A Survey on Feature Extraction Techniques for Palmprint Identification

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Abstract:
Biometric recognition system is a pattern recognition system to provide a reliable personal recognition schemes to either confirm or determine the identity of an individual based on specific physiological or behavioral characteristics possessed by the user. Based on these characteristics, biometrics is normally classified into two categories, physiological and behavioral. Physiological biometrics is based on measurements and data derived from direct measurement of a part of human body. Some of the physiological biometrics include finger print, palmprint, facial etc. Behavioral biometrics is based on the behavioral traits like speech patterns, signature etc. In the biometric family, palmprint based identification system has become one of the active research topics. In this, the identification process consists of image acquisition, preprocessing, feature extraction and identification. A comprehensive survey on different techniques that are used for palmprint identification is presented in this paper.

Keywords: *Biometrics, palmprint, Identification.*

I. INTRODUCTION

Biometric based recognition systems have been receiving much attention in the field of personal identification/verification over the past decade. Based on the traits used for identification, biometrics is broadly classified into two categories such as behavioral and physiological as shown in fig. 1. In biometric system, physiological characteristics are considered to be more reliable compared to the behavioral characteristics. Palmprint comes under the physiological category. Palmprint focuses on the inner surface of a hand, its pattern of lines and the shape of the surface. Palmprint contains more amounts of detail in terms of principal lines, wrinkles and creases

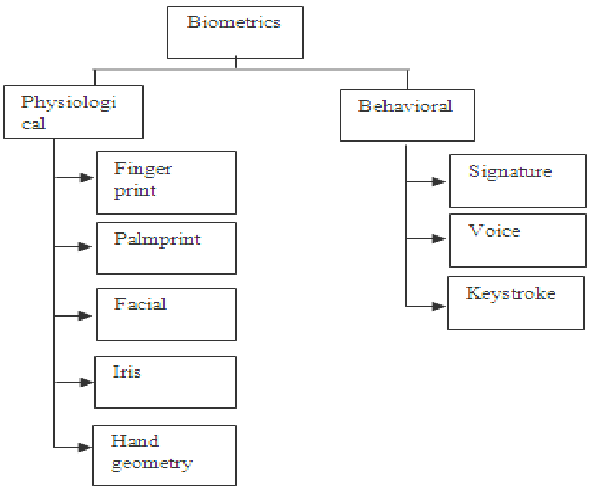

Fig.1: Biometric classifications

The inner surface of the palmprint mainly contains three flexion creases, secondary creases and ridges as shown in fig 2 [13]. The flexion creases are also called as principal lines and the secondary creases are called wrinkles. The flexion and the major secondary creases are formed between the 3rd and 5th months of pregnancy [1] and superficial lines are formed after birth. Basically, palmprint operates in three modes: enrollment, identification and verification.

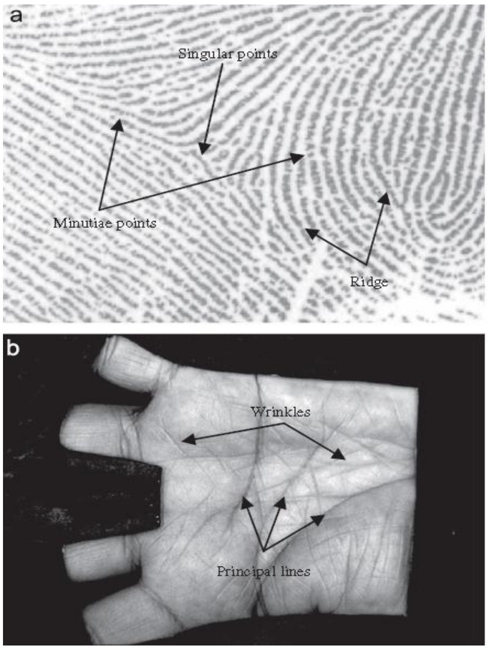

Fig.2: Palmprint features (a) a high resolution image and (b) a low resolution image

In enrollment process, several palmprint samples have to be given by the user to the system. Verification is the process of comparison with only those templates corresponding to the claimed identity. Identification is the process of comparing the palmprint against templates corresponding to all users in the database.

