User Verification by Hierarchical Palmprint Matching

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ABSTRACT
Biometric verification system has high efficiency, high recognition rate and comfortable to user's operating characteristics. Palmprint authentication system is considered to be the most reliable biometric recognition technique due to its merits such as low-cost, user-friendliness, high speed and accuracy. Real time images are captured using a scanner at a resolution of 550 x 460.Each of these gray-scale images are aligned and then used to extract palmprint features. These features are then used for authenticating users. This paper presents a hierarchical palmprint matching system that is used to reduce the computation cost by segmenting the image and matching it with the database, thereby false palmprints are rejected in the subsequent changes by comparing just a portion of the whole palmprint.

General Terms

Preprocessing, Feature Extraction, Matching

Keywords
Palmprint authentication, segmentation, binarization, hierarchical palmprint matching.

1. INTRODUCTION
Reliability in personal authentication is the key to security for any transactional databases and biometric technologies play an important role in various security applications. Biometrics-based authentication is a verification approach using the biological features inherent to each individual. Most of the current research in biometric focuses on fingerprint, iris and face. However it is difficult to extract fingerprint features i.e. minutiae from unclear fingerprints and iris output devices are expensive. The reliability of face biometric is low as it continues to problem with pose, lighting, orientation and gesture. Compared with all of these, the palmprint biometric has several advantages: (i) Palmprint contain rich texture information than fingerprints; (ii) It can easily be integrated with existing authentication system to provide an enhanced level of authentication; (iii) User acceptability is high; (iv) Even with low resolution device palmprints are easily captured.

A palmprint image consists of various features, including principal lines, wrinkles, ridges, minutiae points, singular points and texture. These line structures are stable and remain unchanged throughout the life of an individual. Moreover, no two palmprints from different individuals are the same and people do not feel uneasy to have their palm images taken for testing. Therefore palmprint recognition offers promising future medium-security access control system.

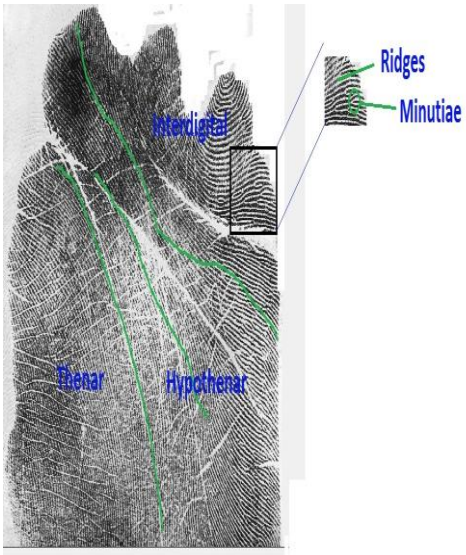

Fig.1.Palmprint Image

Palmprint verification system is a one-to-one matching process. It matches a person's identity to an enrolled pattern. There are two phases in the system—*enrolment* and *verification*. An illustration of typical palmprint system is given below.

a. At the *enrolment* stage, a set of template images represented by their features is labelled and stored into a database.
b. At the *verification* stage, features are extracted from an input image and then are matched with the person's palmprint image features stored in the database.

Both phases comprise the following steps: Pre-processing, Feature Extraction and Matching

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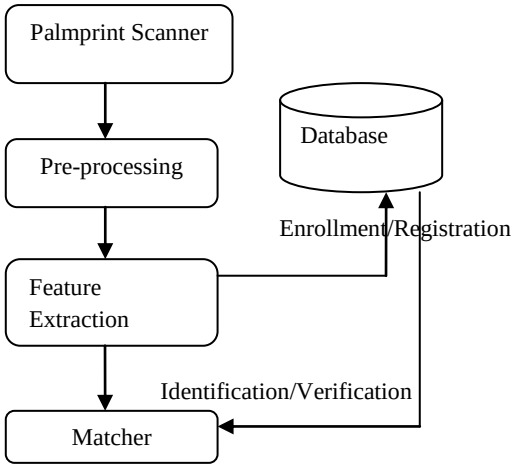

Fig.2. An illustration of a typical palmprint verification system.

