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A Dorsal Hand Vein Pattern Recognition using Invariant Moment

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***Abstract*—** A new method for dorsal hand vein pattern recognition is presented in the paper. To improve the recognition ratio, the vein skeleton extracting with little distortion is very important. Firstly, our method acquires a clean, skeleton with little distortion after a series of processes: size and gray normalizing, Gaussian low pass and wiener filtering, adaptive thresholding segmenting, area thresholding, morphological opening and closing, conditional thinning, spurs pruning. Then, the seven corrected moment invariants of the vein skeleton are extracted as the feature vector. At last, the feature vector is input into KNN for training and recognition. Experiment shows the algorithm achieves a higher recognition ratio of 97.75%.

***Keywords*—** Vein pattern recognition; Preprocessing; Segmenting; Feature extraction; Nearest Neighbor Classifier (KNN)

I. INTRODUCTION

Nowadays, automatic personal identification based on biometric feature plays a significant role in applications of public security, access control, banking, and so on. Vein is one of the most strong and permanence physical characters. Vein pattern recognition has many advantages such as high recognition ratio, difficult to forge, not to be influenced by outer condition. So it has gained more and more research attention in recent years [1-4].

In the vein pattern recognition, acquiring an actual one pixel-width vein skeleton is very important. However, influenced by the gathering equipment, the gathering environment and the hair, the original dorsal hand vein image usually contains noise, especially the horizontal strip scanning noise. It results that there are many obvious protuberances at the boundary of the segmented vein pattern. .Even though the protuberances are eliminated, there are still spurs if it is thinned directly, and the vein skeleton will has much distortion. For this, an algorithm for dorsal hand vein pattern recognition is presented in the paper. Firstly, a novel approach for skeleton extracting is introduced to reduce the distortion of the vein skeleton. Secondly, the seven corrected moment invariants of the vein skeleton are extracted as the feature vector and it is input into the SVM for training and recognition. Experiment shows that it has got a higher recognition ratio of 95.5%. The remainder of the paper is organized as follows. In section II, the vein pattern is segmented from the original dorsal hand vein image. In section III, the vein skeleton of the pattern is extracted. In section IV, the seven corrected moment invariants of the vein skeleton is extracted as the feature vector. Section V presents the vein pattern recognition experiment and has a discussion. At last, we conclude our study in section VI.

II. RELATED WORK

They are several works about feature extraction of hand veins pattern, among them there is the Gabor filter, the Hough transform, discrete Curvelet transform, triangulation of minutiae...etc. most of his method are preceded by a preprocessing step where in the Gabor filter [1] and the Hough transform [2] they use the Median filter, Wiener in Gabor [1] and SIFT method [4], the Mexican hat in triangulation minutiae [5]. The table 1 summarizes most of this works.

Table 1. state of the art on the feature extraction dorsal veins.

Method	Enhan cement	Size of base	Execution Time	Perfor mance
Gabor filter[1]	Median and wiener	-	0.3631	EER=1. 41% FRR=2. 278%
Hough transform [2]	Median & Gaussian filter	400	-	FRR=0. 0025%

Table 1. state of the art on the feature extraction dorsal veins.

Method	Enhan cement	Size of base	Execution Time	Perfor mance
Discret	Gaussien	400	-	EER=1.

curvelettransform [3]	& high passfilter			17%
SIFT[4]	High pass & Wiener filter	-	-	RR=97.95%
Minutie triangulation [5]	MexicanHat	300	-	FRR=1.14% FAR4=1.14%
Across point and black box aproch [6]	-	100	-	FAR=0..1%
Ridgelet transform [7]	-	128	-	ERR=0.13%

III. METHODOLOGY

During pre-processing stage hand image is passed through a feature channel called green channel to enhance the contrast of the veins so that it is easy to operate the veins when they are very clear. If this channel is compared to other channels such as red and blue, they increased the brightness of the veins to be easily visible and lower the contrast of the image respectively. The operation of the pre-processing is done to ensure that the noise that leads to wrong structure of veins and any unwanted information that will cause any trouble to identify a person is removed. As the system distinguishes the person on the basis of the vein patterns which are unique in every human hand and different from rest of people so, it is necessary to get the veins image accurately out of the hand. Therefore, vein image is segmented after enhancing the veins in the image.

