Palm Vein Image Elucidation using 2-D Wavelet Theory

Shriram D. Raut
School of Computational Sciences,Solapur University, Solapur Maharashtra, India

Vikas T. Humbe
School of Technology, S.R.T.M.U.N., Sub-Centre, Latur Maharashtra, India

ABSTRACT
Biometrics is automated tool of recognizing a person depends on physiological or behavioral characteristics. A palm vein is a new member of pattern recognition and biometrics family, has attracted much of the research attention. This paper discusses about the image enhancement operation such as histogram equalization, de-correlation stretch, and contrast stretch etc. which results a quite enhanced palm vein image. The enhanced palm vein image analysis is framed using 2-D wavelet tools and a comparison based on statistical data of these images is shown. The paper also discusses about the usefulness of 2-D wavelet tool for image analysis.

Keywords
Biometrics, PolyU Multispectral image database, pattern, histogram equalization, wavelet, de-correlation.

1. INTRODUCTION
Biometrics authentication is a growing field related to privacy and identity issues. Biometrics can be categorized into physiological or behavioral characteristics. ; Among the features measured akin to face [1], fingerprints [2], hand geometry, handwriting, iris [3], retinal, palm vein [4], voice, gait, and keystroke. A vein biometrics is a robust methodology to recognize a person; because the traits cannot be counterfeit. A key benefit of palm vein biometric authentication is a human vein characteristic that stays constant throughout one's lifetime and is difficult to fake or change [5]. A palm vein is a new member of biometrics family and attracts much of the today's research attention. It has been shown that light in the 700 to 1000 nm (infrared light) ranges will pass through a epidermis of skin, whereas an illumination range between 880 to 930 nm gives a enlighten view of vein at palm region of hand [4]. The optical penetration depth for near-infrared imaging at 850 nm is estimated to be 3.57 mm and such illumination has shown to offer higher contrast for the subcutaneous veins while imaging [6]. Compared to other biometric identification approaches, vein patterns are time invariant and sufficiently distinct in order to identify an individual. The human vascular structure is individually distinct. As per the literature reviewed, even twin has a unlike and unique vein structure [7]. The paper discusses about the enhanced palm vein image and as per the idea put forth with respect to the shape and texture features, [8] can be considered for parameter for image enhancement. An image enhancement is one of the key stages of digital image processing. The paper also discusses about wavelet tool; Wavelet analysis represents a logical step: is a window tool with variant sized portion. It is capable of exposing aspects of information that different input analysis operations miss aspects like discontinuities in higher derivatives, breakdown points, trends, and self-similarity. As it affords a change of view towards data than those presented by earlier techniques, the 2-D wavelet tool can compress, de-noise, synthesize image without much data loss. This is useful where one can get image related analysis in terms of histogram, statistics and image compression and image synthesis. For our study we only concentrated on image statistics. That will be used to compare the enhanced images.

1.1 PALM VEIN PATTERN
It uses near infrared source as light to trace and scan for hemoglobin in the blood. De-oxygenated hemoglobin seems to be as a black shade with the palm showing as a lighter color or white. The image acquisition tool can be used to capture or scan the vein pattern lies at palm region of hand. A back side of palm and palm has much multipart vein structure than fingers [7] and gives more unlike pattern for its validation. In this paper the biometric palm vein based recognition system is developed on the basis statistical properties of palm vein pattern. As it is found physiological biometric can be easily forged by undergoing medical operation and resulted into the medical identity loss of the person. So a strong and robust biometric feature such as palm vein can be studied and is adopted for person identification and it is very difficult to forge and is application for the living being as it monitors the