The rest of the paper is organized as follows: section 2 describes some related works. In section 3, the proposed framework is introduced, and in section 4, experimental results are evaluated and finally this paper is concluded in section 5.

2. RELATED WORK

David Zhang et al (2002) discuss Palmprint recognition based on Fourier Transform that aims at finding out the palmprint template from the database, which is from the same palm as a given palmprint input. Feature Extraction plays an important role in the recognition process [2][3][10]. In order to extract a feature a spatial domain palmprint image is converted into frequency domain using Fourier Transform (FT) and representing palmprint features in the frequency domain. The extracted features are used as indexes to the palmprint templates in the database and the searching for the best match is leaded by these features in a layered fashion [11].

David Zang et al (2003) discuss a biometric approach to Online Palmprint Identification using Palmprint Technology. This system process low-resolution image to achieve effective Personal Identification. The system consists of two parts: a novel device for online palmprint image acquisition and an efficient algorithm for Palmprint recognition [9][4][5].

Jain et al (2009) discuss Latent Palmprint Matching Systems for palmprint-based personal authentication in access control type of applications that is needed in forensic applications. This system is dealing with palmprints captured at 500 ppi or higher resolution and uses minutiae as features to be compatible with the methodology used by latent experts [1].

Dai et al (2011) discuss multi-feature based high resolution palmprint recognition [7]. The algorithm includes :(1) Use of multiple features namely minutiae, density, orientation and principal lines for palmprint recognition to significantly improve the matching performance of the conventional algorithm. (2)Design of a quality based and adaptive orientation field estimation algorithm, which performs better than the existing algorithm in case of regions with large number of creases. (3)Use of a novel fusion scheme for identification application which performs better than the conventional methods, e.g. weighted sum rule, SVMs or Neyman-Pearson rule.

Dai et al (2012) discuss Robust and efficient ridge-based palmprint system. A segment-based matching and fusion algorithm is used to deal with the skin distortion and the varying discriminative power of different palmprint regions and to reduce the computation complexity. Here, the whole palmprint is divided into small segments, which are the separately matched to deal with distortion [6]. The similarity between two palmprints is calculated by fusing the similarity scores of different segments using a Bayesian framework.

Chen et al (2013) discuss Hierarchical and Minutiae Matching for Fingerprint and Palmprint Identification System. This method decomposes the matching step into several stages and rejects many false palmprints on different stages, thus it can save much time while preserving a high identification rate. A hierarchical strategy is used in the matching stage[7]. A randomly selected 500 palms is used to form the training set, and the rest are used for testing.

3. PROPOSED WORK

3.1 Image Acquisition

Image Acquisition can be done in different ways. The image is obtained from the scanner multi-scan basic SDK 2.6. Different Impressions for the same palm are collected from different persons.

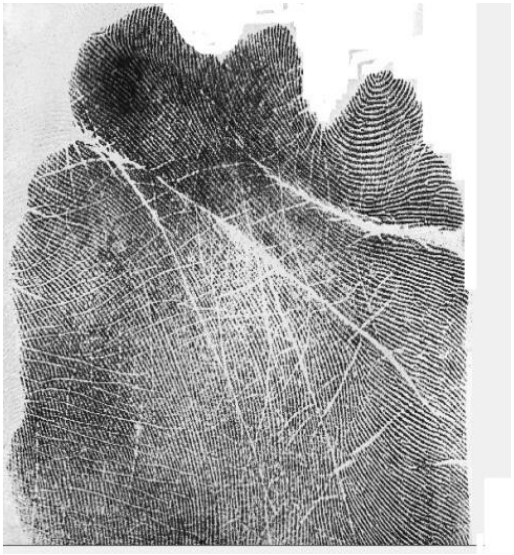

Fig.3. Sample of a registered palmprint collected in our database.

