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A Review on Biometric Recognition

Gagandeep Kaur[1], Gurpreet Singh[2] and Vineet Kumar[3]

[123]*Department of ECE,* [2]*Student Member IEEE, Lovely Professional University, India*
[123]*gsaini6@gmail.com*[1]*, gurpreet.singh.in@ieee.org*[2]*, vineet.15921@lpu.co.in*[3]

Abstract

Biometrics introduce to the recognition of human by their characteristics. It is used to identify individuals in groups. Traditional methods of identification involving passwords and PIN numbers, this new technique of identification is preferred over them. Biometric systems are divided on the basis of medium used for authentication. Face Recognition, Iris Recognition, Palm Recognition; Voice Recognition, Fingerprint Recognition, ECG signal based recognition methods are used for identification. Different techniques are used to extract the features for recognition. This paper gives a literature survey on Biometric Identification system so that new researchers do not find the difficulty for obtaining the information.

Keywords*: Biometrics, Feature Extraction, Wavelet Transform, Clustering, Neural network*

1. Introduction

Biometric identification provides high level security by identifying individual based on the physiological and behavioral characteristics such as face, fingerprint, iris and behavioral characteristics like hand written signature, gait and keystroke. A biometric system operates by acquiring biometric data from individual, extracting features and comparing it with the template set in database. Traditional methods of identification involving passwords and PIN numbers, these techniques are preferred over them. Moreover it is required the person to be physically present at the point of identification. Different techniques are used for identification. A biometric system is a recognition system which operates by acquiring biometric data from individual, extracting feature sets and comparing it with the template set in database.

2. Biometrics

2.1. Face Recognition

A facial recognition system is to identifying or verifying a person from a digital image automatically. A number of algorithms have been proposed for face recognition. Different existing techniques for human face recognition can be summarized in [1]. Such algorithms divided into categories of geometric feature-based and appearance-based methods. Eigen faces used for recognition, Fisher faces, Independent Component Analysis (ICA), Kernel Principal Component Analysis (KPCA), Kernel Fisher Discriminant Analysis (KFDA) all are appearance based methods. Time to time these methods has been updated. In 1987, Sirovich and Kirby developed Eigen faces, a new approach for face recognition and are used by Matthew Turk and Alex Pentland [2]. At present face recognition systems which are used

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impose a number of restrictions on how facial images are obtained. These systems automatically detect the correct face image and are able to recognize the person. General Discriminant Analysis (GDA) is used to deal with nonlinear discriminant analysis using kernel function operator. This method provides a mapping of the input vectors into high dimensional feature space, linear properties make it easy to extend and generalize the classical Linear Discriminant Analysis (LDA) to nonlinear discriminant analysis. Nonlinearities can be handled by using a different kernel [3]. Another approach is using Neural Networks in which local image sampling, a self-organizing map (SOM) neural network, and a convolutional neural network get combine. The SOM gives a quantization of the image samples into a topological space, the convolutional neural network provides partial invariance to translation, rotation, scale, and deformation [4]. Support Vector Machine (SVM) approach is able to extract the relevant discriminatory information from the data. This makes it superior over benchmark methods. As in the case of Fisherfaces when the representation space already captures and emphasizes the discriminatory information content this approach lose their superiority [5, 6].

The drawback of appearance-based method is that the recognition of face under a particular lighting and pose can be performed reliably when the face has been previously seen under similar conditions [1]. The geometry feature-based methods analyze local facial features, and their geometric relationships. The geometry feature-based methods include: Active Shape Model technique has been widely used to analyze images of faces, mechanical assemblies and medical images [7], Local Feature Analysis (LFA) introduced in 1996 which gives better results than PCA [8], Elastic Bunch Graph matching is one of the pattern recognition technique based on a Gabor wavelet transform [9]. Automatic Injection Mold Generation [10], Distributed Local Appearance Model, Face-ARG Matching, Automatic Pose Estimation, Automatic Portrait Generation System, and Multiclass Support Vector Machines [11] are different approaches to recognize face. Another method to increase accuracy and to reduce the time needed to search for a point's location is to use the combination of Support Vector Regression and Markov Random Fields. A new approach introduced in year 2012 in which the facial features from training images are extracted, then ratios of length, width, and area are calculated and stored as feature vectors for individual images. Mean feature vectors are computed. After that these calculated mean feature vector get subtracted from each feature vector for centering of the feature vectors. For recognizing purpose K-NN classifier is used [12].

It is difficult to recognize face from still images because the pose and expression changes in the images create great statistical differences. A newly emerging trend is three-dimensional (3D) face recognition which declared to achieve improved accuracies. This technique used 3D sensors to capture shape of face. By using this information unique features on the surface of face can be identified [1]. Research using 3D face data to identify humans was first published by Cartoux in 1989. Surface Based Approaches and Template Matching Approaches have been used in 3D face recognition. The disadvantage of 3D face recognition method is that they include high cost, treat human face as rigid object, and decreased ease-of-use for laser sensors. In contrast to 3D face recognition algorithms, most 2D face recognition algorithms are already tested on large datasets and are able to handle the size of the data tolerable well. Advantage of 3D facial recognition is that it is not influenced by changes in lighting [1]. Table 1 describes high uniqueness level in this biometric recognition.

