International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869, Volume-2, Issue-11, November 2014

Feature Extraction Techniques for Palmprint Identification: A Survey

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***Abstract*— Palmprint recognition has been investigated over the past decade. Palmprint recognition has five stages palmprint acquisition, pre-processing, feature extraction, enrolment (database) and matching. Due to rich information in palmprint it became a powerful means in person identification. The major approach for palmprint recognition is to extract feature vectors corresponding to individual palm image and to perform matching based on some distance metrics. Palmprint recognition is a challenging problem mainly due to low quality of pattern, large nonlinear distortion between different impression of same palm and large image size, which makes feature extraction and matching computationally demanding. In this paper we talk about the various approaches of palmprint recognition using matching pattern method.**

***Index Terms*— palmprint; recognition; biometrics; feature; extraction**

I. INTRODUCTION

It is necessary to understand a generalized pattern of a common human palm print. The inner surface of the palm normally contains three flexion creases (dark and deep lines), secondary creases and ridges. The flexion creases are also called 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 and superficial lines appear after we born. Although the three major flexion are genetically dependent, most of other creases are not [1]. Even identical twins have different palmprints [1]. These non-genetically deterministic and complex patterns are very useful in personal identification. Human beings were interested in palm lines for fortune telling long time ago. Scientists know that palm lines are associated with some genetic diseases including Down syndrome, Aarskog syndrome, Cohen syndrome and fetal alcohol syndrome.

II. GENERAL APPROACHES

Palmprint research employs either high resolution or low resolution images. High resolution images are suitable for forensic applications such as criminal detection [2]. Low resolution images are more suitable for civil and commercial applications such as access control. Generally speaking, high resolution refers to 400 dpi or more and low resolution refers to 150 dpi or less. Fig. 2 illustrates a part of a high-resolution palmprint image and a low resolution palmprint image. Researchers can extract ridges, singular points and minutia points as features from high resolution images while in low resolution images they generally extract principal lines, wrinkles and texture. Initially palmprint research focused on high-resolution images but now almost all research is on low resolution images for civil and commercial applications. This is also the focus of this paper.

A typical palmprint identification system as shown in fig 1 consists of four phases i.e., palmprint scanner, preprocessing, feature extraction, and identification [2]. Palmprint images are collected using palmprint scanner.

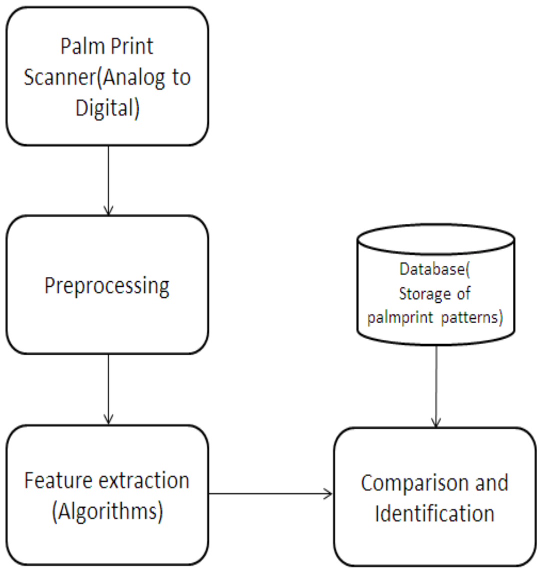

Figure 1: Palmprint Recognition System

III. PALMPRINT ACQUISITION TECHNIQUES

A palmprint system's first step is always the image acquisition. Depending on the image resolution, measured in dots per inch (dpi), different features can be extracted:

i. Low resolution images: With less than 400 dpi, we can appreciate the hand's geometry or identify wrinkles, principal lines and texture.
ii. High resolution images: With at least 400 dpi or more, for features such as singular points, minutiae and ridges can be obtained [3].

Palmprint identification systems rely on the knowledge of the parts of the human hand and the characteristics that it possesses on the palm. To clear some concepts, the following definitions are presented:

Manuscript received November 13, 2014.
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Hand Geometry: A hand can be seen as a whole geometrical figure and its outer shape can be analyzed for human identification. Systems relying on the human hand geometry are fast and simple to implement, however, they don't work well with a big dataset since as the number of people analyzed grows, the chances of encountering two or more individuals with the same hand geometry increases. Systems like this will also be deficient identifying and differencing the left and the right hand, as well as discerning between a pair of twins. For the classification phase, algorithms relying on graph matching are typically implemented.

Principal Lines: These are the three biggest creases that one can see in its own hand which are formed due to the folding of our palm through the course of our lifetime [4]. A system based on principal line extraction and classification would be more complex than a hand geometry system, however the implementation and imaging will be still easy since the features are still visible and have a notorious geometry.

Wrinkles: The wrinkles are the small lines that overlap the principal lines. These lines have the same thickness of a principal line; however they have no individual name since every human being has a set of different wrinkles. Wrinkles tend to be ignored for biometrical purposes [4].

Ridges: Ridges are the thin creases that cover the entire palm and finger in a quasi-continuous way. These lines are harder to see and discern for the human eye, however, they can be obtained with a meticulous ink to paper method or with commercial scanners. Ridges guarantee the uniqueness of a sample from individual to individual.

