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Hand Vein Image Enhancement With Radon Like Features Descriptor

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Abstract—Nowadays, hand vein recognition has attracted more attentions in identification biometrics systems. Generally, hand vein image is acquired with low contrast and irregular illumination. Accordingly, if you have a good preprocessing of hand vein image, we can easy extracted the feature extraction even with simple binarization. In this paper, a proposed approach is processed to improve the quality of hand vein image. First, a brief survey on existing methods of enhancement is investigated. Then a Radon Like features method is applied to preprocessing hand vein image. Finally, experiments results show that the proposed method give the better effective and reliable in improving hand vein images.

Keywords—Hand Vein, Enhancement,Contrast, RLF, SDME

I. Introduction

The biometric recognition technology has always the best choice in identification or verification security system in the society. Moreover, hand vein is a convenient and robustness characteristic that increasing the intention and progress of researches in biometric domain. Newly, many methods have been proposed for Improving quality of contrast in hand vein images. Zhang et al [1] suggested a finger vein image enhancement based on a multi-channel Gabor filter. Zao et al proposed a The Contrast Limited Adaptive Histogram Equalization(CLAHE) as a method to improve hand veins images [8]. Jinfeng Yang et al employed a Frangi filter to enhance finger veins images [3]. In this paper, we propose a reliable enhancement contrast method based on the application of Radon Like Features(RLF) descriptor. Experimental results shows that the proposed method gives better performance in improving hand vein images. This paper is organized as follows. Section 2 gives the related works on existing methods of enhancement vein images. In section 3, we presents the proposed method to improve quality of hand images. Section 4 presents the enhancement performance measure and experimental results. In Section 5 we concludes by a conclusion.

II. Related Works on existing methods of enhancement

An improvement of hand vein image is necessary to obtain a reliable hand vein image in recognition system. Contrast enhancement is correspond to an increase of dynamic information of image. Currently, many methods have been investigated for improvement vein image quality. We introduce here a brief review of the habitual methods of contrast enhancement corresponding to vein image.

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A. Frangi Filter

Frangi filter, largely used in vascular application, is a method used for measure of "vesselness"[2], [3]. The response of Frangi filter method, in a directional image, is defined by these equations:

$$R(r,t) = \begin{cases} 0, if \lambda_2(r,t) > 0; \\ \exp((G^2(r,t)/2)\alpha^2)(1-\exp(S^2(r,t)/2\beta^2)), \end{cases} \quad (1)$$

With,

$$G(r,t) = \frac{\lambda_1(r,t)}{\lambda_2(r,t} \quad (2)$$

$$S(r,t) = \sqrt{\lambda_1^2(r,t) + \lambda_2^2(r,t)} \quad (3)$$

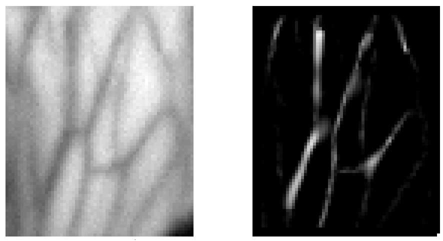
α, β are a adjusting parameters that measure the sensitivity of "vesselness" in the image. The "vesselness" function of enhanced directional image $V_i(i = 1, ..., 8)$ within an interval$(t_{min}, ..., t_{max})$ can be presented by this equation:

$$V_i = maxV_i(r,t), t_{min} \leq t \leq t_{max}. \quad (4)$$

Gives that E(r) is the enhanced image after applying Frangi filter, it can be presented as:

$$E(r) = max(V_i(i = 1, ..., 8) \quad (5)$$

In figure(1) we present an example of image generated by Frangi filter.



(a) (b)

Fig. 1. hand vein image enhancement based on Frangi filter:(a) original hand vein image;(b) image processed by Frangi filter

B. Histogram Equalization and CLAHE

In image processing, Histogram Equalization(HE) [9] is a usual process used to adjusting the contrast from numeric image. This method consists to make the histogram as flat as possible. In other words, the HE make the function of the probability density as uniform. The Contrast Limited Adaptive Histogram Equalization (CLAHE) method is a variant of HE,

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it intends to divide the input image in non overlapping regions of roughly equal size. Enhanced the contrast with CLAHE provides a natural appearance, this explains the use of CLAHE method by Zhao et al to improve the contrast of hand vein image[8]. In figure(2) we gives an example of hand vein image processed by HE and CLAHE methods.