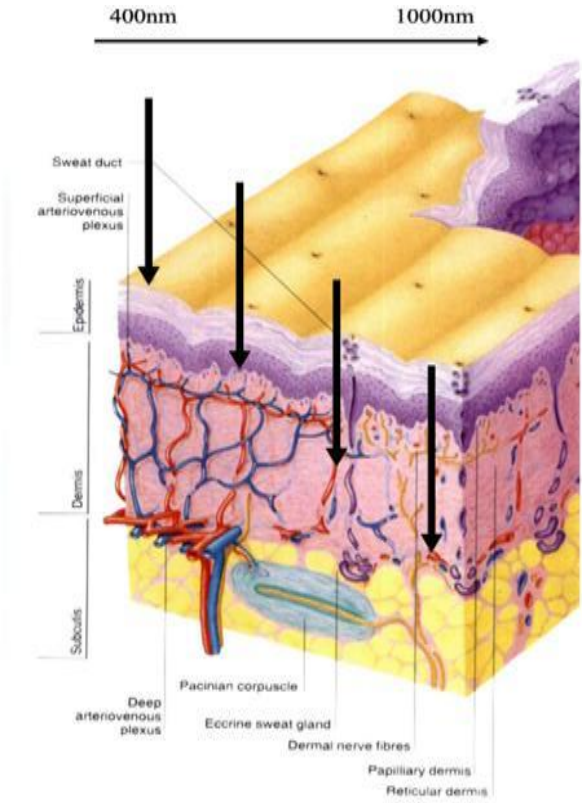

Fig.1: Anatomy view of human skin

blood fluctuation in the vein as heart pump. A person skin in terms of biology can be viewed as of: 1) epidermis; 2) dermis; and 3) sub cutis, as shown in Fig. 1. Each layer will contain a different proportion of blood and fat. The epidermis also contains melanin, whereas the sub cutis contains blood vessel [9]. A light wave cane be passed through an individual's skin

and projected at distinguished spectrum. A near infrared light can pass through a blood components and energy of a light wave will be absorbed by the hemoglobin in the blood [10].

From the view point of visible light spectrum, the three different mono-color Light Emitting Diode such as red, and green, blue and near infrared illumination at 660 nm, 525 nm, blue and 470 nm respectably were used. In the NIR spectrum, an NIR LED array peaking at 880 nm is used. It has been shown that light in the between 700 to 1000 nm range can intersect human skin, whereas in between 880 to 930 nm gives quite visible vein structure [10].

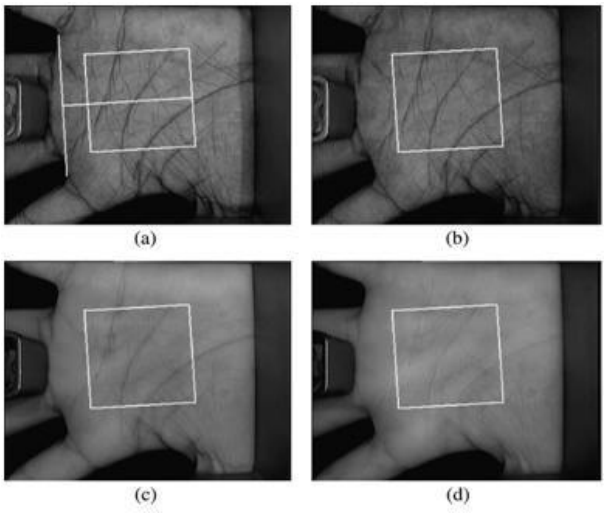

Fig. 2: A typical multispectral palm print image captured under (a) blue LED, (b) green LED, (c) red LED. (d) Near infrared LED light. A white square line is the ROI of the image.

2. IMAGE DATABASE

A Biometric Research Centre (UGC/CRC) of a Hong Kong Polytechnic University developed a multispectral palm print image acquisition device; which can acquire palm print images of blue, green, red and near-infrared (NIR) light incidence, and used that to develop a large-scale multispectral palm print database [4]. About 250 volunteers, amongst them 195 males and 55 females registered their palm. The age of the volunteers was between 20 to 60 years old. They have registered volunteers in two different sessions. In each session, the volunteer registered the 6 sample images for each palm. So the 24 images of each light source from 2 palms were collected from each subject. The database is of 6,000 images from 500 separate palms for one illumination. On an average time elapse of the primary and the next sessions was about 9 days. And devised an extracted ROI images using their ROI extraction algorithm; from 500 different palms for one light source.

Each part of their database was named as "xxxx". "xxxx" stand for the individuality of the person (1 to 500 sample). In their database, the first 6 images (1_xx) were acquired in the first session and then 6 images (2_xx) were acquired in the second session, "xx" indicates the image index for their given session (1 to 6 samples).

