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A Fast and Accurate Palmprint Identification System based on Consistency Orientation Pattern

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Abstract — A palmprint identification system is a relatively most promising physiological biometric approach to identify the person. The numbers of palmprint recognition based biometric system have been successfully applied for real world access to control applications. A typical palmprint identification system identifies a query palmprint and matching it with the template stored in the database and comparing the similarity score with a pre-defined threshold. The Consistency Orientation Pattern (COP) hashing method is implemented in this work to enforce the fast search and to obtain the accurate result. Orientation pattern (OP) is defined as a collection of orientation features at arbitrary positions. The principal palm line is a kind of evident and stable features in palmprint images, and the orientation features in this region are expected to be more consistent than others. Using the orientation and response features extracted by steerable filter and gives an analysis on the consistency of orientation features, and then introduces a method to construct COP using the consistent features. Those features can be used as the indexes to the target template. Because the COP is very stable across the samples of the same subject, the COP hashing method can find the target template quickly. This method can lead to early termination of the searching process.

Index Terms — Consistency, hashing, orientation pattern, principal palm line, searching and steerable filter.

1 INTRODUCTION

A Biometrics refers to metrics related to human characteristics and traits. Biometrics authentication is used in computer science as a form of identification and access control. It is also used to identify individuals in groups. It is wide acceptance in network society due to its security, reliability and uniqueness. The great challenge to biometrics is thus to improve recognition performance in terms of both accuracy and efficiency and be maximally resistant to illusory practices. The characteristics of biometrics are distinguished into two main categories such as physiological and behavioral. The physical biometrics is fingerprint, palm print, face, iris etc. The behavioural biometrics is voice, gesture, signature etc.

A palm is the inner region between wrist and the fingers. Palmprint recognition, a relatively novel but promising biometric technology, has received considerable research interests in the current decade. Like finger prints, palms of the human needless comprise unique pattern of elevations and valleys. Since palm is larger than a finger, palmprint is predictable to be even faster than finger print. The forthright biometric system should use a high-resolution palmprint scanner and it assembles all the structures of the palm such as hand geometry, ridge and valley topographies, principal lines, and wrinkles. The characteristics of palmprint are uniqueness, reliability, security and performance.

A coordinate system is set up on basis of the boundaries of fingers so as to extract a central part of a palmprint for feature extraction. The palmprint authentication system can operate in two modes, enrollment and verification. In the enrollment mode, a user is to provide several palmprint samples to the system. The samples are captured by a palmprint scanner and passes through preprocessing and feature extraction to produce the templates stored in a given database. In the verification mode, the user is asked to provide his/her user ID and his/her palmprint sample. Normally the regions of the human palm contain three flexion creases, secondary creases and ridges. The flexion creases are also called principal lines and secondary creases are called wrinkles.

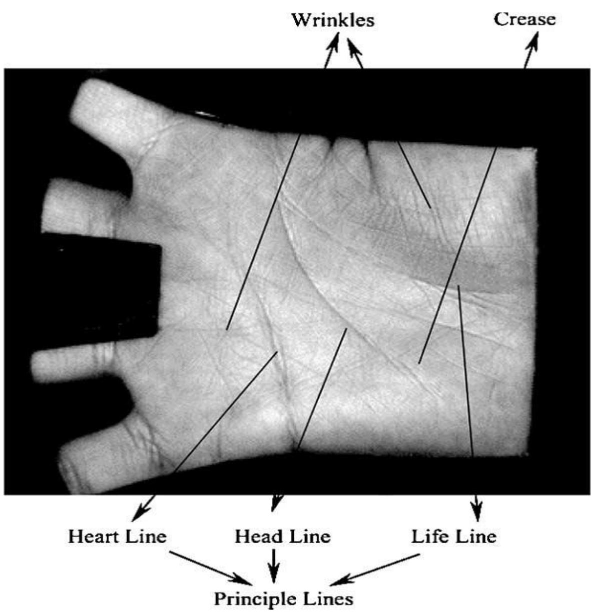

Fig.1 Feature of principal palm line

The flexion creases are also called principal lines and secondary creases are called wrinkles. The figure 1.1 illustrates the features of principle palm lines that could be used to uniquely identify a person. Six major types of features can be observed on a palm.

