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Review of Different Face Recognition Techniques

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Abstract: *Face recognition techniques can be generally separated into three categories based on the face data learning methodology: techniques that manage on intensity images; those that deal with video sequences; and those that require other sensory data such as 3D information or infra-red imagery. Biometrics represents a valid alternative but they suffer of drawbacks as well. Iris scanning, for example, is very reliable but too disturbing; fingerprints are socially accepted, but not applicable to non-consentient people. On the other hand, face recognition represents a good compromise between what's socially acceptable and what's reliable, even when operating under controlled conditions. In this paper, an overview of some of the well known methods in each of these categories is described and some of the benefits and drawbacks of the schemes mentioned there in are examined. Furthermore, a discussion outlining the incentive for using face recognition, the applications of this technology, and some of the difficulties plaguing current systems with consider to this task has also been provided.*

Keywords: *Face recognition; 3-D model; Biometrics; Elastic Bunch Graph (EBG); Principal Component Analysis (PCA); Active appearance Model (AAM)*

I. Introduction

A biometric system is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired data, and comparing this feature set against the template set in the database. Depending on the application context, a biometric system may operate either in verification mode or identification mode. In the verification mode, the system validates a person's identity by comparing the captured biometric data with her own biometric template(s) stored in the system database. In the identification mode, the system recognizes an individual by searching the templates of all the users in the database for a match [1].

Biometric technologies have been divided into two parts and those parts also subdivided into many parts as given below [2].

1) Physiological characteristics; and
2) Behavioral characteristics.

Basically in Physiological characteristics its depend upon how physical appearance of the body appears that is called physiological method of biometrics and these methods also classified in different categories which is described below.

a) Iris and retinal scans
b) Facial recognition
c) Finger print
d) Hand geometry

Behavioral characteristic is defined as nature of the body or human nature or temperature emerges from the body called behavioral characteristic. It is also categorized in many subparts such as.

a) Voice Recognition
b) Iris Recognition
c) Gait Recognition
d) Keystroke Recognition

Basically in terms of universally characteristic, human face is a favorable biometric when it comes to universality, collectability and acceptability etc. This means that everyone has a face, it's easy to take a picture of a face and it's socially acceptable that we authenticate each other based on our face. However the human face has low distinctiveness compared to fingerprints or iris patterns. This motivates future research on multimodal biometric authentication where the face is combined with other more distinct biometrics. Dedicated face recognition systems can be devided in to two major subsystems Face detection: The localization of the face or faces (if present) in an input image.

A. Facial Recognition

Facial recognition tries to match various facial characteristics such as distance between eyes, width of nose, cheekbones, jaw line and chin characteristics to arrive at an identity match. This has found limited success in practical applications due to various factors such as facial features being covered by hats or hair, reflection from spectacles angle of capture.

B. Hand Recognition

Hands by themselves are not descriptive enough to result in positive Identification. It takes into consideration a combination of various factors such as shape, Size, finger length, thickness, and such. It is generally used where fingerprint is considered intrusive.

C. Fingerprint Geometry

Fingerprinting has played a very important role in forensics. Fingerprint scanning devices are one of the most common biometric devices available. However the device used are slightly more complex. They follow various methods from matching print patterns such as whorls, cusps, and ridge the matching of at least 15 different characteristics.

D. Voice Recognition

This is favorite of moviemakers. Some often access their cars, secret underground tunnels by just mentioning a few key phrases. Voice verification is not effective because acoustics and other external disturbances interfere with the process. Iris is a pat inside our eye, which is unique in every individual, it remains unchanged till end of life this is the most prominent technique that can be implemented. The capture of iris is very simple one even need not stand before the camera. So here, we try to give the details of how iris scan is implemented.

E. Iris Recognition

Iris recognition is the best of breed authentication process available today. Iris recognition takes a picture of the iris; this picture is used solely for authentication it is different from retinal scanning. Face recognition is preferred Unique – it is impossible for two Faces to produce the same code. Flexible - Face recognition technology easily integrates into existing security systems. Reliable - Face pattern is distinctive and is not susceptible to theft, loss or compromise.