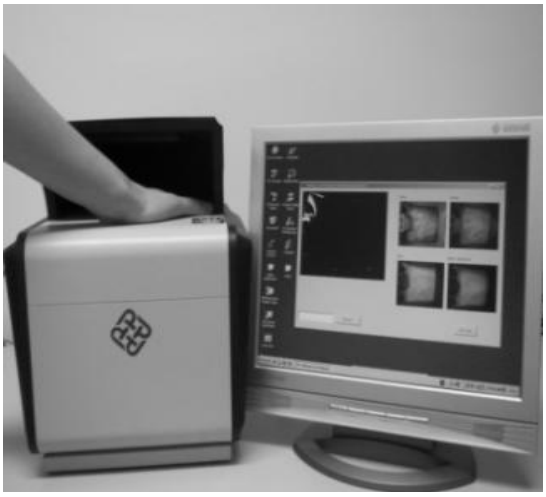

Fig.3: An outlook of multispectral image acquisition device

In study we have worked on the NIR illuminated palm print multispectral image and related statistical measurements. The palm-vein images in contactless imaging present lot of translational and rotational variations. Therefore, more stringent preprocessing steps are required to extract a stable and aligned ROI. The preprocessing steps essentially recover a fixed-size ROI from the acquired images which have been transformed for reduction in terms of rotation, translation and scale change in an image. The goal can be achieved by non-linear enhancement operations in order to clearly visualize the vein pattern lies at palm region of hand [11]..

3. IMAGE ENHANCEMENT

The important goal of enhancement is to make image visually appealing and highlight the fine details of it. An enhancement of an image can be categorized into two: frequency and spatial domain operations. The spatial domain operations are well known to operate on pixels of an image. This is one of the key stages of digital image processing. The enhancement is to be carried to reduce the noise and to make image visually appealing. The various enhancement operations are too much helpful to get the features present in an image. The enhancement can be done in terms of histogram equalization, adjustment in color map, de-correlation stretch and contrast limited adaptive histogram equalization. [3]:

$$g(x,y) = T[f(x,y)]$$

Where $f(x,y)$ is the input image, $g(x,y)$ is the processed image, and T is an operator on$f$, defined over some neighborhood of (x,y).The simplest form of T is when the neighborhood is of dimension m (no. of rows) by n (no. of column) in terms of single pixel information. The value of g relies directly on the value of at f (x,y), and T becomes translation form of the form $S = T(r)$, and for simplicity in notation, r and s are indicates respectively, the image pixel level of $f(x,y) and\ g(x,y)$ at any point (x,y).

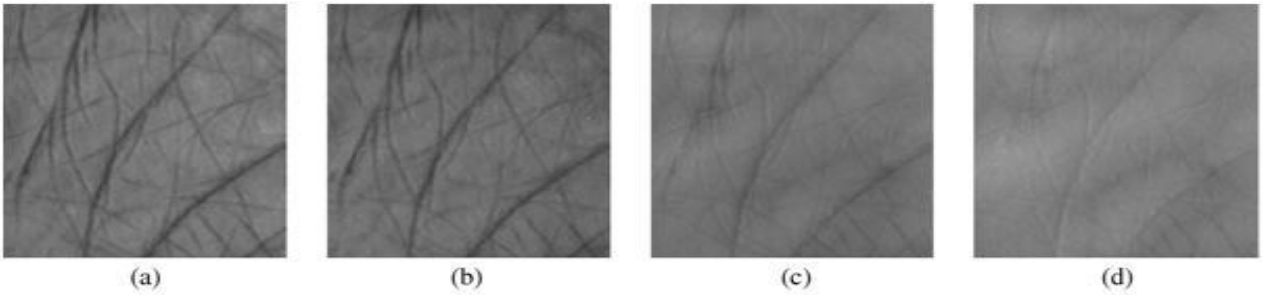

Fig. 4 A ROI snaps of fig 2 images

4. EXPERIMENTAL RESULTS

An experiment is carried out at MATLAB; which is software computing tool. An experiment is focused on image analysis of the enhanced image. Fundamental image enhancement operations are performed on image captured under the NIR spectrum, a NIR Light Emitting Diode illumination projected at 880 nm as shown in fig.4 (d). This image generally appears darker with low contrast. The enhancement operations are useful to extract palm vein pattern from an image. Using 2-D wavelet tool, it is very easy to get the statistical image information and that can be used to show comparison based on statistical values of enhanced image. First of all the image resulted from enhancement operations are to be discussed and then usefulness of 2-D wavelet tool to calculate image statistics. The image enhancement operations such as histogram equalization, contrast and de-correlation stretch, adjusting color map or intensity values are performed. These operations are useful to highlight or trace the palm vein pattern. Following are the resultant images after image enhancement.