a) **Geometry Feature:** According to the palm shape, we can easily get the corresponding geometry feature such as width, length and area.

b) **Principal line feature:** The principal lines in a palmprint are very paramount physiological characteristic for single out the individual because they are very staunch and indisputable. Three persistent lines such as, the heart line, the head line and the life line are specified feature in the principal palm line and which is consistent.

c) **Wrinkles:** In a palmprint there are many wrinkles are available bur wrinkles different from the principal lines. Those principle lines are fragile and more weaving. Wrinkles are classified as coarse wrinkles and fine wrinkles so that it falls on difficulty to identify the more features in detail can be acquired.

d) **Datum points:** Two end points called datum points are obtained by using the principal lines. These intersect on both sides of a palm and provide a stable way to register palmprint.

e) **Delta point feature:** The delta point is defined as the center of a delta like region in the palmprint.

f) **Minutiae:** A palmprint is basically composes of the rides, allowing the minutiae feature to be used as another significant measurement.

For the fast identification task, main goal is to find the target template by matching the query with the minimum number of candidate templates. So that the consistent feature of the query can serve as the indexes to find the target template. Classification approach, hierarchical approach, coding approach, hashing and many more techniques has been used for the searching process. In that hashing is the best technique to enforce the fast search using the consistency analysis by constructing the COP.

2. RELATED WORK

Wu et al. [15] has been applied the classification approach for palmprint identification system, it divides palmprints into several classes and match the query only with the templates in its class.

The classes used in this method are unbalanced. However, this strategy speeds up the searching process but does not obtain the high accuracy.

You et al. [4] was implemented the hierarchical matching method. This method typically involves extracting multiple kinds of features and then searching in a layered fashion. Simpler features which can be quickly extracted and matched are used in higher layers to allow a large number of candidates to be discarded. This approach is also similar to classification approach. It increases matching speed at the cost of accuracy.

Kong et al. [2] proposed the Competitive coding based approach is the most promising ones because of their small feature size, fast matching speed, and high accuracy. In the feature extraction stage, these methods encode the responses of a bank of filters into bitwise code, and in the matching stage, the similarity score can be efficiently computed by Boolean operators. It achieves the accuracy and speed for small number of input images and datasets, but it does not applicable to the large-scale database.

Zhou et al. [12] used the gradient-based approach, the filter-bank based approach which is more robust against noise, and thus has been widely employed to extract orientation features for palmprint recognition. However, when only a small number of filters are used, the extracted orientation feature would be coarse.

Hao et al. [16] proposed a beacon guided fast iris search algorithm. In the pre-processing stage, they divided the database into a number of beacon spaces according to a collection of interleaved iris feature. In the searching stage, they proposed the multiple collisions principle to greatly shrink the search range. Evaluations of this method on a large-scale database (over 632,500 templates) show a substantial improvement in search speed with a negligible loss of accuracy.

Yue et al. [6] proposed a fast palmprint identification strategy based on competitive code and the cover tree method. Compared with brute force search, this approach can obtain identical identification results, and is 33–50% faster.

Zuo et al. [13] applied the methods to overcome the previous disadvantage for the fast matching speed of coding-based methods, when applied on a large-scale identification system, it is often necessary to speed up the searching process. Although several strategies have been proposed for fast palmprint identification, these methods, however, either lead to much accuracy loss or only obtain limited speed.

Yue et al. [8] improved the method by optimizing the tree structure. The experimental results show that the approach can further speed up the searching process without any accuracy loss, and the speedup can be further enhanced by including more templates per subject in the database. While both methods can reduce the identification time without accuracy loss, the speedups over brute force search are somewhat limited. Besides, these methods are not applicable for the identification systems where only one template per subject is stored in the database.

In order to deal with this problem, Zuo et al. [14] proposed a steerable filter based approach for accurate orientation feature extraction and a Generalized Angular Distance (GAD) measure for effective matching of accurate orientations. The GAD has the properties of tolerance for small angular difference and penalty for large angular distance, and thus is more robust against quantization errors.