2.2. Iris Recognition

Iris recognition is the process of identifying people based on unique patterns within the ring-shaped region surrounding the pupil of the eye. Similar to the more common fingerprint

recognition, iris recognition is based on scanning a person's iris and comparing the scan to a stored photograph or template to make an identification match. The iris usually has a brown, blue, gray, or greenish color, with complex patterns that are visible upon close inspection. The concept of iris recognition was first introduced in 1936. Ophthalmologist Frank Burch Proposed the concept of recognize an individual using iris patterns. Dr. Leonard Flom and Dr. Aran Safir in 1985, proposed the concept that no two irides are same [13]. In 1995, Dr. Flom, Dr. Safir and Dr. Daugman delivered a prototype unit and first commercial product became available. In year 2008, a survey on iris biometrics has been done by Bowyer [14]. In 1997, Wildes [15] proposed an automatic segmentation algorithm based on the circular Hough transform. Recognition of the iris of human eyes using zero crossings of the wavelet transform is used to extract the unique features [16]. This technique has been tested for real time implementations. Different neural network models and fuzzy classifiers are used [17], [18].

In year (2000), a new algorithm is introduced based on texture analysis for iris feature extraction using multichannel Gabor filtering and wavelet transform [19]. Further development to wavelet transform has been done using 2-D Haar wavelet transform. Earlier methods proposed for iris recognition were based on Gabor wavelet processing to iris images. Kumar et al. (2003) gave new approach to image recognition by using correlation filters. In this method two-dimensional Fourier transforms of the images are used. These filters also provide benefits like shift-invariance and graceful degradation [20]. Several other methods have also been developed for iris recognition. Sun *et al.*, [21] proposed method using moment- based iris blob matching. Since this method depends on segmentation of image. This will not give satisfactory results on poor quality iris image.

Chen *et al.*, (2006) has proposed Daugman's 2-D Gabor filter with quality measure enhancement [22] and Du *et al.*, (2006) proposed method of recognition using 1-D local texture patterns [23].

Jan Mazur proposed fast algorithm for iris recognition. In which binning is used instead of convolution results in fast recognition [24].

A new method using fractal dimensions of haar patterns has been proposed in which haar wavelet is applied to extract the multiple features form iris image. Further K-NN, Euclidean distance measures used as classifier [25].

2.3. ECG Recognition System

Electrocardiogram (ECG) signal is an alternative method that can be utilized for this objective. Normally ECG signal is employed to observe patient's heart function. The shape of ECG signal indicates about the condition of patient whether or not a heart is in normal condition. Based on the consideration a human heart as a system of each person, its ECG signal which represents as an impulse response of the system, thus has its own feature. A few works have been done on this particular purpose. These works collected various features of ECG signals to make a decision of the identification The use the electrocardiogram (ECG) as a biometric has been found to give relatively high result for human recognition [26, 27].

Biel *et al.*, (2001) investigated identification of human using their ECG. A standard 12-lead ECG system has been used for testing and training purpose. For identification of particular person classifier used is SIMCA. Experimental results show that identification can be made using 1-lead ECG data. Test results show that the features extracted from the ECG signal are unique to an individual and invariant to the individual state of anxiety. Identification performance is not affected by placement of electrodes [26].

In [1] technique used to extract features from an ECG signal is correlation method. Later, to obtain spectral characteristics of ECG beats many techniques like Fourier Transform (FT),

Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) and Continuous Wavelet Transform (CWT) method can be used. A feature extraction method using Discrete Cosine Transform (DCT) was proposed which offers even a better recognition performance. A new approach has been published to extract features from ECG wave named AC/DCT. In this non-fiducially technique auto correlation coefficient of ECG wave was calculated using data window then DCT is applied on calculated correlation coefficients, which requires no synchronization of heart beat pulses [28]. Next, proposed time and frequency domain features demonstrate high accuracy and high class of compactness [29]. Discrete Wavelet Transform (DWT) in feature extraction may lead to an optimal frequency resolution in all frequency ranges as it has a varying window size. DWT compared to Fast Fourier Transform (FFT) or DCT in preserving the energy of the ECG signal with a better time resolution. The DWT characterization will deliver the stable features to the morphology variations of the ECG waveforms [30]. In many research papers Wavelet transform has been done to find QRS complex using different wavelet function. Another method to find features from ECG signal is to find R-R interval using wavelets, known as fiducially detection.

2.4. Voice Recognition

Voice can also be used as identification purpose since every person is having different pitch period. It depends upon the way one speaks so it comes under behavioral category. Voice of the person depends on the vocal tract, mouth, nasal activities and lips movement that are used in synthesis of sound. These physical characteristics of human speech are invariant for individuals. Now the days, these voice recognition systems are commonly used. The speech of person changes over time due to age, medical/physical conditions, and emotional state. Different text dependent and text independent techniques have been used for recognition. Text-dependent systems based on Hidden Markov Model (HMM) using Gaussian or multi-Gaussian distributions [31] are more popular. A survey of text-dependent verification techniques is given in [32]. In text independent speaker verification, the users are not restricted to any fixed or prompted phrases. Voice recognition system can be classified into different types according to which kind of utterances they can recognize [33].