Face recognition technology provides accurate identity authentication without PIN numbers, passwords or cards and the enrollment takes less than 2 minutes. Authentication takes less than 2 seconds. Producing a template to enroll has been made easy with the use of Video-based technology. The term "Facial-scanning" is often used when referring to face recognition technology, but there is no scanning involved at all. Face recognition is based on pattern recognition and the pattern-capturing methodology is based on video camera technology similar to that found in camcorders commonplace in consumer electronics. Face scan the camera has two apertures. The first contains a hologram that helps position the face properly for registration or Verification and performs the actual recognition. The second helps illuminate the face to create an accurate image map of your face. As with the U. Are U system, enrollment is simple and straightforward. People wearing glasses need to take them off during enrollment, but they do not have to remove them later to be identified for login, according to the company. We claim that we can replace any traditional authentication user ID and password schema with Face recognition and iris authentication technology in any application, operating system or any web application. Face is that reliable tool, that, any Organization, which is serious about protecting their network environment to help maintain network integrity.

II. Face Recognition

The actual recognition in terms of identification or authentication of the identity associated with the detected face or faces. Here we try to present one of the various above-mentioned ways that is Facial recognition we try to explain how and where it is employed. Face recognition has been an active research topic in the past few decades due to its scientific challenges and potential applications. In general, there are two main approaches to face recognition, geometric feature-based and template-based [3].Geometric feature-based methods analyze explicit local features (such as eyes, mouth and nose) and their geometric relationships. Representative works include Hidden Markov Model (HMM) proposed by Samaria [4], elastic bunch graph matching algorithm proposed by Wiskott et al. [5], and Local Feature Analysis (LFA) proposed by Penev et al. [6]. Template-based (or appearance-based) methods match faces using the holistic features of face images. The current state of-the art of such methods is characterized by a family of subspace methods originated by "Eigen face" [7]. Peter et al. switched from "Eigen face" to "fisher face"[8]. Moghaddam et al. proposed to estimate density in high-dimensional space using Eigen space decomposition [9] and then derived a probabilistic similarity measure based on Bayesian analysis of image deference's [10]. Wang et al. further developed a unified analysis method that uses three subspace dimensions, i.e. intrinsic deference, transform deference and noise, and achieved better recognition performance than the standard subspace methods [11]. However, although many of the published algorithms have demonstrated excellent recognition results, there are still many open problems. The face recognition vender test (FRVT) 2002 [12] reports that recognition under illumination and pose variations still remain challenging. To obtain good features robust to such variations, many methods applied Gabor-wavelet transform which can capture the properties of orientation selectivity and spatial frequency selectivity [13]. PCA and LDA were employed on Gabor-filtered images instead of the original grey-level ones in [14] [15] respectively. Usually, 40 Gabor kernels (5di®erent scales and 8 orientations) are used. As a result, the dimension of the filtered vectors is up to 40 £ d, where d equals the product of the width w and the height h of the image (i.e. d = w £ h). When the size of original image is 100 £ 100; the dimension of the filtered vector can be as large as 400,000. Such a high dimensional vector will lead to expensive computation and storage cost. To alleviate such problem and make the algorithm robust to pose variations, Gabor-wavelet features were extracted on fiducial points in [5]. The major disadvantage would be that only the areas which can be reliably located are used for recognition purposes. Another work in [15] employed simple down-sampling trick to alleviate the computational burden. Motivated by [16], in this paper, we propose a method which can automatically select discriminant pixels using the discriminant vectors of LDA. Computational benefit is thus obtained when the number of selected discriminant pixels is smaller than that of the whole image. The experimental results show that discriminant pixels are related to local features such as eyes, nose and mouth, which coincide with intuitions. Finally, these local features and global features are combined to form the final classifier and improved face recognition accuracy is obtained. This paper does not describe the details of LDA and Gabor-wavelet. See Ref. [8] and [5] for details in-stead in recent years face recognition has received substantial attention from researchers in biometrics, pattern recognition, and computer vision communities [17] [18] [19] [20]. There are a large number of commercial, securities, and forensic applications requiring the use of face recognition technologies. Many approaches to object recognition and to computer graphics are based directly on images without the use of intermediate 3D models. Most of these techniques depend on a representation of images that induces a vector space structure and, in principle, requires dense correspondence. Appearance-based approaches represent an object in terms of several object views (raw intensity images). An image is considered as a high-dimensional vector, i.e., a point in a high-dimensional vector space. Many view-based approaches use statistical techniques to analyze the distribution of the object image vectors in the vector space, and derive an efficient and effective representation (feature space) according to different applications.