Yue et al. [9] proposed a fast palmprint identification method using orientation pattern (OP) hashing. They introduced three properties required by the hash function and demonstrated that their OP satisfied all of these properties. Experimental results showed that this method could be more than ten times faster than brute force search, depending on the quality of the images in the database, while the identification accuracy almost remains the same.

The aim of this research work is to design a fast and accurate palmprint identification system for large-scale database. To perform the processes have to extract the feature that could be done through steerable filter that is based on Orientation Pattern it gives the better result compare with the previous work.

For searching the template COP hashing method leads to early termination and achieves the high accuracy compared with the previous work.

3. SYSTEM DESIGN

A consistent orientation pattern (COP) hashing method is implemented to enforce the fast and accurate palmprint identification system. At first have to preprocess the image and then extract the orientation features using steerable filter, and then select more consistent ones based on consistency analysis. COPs are then constructed based on the consistent features and are used as the indexes to the target template. Because of the stability of the COP across the samples of the same subject, the proposed COP hashing method can quickly find the target template, leading to early termination of the searching process. Fig 1 depicts the system architecture for proposed system. At first input is taken from various databases or captured images then based on the architecture every process has been performed and finally it identifies the correct template from the various datasets and leads to the early termination. The obtained results are fast and more accurate.

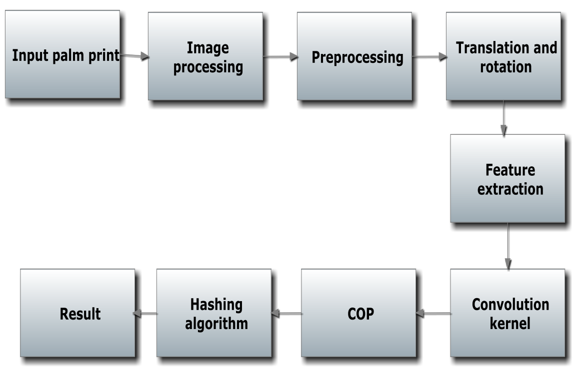

Fig 1: System Architecture

3.1 Image Preprocessing

The datasets has been collected from various databases [1]. The image preprocessing is the basic stage to process the input image. When the input palmprint images are captured, some variations are needed to process the image such as translation and rotation. At first have to translate the input RGB palmprint image into gray scale image, because it contains the low resolution value. On the same time the artifacts noise also be removed. After that ROI region of the palmprint image can be extracted. Then the input image can be enhanced to view the edges and corners of the palmprint image.

3.2 Feature Extraction Using Steerable Filter

Steerable filter is an orientation-selective convolution kernel used for image enhancement and feature extraction that can be expressed via linear combination of a small set of rotated versions of itself. As an example, the oriented first derivative of a 2D Gaussian is a steerable filter. The oriented first order derivative can be obtained by taking the dot product of a unit vector oriented in a specific direction with the gradient. The basis filters are the partial derivatives of a 2D Gaussian. Given the filter responses of basis filters, the response at arbitrary orientation can be analytically determined as a function of orientation. In this work, the optimal steerable filter used in and it is adopted for feature extraction. It has eight basis filters, and the synthesized steerable filter is expressed as

$$f * h_0 = q_0 \cos(\theta)^4 + q_1 \cos(\theta)^3 \sin(\theta) + \cdots + q_4 \sin(\theta)^4 \quad (1)$$

where h_0 is the rotated version of the filter, θ is the rotation angle, and $q_0, q_1, \ldots, q_4$ can be determined by the filter responses of basis filters and the coefficients of h.

3.3 Consistency Analysis on Orientation Features

The features cannot be simply classified as consistent and inconsistent ones since feature consistency seems to be continuously distributed. As for the fast identification task, goal is to find the target template by matching the query with the minimum number of candidate templates.

Thus the query's orientation features which are more consistent are more appealing, which indicates that the target template would have a high probability to have the same features. As a result, the consistent features of the query can serve as the indexes to the target, and how to find the relatively consistent features is the key to the task. Therefore, we need a single sample based consistency analysis method.