Palmprint identification as wide application, is used in both off-line applications as well as in on-line applications. In the case of off-line applications mainly high resolution images are used. Off-line applications include criminal detection. On-line applications like civil and commercial application use low resolution images.

A typical palmprint identification system as shown in fig 3 consists of four phases i.e., palmprint scanner, preprocessing, feature extraction, and identification [2]. Palmprint images are collected using palmprint scanner.

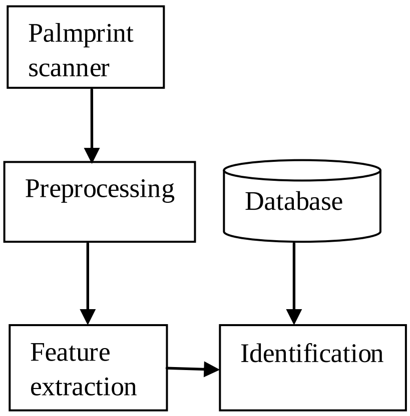

Fig.3: Typical palmprint identification system

II. PALMPRINT IDENTIFICATION TECHNIQUES

There are many techniques available for palmprint identification proposed by many researchers. This survey is based on various palmprint identification techniques.

2.1. Palmprint identification using 2-D Gabor filter

Among the various palmprint identification methods 2-D Gabor filter is used by Kong et al [3]. In this method texture information is obtained by using 2-D Gabor filter. In this, the Gabor function with certain parameters are used which is transformed into discrete Gabor filter. To provide robustness to brightness, Gabor filter is turned to zero DC. The adjusted Gabor filter is convoluted with sub images. Sample points in the filtered image are coded into two bits by using certain inequalities. By using this coding method, only the phase information about the palmprint image is stored in feature vector. In the matching process the two palmprint images are compared using the hamming distance. Here, each feature is considered as two 2-D feature matrices that is real and imaginary. A normalized hamming distance is used for palmprint matching. For perfect matching, hamming distance is zero. It provides robustness against varying brightness and contrast for images. However, they lack the ability of orientation selectivity and representation of major principal lines and wrinkles in the palmprint.

2.2. Using Fisherpalm

In [4], palmprint recognition method called fisherpalms is used. In this method, the points in the high dimensional image space are the palmprint images. In order to discriminate different palmprints efficiently, a linear projection based on FLD (Fisher's linear discriminant) is used to project palmprint from this high dimensional space to a lower dimensional feature space. The points in the high dimensional image space are called as original palmprint space (OPS). The two stages present in this method are Enrolment stage and Recognition stage. In the enrolment stage, the Fisherpalms linear transformation has to be computed by using the training samples and at first it is saved as Fisherpalm space and the mean of the palmprint classes is projected to Fisherpalm space. In the recognition stage, the feature vector is obtained by projecting the input palmprint image onto the stored Fisherpalm space. The feature vector is compared to that of the stored templates to obtain the recognition result.

2.3. Using Eigenpalm features

Another palmprint recognition method used in [5] is based on Eigen space technology. In this method, the original palmprint images are transformed into "eigenpalms" using Karhunen-Loeve (K-L) transform which is a small set of characteristic feature image. Eigen palms are the Eigen vectors of the training set. K-L transform normally represents the eigenvectors of the covariance matrix which contains the set of palmprint images. Eigenvectors is defined as the subspace of the palmprint, which are referred to as eigenpalms. Each training set contains different palmprints. In that, each palmprint is represented by an eigenvector. Because of that, the number of eigenpalms is equal to the number of different samples in the training set. According to the theory of Principal Component Analysis (PCA), it is not necessary to select eigenvectors as base vectors. Only the eigenvectors corresponding to the largest Eigen values can be used to represent the characteristics of the set. Features are extracted in the form of Eigen values and then Euclidean distance classifier is used for palmprint recognition.