Face recognition scenarios can be classified into two types; (i) face verification (or authentication) and (ii) face identification (or recognition). Face verification (”Am I who I say I am?”) is a one-to-one match Face identification (”Who am I?”) is a one-to-many matching process that compares a query face image against all the template images in a face database to determine the identity of the query face . The identification of the test image is done by locating the image in the database that has the highest similarity with the test image. The identification process is a “closed” test, which means the sensor takes an observation of an individual that is known to be in the database. The test subject’s (normalized) features are compared to the other features in the system’s database and a similarity score is found for each comparison. These similarity scores are then numerically ranked in a descending order. The percentage of times that the highest similarity score is the correct match for all individuals is referred to as the “top match score.” The watch list (”Are you looking for me?”) method is an open-universe test.

The test individual may or may not be in the system database. That person is compared to the others in the system’s database and a similarity score is reported for each comparison. These similarity scores are then numerically ranked so that the highest similarity score is first. If a similarity score is higher than a preset threshold, an alarm is raised. If an alarm is raised, the system thinks that the individual is located in the system’s database. There are two main items of interest for watch list applications. The first is the percentage of times the system raises the alarm and it correctly identifies a person on the watch list. This is called the “Detection and Identification Rate.” The second item of interest is the percentage of times the system raises the alarm for an individual that is not on the watch list (database). This is called the “False Alarm Rate.” Illumination (including indoor/outdoor) facial expression occlusion due to other objects or accessories (e.g., sunglasses, scarf, etc.) Facial hair Aging [21].On the other hand, the inter-subject variations are small due to the similarity of individual appearances image-based face recognition techniques can be mainly categorized into two groups based on the face representation which they use: (i) appearance-based which uses holistic texture features; (ii) model-based which employ shape and texture of the face, along with 3D depth information, Appearance-based (View-based) face recognition.

III. Types of Face Recognition Method

Face recognition techniques categorized in different way which I described below.

A. Appearance based Technique
B. Model based Techniques

Basically these methods also categorized in sub category which is given below.

A. Appearance Based Face Recognition

Three face recognition methods, all coming under the general heading of appearance-based approaches:

a) Direct Correlation;
b) The Eigen face Method And The
c) Fisher face Method.

B. Modal Based Face Recognition

The model-based approach offers a potential solution - by projecting the image data into the model frame, we have a means of registering the data from frame to frame. Intuitively, we can imagine different dynamic models for each separate source of variability. In particular, given a sequence of images of the same person we expect the identity to remain constant, whilst lighting, pose and expression vary each with its own dynamics. In fact, most of the variation in the model is due to changes between individuals, variation this does not occur in a sequence. If this variation could be held constant we would expect more robust tracking, since the model would more specifically represent the input data [22]. Some steps implemented in model based face recognition which is given in below figure 2.