This method is based on two reasonable assumptions. First, principal palm line is a kind of evident and stable features in palmprint images, and the orientation features in this region are expected to be more consistent than others. Second, since principal palm line is thick and dark in palmprint images, the minimum filter responses in this region are much lower than those in other regions. Thus the principal line area can be determined by those orientation features with low responses. One can see that the features in the regions corresponding to principal palm lines are relatively consistent. In fact, the structure of principal palm lines can be easily observed from this weight map, which validates the first assumption. It can estimate that most of them locate in the regions are resemble to principal lines, which confirm and validates our second assumption. Thus it can conclude that, it is reasonable to find consistent features by examining the filter responses of a single sample.

Besides, the closeness of the orientation to the quantization border should also be considered in consistency analysis. When the orientation corresponding to the minimum response is close to any quantization border, the feature after quantization is likely to be inconsistent because of some factors like the deformation caused by finger movement and inaccurate pre-processing method.

To deal with this, we propose to consider two features when orientation is close to any quantization border. For example, when a query comes, if its orientation at one sampling point is between 25 and 35, then the templates whose feature is either 0 or 1 are regarded as candidates. As a result, although the feature may be inconsistent, with the help of consistency analysis, the target template will be successfully retrieved.

3.4 Hashing based Fast Identification

The core of hashing is the design of hash function, especially when the data contain a certain amount of noises. Based on the three properties required by a hash function that is discrimination, consistency, and randomness, this method develops a fast identification method using consistent orientation pattern hashing.

a) COP Construction

Orientation pattern (OP) is defined as a collection of orientation features at arbitrary positions. If the features are more consistent ones found by consistency analysis, and then call it as consistent orientation pattern (COP). A COP can be determined by two parameters, the size k and the position P. For an example take 5 COPs with size k = 10 that can perform the following operations. After filtering the palmprint image using steerable filter, then sort the filter responses in ascending order and select the first 50 features as consistent features, denoted as $cf_1, \ldots, cf_{50}$. Then divide them into 5 groups $\{cf_1, \ldots, cf_{10}\}, \ldots, \{cf_{41}, \ldots, cf_{50}\}$ and construct 5 COPs. Then call it as sequential COP because the features in the COPs are organized in a sequential fashion. Although the sequential COP is discriminative and consistent, it does not have the randomness property because of the strong local correlation. As can be observed, in each COP a large portion of orientation features located. An inconsistent feature caused by coarse quantization. That the features in each random COP are more scattered, and thus the local correlation of the COP can be greatly reduced. As a result, the random COP satisfies all the three properties required by a hash function and is expected to be more suitable for hashing based fast palmprint identification.

b) COP Hashing

The proposed COP hashing method subsists of two phases such as preprocessing and searching. In the pre-processing stage, first index all the templates in the database according to their orientation features, and build a hash table to facilitate fast searching. And also use two additional tables to record the offset and size of each bin in the hash table. Because there are 6 kinds of orientation features and each template is composed of 1024 features, the hash table has 1024 x 6 bins in total. If there are N templates in the database and each template is identified by a 4-byte integer, then the memory required to store the hash table is 1024 x 4 x N bytes, and the memory required by the other two tables is 1024 x 6 x 4 x 2 = 48 K bytes.

In the searching stage, extract the orientation features and the filter responses of the query, sort the filter responses in ascending order, and construct a number of COPs. According to the position and value of the first COP, look up in the hash table to find a collision, and carry out a full match to test whether the similarity score is higher than the threshold. If yes, return the ID and stop the identification process.

If not, it should examine the next COP in the same manner until find a match or have to considered all the COPs.

4. CONCLUSION

A COP hashing method is implemented for fast palmprint identification. The method is composed of four components: orientation feature extraction, consistency analysis, COP construction, and hashing. The proposed COP hashing method has been applied for several palmprint databases. The COP hashing can obtain comparable accuracy and high speed compared with brute force search, which verifies the effectiveness of the proposed method for fast and accurate palmprint identification.

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