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Enhanced skeletonization algorithm for fingerprint images

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ABSTRACT

Minutiae feature based fingerprint recognition systems heavily depend on the pixel-wise operations on skeletonized fingerprint image. The skeletonization is done by proper thinning algorithms. The minutiae features (Ridge endings and Bifurcations) can be extracted from a finely skeletonized fingerprint image. The efficiency of the thinning method determines the quality of the image skeleton and the accuracy in feature extraction. Therefore a new skeletonization technique is proposed. The new skeletonization algorithm uses a number of masks to check whether the pixel is on the boundary or not. Once the pixel is marked as boundary pixel, then the algorithm eliminates that pixel and repeat the process to get the fingerprint image skeleton of one-pixel width. The proposed system is computationally efficient and it preserves the connectivity of the pixels in the image.

Keywords— *Skeletonization, Fingerprint classification, Connectivity preservation, Unit-width skeleton*

1. INTRODUCTION

Fingerprint-based biometric authentication is one of the reliable systems to verify the identity of an individual. Image processing provides a variety of tools for this purpose. The processing of fingerprint image is mainly divided into image preprocessing, extraction of fingerprint features and classification.

The main challenge is how to reduce the time required for the processing of all the pixels in the image. Therefore, by the reduction of the number of pixels in the input fingerprint image the time consumption can be reduced. To solve this problem binary image thinning techniques can be used. Image thinning is a morphological operation that eliminates the selected foreground pixels from binary images and the algorithm produces the image skeleton of one-pixel width. Thereby reduce the size of the memory space used by the fingerprint image database.

The thinning algorithms are mainly divided into two categories, Iterative and non-iterative thinning. Iterative algorithms delete pixels on the boundary until we get the image skeleton of one-pixel width. Non-iterative algorithms are not useful for general applications, because they are not robust for the patterns with highly variable stroke directions and thicknesses.

2. PROPOSED METHOD

The proposed method is an efficient thinning technique that detects the contour points and eliminating them without losing the connectivity of the image. The contour points are the pixel that concatenated to exactly one background pixel in the image. The method uses 40 masks shown in figure 1 for detecting and deleting the border points.

The processing of the poor quality fingerprint images is very difficult, therefore the automated fingerprint recognition system preprocesses the image before feature extraction and classification. The preprocessing steps are,

2.1. Normalization

It is the process of standardizing grey level values in the input fingerprint image by adjusting the pixel intensities into a standard level. For that, variance thresholding [6] techniques can be used.

2.2. Segmentation

It separates the foreground pixels in the fingerprint image that containing valuable information for the classification from the background. For that standard segmentation algorithm [7] [10] can be used.

2.3. Binarization

It is the process of converting the gray level image into the two-level image, i.e. binarized [8] [9] image contains only two values. Most of the thinning algorithms are operates only on the binarized version of images. So it is an important preprocessing step in the automated fingerprint recognition system.

2.4. Hole removal

The unwanted holes in the ridges of binarized fingerprint image can be removed by using the concept of a small area analysis.

2.5. Thinning

It is very difficult to deal with images having a huge number of pixels. The solution to this problem is to reduce the number of pixels in the image. Here is the role of image thinning algorithms. Thinning is a morphological operation that eliminates the border pixels successively to get an image skeleton of one-pixel width by preserving the connectivity of the pixels in the image.

In the proposed algorithm, the thinning rules are used to find the contour point and it checks whether the pixel is deletable or not. If it is deletable, then the value of that pixel is set to zero.

Rule 1: The number of non-zero neighbours in the eight neighborhood is in the range of two to six.

Rule 2: The number of either 0-to-1 or 1-to-0 patterns in eight neighborhood is exactly one.

