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Survey of Facial Recognition Security System

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Abstract: ***In recent time, the demand for biometric security framework has ascended because of a wide scope of surveillance, access control and law enforcement applications. Among the different biometric security frameworks based on fingerprint, iris, voice or speech, face recognition is easy accessible, non-intrusive and most general framework. Face recognition has been a flourishing and exigent area in real time applications. Face recognition at real time is a part of the field of biometrics. In last few decades, a wide variety of face recognition techniques have been come into existence. Facial recognition technology is essentially utilized in areas including network security, content ordering and recovery and video compression. This paper at-tempts to made contemporary review of vital facial recognition techniques that have been used for security system.***

Keywords: Independent Component Analysis, Face Recognition, Linear Discriminant Analysis, Neural Networks, Principal Component Analysis

1. Introduction

Face is considered as the most important part of the human body. Researches shows that face can speak and it is having different words for different emotions. It plays a very important role in interacting with people in the society. It conveys people's identity and therefore it can be used as a key for security solutions. Face recognition system is increasing all over the world as it provides a safe and reliable security. It gains importance and attention in a wide range of organizations mainly because of its high level security and reliability. Face recognition is a practical application of identifying or verifying the identity of an individual using their face. Face recognition is a part of human perception system. It can be used for identity verification in photos, videos or in real-time identification. This is found in many real time applications such as bankcard identification, access control, mug short searching, security monitoring and surveillance system. Thus face recognition is a challenging technology in the real time systems. A generic face recognition system is shown in figure 1. Face recognition is an important problem which extends across diverse fields. This is because it is having numerous practical applications as well as it is essential for effective communications and interactions among people. The quick advancement of face recognition is
expected to a blend of elements, for example, dynamic advancement of calculations, the accessibility of vast databases of facial images and a technique for assessing the execution of different face recognition calculations. Facial recognition is a biometric point of view that utilizes mechanized strategies to confirm or perceive the personality of a living individual dependent on his/her physiological attributes.

A biometric recognition framework makes utilization of either physiological attributes, for example, a fingerprint, iris pattern, or face or behavior attributes, for example, handwriting, voice, or key-stroke example to recognize an individual. Face recognition is a non intrusive system to verify personal identity in a natural and friendly way. Face recognition starts with the detection of face patterns in some cluttered scenes, proceeds by synthesizing the face images to account for geometrical and illumination changes, possibly using information about the location and appearance of facial gestures, distinguishes the faces utilizing classification algorithms, and post forms the outcomes utilizing model based plans and strategic feedback.

The application of face recognition techniques can be categorized into two main parts such as law enforcement application as well as commercial application. Face recognition technology is basically used in law enforcement

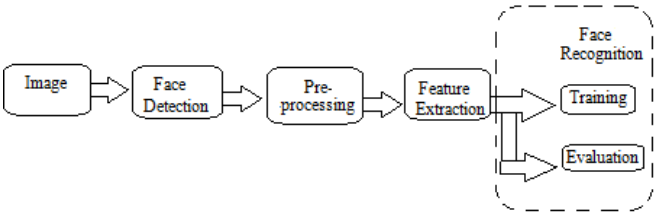

Figure 1: A generic face recognition system

applications especially in static matching of Mug shot albums and real-time matching of video surveillance. The commercial applications includes static matching of photographs on credit cards, ATM cards, passports, drivers licenses, and photo ID and real-time matching of still images and video image sequences for access control. Every face recognition algorithms consists of two main parts, one is the face detection and normalization and another one is the face identification. Algorithms that consist of both the face detection part and face identification part are referred to as fully automatic algorithms whereas those that consist of only the face identification part are called partially automatic algorithms. For the partially automatic algorithms, a facial image as well as the coordinates of the center of the eyes are given. Facial images are only given for fully automatic algorithms. Face recognition approaches can be classified into global approach and component based approach on the basis of pose invariance. In global approach, a single feature vector represents the whole face image and this is used as input to a classifier. On the other hand, the primary thought behind component based recognition is to make up for posture changes by permitting an adaptable geometrical

connection between the components in the classification change.

Researches on facial recognition techniques still face challenge in some specific domains such as pose and illumination changes. Although various methods have been proposed to solve these problems and have demonstrated significant promises, the difficulties still remain. Face recognition frameworks uses computer algorithms to choose exact and recognizing insights concerning an individual's face. These details incorporate distance between the eyes or state of the jaw which are then changed over into a mathematical representation and contrasted with information on other faces gathered in a face recognition databases. The data about a specific face is often called a face template and is different from a photograph. Rather than emphatically distinguishing an unknown individual, some face recognition frameworks are intended to discover a probability coordinate score between the unknown individual and explicit face templates saved in the database. Face recognition frameworks shifts with their capacity to distinguish individuals under various conditions such as poor lighting, low quality picture resolution, and imperfect edge of view such as in a photo taken from above looking down on an unknown individual.