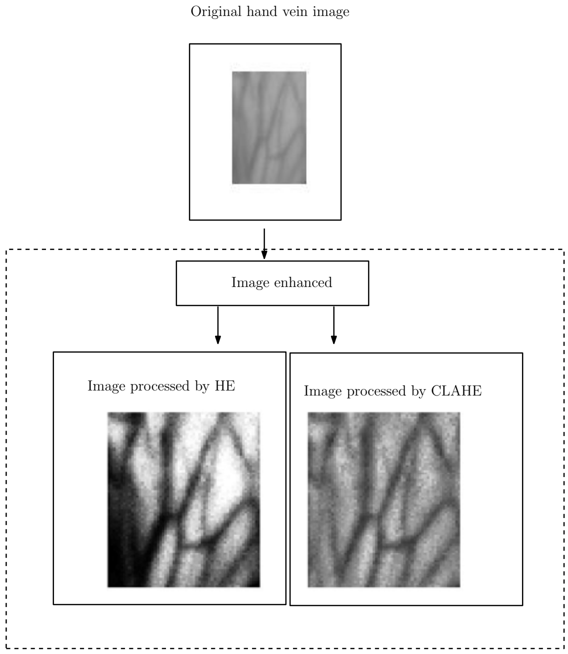

Fig. 2. Contrast enhancement results from hand vein image using HE and CLAHE.

C. Gabor filter

Gabor filter proposed by Gabor in 1946 is a selective filter in frequency and orientation [4] This filter largely used in computer vision applications. It achieve a acceptable performance in preprocessing image of finger print [5], iris [6] and palmprints [7] recognition systems. The two dimensional function of Gabor filter is defined as :

$$G(x,y) = \frac{1}{2\Pi\sigma^2}\exp[-\frac{(x^2+y^2)}{2\sigma^2}]\times exp[i2\Pi f_c(\sqrt{(x^2+y^2)})] \quad (6)$$

Where f_c and σ is the central frequency and the scale deviation of the filter respectively. All these parameters are usually chosen in specific experimental study. Furthermore, Gabor filters offer eight possible orientations in each coordinate (x, y). In figure(3), we presented the bank of Gabor filter in the spatial domain with eight direction . The hand vein image generated by Gabor filter is obtained by the 2D convolution between the kernel filter and the input image. Figure(4) shows the result of an example of hand vein image generated using Gabor filter.

III. Hand vein image enhancement using Radon Like Features method

The Radon Transform(RT) is a technique used extensively in tomography applications. It is defined by the integrated

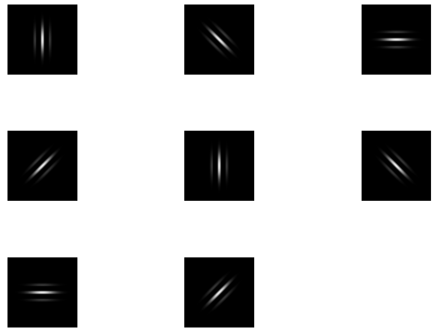

Fig. 3. bank generator of Gabor filter in the spatial domain

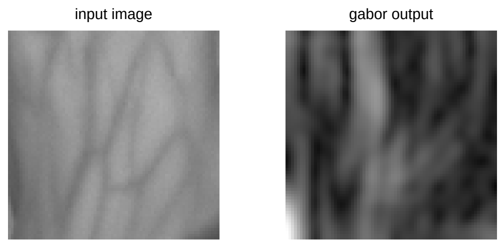

Fig. 4. Hand vein image enhancement based on Gabor filte

function $I(x, y)$ on a line L that is characterized by an intercept m and a slope z:

