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Face Recognition and Verification: A Literature Review

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***Abstract*— Face recognition and verification has been actively researched in recent years as information and data accumulating in abundance, and there is a crucial need for high security has received more attention. As face recognition, useful for a person's authentication is quite simple and non-intrusive method that recognizes faces in complex multidimensional visual model and also a computational model for it. In this paper we try to present an overview of face recognition and verification including its applications thereafter face recognition techniques listing their advantages and disadvantages. Finally, their conclusions are also given.**

***Keywords*— Face recognition, Face verification, Feature extraction, Facial expression, Feature Matching.**

I. INTRODUCTION

Face recognition, an effective method that has a wide application especially as an identification solution that meets the desperate need in security areas [1]. A short time ago, of biometrics has really improved to large extent in access control or personal security applications. It is a technology that replace out dated certification methods that are easily copied, stolen and elapsed. Iris,, voiceprints, face fingerprints are normally used as biometric features [2]. All of these face offer a more direct, convenient, friendly documentation method compared to other discrete identification methods of biometric method [1]. It includes pattern recognition, image processing, intelligent learning etc. [3]. So, face recognition technologies have been comes into the picture during the past few years and used as an effective tool for automatic video observation and entry control. Face recognition one kind of biometric credentials, examined in various filed like pattern recognition, computer vision and image analysis and considered to be a usual and straight biometric method [4][5]. Automated methods that follow facial features as crucial elements of discrepancy to identify the identity that involved in the process of facial identification [6]. Automatic face recognition as a mean of human identification has been strongly experimented and reviewed for more than twenty five years.

The achievements of face recognition routine degrades with lightning variations and pose, also the recognition performance has been developed significantly under optimal lightning and frontal pose scenario [7]. The block diagram for face detection is shown in Fig.1. below:

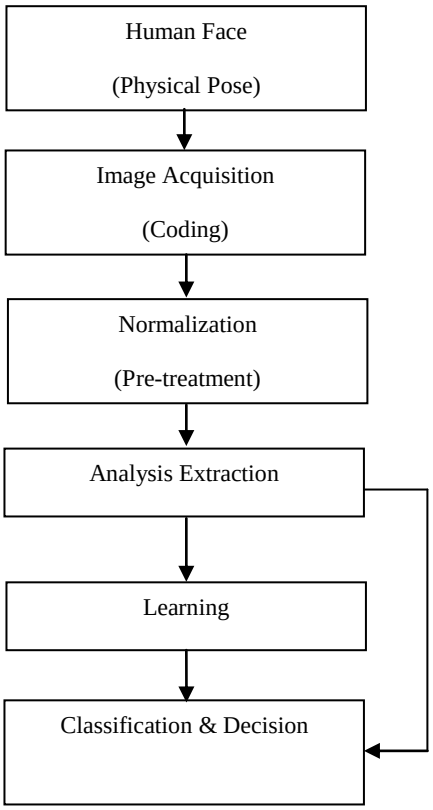

Fig.1: Face detection system

Persons are generally identified by their face, and automatic face recognition is now possible because of the growths made in the computing capability over the past few years. Information security, law implementation, investigation, smart cards, access control are some of the zones that have potential applications for Face Recognition [8]-[10].

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Since faces of varied persons contribute to global shape features, whereas face images of a single person is exposed to significant differences, which might overcome the measured inter-person variations, face recognition appears to have aspiring challenges. Based on the modeling necessities of a face Recognition system, we study, categorize and go over the existing modeling methodologies.

II. Face Recognition

Face detection and recognition are the difficult complications in computer vision area. This is the intention why this field receives a vast consideration in medical field and research communities together with biometric, pattern recognition and computer vision communities [8, 11, 12, 13]. For several applications, the act of face recognition systems in controlled environments has now reached a adequate level; but, still there are many challenges posed by uncontrolled environments. Certain challenges are posed by the problems caused by variations in illumination, face pose, expression, Identity and occlusion etc. [14]. All existing face recognition techniques can be classified into four types based on the way they signify the face. Classification of face recognition is shown in Fig.2.