2. Literature Review

Mrutyunjaya Sahani et al. proposed [1] a web based online embedded door access control and home security system based on face recognition which explains the design and

development of a home security system, based on human face recognition technology and remotely monitoring technology, to confirm visitor identity and to control door accessibility. This system finds an application in areas in which physical presence is not possible always. The system is a wireless access control system mainly designed for smart home environment. It consists of a raspberry pi based door access control and home security system through webpage with ZigBee based technology. ZigBee module is combined with electromagnetic door lock module to provide the door access. Face detection and recognition algorithms along with wireless interface helps to detect and identify visitors and also send an email or message alert via a GSM module to the authorized mobile phone or any communication devices.

Mohammad javed R. Mulla et al. aims to identify a person through face recognition in facial image based security system using PCA [2]. PCA is used for face matching decision and facial features are extracted from the face and eigen values are calculated and represented as eigen vector. By using Euclidian distance method, the comparison of unknown face image and database image is done. The face is recognized if the facial image has minimum Euclidian distance with the database images. PCA reduces the facial feature components for comparison called eigen values which reduces the computation time and space required for calculation and comparison of eigen faces and thus makes the system more faster. This system is done by MATLAB and embedded system thus makes the system cost effective, reliable and accurate.

Ylber Januzaj et al. develop a security access control application based on face recognition [3] in order to avoid thefts and identify frauds. This paper explains the implementation of an application that will control access to a building. It shows that when the factors like background, lighting and number of images are controlled, then the accuracy is higher. Face detection is done using haar like features and PCA is used for face recognition. The embedded device raspberry pi is used for training and identification. The entire software part is divided into three major parts such as recording the images, their training and face recognition. It takes 30 images of the person in different position and different lightning in image recording. Training the images means the process of saving the recorded images into numeric values and these values are used for identify the faces. The next part is the face recognition that comes to get identified in order to be granted access to the building. This is done by recording the images that comes to be identified and converting it into numerical values and the comparing the values to the already existing data. This system was designed to be used in home and other buildings entry systems but it was found its application on other environments like detecting unauthorized people, surveillance systems and courts.

Esther Annlin Kala James et al. proposed an implementation of incremental linear discriminant analysis using singular value decomposition or face recognition [4]. Linear discriminant analysis is a dimensionality reduction method. Incremental LDA is used to overcome the scalability problem of LDA face recognition. This paper is divided into two categories such as conventional LDA algorithm if the projection matrix is determined in full space and subspace LDA if the projection matrix is determined in subspace. The conventional LDA will give more discriminant power than subspace LDA. The proposed system find two advantages that the algorithm can process the samples in sequence which is desirable for large databases and it can constraint the computational cost with the dynamically adding samples. This system adopts the concept of singular vector decomposition updating algorithm to obtain the projection matrix with low computational cost and low memory requirement.

Kishor S Kinage et al. explained face recognition based on independent component analysis on wavelet subband[5]. They examined multi-resolution analysis based on ICA for facial recognition by extracting the image features of facial images from various wavelet transforms. The obtained features are then identified by ICA and Euclidian distance measure. The experiment is conducted on ORL face database which contains 40 individuals with each person's having 10 frontal images. Some of the variations used in facial expressions includes open or closed eyes, smiling or non- smiling and glasses or without glasses. It is found that accuracy using only ICA is 73 percent whereas accuracy using ICA with wavelet subbands is 91.5 percent.

Marko Arsenovic et al. presented a new deep learning based face recognition attendance system with goal of practical employment of the state-of-the-art deep learning approaches for face recognition tasks [6]. It is composed of CNN cascade for face detection and CNN for generating face

embeddings. The entire method of developing deep learning based attendance system is divided into several stages such as obtaining the training dataset and augmentation, preparing the images and training the DNNs and integration into an existing system for testing the system. This system determines that with smaller number of face images an overall accuracy of 95.02 can be obtained.

Samuel Lukas et al. aims at developing a student attendance system in classroom using face recognition technique [7]. This is done by combining Discrete Wavelet transform (DWT) and Discrete Cosine Transform (DCT) to extract the features of face. Then a Radial Basis Function is used for classifying the facial objects. Facial features are extracted from the students facial images by performing grayscale normalization, histogram equalization, DCT and DWT. The training image consists of set of student's facial image. For this, 186 student facial images are created from 16 students and results in 121 out of 148 successful face recognition with a recognition rate of 82 percent.

