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Analysis of Palm Vein Pattern Recognition Algorithms and Systems

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ABSTRACT

Palm vein authentication has high level of accuracy because it is located inside the body and does not change over the life and cannot be stolen. This paper presents an analysis of palm vein pattern recognition algorithms, techniques, methodologies and systems. It discusses the technical aspects of recent approaches for the following processes; detection of region of interest (ROI), segment of palm vein pattern, feature extraction, and matching. The results show that, there is no benchmark database exists for palm vein recognition. For all processes, there are many machine learning techniques with very high accuracy.

Key Words: Biometric, palm vein pattern, ROI extraction, feature extraction, matching.

1. INTRODUCTION

Recently, many researchers investigated the finger, hand, and palm vein recognition for automated personal identification. By using modern technology a person can control their personal information easily at any time and any place, but also there are some risks that other people can take control of this information. Because of these risks researchers tried to use biometric authentication technologies [1]. Biometrics is automated methods of recognizing a person based on a physiological or behavioural characteristic. An example of behavioural characteristic are face recognition, fingerprints, hand geometry, signature verification, iris, retinal, finger/hand/palm vein recognition, ear recognition, and voice recognition.

Academic and industry tried to develop a device that can catch the vascular patterns under the skin .Fujitsu has developed a palm vein pattern authentication technology that uses vascular patterns as personal identification data [2] .Vein recognition technology is secure because the authentication data exists inside the body and so it is very difficult to forge [3]. It is highly accurate. This technology has many applications like in banking, hospitals, government offices, in passport issuing, libraries, personal computer, etc. Business growth will be achieved with these solutions by reducing the size of the palm vein sensor and shortening the authentication time [3].

The contactless palm vein authentication technology consists of image sensing and software technology [4]. Palm vein recognition system consists of four key steps: Infrared palm images capture Detection of Region of Interest (ROI) and pre-processing and Palm vein pattern extraction, feature extraction and feature matching [5].

The rest of the paper is organized as follows. In Section 2, we briefly explain the general architecture of the palm vein system. Section 3 introduces the details of detection of Region of Interest (ROI) including pre-processing step. The extraction of the Palm Vein Pattern is discussed in section 4. Section 5 discusses the feature extractions of the palm vein pattern and feature matching. The results and discussion are introduced in section 6. Finally, conclusion is presented in Section 7.

2. PALM VEIN MODEL

Palm vein technology works by identifying the vein patterns in an individual's palm. When a user's hand is held over a scanner, a near-infrared light maps the location of the veins. The red blood cells present in the veins absorb the rays and show up on the map as black lines, whereas the remaining hand structure shows up as white. This vein pattern is then verified against a preregistered pattern to authenticate the individual. As veins are internal in the body and have a wealth of differentiating features, attempts to forge an identity are extremely difficult, thereby enabling a high level of security [6]. Figure 1 shows the general processes of the identification model using Palm veins biometrics.

After image capture, a small area of a palm image is located as the region of interest (ROI) to extract the features and to compare different palms. Using the features within ROI for recognition can improve the computation efficiency

significantly [7].

In the image-based biometric systems there is a number of processing tasks used to produce a better quality of image that will be used on the later stage as an input image and assuring that relevant information can be detected. Normally, the captured palm vein pattern is grayscale and subject to noise. Noise Reduction and Contrast Enhancement are crucial to ensure the quality of the subsequent steps of feature extraction [7]. Also, the vein pattern extracted from infrared-ray images is represented as dark lines. To extract these lines many researcher used edge detection and morphological operators [4].

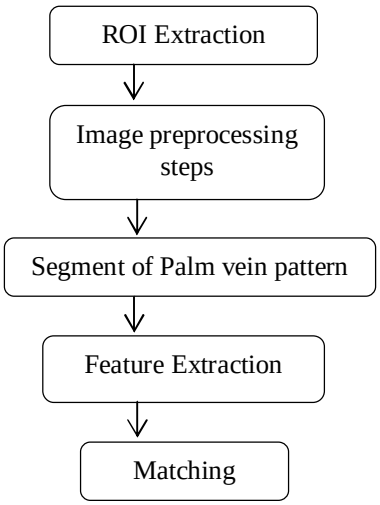

Figure 1: The processes of the identification model using Palm veins biometrics.