The images resulted from the enhancement operations shows vein pattern in dark or lighter shade at palm region of hand. In fig.5 (a) its original image; (b) adjusted color map image;
(c) De-correlation stretched image; (d) histogram equalized image; (e) contrast limited adaptive histogram equalization (CLAHE) image.

5. COMPARISON

Now the 2-D wavelet tool is used to calculate the enhanced palm vein image statistics. The summary statistics of these images can be in terms of mean, median, mode, standard deviation, median absolute deviation, mean absolute deviation.

A Table 1 shows statistical values calculated using 2-D wavelet tool. The analysis can be framed using these values as we compare these with respect to original palm vein image and enhanced images. From these observations we can state that the statistical measurement for each and every image is unique and distinct. As we see the mean, median of these images, the enhanced image through contrast limited adaptive histogram equalization (CLAHE) is having highest of those values. The Histogram equalized image has the highest Mode value and second most standard deviation and mean absolute deviation values. The De-correlation stretch image has the highest value of standard deviation, median absolute deviation and mean absolute value too. From these we can conclude these values are distinct and unique; that means original image data values changes as we perform the enhancement operations. The image analysis can be done using 2-D wavelet tool. The comparison sheet is generated and from which we can conclude in terms of summary statistical values are much useful if we want to progress further for classification based on statistical properties or as a base of statistical pattern recognition.

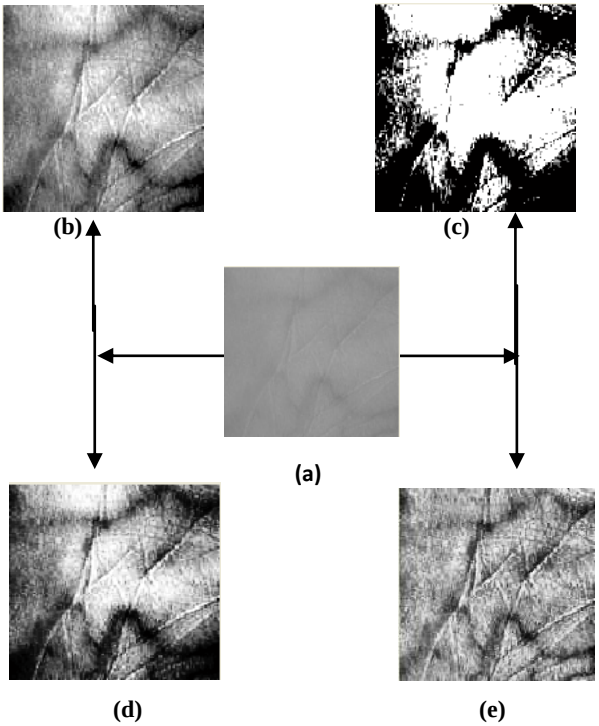

Fig. 5. (a) Original image; (b) - (e) Enhanced image

6. CONCLUSION

A palm vain is a new member of pattern recognition and biometrics family, has attracted much of the research attention. In human vein when acquired under near infrared light source, de-oxygenated hemoglobin looks as white or color in light shade.

The image preprocessing operations such as image enhancement are performed. Fundamental image enhancement operations are useful so as to trace or highlight the vein pattern that lies at palm of hand. The paper discusses about the palm vein original image and enhanced image through enhanced operations such as histogram equalization, contrast limited adaptive histogram equalization, De-correlation stretch and adjust color map. The analysis is framed by taking into consideration the statistical values of original image and enhanced image. These statistical features are useful for pattern matching or simply classification of an individual.

Table 1. Image Data Analysis using 2-D wavelet tool shows summary statistics of enhanced images

	Mean	Median	Mode	Std. Dev	Median abs. dev	Mean abs. dev
Original Image	146.9	147	146.4	5.638	4	4.483
Histogram Equalized Image	128.5	129	253.4	74.63	64	64.55
CLAHE Image	170.7	170	167.1	13.55	9	10.85
De-correlation Stretched Image	126.4	124	3.55	106.9	120	99.84

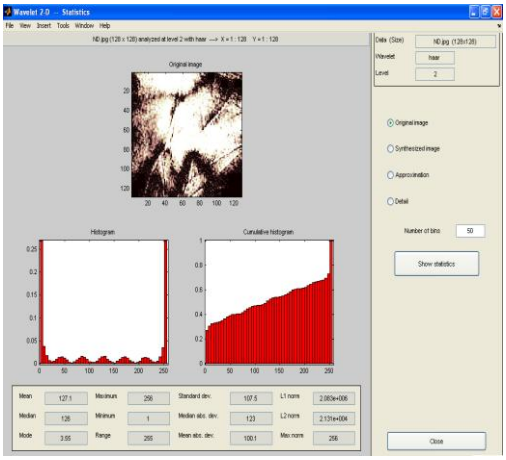

Fig. 7: 2-D wavelet tool to calculate image statistics of image sample under de-correlation stretch enhancement operation