The foreground of the image is under consideration. Veins of hands are enhanced in order to achieve the less and poor visible veins accurately to abandon the mismatching. This is done by following three steps. In first step morphological operations are applied in order to improve the contrast plus normalizing the contrast and applying the filter banks. In second step parallel segmentation for the hand veins is

done. In final step all spurious hand veins are eliminated so that the classification accuracy is increased. There are many factors that make the image unclear to view and make the identification very difficult for the systems such as: variability in clarity of the image, texture on the background of an image varies, low illumination on region of interest and etc. In order to smooth the dark regions of the hand veins morphological operation known as opening is used as defined in following equation 1.

$$\phi\frac{(sB)}{f} = \max[\min(f(x+b))] \quad (1)$$

$$\phi\frac{(sB)}{f} = \max[\min(f(x+b))]$$

Where sB is a structuring element B having size s. b 6 sB and-f is an image before processing. As a result of this morphological operation we find smooth dark veins that need only contrast enhancement. Contrast enhancement is done to improve the visibility of the veins in order to achieve better detection. This enhancement is done by using a w x w window, moved over the image keeping in mind that local distributions are independent on the basis of statistics and window is large enough for it. Equations 2 and 3 show mathematical expression for contrast enhancement

$$\alpha_w(\phi_f) = [1+\exp(\frac{m_{w} - \phi_f}{\sigma_w})]^{-1}$$

$$G = 255\frac{[\alpha_w(\phi_f) - \alpha_w(\phi_{f\min})]}{[\alpha_w(\phi_{f\max}) - \alpha_w(\phi_{f\min})]} \quad (2)$$

φfmin and φfmax are minimum and maximum values of intensity of the image obtained after smoothing whereas mw and ow are mean and variance of the intensity values located inside the region covered by the window respectively. G is an output image after the contrast enhancement step which is provided to obtain enhancement of veins to Jerman filter. This filter is based on multiscale Hessian eigenvalues, which produces a similar response in all the vein pattern and enhances the border between the vein pattern and the background [8]. Enhancement filters are scalar functions V : R ->. R, which selectively amplify a specific local intensity profile or structure in an image. Some of the image enhancement filters describes local structure by evaluating hessian or second order intensity derivative at each and every point in the image. To enhance the local structures of various sizes, the analysis is typically performed on a Gaussian scale space of the image.

The I(x) represent the intensity of a D-dimensional image at coordinate x - [xl,....,xD]T, then the Hessian of I(x) at scale s is represented by a D X D matrix defined as:

where G(x,s) = (2π S2)-D/2 exp(-xTx/2s2) is a D-variate Gaussian and * denotes convolution.

When the enhancement is done, veins are segmented by using adaptive thresholding. After the enhancement process while doing segmentation only one general threshold is not selected because thick veins provide higher response as compared to thin veins. That's why an adaptive threshold is applied and also recorded. The enhanced image provided by the filter bank response is recorded and then histogram of this enhanced image is calculated. For the grayish background, there occur maximum intensity values but veins have values slightly greater than the background values because veins are of bright colors. Adaptive thresholding separates the veins from the rest of the hand. A binary image is obtained by using this threshold.

This thresholding method yields veins structure that is segmented having variable thickness. The thickness is made uniform by using morphological thinning procedure. These morphological operations decrease the width of hand veins to one pixel. Background mask is eroded to extract the back side of the hand corresponding to palm area. So region of interest is extracted and all the extra area is neglected. Figure- 3 shows the outputs of preprocessing, vein enhancement and segmentation.

Fig 1. Original Image

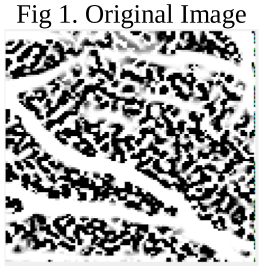

Fig 2. Jerman Filter Image

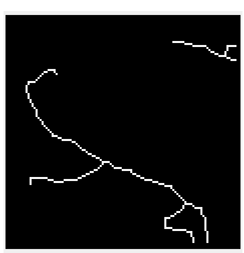

Fig 3. After morphological operation

IV. FEATURE EXTRACTING

Hu proposed geometrical moments based on rectangular coordinate system in 1961. Later, he defined seven moment invariants based on normalized central moment. Compared with other moments, the seven moment invariants are better or the invariance property with regard to translation, rotation and scale. So they are more suitable for being used as the feature of recognition and classification. But the recognition result is not so good when they are used as the feature directly for their values varying widely. So it should be corrected. And more, considering that they may be negative, the value of (3) is used

$$M_i = 1g\left|M_i\right| \qquad i = 1,2,3,\ldots,7 \tag{3}$$

As the feature in the paper.

$$M = (M_1, M_2, M_3, \ldots, M_7) \tag{4}$$

Based on this, the seven corrected moment invariants of the vein skeleton are extracted as the feature vector.