Feature extraction plays an important role in palm vein recognition because the performance of feature matching is greatly influenced by its output [4]. Feature matching is achieved by check whether the input image exist in the database to give the permission to that person being authenticated. When one place his/her palm the sensor sense the veins and if they are matched with the registered ones the system allows the person to use it [2].

3. Detection of Region of Interest (ROI) and pre-processing step Algorithms

Before feature extraction, it is necessary to extract from the original images a specific portion to work with. This is known as extraction of region of interest (ROI). The ROI extraction has two important advantages. First, it serves as a pre-processing to remove the translation and rotation of palm vein images introduced in the data collection process. Second, ROI extraction extracts the most informative area in the images. It reduces a lot of data amount without losing much useful information. This will speed up the feature extraction and matching processes [8].

Zhou and Kumar [9] processed the palm-vein images acquired from the completely contactless imaging by normalize it. First segmenting the ROI, the acquired palm images are first binarized so that they able to separate the palm region from the background region. This is followed by the estimation of the distance from center position of the binarized palm to the boundary of palm. After segmentation, the ROI images are scaled to generate a fixed size region. Finally, histogram equalization is employed to obtain the normalized and enhanced palm-vein image. The enhancement has been quite successful in improving the details and contrast of the ROI images. Most of researchers employed this method to find the ROI; like [10].

Li et al. [11] adopted a 5x5 median filter to remove the speckling noise in the ROI image. Ladoux et.al [12] extracted the region of interest (ROI) and applied 5x5 box filter on the ROI in order to reduce the noise. After then, they corrected the brightness, which is not uniform, by applied a Gaussian low-pass 51x51 filter on the ROI in order to obtain the brightness image which is considered as low frequencies. Then, the brightness is subtracted of the original ROI. At this step, the contrast was still too bad. Therefore they applied a normalization method.

In [7], a small area (128*128 pixels) of the palm image capture is located as the region of interest (ROI). After that, noise reduction and contrast enhancement are carried out to produce a better quality of image through the following steps; (a) binarization that transforms the grayscale pattern into a black and white image, (b) skeletonization that reduces the width of lines to one pixel and (c) isolated Pixel Removal that eliminates the unwanted isolated points. These three steps constitute the procedure of image preprocessing as shown in Figure 2.

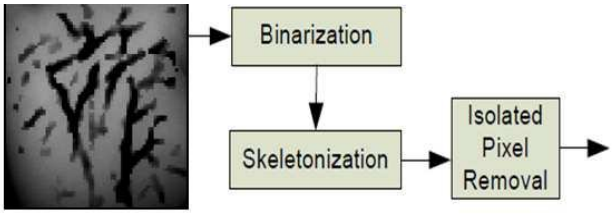

Figure 2: Three steps of Image Preprocessing [7].

4. Segment of Palm Vein Pattern

Extracting the vein pattern from the background is an important step the next step in the palm vein system [12]. Figure 3 illustrates extract the palm vein pattern. Table 1 shows the different palm vein pattern extraction algorithms used in palm vein authentication research Zhang et al. [10]; proposed a multiscale scheme to improve the performance of

vein detection. Used Gaussian shaped filter to de-noise and the zero-sum to suppress the background pixels.

Bhattacharyya et al. [8] proposed three different algorithms for processing Palm Vein Pattern Image of an individual. These three different processes are: a. Vascular Pattern Marker Algorithm (VPMA); b. Vascular Pattern Extractor Algorithm (VPEA); and c. Vascular Pattern Thinning Algorithm (VPTA). In Vascular Pattern Marker Algorithm, two-pass masking is used, namely, Horizontal and Vertical kernels; the process is Smoothing the Image. In Vascular Pattern Extractor Algorithm, a binarized image is created with only 2 colors, black (0) and white (255). Image thresholding is very useful for keeping the significant part of an image and getting rid of the unimportant part or noise.