1. Appearance based which uses all-inclusive texture features.
2. Model based which works shape and texture of the face, along with 3D depth information.
3. Pattern based face recognition.
4. Techniques using Neural Networks

Generally, a face recognition system consists of three key elements:

1. Face detection & normalization.
2. Feature extraction & discriminant analysis.
3. Identification and/or verification.

The strength of face recognition may possibly improve by handling the variations in these elements. Feature extraction involves very important step for face recognition. Several methods need exact locations of key facial features such as eyes, nose, and mouth to stabilize the faces.

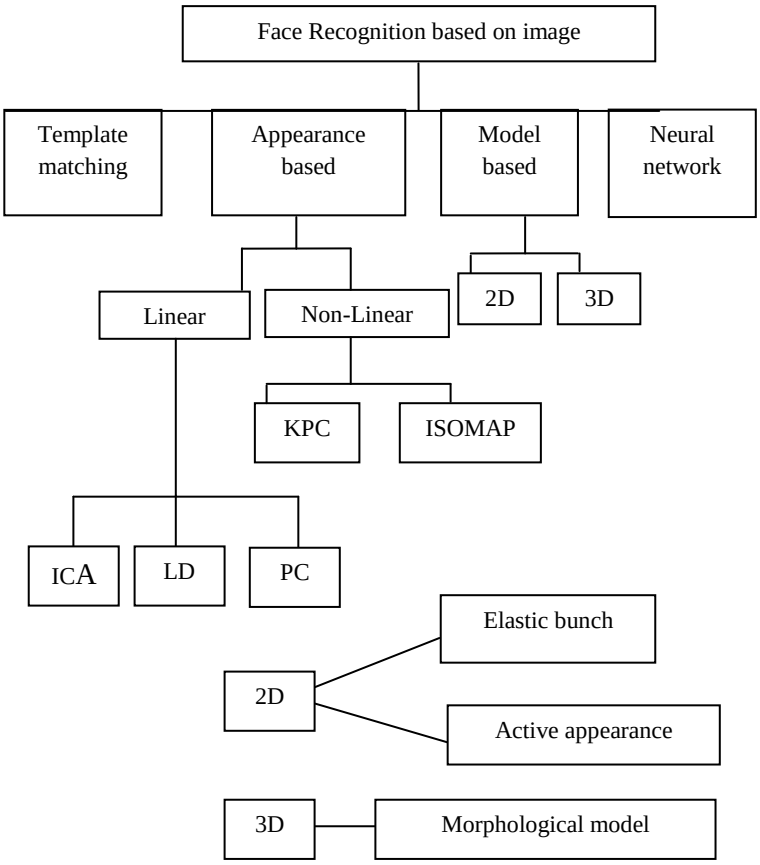

Fig. 2: Classification of face recognition

III. Face Recognition Challanges

Though face recognition have been a grown up research area, however, there still remain many problems that must be overcome to develop a robust face recognition system that works well under various circumstances such as illumination, pose, occlusion, pose and illumination, pose & occlusion, illumination and occlusion and lastly illumination and pose and occlusion.

Since, we are representing a review paper on pose-illumination-occlusion invariant face recognition systems. So it is very essential to head in the direction of knowing what basic approaches had been adopted to deal with pose-illumination-occlusion invariant face recognition system. So, to face this problem, the face with different poses and occlusions is recognized under diverse lighting conditions by our proposed models.

IV. Survey Of Face Recognition

Numerous algorithms have been proposed for face recognition; Chellappa et al (1995), Zhang et al (1997) and Chan et al (1998) use face recognition techniques to browse video database to find out shots of particular people. Haibo Li et al (1993) code the face images with a compact parameterized facial model for low-bandwidth communication applications such as videophone and teleconferencing. As the technology has matured, commercial products have appeared on the market [15].

Turk et al (1991) developed Principal Component Analysis (PCA) technique for Face recognition to solve a set of faces using Eigen values. Rama Chellappa et al (2003) have dealt with the feature based method using statistical, structural and neural classifiers for Human and Machine Recognition of Faces [16].