2.4. Using Binary orientation co-occurrence vector

Normally for palmprint verification various approaches are being used. Among them the most commonly used approach is orientation based coding methods. In the orientation based coding approach, different types of codes are there like competitive code (comp-Code) [6] and robust line orientation code (RLOC) [7]. In this the images are convoluted with filters of different orientations and dominant orientations are determined based on some criterion. High accuracy palmprint identification could be implemented by simply coding the orientation map of palmprint. By doing this some valuable information will be lost as only one dominant orientation is used to represent a local region. In [8], multiple orientations are used to represent the local region. This multiple orientation is obtained by preserving all orientation information. This preservation is done by concatenating the responses as a vector. Then thresholding is done in order to binarize the response vector. Hamming distance is used for identification purpose.

2.5. Using Gabor feature based $(2D)^2$ PCA

According to the earlier works, Gabor filter convoluted with palmprint images is used for extracting the features. The features are represented using hamming code and identification is carried out using hamming distance approach. It has several advantages. But it needs more time and memory for feature coding and matching pixels. In order to extract more local features, a series of Gabor filters of various scales and orientations (Gabor filter bank) are used. But it is difficult to implement. By combining the above two procedures a new algorithm was put forward in [9]. In this process, Gabor filter bank is used in the first step for extracting the Gabor features by convolution with the original image. Gabor feature space will contain all the Gabor feature metrics of the training samples. In the second step, the dimension of Gabor feature space is reduced in both row and column direction $(2D)^2$ PCA is used. This in turn will result in fewer coefficients for feature matching. In the last step to perform feature matching and classification, Euclidean distance and nearest neighbor classifier respectively are used.

2.6. Using Gabor-based local invariant features

Another feature extraction process is proposed by X.Pan et. al., in [10]. Typical palmprint recognition system consists of three stages that is preprocessing, feature extraction and identification. In feature extraction stage, features are extracted. For extracting the features, three steps are mainly used. In the first step, a 2D Gabor filter is used. Gabor filter is used for extracting local invariant features by convolution with the palmprint image. In the next step, the obtained feature is given to the two layer partition. In the first partition, each palmprint image is divided into upper-layer blocks. Later in the second partition each of the upper-layer block is divided into four and constitute the lower layer partition. In the last stage, the local relative variance of the partitions are calculated. In order to get the local invariant feature first it is partitioned and then the difference of variances between these partitions that is lower-layer and upper layer is calculated. For matching purpose, nearest neighbor classifier is used.

2.7. Using 2-D Gabor wavelet

In [11], palmprint image is taken as input. The palmprint image is normalized based on its orientation, position and illumination. The feature extraction step is carried out in two phases. In the first phase, a 2D Gabor wavelet is used for decomposing the image. The image is decomposed by using the Gabor filters, that is by convoluting the image with the Gabor function. And the decomposed image is given to the next phase of the feature extraction step. In this phase a Pulse Coupled Neural Network (PCNN) is used. PCNN converts each of the decomposed sub band into a series of binary images. From these binary images, entropy value is calculated and regarded as the feature. These features are given to support vector machine for palmprint classification purpose.

2.8. Using adaptive lifting wavelet scheme

The earlier work done on the palmprint recognition takes a lot of time as well as it is difficult to implement with hardware. So, in order to avoid this problem in feature extraction phase, wavelet based method is used. In this method [12] mainly three steps are used. To extract the features, adaptive lifting scheme and PCNN are used and support vector machine is used for the identification purpose. In the first step, adaptive lifting wavelet scheme is used. The lifting scheme provides a simple yet flexible method for building new, possibly nonlinear, wavelets from existing ones. It comprises of a given wavelet transform, followed by an update and a prediction step. Each of the image is decomposed into approximate image and detail image using a wavelet transform. The output comprises of three detail sub bands and one approximate sub band. The detailed sub band is given to the PCNN. In this each of the sub band is converted into a series of binary images. From these binary images entropy values are calculated and these are considered as features. These features are given to the next step, i.e., to the classifier. Support vector machine is used to analyze data and recognize patterns.

III. CONCLUSIONS

This survey shows the various techniques that are used for palmprint identification. In some of the techniques the major demerit found is the orientation selectivity problem, complex encoding process and difficult to implement with hardware. Some techniques are efficient and consume less time for identification process. Each technique has its own advantage and disadvantage based on cost, classification time and robustness to varying factors. The techniques can be selected based on the requirement.

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BIOGRAPHIES

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