Ladoux et.al [12] observed that the grey level is low where the hemoglobin absorbs the Near Infrared light (NIR). They have chosen the extraction algorithm of the vein pattern to be the local thresholding that depending on the mean value of the neighborhood of each pixel.

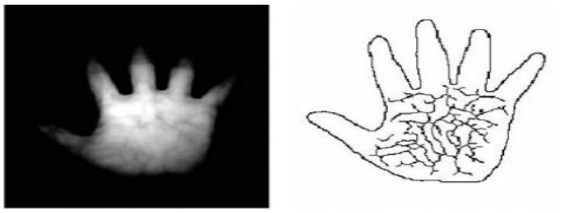

Figure 3: Extracting a palm vein pattern [4].

5. Feature Extractions of the Palm Vein Pattern and feature Matching

Various feature extraction methods have been used in the literature for extract features from the palm vein images. Matching is used to determine the identity of a person, or verify that someone is indeed who he or she claims to be. To perform matching, the system takes image from the person and extracts the features. For the purpose of identification, the features will be compared with all the records in the database to see if there is a match. For verification, the system will retrieve the features of a single person and perform a one-to-one comparison.

6. Results and Discussion

Many researchers try to capture vein images by using a special device usually consist of scanner and near infrared light source. Simply hold your palm a few centimeters over the scanner and within a second it reads your unique vein pattern. A vein picture is taken and palm pattern is registered [2]. Table 1 shows the databases used in palm vein authentication research. From table 1, there are different database used in the literatures, no benchmark database exists for palm vein recognition.

Table 2 shows the results of different palm vein models for different feature extraction methods and different matching methods. From table 2, it can be seen that; (a) various pattern extraction methods have been used for extract palm vein pattern from the palm vein images such as; Histogram equalization [9], [11], [19], Gaussian filter [10], [12], [20], shock filter [17]. (b) Various feature extraction methods have been used in the literature for extract features from the palm vein images. The principal component analysis (PCA) [11], Scale invariant feature transform (SIFT) [5], [7], [12], Gabor filters [13], Laplacian palm [14], and Ordinal Code [15] are the most feature extractions methods used in the literature. And (c) various distance matching have been used such as Euclidean distance, Hamming distance, Cosine similarity, Exclusive-or operator, AND operator, and OR operator. Also some models of neural networks have been used for matching step such as LVQ, Cellular, and ART1 networks.

Further, some researchers used a small database [10], [21] because of the difficulty of collect a large number of images. Other research used palm vein and other biometric to get best result in identification to person. In [20], the authors fused palm print and palm vein they find that the Genuine Acceptance Rate (GAR) when using the palm print alone is 99%, the palm vein alone is 99.1% and the fusion of them is 99.7% so that the fusion of them get better result than use one of them alone. Other researcher in [7] fused palm vein and signature biometrics, they find that the Genuine Acceptance Rate (GAR) when using the signature alone is 89.59%, the palm vein alone is 95.68% and the fusion of them is 96.98% so that the fusion of them gets better result than use one of them alone. The future work using these comparisons to improve the palm vein feature extraction and matching algorithms.

Table 1: Databases used in palm vein authentication research

Reference No.	Database name	Database Size and Features
Watanabe et al**.** [22]	Fujitsu database	140,000 images (70,000 individuals from 5 to 85 years old)
Zhang et al. [10]		144 images (24 individuals)
Zhang et al. [20]		6000 palm print and vein images (500 individuals from 20 to 60years old)
Zhou and Kumar [9], (CASIA database) [23]	CASIA database	600 images (100 individuals)
Zhang et al. [13]	PolyU database	3000 images (250 individuals)
Li et al. [11]		1000 images (50 individuals from 18 to 60 years old)

Ladoux et al. [12]	home database	192 images (24 individuals)

Table 2: Palm vein recognition algorithms and systems.