$$R(m,z)[I(x,y)] = \int_{-\infty}^{+\infty} I(x, m+zy)dx \quad (7)$$

Furthermore, for each intercept and slope in space, the Radon back-projection is used to reconstruct the original input image. Further, Kumar et al[10] propose an other approach based on RT called Radon Like Features (RLF). This latter is intended to redistribute the statical input image in the compact feature descriptors and to improve the cell boundary from image. In fact, In hand vein recognition process, it aims always to improve the input hand image so that it is exploitable in feature extraction step by a simple thresholding or histogram. This is the main idea behind the use RLF to exploit the preprocessing hand vein image. The idea the RLF is to distribute some desired information derived from the 2D function $I(x, y)$ between different line segment L presented by a series of principal point K_{nots}. If the series of of K_{nots} is considered as $t_(1, ., t_n)$, the RLF at a point P along the line l and between $(X(ti), y(ti))$and $(X(ti + 1), y(ti + 1))$ is presented by the following equation:

$$\Psi(p, l, t_i, t_{i+1})[I(x, y)] = T(I, l(t)), t\epsilon[t_i, t_i + 1], \quad (8)$$

with T is the extraction function. In figure(5) we presented an example of hand vein image enhanced using RLF method. In the end, we apply (in the following) two criteria of evaluation for see that RLF is the best method to improve hand vein image .

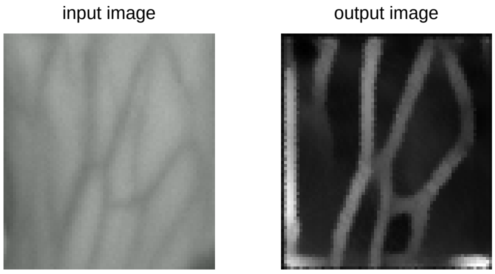

Fig. 5. Example of hand vein image processed by RLF method.

IV. Enhancement Performance Measure and Experimental Results

In the evaluation phase, we use 500 images from BOSPHORUS hand vein database[11]. This latter is available to encourage the researchers and progress of hand vein identification or verification process. To test the performance of the proposed enhancement approach, we selected only the image with lower resolution. In fact, two criteria are used to compared the effectiveness of our proposed method compared with other methods of contrast enhancement:

- Statistical measure of contrast by co-occurrence matrix
- The Second Derivative Measure of Enhancement

A. statistical measure of contrast by co-occurrence matrix

As the first criteria to measure the contrast in the image, we use the statical properties based on the co-occurrence matrix. This latter aims to measure the number of repetition of each pairs pixel in the image within a distance and direction. In the figure (6) we illustrate by an example of the co-occurrence matrix in the image.

Therefore, for 256 gray level image, we obtained 256×256 co-occurrence matrix. This latter, contains a large quantity of information difficult to use directly. Harlik et al created a new descriptor [12] to solve this problem. This descriptor returns a measure of the intensity contrast between a pixel and its neighbor over the whole image and it's defined by this equation:

1	4	4	3
4	2	3	2
1	2	1	4
1	2	2	3

Image

	1	2	3	4
1	0	2	0	2
2	1	1	2	0
3	0	1	0	0
4	0	1	1	1

Matrix for distance = 1 and direction = 0^o

Fig. 6. Example of the co-occurrence matrix in the image.

$$C = \sum_{i=0}^{l-1}\sum_{j=0}^{l-1} |i - j|^2 C_R(i, j), \quad (9)$$

where $C_R(i, j)$ is the co-occurrence matrix of $L \times L$ dimension. TableI shows the results of comparative study of techniques seen in sectionII.

Method of enhancement	Value of statical contrast
Gabor filter	0.5
HE	1.1
CLAHE	1.5
Frangi filter	1.8
RLF	2.6

TABLE I
STATISTICAL MEASURE OF CONTRAST OF AN EXAMPLE OF HAND VEIN IMAGE

B. The Second Derivative Measure of Enhancement

The Second Derivative Measure of Enhancement is also an efficient metric to measure the contrast of the gray image. This measure is derived from the concept of the second derivative and it's presented by the following equation:

$$SDME = \frac{-1}{k_1 k_2} \sum_{l=1}^{k_1}\sum_{k=1}^{k_2} 20 \ln \left|\frac{I_{max;k,l} - 2I_{ctr;k,l} + I_{min;k,l}}{I_{max;k,l} + 2I_{ctr;k,l} + I_{min;k,l}}\right| \quad (10)$$

Where $(k1 \times k2)$ are the size of the blocks of the image. $I_{max;k,l}$, $I_{min;k,l}$ presents to the maximum and minimum pixel values in each block. $I_{ctr;k,l}$ is the center pixel value in the block.