3.2 Preprocessing

In this module palm image is pre-processed and palmprint region is extracted. The palm image is binarised using a global thresholding. Due to regular and controllable uniform background illumination condition during image capturing, and contrasting colour of palm image and background, global thresholding can be applied to extract the palm from the background [7]. Image is pre-processed using image enhancement procedures and processed with morphological operations to remove any isolated small blobs or holes. In the

pre-processing stage the gray level image is converted to binary image.

3.3 Minutiae Extraction

Enhancement of the image is the extraction of minutiae. The enhanced image is binarised first in this step. The skeleton of the image is then formed. The minutiae points are then extracted by the following method. The binary image is thinned as a result of which a ridge is only one pixel wide. The minutiae points are thus those which have a pixel value of one (ridge ending) as their neighbour or more than two ones (ridge bifurcations) in their neighbourhood. This ends the process of extraction of minutiae points. The similarity of two sets of minutiae are computed as the product of matching quantity score S_{mn} and quality score S_{mq} computed in Equation (1).The matching quantity score is measured by the sum of matched minutiae pairs. The matching quality score is computed as the proportion of matched minutiae in all minutiae within the common area [7].

$$S_m = S_{mn} \times S_{mq} \quad (1)$$

3.4 Segment based Hierarchical Palmprint Matching

In this work a quantitative statistical study of various characteristics of various palmprints to be conducted to guide the design and parameter selection of matching system. A hierarchical strategy is used in the matching stage [8]. A randomly selected 500 palms is used to form the training set, and the rest are used for testing. In order to deal with distortion and varying discrimination power of different palmprint regions, a segment-based palmprint matching and fusion algorithm can be used. Hence the whole palmprint image is divided into small segments, which are then separately matched to deal with distortion. The similarity between two palmprints is calculated by fusing the similarity scores of different segments using k nearest neighbour algorithm. A filter is built to reject non-matched palmprints in an early stage by comparing just a portion of the whole palmprint. The Palmprints are aligned at segment level. The segmented image is matched with the corresponding segment from the database[6]. The hierarchical matching scheme is used to reduce the computation required to match two images [8]. In order to avoid the blind searching for the best fit between the given patterns, a guided search strategy is used that searches first at the low level, coarse grained images, to the high level, fine grained images. The training set is used to learn the threshold for each step. In each step the threshold is determined to allow the right template in the database. Hence this Hierarchical strategy can reject many false palmprints which do not belong to the same palm as the input palmprint quickly, thus it can save searching time compared to the conventional method. The similarity scores of minutiae are combined by k-nearest neighbour, k-means to output a match score[4]. The likelihood ratio of Genuine versus Impostor can be calculated. If the calculated likelihood ratio is greater than the threshold, the match pair is declared as impostor.

4. EXPERIMENTATION AND RESULTS

Till now there has been no publicly available high resolution palmprint database to our knowledge. To test the algorithm 218 palmprints from 30 subjects have been collected from persons (two palms per person and four impressions per palm). All these palmprints are made up of 550x460 pixels and 96 ppi. Among all the palmprints about 20 percent are poor qualities due to large amount of creases, deformation, smudges, blurs, and incompleteness.