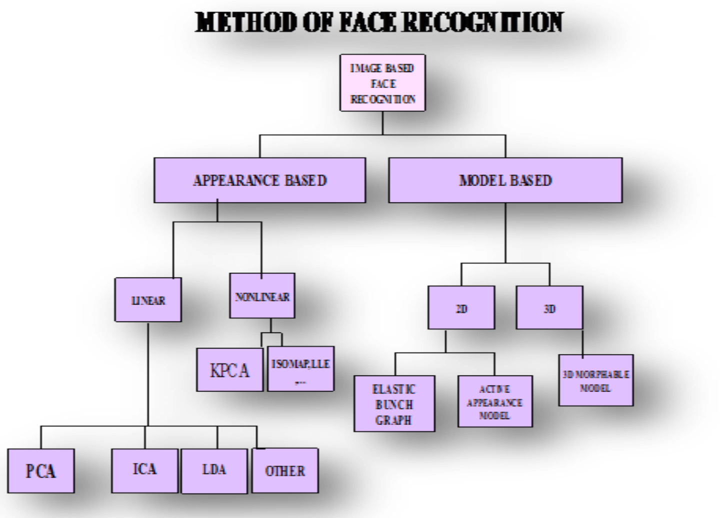

Figure 1. Types of Face recognition method

Figure 2. Flow chart of Model based Face recognition

The model based face recognition scheme is aimed at constructing a model of human face which is able to capture the facial variations. the prior knowledge of human face are very utilized to create the modal for example feature based matching driver distance and relative position features from the placement of internal facial element as Eye A more recent feature based system based on elastic Bunch Graph matching. Model based face recognition not used in Real system because it is hard to implement and too slow also and very time consuming the models were generated by combining a model of shape variation with a model of the appearance variations in a shape-normalized frame. We require a training setoff labeled images, where landmark points are marked on each example face at key positions to outline the main features. Given such a set we can generate a statistical model of shape variation (see [23] for details). The labeled points on a single face describe the shape of that face. We align all the sets of points into a common co-ordinate frame and represent each by a vector; we then apply a principal component analysis (PCA) to the data.

a) PCA & LDA

The face is our primary focus of attention in developing a vision based service robot to serve peoples. Unfortunately, developing a computational model of face recognition is quite difficult because faces are complex, meaningful visual stimuli and multidimensional. Modeling of face images can be based on statistical model such as Principal Component Analysis (PCA). PCA is a standard statistical method for feature extraction by reduces the dimension of input data by a linear projection that maximizes the scatter of all projected samples. The scheme is based on an information theory approach that decomposes faces images into a small set of characteristic feature images called eigenfaces, as the principal components of the initial training set of face images. Recognition is performed by projecting a new image into the subspace spanned by the eigenfaces called face space, and then classifying the face by comparing its position in face space with the positions of known individuals. PCA based approaches typically include two phases: training and classification. In the training phase, an eigenspace is established from the training samples using PCA and the training face images are mapped to the Eigen space for classification. In the classification phase, an input face is projected to the same eigenspace and classified by an appropriate classifier.

The ICA can be considered as a generalization of the PCA, but providing three main advantages:(1) It allows a better characterization of data in an n-dimensional space; (2) the vectors found by the ICA are not necessarily orthogonal, so that they also reduce the reconstruction error; (3) they capture discriminate features not only exploiting the covariance matrix, but also considering the high-order statistics. Besides linear projection analysis technologies, non-linear projection analysis represented by both KPCA and KFD also has aroused considerable interest in the fields of pattern recognition and machine learning, and over the last few years have shown great potential in biometrics applications. KPCAwas originally developed by chölkopf [24], while KFD was first proposed by Mika [25, 26]. The performance of PCA depends on the task statement, the subspace distance metric, and the number of subspace dimensions retained. The performance of ICA depends on the task, the algorithm used to approximate ICA, and the number of subspace dimensions retained. Even more confusingly, there are two very different applications of ICA to face recognition.ICA can be applied so as to treat images as random variables and pixels as observations, or to treat pixels as random variables and images as observations. The LDA (Linear Discriminate Analysis) has been proposed as a better alternative to the PCA. It expressly provides discrimination among the classes, while the PCA deals with the input data in their entirety, without paying any attention for the underlying structure. Indeed the main aim of the LDA consists 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 the between- and within-class differences are represented by the corresponding scatter matrices Sb and Sw, while the ratio detjSbj/detjSwj has to be maximized. Even if the LDA is often considered to outperform the PCA, an important qualification has to be done. Indeed the LDA provides better classification performances only when a wide training set is available.