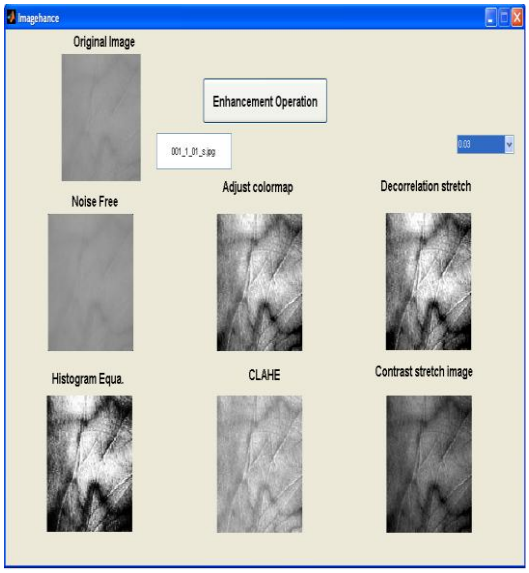

Fig. 6: GUI in MATLAB, to demonstrate Image enhancement operation

7. ACKNOWLEDGMENT

We would like to thank the Research Centre at Hong Kong Polytechnic University as they provided the access to their image database. We are also grateful to University Department of Computer Science and Applications, School of Computational Sciences, Solapur University, Solapur and University Department of Computer Science, School of Technology, S.R.T.M.U.N. Sub-Centre, Latur for providing us an infrastructure and research laboratories.

8. REFERENCES

[1] R. Singh, M. Vatsa, H. Bhatt, S. Bharadwaj, A. Noore, and S. Nooreyezdan, "Plastic surgery: A new dimension to face recognition," IEEE Trans. Inf. Forensics Security, vol. 5, no. 3, pp. 411–418, Sep.2010.

[2] T. Matsumoto, H. Matsumoto, K. Yamada, and S. Hoshino, "Impact of artificial "gummy" fingers on fingerprint systems," Proc. SPIE, pp. 275–289, 2002.

[3] Z. Wei, X. Qiu, Z. Sun, and T. Tan, "Counterfeit iris detection based on texture analysis," in Proc. Int. Conf. Pattern Recognition, , Pp. 1–4, 2008.

[4] D. Zhang, Z. Guo, Guangming Lu, Lei Zhang, Wangmeng Zuo, "An Online System of Multispectral Palm print verification", IEEE Transaction on Instrumentation and Measurement, vol. 59, issue. 02, Pp. 480-490, 2010.

[5] I. Sarkar, F. Alisherov, T. Kim and D. Bhattacharyya, Palm vein authentication system: a review. International Journal of Control Automation, Vol.03, No. 01, pp. 27-34, 2010.

[6] A. Kumar and K. V. Prathyusha, "Personal authentication using hand vein triangulation," IEEE Trans. Image Process., vol. 38, no. 9, pp. 2127–2136, Sep. 2009.

[7] Li Xueyan, Guo Shuxu, "A Fourth Biometric-Vein Recognition", *Pattern* recognition techniques, technology and applications, ISBN -953-7619-24-4, 2008.

[8] M. Deepamala, M. Madheswaran, "An enhanced palm vein recognition system using multi-level fusion of multimodal features and adaptive resonance theory", IJCA, vol. 01, no. 20, Pp. 95-101, 2010.

[9] D. J. Gawkrodger, Dermatology: An Illustrated Colour Text. 3rd ed. Elsevier Health Sci., 2002.

[10] V. P. Zharov, S. Ferguson, J. F. Eidt, P. C. Howard, L. M. Fink, and M. Waner, Infrared imaging of subcutaneous veins. Lasers Surg. Med., vol. 34, no. 1, pp. 56–61, Jan. 2004.

[11] Yingbo Zhou, Ajay Kumar, "Human Identification Using Palm-Vein Images", IEEE Trans. on Inf. Forensics and Security, vol. 6, no. 4, Pp. 1259-1274, Dec. 2011.