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Palmprint Principal Lines Detecting Based on Maximum Response Filter

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Abstract: This study presents a novel detection method of palmprint principal lines. After filtering palmprint ROI based on maximum response, 5% maximum magnitude is taken as the searching seeds of the principal lines, then combined with a threshold from standard deviation for region growing. Finally palmprint principal lines are obtained by closing operation and thinning. Experimental results show that this method, only several more steps added on feature extraction, can improve the recognition accuracy and have little impact on real-time performance, which is very important in embedded real-time recognition systems.

Key words: Palmprint principal lines, maximum response, seeds, region growing, thinning

INTRODUCTION

Palmprint identification is a biometric technology with great potential development and an significant supplement to the existing biometric identification technology. Palmprint recognition has received considerable research interests for its advantages such as abundant and steady features, convenient collecting methods and high recognition accuracy. Palmprint features mainly contain rich additional distinctive features such as principal lines and wrinkles; by extracting these features, we achieve the purpose of recognition.

Principal lines are more evident and stable features in palmprint images, which can be used for palmprint classification, rapid registration, matching and recognition. Palmprint principal lines features detection plays an important role in palmprint recognition systems. Many scholars have done a lot of research work on palmprint principal lines detection and classification (Yuan *et al*., 2006; Shu and Zhang, 1998, 1999; Wu *et al*., 2004a; Zhang and Zhang, 2004; Huang *et al*., 2008; Li *et al*., 2011). These methods generally require complex processes or large calculations on palmprint ROI. In the condition of high real-time systems, especially in embedded real-time recognition systems, speed is a very important index to system performance. If palmprint principal lines detection for auxiliary recognition besides feature extraction is needed, though these methods can improve recognition accuracy, they will reduce the speed of systems. Based on above viewpoint, how to combine palmprint principal detection and feature extraction becomes a very meaningful work.

According to methods of feature representation and matching, palmprint recognition methods can be divided into four categories (Kong, 2007) based on structure, basic statistics, subspace and coding. Competitive coding (Kong and Zhang, 2004) belongs to the coding methods with high efficiency performance and a extensive application. Competitive coding employs six multiple 2-D Gabor filters to extract orientation information from palm lines and codes the orientation of minimum magnitude. In this study, by referring the principle of competitive coding, presents a palmprint principal lines detection method which uses intermediate result of feature extraction to detect principal lines and improves the system accuracy with a less calculating and processing time.

The rest of this study is organized as follows. First is a description of the method, then follows some experimental results and discussions and the last part is a conclusion of the whole study.

PALMPRINT PRINCIPAL LINES DETECTION

Principal lines can be used to classify the palm prints (Wu *et al*., 2004b), but it is very difficult to detect palmprint principal lines accurately and consistently (Huang *et al*., 2008; Liu *et al*., 2007). Intermediate result of feature extraction is used to detect principal lines in this study. First anisotropic iterative Gabor filter is employed in six orientations to filter palmprint ROI and the maximum response of six orientations is chosen as the magnitude of

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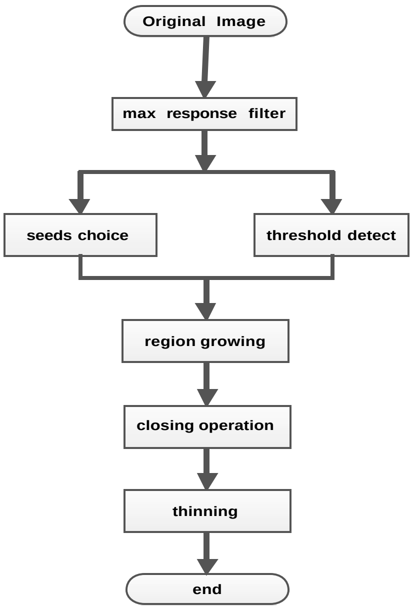

Fig. 1: Flow chart of our method

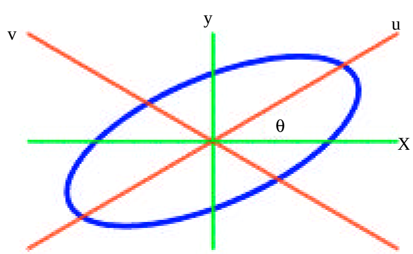

Fig. 2: 2-D anisotropic Gaussian filter

Fig. 3: Filter bank

each point. In process of region growing, we combine seeds with threshold and then use closing and thinning operations to get final palmprint principal lines. The flow chart of proposed algorithm is shown in Fig. 1.