Shrikrishna Jogdand et al. aims to provide a door security of sensitive locations by using face detection and recognition [8]. The system consists of 3 parts such as face detection, face recognition and automatic door access control system. Viola jones algorithm is used for face detection and PCA is used for face recognition. If the face is recognized then it is a known face otherwise it is unknown and the door will be unlocked automatically for recognized person by using the command of the microcontroller. The training set contains the images that are stored in the databases which are the pictures of the people for whom the access should be granted. Face recognition process consists of 4 interrelated stages which poses very significant challenges to the successful operation of a face recognition system namely face detection, normalization, feature extraction and recognition.

3. Face Recognition Techniques

Face recognition has dependably been a very challenging task for the researchers. From one perspective, its applications
may be valuable for individual confirmation and recognition. Due to the trouble of the face recognition task, the quantity of methods is substantial and diverse. Furthermore, the applications include a huge number of circumstances. The primary inspiration for recognition is on the grounds that it is considered as a passive, no intrusive framework to check and distinguish individuals. It is additionally imperative that a identification technique is nearer to the way individuals perceive one another.

a) Principal Component Analysis

Principal Component Analysis (PCA) is one of the statistical approach that has found application in fields such as face recognition and image compression [14]. It is a standard technique for finding patterns in data of high dimensions. It uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of defines a feature space which reduces the dimensionality of the original data space and this is used for recognition [15]. PCA is also known as Karhunen-Loeve method. It is one of the popular methods for feature selection and dimension reduction. It reduces attribute space to a smaller number of factors from a larger number of variables and as such is a non dependent procedure. The main goal of PCA is dimension reduction and there is no guarantee that the dimensions are interpretable. PCA is for the most part utilized as an apparatus in exploratory data analysis and for making predictive models. It is commonly used to visualize genetic distance and relatedness between populations. PCA should be possible by eigen value decomposition of a data covariance or correlation matrix or singular value decomposition of a data matrix, as a rule after a standardization venture of the underlying data. Recognition of human faces using PCA was first proposed by Turk and Pentland [9]. In this technique, the image is converted into small set of characteristics. This characteristics is largely different from other facial images, and based on this difference the recognition is more dependent. The procedure for PCA is defined [2] as follows:

- Building a training database of human face.
- Represent each image of the database in the form of vector.
- The average face vector is to be calculated and subtracted from the average face vector of each face image vector.
- Calculate eigenface vector space and project the training faces into eigen face space.
- Coordinate coefficients are obtained from the above calculation.
- Calculate the Euclidian distance between coordinate coefficients of test image and images in the database.
- The test image is classified using the nearest Euclidian distance.

Face detection and recognition describes an eigen space density estimation technique for real time face recognition with a training set of 204 images of 68 persons [13]. Each persons of the training set has 3 images of different expression. All the image size of the training set is 256 x 256. It has achieved a recognition rate of 81 percent and a false detection rate of 7 percent in uniform background. For complex background it has a recognition rate of 76 percent and false detection rate of 17 percent. Successful recognition of human faces using PCA is done with 36 face images of 18 persons from RUET dataset and ETE-07 series in 2012[11]. It worked better in different conditions of face orientation.

An image processing and recognition of faces using PCA based face recognition techniques with 2 databases is described [5]. One is the face recognition data, university of Essex, UK consisting of 395 individuals both male and female facial images consisting of 20 images per individual which is in JPEG formats. The second is the Indian face database consisting of 40 distinct subject with 11 different poses for each individual. The system is tested with 100 different images. It achieved a recognition rate of 84.1 percent and 94.45 percent for male and female respectively. 92.5 percent and 85 percent are respectively the recognition rate of male and females in face recognition data.

b) Linear Discriminant Analysis

Linear Discriminant Analysis (LDA) is a methodology utilized in various fields such as statistics, pattern recognition and machine learning to locate a linear

combination of features which recognize at least two classes of objects or events. The resulting combination of features can be user as the linear classifier for reduce dimensions before classification. LDA is closely related to PCA in such a way that both look for linear combinations of variables which best explains the data. The major difference between LDA and PCA is that PCA does feature classification while LDA does data classification. The shape and location of the original data sets changes in PCA when transformed to a different space but LDA doesn't change the location. It tries to provide more class separability and draw a decision region between the given classes. LDA explicitly attempts to model the difference between the classes of data whereas PCA take into account any difference in data. The major objective of LDA is to dimensionality reduction while preserving as much of the class discriminatory information as possible. LDA maximizes the ratio of between-class variance to the within-class variance in any particular data set thereby guaranteeing maximal separability. In LDA, the dataset can be transformed and the test vector can be classified in the transformed space by using two different approaches. First is the class-dependent transformation which involves maximizing the ratio between class variance to within class variance to obtain adequate class separability [16]. The second is the class-independent transformation which involves maximizing the ratio of overall variance to within class variance. The choice of the type of LDA whether class-dependent or class-independent transformation depends on the data set and the goals of the classification problem.