Krishnaswamy et al (1998) proposed automatic face recognition using Linear Discriminant Analysis (LDA) of Human faces. Chengjun Liu and Harry Wechsler (2002) presented new coding schemes, the Probabilistic Reasoning Modes (PRM) and Enhanced Fisher linear discriminant Models (EFM) for indexing and retrieval from large image databases [17, 18].

Michael Bromby (2003) has presented a new form of Forensic identification-facial biometrics, used computerized identification. Joss Beveridge et al (2003) provided the PCA and LDA algorithms for face recognition. A detailed Literature Survey of Face Recognition and Reconstruction Techniques were given by Roger Zhang and Henry Chang (2005) [19].

Vytautas Perlibakas (2004) has reported a method in "Face Recognition Using Principal Component Analysis and Wavelet Packet Decomposition" which allows using PCA based face recognition with a large number of training images and performing training much faster than using the traditional PCA based method [19].

Kyungnam Kim (1998) has proposed PCA to reduce the large dimensionality of the data space (observed variables) to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the data economically in "Face Recognition using Principle Component Analysis". The original face is reconstructed with some error, since the dimensionality of the image space is much larger than that of face space. Jun-Ying et al (2005) have combined the characteristics of PCA with LDA. This improved method is based on normalization of within-class average face image, which has the advantages of enlarging classification distance between different-class samples. Experiments were done on ORL (Olivetti Research Laboratory) face database. Results show that 98% of correct recognition rate can be acquired and a better efficiency can be achieved by the improved PCA method [20].

Wangmeng Zuo et al (2006) have described in "Combination of two novel LDA-based methods for face recognition" the Combination of two LDA methods which performed LDA on distinctly different subspaces and this may be effective in further improving the recognition performance. Fisher face technology uses 2D-Gaussian filter to smooth classical Fisher faces [18].

El-Bakry (2007) has proposed a new PCA implementation for fast face detection based on the cross-correlation in the frequency domain between the input image and eigenvectors (weights) in "New Fast Principal Component Analysis for Face Detection". This search is realized using cross correlation in the frequency domain between the entire input image and eigenvectors. This increases detection speed over normal PCA algorithm implementation in the spatial domain [21].

Xiaoxun Zhang and Yunde Jia (2007) have explained the principal subspace, the optimal reduced dimension of the face sample in "A linear Discriminant analysis framework based on random subspace for face recognition Pattern Recognition" to construct a random subspace where all the discriminative information in the face space is distributed in the two principal subspaces of the within-class and between-class matrices [22]. Moshe Butman and Jacob Goldberger (2008) have introduced a face recognition algorithm in "Face Recognition Using Classification-Based Linear Projections" based on a linear subspace projection. The subspace is found via utilizing a variant of the neighborhood component analysis (NCA) algorithm which is a supervised dimensionality reduction method that has been recently introduced.

Changjun Zhou et al (2010) have introduced a features fusion method for face recognition based on Fisher's Linear Discriminant (FLD) in "Features Fusion Based on FLD for Face Recognition". The method extracts features by employing Two-Dimensional principal component analysis (2DPCA) and Gabor Wavelets, and then fuses their features which are extracted with FLD respectively [23].

Hui Kong Lei Wang et al (2005) have explained in their paper, "Framework of 2D Fisher Discriminant Analysis: Application to Face Recognition with Small Number of Training Samples" that 2D Fisher Discriminant Analysis (2D-FDA) is different from the 1D-LDA based approaches. 2D-FDA is based on 2D image matrices rather than column vectors so the image matrix does not need to be transformed into a long vector before feature extraction which contains unilateral and bilateral 2D-FDA.

