stream without computing the corresponding covariance matrix and without knowing the data in advance. The proposed incremental PCA-LDA algorithm is very efficient in memory usage and it is very efficient in the calculation of first basis vectors. This algorithm gives an acceptable face recognition success rate in comparison with very famous face recognition algorithms such as PCA and LDA. A new face recognition method based on PCA, LDA and neural network were proposed. This method consists of four steps: i) Preprocessing ii) Dimension reduction using PCA iii) feature extraction using LDA and iv) classification using neural network.

C. Support Vector Machine (SVM)

Support Vector Machines (SVM) is one of the most useful techniques in face recognition. However, SVM cannot be applied when the feature vectors defining samples have missing entries. A classification algorithm that has successfully been used in this framework is the all-known Support Vector Machines (SVM), which can be applied to the original appearance space or a subspace of it obtained after applying a feature extraction method. The advantage of SVM classifier over traditional neural network is that SVMs can achieve better generalization performance.

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, which will give better results as compared with existing systems [11] [12]. What distinguishes ICA from other methods is that, it looks for component that is both statistically independent and non Gaussian. The ICA is similar to blind source separation problem that boils down to finding a linear representation in which the components are statistically independent. The comparison of face recognition using PCA and ICA on FERET database with different classifiers were discussed and found that the ICA had better recognition rate as compared with PCA with statistically independent basis images and also with statistically independent coefficients.

E. Gabor wavelet

Gabor features have been recognized as one of the best representations for face recognition. In recent years, Gabor wavelets have been widely used for face representation, because the kernels of the Gabor wavelets are similar to the 2D receptive field profiles of the mammal cortical simple cells, which exhibits desirable characteristics of spatial locality and orientation selectivity. Previous works on Gabor features have also demonstrated impressive results for face recognition. In this paper, [13] it was observed that though Gabor phases are sensitive to local variations, they can discriminate between patterns with similar magnitudes, i.e. they provide more detailed information about the local image features. Therefore, the Gabor phases can work comparably well with the magnitudes, as long as its sensitivity to misalignment and local variations can be compensated carefully.

F. Artificial Neural Network (ANN)

Multi-Layer Perceptron (MLP) with a feed forward learning algorithms was chosen for the proposed system because of its simplicity and its capability in supervised pattern matching. It has been successfully applied to many pattern classification problems. A new approach to face detection with Gabor wavelets & feed forward neural network was presented in [14]. The method used Gabor wavelet transform and feed forward neural network for both finding feature points and extracting feature vectors. The experimental results have shown that proposed method achieves better results compared to the graph matching and eigenfaces methods, which are known to be the most successful algorithms. A new class of convolutional neural network was proposed in [15] where

the processing cells are shunting inhibitory neurons. Previously shunting inhibitory neurons have been used in conventional feedforward architecture for classification and non-linear regression and were shown to be more powerful than MLPs i.e. they can approximate complex decision surfaces much more readily than MLPs. A hybrid neural network solution was presented further which combine local image sampling, a self-organizing map neural network, and a convolutional neural network.

G .Local Binary Pattern (LBP)

The LBP operator is a powerful texture descriptor. The square matrix of pixels is considered to generate the labels. The binary number sequence after thresholding is considered as resultant labels. The histogram of labels is used as texture descriptor. Figure 6. Illustrate the preparation of LBP operator.

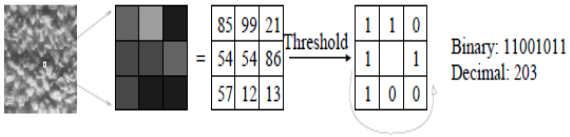

Figure 6. Preparation of LBP operator

After LBP operation, the face is automatically located and recognized from a general view point under different illumination conditions, facial expressions, and aging effects. Figure 7 shows authenticated face identification and recognition, where matching of original image is done with various images stored in database.

(a) 1:1 Matching

(b) 1:N Matching

IV. CONCLUSION

This paper has attempted to review a significant number of papers to cover the recent development in the field of face recognition. Present study reveals that for enhanced face recognition new algorithm has to evolve using hybrid methods of soft computing tools such as ANN, SVM and SOM may yields better performance. The list of references to provide more detailed understanding of the approaches described is enlisted. We apologize to researchers whose important contributions may have been overlooked.

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