2.4.1. Isolated Word Recognition Systems: These systems accept single word or one single utterance. It will depend on reader because reader will recognize word from a list. Different techniques have been used for recognition like parallel processing or serial processing techniques. Both of these techniques have different algorithm to recognize words. Modern approach to word recognition based on neuron networks or neural networks.

2.4.2. Connected Word Recognition Systems: In connected word system isolated words run together with minimum pause. It is quite similar to isolated words running together. Efficient algorithm must be implemented to find out the best sequence and that sequence should be matched to actual sequence [33].

2.4.3. Continuous Speech Recognition Systems: Continuous speech recognizers permits user to speak, while the computer determine the content. Systems with continuous speech recognition are most difficult to implement. LDA is used for classification having better efficiency, resulting improved performance.

In 2003, a new approach for speech recognition has been introduced and is based on the neighborhood word to find out the word/speech [34]. Different techniques have been used in these systems to extract features. Principal component analysis is traditional nonlinear method that can be used to extract features, uses eigenvectors and covariance matrix and fast

processing [35]. Linear Discriminate Analysis (LDA), Linear Predictive coding, Cepstral Analysis, Kernel based feature extraction method, Wavelet based techniques are well known to extract features. K-mean clustering, Vector quantization, HMMs [1], Artificial Neural Networks (ANN), Gaussian Mixture Models (GMMs) and SVM are commonly used techniques for classification.

2.5. Palm Recognition

The region between our fingers and wrist is known as palm. Different lines based, texture based, orientation based and appearance based palm verification techniques have been used [1]. Biometric verification systems are becoming most popular in scenario as security concerns increases. Every person possesses different hand geometry based on this concept different technique used to identify person. Kong and Zhang were first to investigate the orientation information of the palm for palm print verification and their approach was defined as Competitive Code. This proposed scheme uses two fusion methods and gives 100% recognition rate [36], [37]. Robust palm verification system has been developed in 2008 used Principle component analysis [38]. Appearance based approaches includes principal component analysis (PCA), independent component analysis (ICA), locality preserving projections (LPP), linear discriminant analysis (LDA), etc. for palm print verification.

A new approach based on local texture pattern is proposed uses multi-scale Local Binary Patterns and Local Derivative Patterns as feature extraction techniques. Since palm vein feature extraction is a challenging problem in hand pattern recognition this approach promises for better results [39], [40]. An orientation based vertical correlation of 2DPalmHash Code and vertical correlation of Gabor feature matrix is introduced in which vertical correlation of 2DPalmHash Code and both the real part and imaginary part of Gabor feature matrices are suppressed [41].

3. Conclusion

Automatic human identification has numerous applications in many areas where the identity of person needs. To get the higher or air tight security complex security systems have been developed. In this scenario human identification plays an important role in every field of life.

Table 1. Comparison of Different Biometrics

Biometrics	Uniqueness	Performance	Measurability
Face Recognition	High	Medium	High
Iris Recognition	High	High	Medium
ECG Recognition	High	High	Medium
Voice Recognition	Low	Low	Medium
Palm Recognition	Medium	Medium	High

For example using one single key to open the lock code lock must be used for better security, different areas where it must be necessary to recognition persons, instead of doing this task manually a smart systems should be there for recognition purpose like in companies for attendance of every employ there must be an identification system. Table 1 depicts the performance level of different biometrics. Different analysis method used for feature

extraction purpose. Neural networks and clustering methods adopted for better classification purposes. Main concerns are about high level security, where rate of falsification as low as it can be.

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Authors

Gagandeep Kaur has received the B.Tech and M.Tech degrees, both in Electronics and Communication Engineering, from Punjab Technical University, Jalandhar, India in 2011 and Lovely Professional University, Phagwara, India in 2014 respectively. She had worked as Assistant engineer in BIOSTAR HEALTHCARE pvt. Ltd, Mohali, India. Her research topics include Biomedical Signal Processing, Pattern Recognition and Image Processing.

Gurpreet Singh has received the B.tech degree in Electronics and communications Engineering, from Punjab Technical University, India in 2012 and M.tech degree from Lovely Professional University, India in 2014 in stream Electronics and Communication Engineering. He is a member of IEEE. His research area includes Image Processing, Audio Signal Processing and Biomedical Signal Processing.

Vineet Kumar graduated in 2009 at the West Bengal University of Technology in ECE. He received the M. Tech degree in Electronics and Communication from Dr. B.R.Ambedkar NIT Jalandhar, India. Now he works as assistant professor at the Lovely Professional University, Faculty of Technology and Science, Department of Electronics and Communication. His research topics include Biomedical Signal Processing, biometrics, security and cryptography.