보조영상 재구성을 이용한 장문 검증

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Palm Print Verification Using Subimage Reconstruction

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Abstract

The palm print recognition is the most reliable authentication method in the biometrics. In this paper, using the efficient segmentation of the palm print region we propose the method of enabling the palm print recognition as the same method applicable to the finger print recognition. To achieve this, we propose the image processing procedures of the palm print segmentation and the feature extraction. We compare the matching result after extracting the features for the finger print and the palm print.

1. Introduction

Palm print, as well as fingerprint which has been used as a positive human identifier for more than 100 years, is still considered as one of the most reliable means of distinguishing a person from the others due to its stability and uniqueness[1,2]. Palm is the inner-surface of the hand between the wrist and the fingers(see Fig. 1). There are usually three principal lines made by flexing the hand and wrist in the palm, which are named as heart line, head line, and life line, respectively [2]. There are many unique features in a palm print image that can be used for personal identification. Principal lines[3,4] wrinkles[4], texture[5,6,7], datum[2], minutiae points[8] and singular points are regarded as useful features for palm print representation. In addition, eigenpalmsInternational Conference on Pattern Recognition, (1998) 1849-1854
[9] and fisherpalms[10] are also used for features palm print.

Among them, geometry features, principal line features and wrinkle features, which are extracted form the low resolution image, have the limitation of recognition rate. Delta point features and minutiae features require high resolution image which can recognize the ridge and valley of the palm print. Since the palm print is larger than the finger print in image size, the method recognizing the line of the palm or geometry feature with the low resolution extraction of the palm print has been widely researched. However, with the recent development of the hardware, the high resolution image for the palm print can be extracted easily and the algorithm based on features having better performance can be applicable to the palm print.

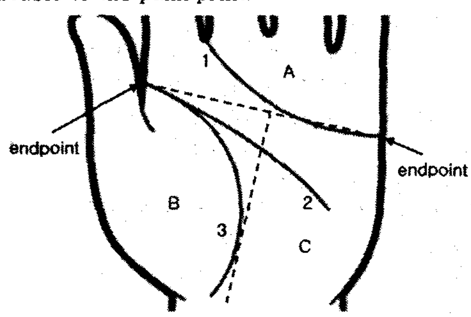


Fig. 1 Definitions of a palm print: principal lines(1-heart line, 2-head line and 3-life line), regions(A-finger-root region, B-inside region and C-outside region)

In this paper, the palm print recognition method using the feature based algorithm is proposed. In Section 2, we propose the feature extraction algorithm suitable to the palm print recognition and in Section 3, the fingerprint and palm print recognition are evaluated using the proposed algorithm. Finally, the conclusion is followed in Section 4.

2. Proposed Palm print System

The main step for extracting feature points in the palm print image is the same method as the feature point extraction in the finger print image. But the palm print image with the high resolution may have much load in the matching step since the image size is large. To solve this problem, the segmentation step is added as a preprocessing step in order to try to match among the simular regions by segmenting the palm print image into the significant regions. Fig. 2 shows the main method of processing the image. The main steps of the proposed algorithm is as follows:

1. Segmentation : After the input image is separated to the foreground and background, the foreground is divided into 5 regions using the palm print.

2. Orientation Image Estimation : Calculate the directions of ridges about each pixel.
3. Filtering : Filter the ridge out according to directions.

4. Binarization & Thinning : Binarization and thinning about the enhanced image.
5. Minutiae Extraction : Extract feature points using the thinning of the image.