Yanwei Pang et al (2004) have proposed "A Novel Gabor-LDA Based Face Recognition Method" in which face recognition method based on Gabor-wavelet with linear Discriminant analysis (LDA) is presented. These are used to determine salient local features, the positions of which are specified by the discriminant pixels. Because the numbers of discriminant pixels are much less than those of the whole image, the amount of Gabor Wavelet coefficients is decreased [23]. Xiang et al (2004) have reported in "Face Recognition using recursive Fisher Linear Discriminant with Gabor wavelet coding" that the constraint on the total number of features available from Fisher Linear Discriminant (FLD) has seriously limited its application to a large class of problems. In order to overcome this disadvantage of FLD, a recursive procedure of calculating the Discriminant features is suggested. Work is currently under progress to study the various design issues of face recognition, and the objective is to achieve 99% accuracy rate for identity recognition for all the widely used databases, and at least 80% accuracy for facial expression recognition for Yale database [24,25].

Juwei Lu et al (2003) have shown in "Regularization Studies on LDA for Face Recognition", that the applicability of Linear Discriminant Analysis (LDA) to high-dimensional pattern classification tasks such as face recognition (FR) often suffers from the so-called small sample size (SSS) problem arising from the small number of available training samples compared to the dimensionality of the sample space.

The effectiveness of the proposed method has been demonstrated through experimentation using the FERET database [25].

Chengjun Liu and Harry Wechsler (2002) have reported in "Gabor Feature Based Classification (GFC) using the Enhanced Fisher Linear Discriminant Model for Face Recognition" that the feasibility of the proposed GFC method has been successfully tested on face recognition using a data set from the FERET database, which is a standard 16 tested for face recognition technologies [26].

Further, Rowley et al (1998) have provided a neural network-based upright frontal face detection system in "Neural Network-Based Face Detection". To collect negative examples, a bootstrap algorithm is used, which adds false detections into the training set, as training progresses. Jianming Lu et al (2007) have presented a new method of face recognition on fuzzy clustering and parallel neural networks, based on the neuron-fuzzy system. The face patterns are divided into several small-scale parallel neural networks based on fuzzy clustering, and they are combined to obtain the recognition result.

V. Face Identification & Verification

Identification and verification of face recognition is the key issue from security point of view. The face identification and verification model is shown in Fig.3 below. Steps involved for identification and verification is discussed below:

1. Camera as a source used to verify or recognize the identity of a living person based on his/her physiological characteristics [27].
2. Face recognition starts with the detection of face patterns in sometimes cluttered scenes, proceeds by normalizing the face images to account for geometrical and illumination changes, possibly using information about the location and appearance of facial landmarks, identifies the faces using appropriate classification algorithms, and post processes the results using model-based schemes and logistic feedback system [27].
3. The face image can be treated with a series of pre-processing techniques to minimize the effect of factors that can adversely influence the face recognition algorithm. The most critical of these are facial pose and illumination. In this step the features used in the recognition phase are computed. These features vary depending on the automatic face recognition system used.

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For example, the first and most simplistic features used in face recognition were the geometrical relations and distances between important points in a face, and the recognition 'algorithm' matched these distances the most widely used features in face recognition are KL or eigen faces, and the standard recognition 'algorithm' uses either the Euclidian or Mahalanobis distance to match features. This consists of 2 separate stages: a training process, where the algorithm is fed samples of the subjects to be learned and a distinct model for each subject is determined; and an evaluation process where a model of a newly acquired test subject is compared against all existing models in the database [28].