The main goal of the LDA technique is to project the original data matrix onto a lower dimensional space. To achieve this goal, three steps needed to be performed [12].

- Calculate the separability between different classes which is called the between-class variance or between-class matrix.
- Calculate the distance between the mean and samples of each class which is called the within class variables or within class matrix.
- Construct the lower dimensional space that maximizes the between class variance and minimizes the within class variance.

Although LDA is one of the most commonly used data reduction techniques, it suffers from two main problems such as small sample sizes and linearity problems. Small sample size is one of the big problems of LDA technique which results from high-dimensional pattern classification tasks or a lower number of training samples available.

c) Independent Component Analysis

Independent component analysis (ICA) is a numerical or computational approach for broadcasting hidden factors that underlies set of random variables, neural computation, advanced statistics, measurements or signal processing. The major goal of ICA is to find a linear representation of non Gaussian data so that the components are statically independent. ICA interprets a generative model for the observed multivariate data that is given as a large database of samples. In this model, data variables are treated as linear mixtures of some unknown latent variables and the mixing system is also unknown. The latent variables are non-gaussian and are mutually independent and thus they are called independent components of the observed data [18]. ICA is externally related to principal component analysis. Both ICA and PCA are statistical transformation. Both ICA and PCA try to find a set of vectors which is the basis for the data. In PCA the basis is the one that best explains the variability of the data whereas in ICA, the basis is the one in which each vector is an independent component of the data. ICA is much more powerful technique that is capable of finding the underlying factors. The data examined by ICA is originated from different application fields such as digital images, document databases, economic indicators and psychometric measurements [17]. A face recognition scheme using independent component analysis and wavelet transform is proposed in [7]. Wavelet Transform is a commercial tool used in fields such as image processing and computer vision due to its ability to capture localized time-frequency information of image extraction. It extract image features of facial images from various wavelet transforms by decomposing face images in subbands and compares the recognition performance of wavelets at 8 levels. It found an accuracy of 91.5 percent. Face recognition using independent component analysis implemented using MATLAB R2012b is presented in [8]. It uses a dataset that has more than 40 students and each student has 8 images such as neutral, smiling, open mouth, scarf, sunglass and scarf and sunglass images. It gives a best result in illumination images comparing with occlusion images.

d) Neural Networks

Deep learning is a piece of a huge group of machine learning techniques dependent on learning data representations, instead of task-specific algorithms. It is an artificial intelligence undertakings that looks like the working of the human brain in preparing data and creating patterns for use in decision making. Gender recognition from face images with deep learning is described in [9]. The local receptive field extreme learning machine and convolutional neural networks are used in this which found a performance rate of 87.13 percent. A deep learning based face recognition attendance system is described in [10]. It explains the entire procedure of developing a face recognition component by combining state of the art methods and advances in deep learning. It uses a convolutional neural networks in which CNN cascade is used for face detection and CNN is used for generating face embeddings. This strategy acquires a general accuracy of 95.02 percent on a small dataset of the original face pictures of employees in the real-time environment. A novel approach for recognizing the human faces by comparing the characteristics of the new face to that of known individuals is presented in [11]. It consists of a face localization part where mouth end points and eyeballs are obtained and in feature extraction, distance between the eyeballs and the mouth end points will be calculated. The recognition is done by the neural networks using back propagation networks and radial basis function networks. A system which can identify the person with the help of a face using artificial neural network technique is developed in [19] which is implemented in two stages namely learning stage and the testing stage. Image acquisition, preprocessing, image filtering, feature extraction and learning are part of

learning stage. The system takes the face of the image of a person for recognition in the testing stage.

4. Conclusion

Face recognition is an active research area in real-time processing. Probably the best algorithms managing complex situations are computationally costly. Face recognition methods have by and large connected with in all respects expensive best secure applications. Certain uses of face recognition innovation are cost effective, reliable and very accurate. This paper experiments with to survey an outstanding number of papers to conceal the present improvement of face recognition.

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