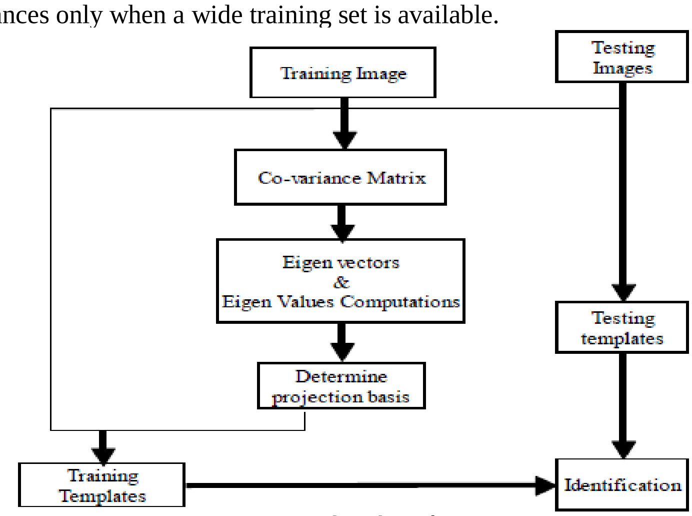

Figure.3 Flow chart of PCA

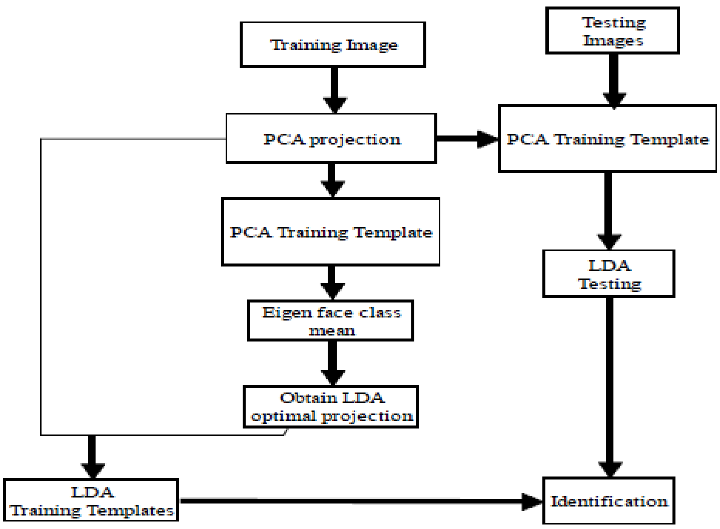

Figure.4 Flow chart of LDA

b) Elastic Bunch Graph

To find fiducially points in new faces, one needs a general representation rather than models of individual faces. This representation should cover a wide range of possible variations in the appearance of faces, such as differently shaped eyes, mouths, or noses, different types of beards, variations due to sex, age, race, etc. Its obvious that it would be too expensive to cover each feature combination by a separate graph. We instead combine a representative set of individual model graphs into a stack-like structure, called a face bunch graph(FBG); see Figure 3. Each model has the same grid structure and the nodes refer to identical fiducially points. A set of jets referring to one fiducially point is called a bunch. An eye bunch, for instance, may include jets from closed, open, female, and male eyes, etc., to cover these local variations. During the location of fiucial points in a face not seen before, the procedure described in the next section selects the best fitting jet, called the local expert, from the bunch dedicated to each fiducially point. Thus, the full combination of jets in the bunch graph is available, covering a much larger range of facial variation than represented in the constituting model graphs themselves.