V. RESULT AND DISCUSSION

K-nearest neighbors algorithm (k-NN) have been promising methods for classification and regression analysis because of their solid mathematical foundations which convey several salient properties that other methods hardly provide. They have been applied to tasks such as complex structured objects prediction, handwritten recognition, and so on [9]. On a dorsal hand vein database including 100 persons, 12 sample images per person, 1200 sample images altogether. Before the feature vector being input into the K-NN, it should be normalized to a value varied from 0 to 1. Supposed Mmax and Mmm is the maximum and minimum of the feature vector M, then the normalized feature vector M* is shown as (3).

$$M^* = \frac{M - M_{\min}}{M_{\max} - M_{\min}} \tag{5}$$

Experiment selects 8 images from 12 images randomly for every person as training samples, and the other 4 images as test samples. Taking number 0007 vein images (Imgl.bmp ~Img4.bmp) as example, their corrected moment invariants are shown as Table 2.

Table 2. Corrected Moment Invariants

Moment invariants	Vein images			
	Img1	*Img2*	*Img3*	*Img4*
M_1	0.01	0.02	0.01	0.01
M_2	1.51E-05	1.01E-05	1.31E-05	6.77E-06
M_3	2.22E-07	2.73E-07	1.36E-07	2.42E-07
M_4	1.19E-07	3.32E-07	4.67E-08	1.05E-07
M_5	1.65E-14	-1.13E-13	3.32E-15	-4.69E-15
M_6	4.61E-12	2.15E-10	-1.62E-10	2.66E-10
M_7	-2.51E-14	1.22E-13	7.57E-16	2.16E-14

In the experiments, we found that if we exclude 12 serious noised samples, then the recognition ratio will improve to 98.3%. Therefore, the quality of the original vein image, the segmenting and the skeletonizing of the vein pattern will influence the recognition result greatly. Improving the image gathering, the vein pattern segmenting and skeletonizing is an effective approach for vein pattern recognition.

We have a comparison with other algorithms presented in [5] and [7]. Under the same conditions, the recognition ratio is 94.5% and 93.0%> respectively. It shows that we have got a higher recognition ratio i.e. 97.75%.

VI. CONCLUSION AND FUTURE SCOPE

In the paper, dorsal hand vein pattern recognition is presented. To improve the recognition ratio, our method acquires a clean, actual vein skeleton from the original image by a series of processes. Then the seven corrected moment invariants of the vein pattern are extracted as feature vector which is inputted into the KNN for training and recognition.

All the methods described above are implemented. And we have got a recognition ratio of 97.75% on a database including 1200 samples. The experiment shows that the algorithm has obtained a good result.

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REFERENCES

[1] Zahra Honarpisheh, Karim Faez, *"An Efficient Dorsal Hand Vein Recognition Based on Firefly Algorithm"*, International Journal of Electrical and Computer Engineering (IJECE), **Vol. 3, pp. 30-34, 2013.**

[2] P. Ramsoful and M. Heenaye Mamode Khan, *"Feature extraction Techniques for dorsal hand vein pattern,"* Third International Conference on Innovative Computing Technology (INTECH 2013), IEEE Transaction, **London, pp. 49 -53, 2013.**

[3] Shangqing Wei, *"International Conference on Transportation, Mechanical, and Electrical Engineering (TMEE)"* Changchun, **China, pp.1696-1693,2011.**

[4] Yiding Wang , Yun Fan , Hand vein recognition based on multiple keypoints sets, 5th IAPR International Conference on Biometrics (ICB), IEEE Transaction, **pp.367-371, 2012.**

[5] Ajay Kumar, Personal Authentication using Hand Vein Triangulation and Knuckle Shape, IEEE Transactions on Image Processing, **vol. 38, pp. 2127-2136, 2009.**

[6] Amioy Kumar, M. Hanmandlu, *"Biometric Authentication Based on Infrared Thermal Hand Vein Patterns"*, Digital Image Computing: Techniques and Applications, **IEEE, pp.331-338, 2009.**

[7] Zhang Y., Han X., Ma S., *"Feature Extraction of Hand-Vein Patterns Based on Ridgelet Transform and Local Interconnection structure Neural Network"*, Intelligent Computing in Signal Processing and Pattern Recognition,.Springer, Berlin, Heidelberg, **vol 345, pp.870-875, 2006.**

[8] Tim, Jerman, Beyond Frangi, *"an improved multiscale vesselness _lter"*, Medical Imaging 2015: Image Processing, edited by Sebastien Ourselin, Martin A. Styner, Proc. of SPIE **Vol. 9413, pp.94132A-l -94132A-11,2015.**

[9] J. Yang, L. Zhang, J. Yang, D. Zhang, *"From classifiers to discriminators: A nearest neighbor rule induced discriminant analysis"*, Pattern Recognit., **vol. 44, no. 7, pp. 1387-1402, 2011.**

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