1	1	0	0	1	1	0	0	1	0	0	0
0	P	0	0	P	0	0	P	1	0	P	1
0	0	0	0	0	0	0	0	0	0	0	1

0	0	0	0	0	0	0	0	0	1	0	0
0	P	0	0	P	0	1	P	0	1	P	0
0	1	1	1	1	0	1	0	0	0	0	0

1	1	1	0	1	1	0	0	1	0	0	0
0	P	0	0	P	1	0	P	1	0	P	1
0	0	0	0	0	0	0	0	1	0	1	1

0	0	0	0	0	0	1	0	0	1	1	0
0	P	0	1	P	0	1	P	0	1	P	0
1	1	1	1	1	0	1	0	0	0	0	0

1	1	1	0	1	1	0	0	1	0	0	0
0	P	1	0	P	1	0	P	1	0	P	1
0	0	0	0	0	1	0	1	1	1	1	1

0	0	0	1	0	0	1	1	0	1	1	1
1	P	0	1	P	0	1	P	0	1	P	0
1	1	1	1	1	0	1	0	0	0	0	0

1	1	1	0	1	1	0	0	1	0	0	0
0	P	1	0	P	1	0	P	1	1	P	1
0	0	1	0	1	1	1	1	1	1	1	1

1	0	0	1	1	0	1	1	1	1	1	1
1	P	0	1	P	0	1	P	0	1	P	1
1	1	1	1	1	0	1	0	0	0	0	0

1	1	1	0	1	1	0	0	1	1	0	0
0	P	1	0	P	1	1	P	1	1	P	1
0	1	1	1	1	1	1	1	1	1	1	1

1	1	0	1	1	1	1	1	1	1	1	1
1	P	0	1	P	0	1	P	1	1	P	1
1	1	1	1	1	0	1	0	0	0	0	1

Fig. 1: Thinning rules

2.6. Proposed Algorithm

For each foreground pixels in the image,

1. Compute the number of non-zero neighbors (BP) in the eight neighborhood of the candidate pixel P.
 If 2<=BP<=6 go to step 2.
2. Compute the number of zero to one or one to zero transition (AP) in the eight neighborhood of the pixel P.
 If AP=1 go to step 3.
3. Apply the 40 rules to each pixels P in the binary image.
 If the pixel and its eight neighborhood satisfies any of the rules,
Delete P.
4. Repeat until no pixels are changed from black to white.

3. RESULTS AND DISCUSSION

The proposed system has been successfully tested on 50 fingerprint images. The main idea is to develop an efficient thinning technique for improving fingerprint classification. In the minutiae-based fingerprint classification system, the feature extraction phase heavily depends on the quality of image skeleton. The better skeleton can be obtained only by an efficient thinning technique. Already existing thinning techniques like ZS, LW, and KNP are studied, implemented and tested using the test images, but none of them satisfies all the criteria of an ideal skeleton. The proposed thinning algorithm uses 42 thinning rules to get a perfect fingerprint image skeleton. The comparison of the results obtained from the proposed method and the existing methods shows that the proposed method provides a better result by preserving the connectivity of the pixels and doesn't produce spurs.

The results are as shown in figure 3(a) and (b). From the results, it can be observed that the connectivity of the pixels are preserved in the proposed algorithm than ZS and Hall thinning techniques and the rate of erosion is negligible. The algorithm is rotationally invariant by the use of derived thinning rules.

Fig. 2: Input fingerprint image

Fig. 3 (a): Result of ZS and Hall thinning

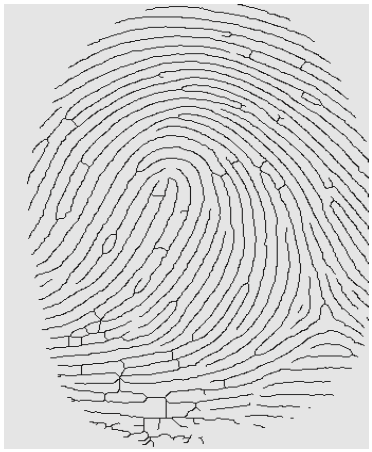

Fig. 3 (b): Result of the proposed algorithm

4. CONCLUSION

This paper presented an efficient thinning algorithm for improving the classification of fingerprint images. The proposed methodology was tested on different fingerprint images and the results show that it produce better results in terms of robustness and preservation of connectivity while compared with existing thinning algorithms.

5. REFERENCES

[1] Zhang, T. Y., and Ching Y. Suen. "A fast parallel algorithm for thinning digital patterns." Communications of the ACM 27.3 (1984): 236-239.

[2] Lee, C. L., and Patrick Shen-Pei Wang. "A simple and robust thinning algorithm." International journal of pattern recognition and artificial intelligence 13.03 (1999): 357-366.

[3] Kardos, Péter, Gábor Németh, and Kálmán Palágyi. "An order–independent sequential thinning algorithm." Combinatorial Image Analysis. Springer Berlin Heidelberg, 2009. 162-175.

[4] Hilditch, C. J. "Comparison of thinning algorithms on a parallel processor."Image and Vision Computing 1.3 (1983): 115-132.

[5] Hall, Richard W. "Fast parallel thinning algorithms: parallel speed and connectivity preservation." Communications of the ACM 32.1 (1989): 124-131.

[6] Hong, Lin, Yifei Wan, and Anil Jain. "Fingerprint image enhancement: algorithm and performance evaluation." Pattern Analysis and Machine Intelligence, IEEE Transactions on 20.8 (1998): 777-789.

[7] Bazen, Asker M., and Sabih H. Gerez. "Segmentation of fingerprint images."Proc. Workshop on Circuits Systems and Signal Processing (ProRISC 2001). Vol. 276280. 2001.

[8] Kim, Doo-Hyun, and Rae-Hong Park. "Fingerprint Binarization using Convex Threshold." Computer Graphics and Imaging. 2003.

[9] A Bartnk, Josef Strm, et al. "Adaptive fingerprint binarization by frequency domain analysis." Signals, Systems and Computers, 2006. ACSSC'06. Fortieth Asilomar Conference on. IEEE, 2006.

[10] Msiza, Ishmael S., et al. "Fingerprint segmentation: An investigation of various techniques and a parameter study of a variance-based method." International Journal of Innovative Computing, Information, and Control (IJICIC) 7 (2011): 5313-5326.