Maximum response filter: Anisotropic iterative Gaussian filter (Geusebroek *et al*., 2003) is a fast calculating method for anisotropic Gaussian filter. This method decomposes the anisotropic Gaussian in two Gaussian line filters in non orthogonal directions and filters images in time domain. Figure 2 is an example of an anisotropic Gaussian with aspect ratio 2:1 and orientation $\theta = 45^0$. We filter images by using 2-D Gaussian filter with recursive method at, especially. Choose the maximum magnitude for the six values as the energy of each point. Figure 3 shows our filter bank.

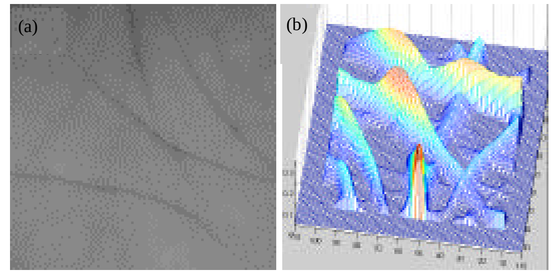

Fig. 4(a-b): Filtering effect chart, (a) Original image, (b) Filtering image

The choice of the filter parameters is very important to lines detection in images. Noise produced when parameters are too big and the whole line can not be detected when parameters are too small. Liu *et al*. (2007) proposed that the mask required by complete line detection should be at least bigger than the line width. For an image with size of 640×480, if we assume the whole palm must be in visual field, the width of palmprint principal lines is generally not bigger than four pixels. Therefore, we choose our elliptic filter parameters $\sigma_x = 4$, $\sigma_y = 4$, the ratio with 2:1. In filtered image, the results of both sides of principal lines are negative values. Since our main purpose is to detect the principal lines, if we neglect the negative values, it does not affect the principle lines detection. We set the negative values to 0(flat area) and its filtering image is shown in Fig. 4.

Seeds choice: Palmprint ROI contains principal lines, wrinkles and other information, so it is not easy to detect these features accurately and consistently. We can observe that principal lines are generally darker and larger than other lines and the filter magnitude is larger too, as show in Fig. 4b. 10% highest magnitude points is chosen in filtered image while detecting principal lines (Yue *et al*., 2013) and most of these points locate in the regions corresponding to principal lines. But there is still some noise which will affect the detection of principal lines, so we choose the highest 5% as our principal lines detecting seeds. Its calculation result of image in Fig. 4a is show in Fig. 5b and a is the whole maximum response image.

Table 1: Region growing

```
if p (x_i, y_i) is seed point
    if p (x_i-1, y_i-1 or i or I+1)>t
    Search orient is left
    p (x_i-1, y_i-1 or i or I+1)>t are principal lines points
    if p (x_i-1, y_i-1 or i or I+1)>t
    Search orient is right
    p (x_i-1, y_i-1 or i or I+1)>t are principal lines points
```

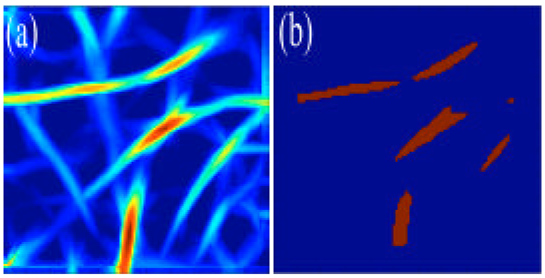

Fig. 5(a-b): Filtered image and seeds, (a) Maximum response image, (b) Seeds image

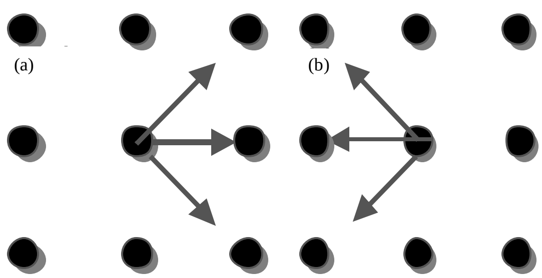

Fig. 6(a-b): Searching orientation, (a) Is right searching , (b) Is left searching

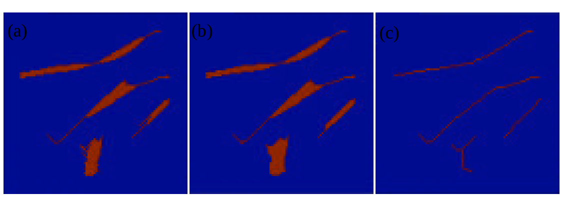

Fig. 7(a-c): Region growing, closing and thinning, (a) Region growing result, (b) Closing result and (c) Thinning result

In order to get the whole principal lines, this study employs the 5% highest magnitude as our seeds and then combines with threshold, orientation parameters to detect.