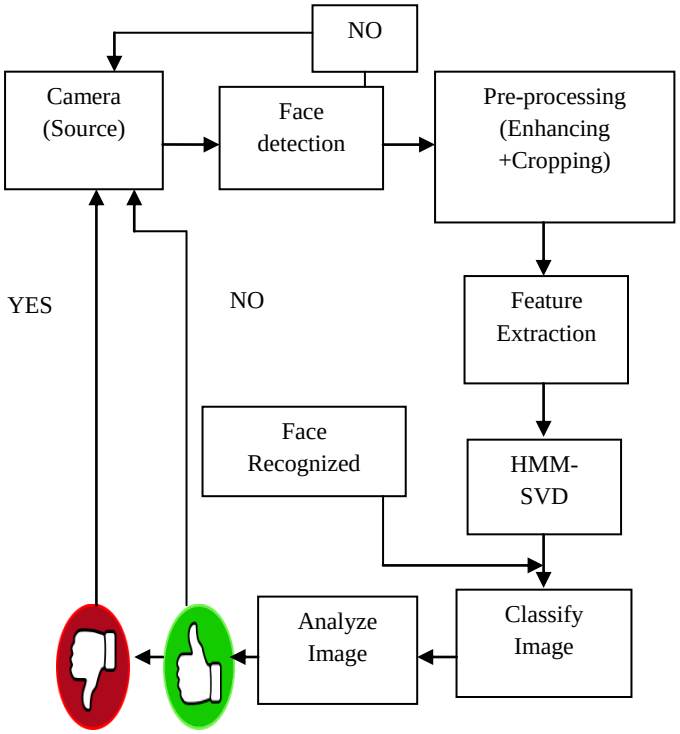

Fig. 3: Speaker identification and verification

4. The Hidden Markov Models are stochastic models which provide a high level of flexibility for modeling the structure of an observation sequence. They allow for recovering the (hidden) structure of a sequence of observations by pairing each observation with a (hidden) state. Hidden Markov Models (HMMs) represent a most famous statistical pattern recognition technique and can be considered as the state-of the- art in speech recognition. This is due to their excellent time warping capabilities, their effective self organizing learning capabilities and their ability to perform recognition and segmentation in one single step. They are used not only for speech and handwriting recognition but they are involved in modeling and processing images too [29].
5. In the context of face identification problem, we need to make a few image pre-processing; we need transform the face image to a uniform by level and size normalized. Then we need do fractal coding, we change face image in to matrix of fractal code [30].

VI. Applications

The application of face recognition technique can be categorized into two main parts: law enforcement application and commercial application. Face recognition technology is primarily used in law enforcement applications, especially Mug shot albums (static matching) and video surveillance (real-time matching by video image sequences). The commercial applications range from static matching of photographs on credit cards, ATM cards, passports, driver's licenses, and photo ID to real-time matching with still images or video image sequences for access control. Each application presents different constraints in terms of processing [30].

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VII. SUMMARY

TABLE 1:
Summary of Literature Review

Year	Author	Title	Approach	Result
2013	Rachid Aliradi, Naima Bouzera, Dr Abdelkrim Meziane	Detection of facial components based on SVM classification and invariant feature	Support vector machines (SVM) has been adapted	Succeeds in locating facial features in the facial region exactly
2012	Chaoyang Zhang, Zhaoxian Zhou, Hua Sun, and Fan Dong,	Comparison of Three Face Recognition	Principal Component Analysis (PCA), Linear Discriminate Analysis (LDA), and Elastic Bunch Graph Matching (EBGM)	Performance benchmarking are compared for each of the algorithms in terms of recognition accuracy, computational cost, and recognition tolerance
2012	Chen Da-jin/Chen Si-yu/Su Yun-huan, Peng Min-jing	A Fast Detection Model for Omni-directional Faces	Technique of HSI based skin detection combined with eye-core detection	Detection accuracy was 95% proved
2012	Salem Alelyani, Huan Liu	Ensemble Feature Selection in Face Recognition ICMLA 2012 Challenge	Filter-based feature selection	Achieve very high accuracy, 99% distinguish human faces
2012	Emir Kremic, Abdulhamit Subasi, and Kemal Hajdarevic	Face Recognition Implementation for Client Server Mobile Application using PCA	Client – server model and GPG infrastructure	Detection accuracy was improved

VIII. CONCLUSION

Face recognition has been considered for over two decades, and it is still an active subject owing to extensive practical applications.

Several potential applications include law enforcement, access control, security surveillance and monitoring, bankcard identification, and human-robot interface. In all these cases, face recognition acts as a critical role. It is a difficult prototype recognition problem due to the complex pattern distributions from large variations in facial expressions, facial details, and illumination conditions. In this paper, we have offered an extensive review of the significant researches in existence for face recognition based on various conditions such as pose, illumination, occlusion and expression. A concise description about the face recognition methods is also presented. The object of this research survey is to help the budding researchers in the field of content based video indexing and retrieval to understand the available methods and to support their further research.

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