IV. PALMPRINT RECOGNITION TECHNIQUES

A typical palmprint identification system as shown in figure consists of four phases i.e., palmprint scanner, preprocessing, feature extraction, and identification [5]. Palmprint images are collected using palmprint scanner.

Feature Extraction considering elimination of creases

In this method we go through three major stages which are namely ridge candidate is extracted from the image, the particular ridge candidate is extracted and then the image is processed. First a palmprint image is fed to the ridge candidate extraction part. Here, we convert the image into small special regions we want to examine further, and several ridge candidates are detected by using only local information in each local area. Since several candidates are extracted, they are bound to include both ridges and creases. Next, in the ridge candidate selection part, in each local area we select the candidates which represent the ridges by using global information such as the continuity. An image is then constructed by the candidates who are selected in each of the local areas. There is no noise or creases in the restored image. Then in the post process part, the image is binarized, thinned, checked for correctability as the thinned image, and repaired. Finally minutiae are extracted from the thinned image. In the post process part, conventional methods are used. Experimental results confirm that even if the image contains areas including many creases the new method has the ability to extract ridges accurately[10].

Using statistical and wavelet features

In this method a set of features is used to capture the behavior of the palmprint in both spatial and frequency domains. Based on the simulations, this results in a very highly accurate identification method for palmprints. Two images may have similar global characteristics but look different in local regions. Thus the local features are extracted from different parts of each palmprint and combined to create a feature matrix for every image. Each palmprint is divided into non-overlapping blocks, and from each block, 5 statistical and 9 wavelet-based features are derived which are expected to capture the frequency information of the palms. To obtain the statistical features of each block, it is necessary to find the histogram of pixel intensities first.
The goal of palmprint recognition is to identify a person using their palmprint samples. It is possible to use the derived features of each person for identification. After finding the features of all people in the dataset, a classifier is required so that the features of each test palmprint can be compared with all of the available samples in the dataset and find the most similar one. There are different classifiers that can be used for this job; for example, minimum distance classifier and probabilistic neural networks. By using this method, our algorithm is able to identify palmprints with similar line patterns as well as unclear palmprints. The proposed algorithm has significant advantages over the previous popular methods. The used features are very simple to extract. The algorithm is very fast and it does not need a lot of calculations. Most importantly, it has a very high accuracy rate [11].

Holistic Based Approaches

Holistic-based approaches are the ones in which the hand is considered as a whole, hence, characteristics such as the geometry or inside lines are not essential. The palmprint image is first represented as a spatial or transform domain, therefore treated as any particular image. Subsequently, three different holistic feature extractions may be used [7]. In the sub spaced method, the image is converted into a vector, a two-dimensional matrix or a second order tensor, with the aid of principal component analysis (PCA). For the transform-based methods, Fourier transform or Discrete-Cosine Transformation (DCT) is used to extract features form the image's transform domain. Finally, in the invariant moment-based technique proposed by Wu et al. [8], algebraic features let the system consider each pixel of the palmprint image as a coordinate in a high-dimensional image space. Although robust and effective for simple matching, holistic-based approaches are mostly considered for low resolution images in which the palm inner features are not easily seen. The use of various transforms like Fourier transform or DCT really affect the overall performance of the system and there are better ways for feature extraction since this method cannot be efficiently used for high resolution images but it does give good performance for low resolution images.

Line Based Approaches

This approach develops edge detectors or use existing one to extract palm lines. Palm line are matched directly or represented in other format for matching. First using sobel masks magnitude of palm lines are computed. The magnitude are projected in x and y directions to form histograms. They computed first and second order derivative of palm images. These derivatives can be obtained by rotating the masks. The zero crossing of first order derivative is used to identify the edge points and corresponding directions. Second order derivative is used to identify the magnitude of the lines. The weighted sum of local directional magnitude is an element in the feature vector. Euclidian distance is used for matching. Line-based methods deal with the representation of certain lines chosen from the palmprint, such as the principal lines, wrinkles or ridges (according to the resolution). For example, the proposal made by Wu et al. [9] uses the first and second order derivatives of a Gaussian 1-D function to convolve it with the original image matrix and locate a certain line with a certain direction. Once the new matrix has been obtained, the image is rotated to obtain several lines according to their direction. Finally, every obtained image is overlapped to generate the total feature extraction. On Figure 2.7, the structure of the line-based algorithm presented in [9] is shown, starting from the original image and finishing with the extracted features.

Hybrid Approaches

The characteristics of the holistic and the feature based systems can be combined to create a feature extraction made with both holistic and feature-based characteristics. The combination and accumulation of several features is reflected in higher accuracy for the matching, as proven by Kong et al. and Kumar et al. mentioned by [7]. The disadvantage of these approaches resides in the increase of computational resources and the complexity of developing parallel algorithms working for a same image's vast different characteristics, reflected in a much more diverse research group and thus, a bigger economical cost. These approaches should only be implemented for high security applications where the economic cost is not a factor, such as military devices.

V. CONCLUSION

The paper tries to summarize the various palmprint recognition strategies which can be taken to implement the system. All the techniques have some advantages and some disadvantages such as a major drawback was the orientation selectivity problem whereas some techniques suffer from complex encoding process and some are tedious to implement with hardware. Some techniques consume less time and are efficient for the process of identification. Each technique has its own advantage and disadvantage based on classification time,robustness and cost to varying factors. The techniques can be selected based on the requirement.

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