Threshold detect: Liu *et al.* (2007) employed standard deviation of input gray image as edge detection threshold. We refer to the method, calculating threshold t on the filtered image and taking the seeds as start points, if the magnitude of a point on search orientation is greater than t, we conclude this point is on principal lines. t is defined by Eq. 1:

$$t = \text{std}(E) \quad (1)$$

is the filtered image, is the standard deviation.

Region growing: Wu *et al.* (2004b) classified palmprint into six categories according to principal lines. Principal lines have their specific characteristics in palmprint images, which can be used as our searching orientation determination. Instead of a single point, our seeds on principal lines are a series of magnitude points, so we can detect either to the left or to the right according to the searching methods of 8 neighborhood, the left side including upper left, left and lower left and the right side including upper right, right and lower right, as shown in Fig. 6.

Define p (x_i, y_i) as the point coordinate with that of (x_i, y_i) in the chart, region growing can be described as Table 1.

Figure 7a is the region growing result with the seeds of Fig. 5b and the adaptive threshold t = 0.481.

We can see from Fig. 7a that most of principal lines are detected but lines width from region growing is less than seeds and there are cavities within the principal lines. We do closing and thinning at last. The results are shown in Fig. 7b, c and b is closing result and Fig. 7c is thinning.

EXPERIMENTAL RESULTS

We employed the public palmprint database of PolyU (The Polytechnic University, 2009) to verify the algorithm, the size of ROI is 128×128 and the gray level is 256. This database consists of 7752 images of 386 palms, 193 persons.

The experimental results are shown in Fig. 8. Figure 8 shows this method has two problems. One is that the detected principal lines are not complete and some images contain only part of principal lines; the other is that lines detected are not the principal lines. We give two reasons about these problems as follows:

This method is based on the magnitude of filtered images, when the magnitude of parts of specific principal line is smaller than threshold , the whole principal line is interrupted. And if magnitude of the points in principal lines is not very large, judgment depending on threshold alone would bring in noise.

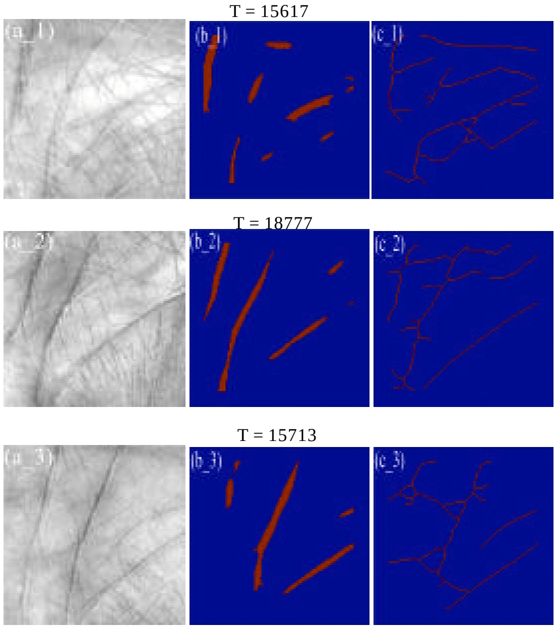

Fig. 8(a-c): PolyU results, (a) Gray images, (b) Seeds images and (c) Thinning images

CONCLUSION

This study presents a novel detection method of palmprint principal lines. We use six anisotropic iterative Gaussian filters to process the gray original image and set each point the highest magnitude value. Take 5% maximum magnitude as the searching seeds. Calculate the standard deviation of filtered image and regard it as searching threshold, any magnitude bigger than threshold is considered a point of the principal lines. Experimental results show that this method, only several more steps added on feature extraction, can improve the recognition accuracy and have little impact on real-time performance, which is very important in embedded real-time recognition systems.

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