For the measure of the performance by applying SDME, our proposed approach displays better enhancement and high value of SDME than previews particularly in preprocessing of hand vein images with low resolution as shown in figure(7).

V. Conclusion

Hand vein image enhancement eases the process of hand vein identification. Accordingly, the techniques of enhancement hand vein image draws increasingly the attention of

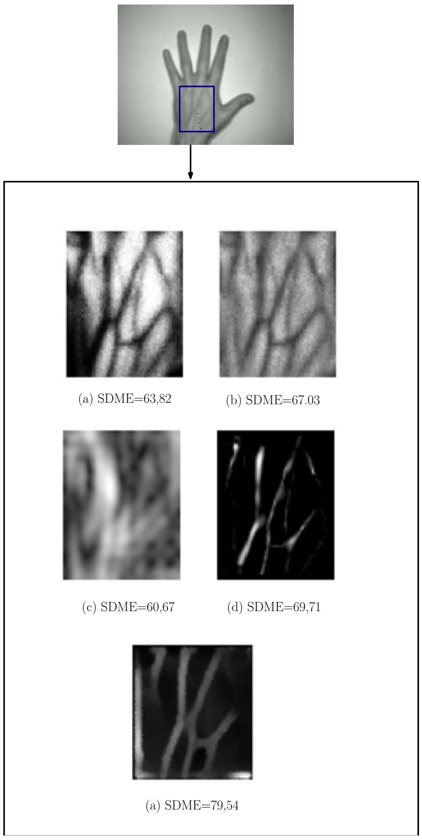

Fig. 7. Measure of SDME of different enhancement techniques.(a): image processed by HE,(b): image processed by CLAHE,(c)image processed by Gabor filter,(d)image processed by Frangi filter,(e)image processed by RLF.

researchers. In this paper, we presented a reliable and an efficient approach for hand vein enhancement. The proposed approach is based on the application of Radon Like Features descriptor. This latter has been investigated to improved the contrast in hand vein images. Experiments results proves that the proposed approach is capable of enhancing the hand vein images with lower resolution better than the others works existing in the literature.

References

[1] Jing Zhang and Jinfeng Yang, Finger-Vein Image Enhancement Based on Combination of Gray-Level Grouping and Circular Gabor Filter, International Conference on Information Engineering and Computer Science, 2009.

[2] Andinet Enquobahrie and Luis Ibanez, Vessel Enhancing Diffusion Filter, Insight Journal, 2007.

[3] Jinfeng Yang and Minfu Yan, An Improved Method for Finger-vein Image Enhancement, IEEE 10th International Conference on Signal Processing (ICSP), 2010.

[4] Daugman, J. G. Uncertainty relation for resolution in space, spatial frequency, and orientation optimized by two-dimensional visual cortical filters, Journal of the Optical Society of America, 1985.

[5] Jianwei Yang, Lifeng Liu, Tianzi Jiang and Yong Fan, A modified Gabor filter design method for fingerprint image enhancement, Pattern Recognition Letters, pp.1805- 1817 (2003).

[6] L. Ma, T. Tan, Y. Wang and D. Zhang, Personal identification based on iris texture analysis, IEEE Trans. on Pattern Analysis and Machine Intelligence, 2003.

[7] David Zhang, Wai Kin Kong, On Line Palmprint Identification, IEEE Transactions on Pattern Analysis and Machine Intelligence, 2003.

[8] J. Zhao, X. Xiong, L. Zhang, T. Fu and Y. Zhao, Study on enhanced algorithm of hand vein image based on CLAHE and Top-hat transform, Chinese journal of Laser and Nfrared, pp. 220-222, 2009.

[9] Seungjoon Yang, Jae Hwan Oh, and Yungjun Park, Contrast enhancement using histogram equalization with bin underflow and bin overflow, International Conference on Image Processing (ICIP), 2003.

[10] Ritwik Kumar, Amelio Vazquez-Reina and Hanspeter Pfister, Radon-Like Features and their Application to Connectomics, IEEE Computer Society Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), 2010.

[11] Hand vein database is available to "http://bosphorus.ee.boun.edu.tr/".

[12] R.M. Haralick , Statistical and structural approachs to texture, Proceedings of the IEEE In Proceedings of the IEEE 67 (1979), 786–804.

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