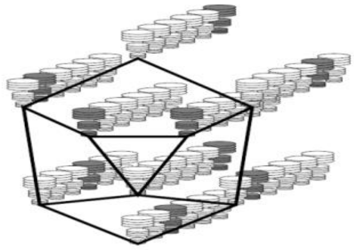

Figure.5 EBG Model

Generating Face Representations by Elastic Bunch Graph Matching-So far we have only described how individual faces and general knowledge about faces are represented by labeled graphs and the FBG, respectively. Simplest method is to do so manually. We have used this method to generate initial graphs for the system, one graph for each pose, together with pointers to indicate which pairs of nodes in graphs for different poses correspond to each other. Once the system has an FBG (possibly consisting of only one manually defined model), graphs for new images can be generated automatically by Elastic Bunch Graph Matching. Initially, when the FBG contains only a few faces, it is necessary to review and correct the resulting matches, but once the FBG is rich enough (approximately 70 graphs) one can rely on the matching and generate large galleries of model graphs automatically.

c) Active Appearance Model

The AAM contains a statistical, photo-realistic model of the shape and grey-level appearances of faces we use the AAM as a basis for face recognition, obtain good results for difficult images. We show how the AAM framework allows identity information to be decoupled from other variation, allowing evidence of identity to be integrated over a sequence. The AAM approach makes optimal use of the evidence from either a single image or image sequence model-based approach, called Active Appearance Models, for the interpretation of face images, capable of overcoming these difficulties. This method is capable of 'explaining' the appearance of a face inters of a compact set of model parameters. Once derived, this model gives the opportunity for various applications to use it for further investigations of the modeled face (like characterize the pose, expression, or identity of a face)The Active Appearance Model, as described by Coots, Taylor, and Edwards(see, [27] and [28]) requires a combination of statistical shape and texture models to form a combined appearance model. This combined appearance models then trained with a set of example images. After training the model, new images can be interpreted using the Active Appearance Search Algorithm.3D Morph able Models Description Morphing between 3D objects is a well-known computer graphics technique. 3morphable face models apply the general concept into the vector space representation of face models. The main idea behind the morph able face model approach is that given sufficiently large database of 3D face models any arbitrary face can be generated by morphing between the ones in the database To create a 3D face model from a set of 2D face images, an analysis by synthesis loop is used to find the morphing parameters such that the rendered images of the 3Dmodel are as close as possible to the input images. These parameters include shape and texture coefficients, illumination, orientation, and face position. The optimization algorithm starts with manual alignment of the average face (of the 200 head models) with the face in the image. Iteratively, the algorithm attempts to minimize the error between the synthetic reconstruction at that point with the input image with respect14to the the sum of square errors over all color channels and all pixels [3].

C. Image Based Face Recognition

Face detection and recognition with higher accuracy, Image based ap- Face recognition From Image is a popular topic in biometrics research he actual advantages of face based identification over other biometrics are uniqueness and acceptance. As human face is a dynamic object having high degree of variability in its appearance, that makes face detection a difficult problem in computer vision . in this field accuracy and speed of identification The goal of this paper is to evaluate various face detection and recognition methods, provide complete solution for image based approaches are possibly the most promising and practical ones However the 2D images patterns of 3D face objects can change dramatically due to lighting and viewing variations Hence, the illumination and pose problems present significant obstacles for wide applications of this type of approaches To overcome these issues, we propose using a generic 3D model to enhance existing image based systems More specifically we use a 3D model to synthesize the so called proto type image from a given image acquired under different lighting and viewing conditions This enhancement enables the existing systems to handle both illumination and pose problems specific to face recognition under the following assumption just one image per face object is available.

IV. **Applications**

Face technology is implemented in various places like offices, traffic control centers, airports, and at several public places Offices: Data centers, material storage, safes, executive offices, secure meeting rooms Laboratories and Factories: Drug or dangerous materials storage rooms, night or holiday entry control Financial Institutions: Safes, safety deposit box room Lifeline Facilities: Power generator rooms, dam management offices, gas company control rooms Traffic Control Centers: Expressway administration centers, railroad dispatcher rooms Airport and Harbor Facilities: Staff gates, immigration, workshop.

V. Conclusion

The three techniques work under different environmental conditions and hence have varying efficiencies and applications. Another challenge is that the speed of authentication should be sufficiently high to make it usable, and it is quite possible that the facial expression would not always be the same. With these as our parameters, each algorithm is evaluated as to its suitability for this environment.

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