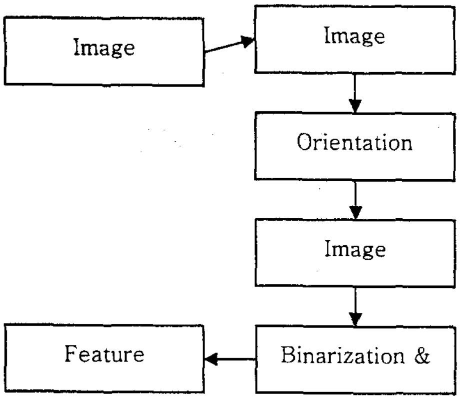


Fig. 2 A flowchart of the proposed palm print feature extraction algorithm

2.1 Segmentation

Since the palm print image is absolutely bigger than the finger print image, it is divided into several regions after separating the foreground and separated using the difference of the variance. At first, the palm print image is divided into as $w \times w$ blocks. In this case, the number of divided blocks is N. The variance(*Var(k)*) of k-th block of the Gray-level palm print can be expressed by the following equation:

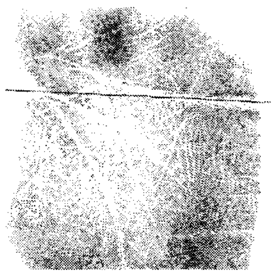
$$Var(k) = \frac{1}{\varpi^2}\sum_{x=1}^{\varpi}\sum_{y=1}^{\varpi}\left(G(x,y)-\bar{G}(k)\right)^2 \quad (k=1,\Lambda,N) \tag{1}$$

$\overline{G(k)}$ is the mean value of the k-th block and $G(x,y)$ is a gray value of the (x,y) pixel.

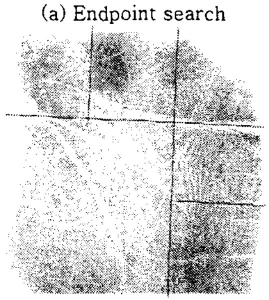
The foreground omage is segmented based on the palm print. Since the size of the palm print is large, the matching calculation can be decreased through conformity of same part of the segmented images. In this paper, we segment the finger root region and outside region with good quality among the palm prints. The image segmentation is expressed by the following step:

1. Search the root of the heart line.
2. Search the root of the head line.
3. Segment vertically connecting the root of the heart line and the head line.
4. Segment the upper part by trisection.
5. Segment the root of the lower part by bisection.

Fig. 3 shows the result of the segmentation.

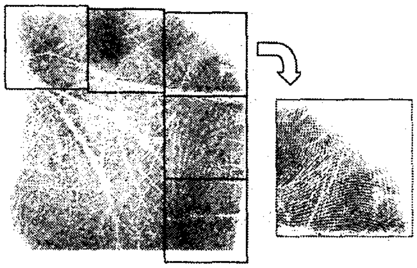


(a) Endpoint search



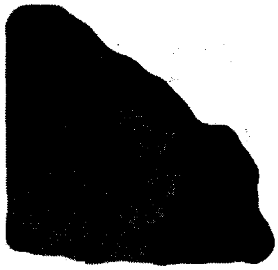
(b) Segmentation into 5 regions

background. The foreground and background are



(c) Extraction the segmented image

Fig. 3 Segmentation of Palmprint Image



(b) Orientation Image

Fig. 5 Orientation estimation result

2.2 Orientation Image Estimation

The directional image represents the ridge direction of the palm print image. To extract feature point, the ridge is extracted accurately in the first. To extract the ridge accurately, the direction of the ridge must be extracted accurately. The least mean square orientation estimation algorithm[11] is used in this paper among the various algorithms to extract the direction. The equation to obtain the direction $\theta(i, j)$ in the pixel (i, j) is following:

$$S_x(i,j)=\sum_{u=i-w/2}^{i+w/2}\sum_{v=j-w/2}^{j+w/2}2g_x(u,v)g_y(u,v) \quad (1)$$

$$S_y(i,j)=\sum_{u=i-w/2}^{i+w/2}\sum_{v=j-w/2}^{j+w/2}\left(g_x^2(u,v)-g_y^2(u,v)\right) \quad (2)$$

$$\theta(i,j)=\frac{1}{2}\tan^{-1}\left(\frac{S_y(i,j)}{S_x(i,j)}\right) \quad (3)$$

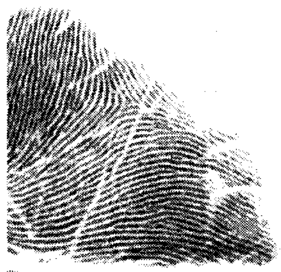
$g_x(u,v)$ is a x gradient of the pixel (u,v) and $g_y(u,v)$ is a y gradient of the pixel (u,v). Fig. 4 shows the direction images depending on pixels.