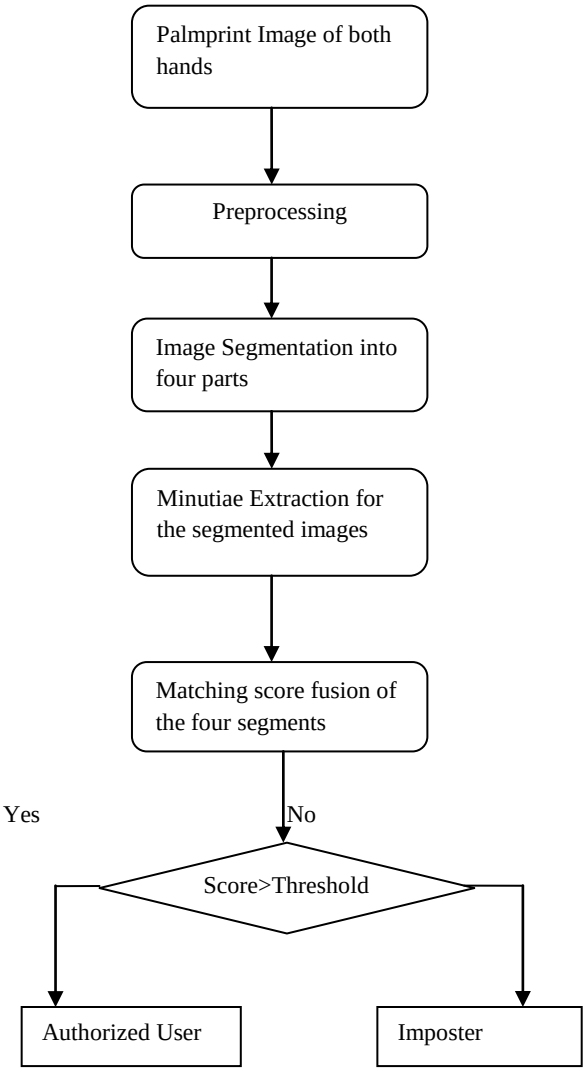

Fig.4 .Flowchart of the proposed Palmprint Matching System

As for accuracy 18 palmprints are not registered in database because of poor quality which is 0.3 percent of all the palmprints. All these failure cases are due to improper impression or of bad image quality. The accuracy is effective in this case of minutiae based method than texture based methods.

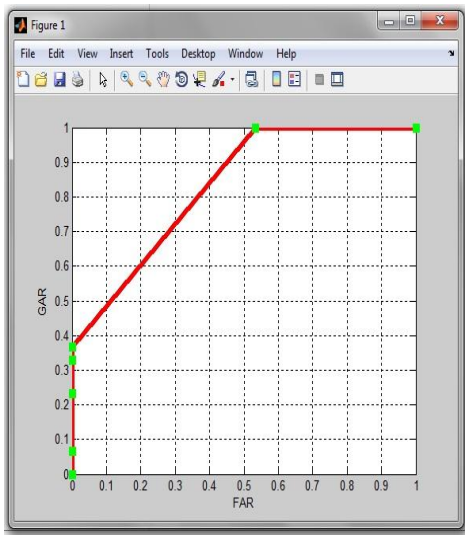

Fig.4.1. GAR and FAR graph

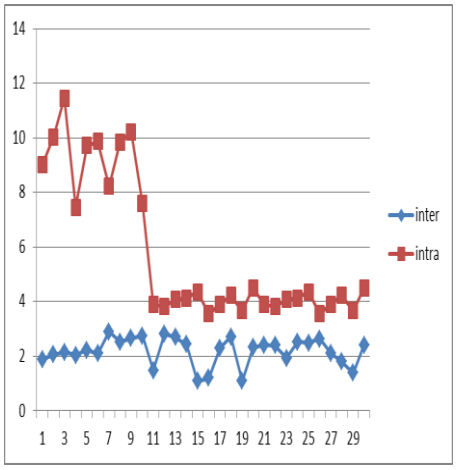

Fig.4.2 Matching Score of the Proposed System

As for accuracy is concerned the proposed palmprint matching system detects with 73 percent inter, intra matching at an absolute error rate of 0.182(calculated based on threshold value).

5. CONCLUSION AND FUTURE WORK

The segmentation and hierarchical matching strategy can reject many palmprints which do not belong to the same palm as the input palmprint quickly, thus it can save much time. Experimental results show that the proposed algorithm can produce high accuracy compared to the traditional method and illustrate its effectiveness. Not as the conventional method based on classification and indexing, the proposed method does not use more features than or information than minutiae, and it can be integrated as the conventional identification systems in future.

6. REFERENCES

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