(a) Segmentation Image

2.3 Processing

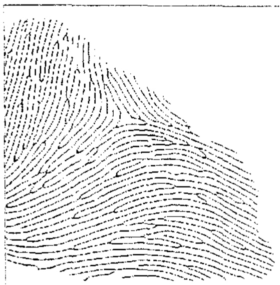
Each ridge and valley of palm print images is emphasized when the ridge is extracted in the palm print images, and the binary image is made by the extracted image. We extract the feature point after operating the postprocessing of emphasizing the binary image. All the steps are the same as the process extracting the feature in the finger print image. Fig. 5 shows these steps.

(a) Segmentation Image



(b) Filtering Image

(c) Binary Image



(d) Thinning Image

Fig. 4 Fingerprint Image Processing

3 Performance Evaluation

The evaluation is tested about the palm print image and the finger print image through the FVC2004 system. The feature point extraction of the palm print image follows the steps in this paper. And the processing for the finger print image also follows the steps in this paper except the segmentation step.

The palm print image is 8 bits gray scale image with 500 dpi using the optical sensor(1576 × 1572). The palm print data consist of 200 (2 × 10 × 10) images obtaining from both palms of 10 subjects. The finger print image is 8 bits gray scale image with 500 dpi using the optical sensor (328 × 364). The finger print data consist of 900(9 × 10 × 10) images from 10 fingers of the 9 persons among the same 10 persons.

We measured the matching performance using the same finger print matching method in order to obtain the recognition performance about palm print and finger print algorithms. The PC having Pentium 4 Mobile 1.86GHz is used for evaluation. The whole matching is used for the evaluation of the algorithm performance and we use the EER, FMR and FNMR as evaluation items. Table 1 shows the recognition

Table 1. Matching Result

	Palm print	Finger print
No. of registration images	200	900
No. of the comparison of persons concerned	900	4050
No. fo the comparison of others	19000	400500
EER	0.01%	0.64%
FMR100	0.00%	0.52%
FMR1000	0.00%	1.41%
FMR10000	0.11%	3.21%
Mean of registration time	2.604915sec	0.195174sec
Mean of matching time	0.011789sec	0.000753sec

The result of performance test shows that the authentication performance for the palm print image is absolutely better than that for the finger print image. However, it is noticed that palm print recognition takes longer time than finger print recognition with respect to registration and matching times since the size of image is very large. Palm print registration time is 13.3 times larger than finger print registration time and palm print matching time is 15.7 times lager than finger print matching time. However it is efficient to decrease the extraction and the matching time of the palm print image by segmenting the image and matching the some regions because we use same algorithm and consider that the size of palm print is 20.8 times bigger than that of the finger print.

4 Conclusion

In this paper, we proposed the algorithm about suitable feature point extraction for the palm print recognition. At first, we proposed the algorithm of segmenting the palm print in order to conform with the finger print algorithm directly. Then we introduced the finger print image processing to extract features in the segmented image. Through the experiments for the palm and finger prints, the performance result for each image.

EER for the finger print is 0.52 % while the EER for the palm print is 0.01%. The EER for the palm print has better performance than that for the finger print. The registration time for the palm print is 13.3 times longer than that of the finger print. The matching time for the palm print is 15.7 times longer than that of the finger print. In other words, the authentication rate for the palm print has better performance than that for the finger print while the proposed algorithm needs some improvements on the registration and matching time.

The main problem for the palm print is the registration time. In order to use the palm print verification system based on the feature points on the real time, we need the improvement for the extraction time of the palm print. Thus, the most efficient segmentation of the palm print region and the faster extraction processing time are required to improve under the condition of nondecreasing the authentication rate.

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