Authors	pattern extraction	Feature extraction	Matching
Hassan et al. [7]		SITF	Linear Vector Quantization (LVQ)
Zhou and Kumar [9]	Histogram equalization	Hessian phase	Neighborhood matching Random Transform
Zhang et al. [10]	Gaussian-shaped filter		template matching (exclusive or operation)
Li et.al [11]	Histogram equalization	curvelet transform and PCA	nearest-neighbor (NN) classifie
Ladoux et al. [12]	Gaussian low-pass 51x51 filter	SIFT	Euclidean distance between SIFT descriptors
Malki et al. [16]			Cellular Neural Network
Deepamala et al. [17]		Gabor filter, hand shape features, and thinning and pruning algorithms	K-NN with Euclidean distance and ART1 neural network
Zhou and Kumar [19]	Histogram equalization	Hessian phase & localized Radon transform (LRT)	Cosine similarity& Hamming distance
Zhang et al. [20]	Gaussian-shaped filters		Measure distance between two palm vein feature maps by using AND and OR operators
Mirmohamadsadeghi and Drygajlo [21]	Local Binary Patterns (LBP) and Local Derivative Patterns (LDP)	LBPs & high order LDPs	Histogram intersection

7. CONCLUSION

This study presents an analysis of palm vein recognition algorithms and systems for biometrics authentication and identification. Many research used palm vein system only to identify the person by extracting his palm vein. At present, the challenges faces the researchers are the capture device which is very sensitive to the outside lights. The outside lights can affect the inside infrared light source so that some images have very poor quality due that the capture device should improve to increase the system performance. Resolution of image captured depends on ambient light intensity and temperature. Because these two factors strongly affects the resolution of captured image and hence the accuracy of the device, so still some improvements are required in the technology and some progress is going on. In near future these problems are expected to be solved and more enhanced, accurate and secure device will be manufactured.

REFERENCES

1. S. Prabhakar, S. Pankanti, and A. K. Jain. **Biometric Recognition: Security and Privacy Concerns**, *IEEE Security and Privacy*, Vol.1, No. 2, pp. 33-42, 2003.
2. Shigeru Sasaki, and Akira Wakabayashi, **Business Expansion of Palm Vein Pattern Authentication Technology**, Fujitsu Sci. Tech. J., 41, 3, pp. 341-347, 2005.
3. P**alm Vein Pattern Authentication Technology,** Fujitsu white paper, 2005.
4. Hao luo,Fa-Xin Yu,Jeng-Shyang Pan,Shu-Chuan Chu and Pei-Wei Tsai, **A Survey of Vein Recognition Techniques** ,information technology Journal,vol.9,no 6,pp.1142-1149,2010.
5. Bhudev Sharma **Palm Vein Technology**. Sardar Vallabhbhai National Institute of Technology, December-2010.
6. Ishani Sarkar, Farkhod Alisherov, Tai-hoon Kim, and Debnath Bhattacharyya, **Palm Vein Authentication System: A Review**, International Journal of Control and Automation, Vol. 3, No. 1, pp.27-34, March, 2010.
7. Hassan Soliman, Abdelnasser Saber Mohamed and Ahmed Atwan, **Feature Level Fusion of Palm Veins and Signature Biometrics** , International Journal of Video & Image Processing and Network Security IJVIPNS-IJENS Vol: 12 No: 01, pp.28-39, 2012.
8. Debnath Bhattacharyya , Poulami Das, Tai-hoon Kim and Samir Kumar Bandyopadhyay, **Vascular Pattern Analysis towards Pervasive Palm Vein Authentication** , Journal of Universal Computer Science, vol. 15, no. 5, pp.1081-1089,2009.
9. Yingbo Zhou and Ajay Kumar, **Human Identification Using Palm-Vein Images** , IEEE transactions on information forensics and security, vol. 6, no. 4,pp.1259-1247, December 2011.
10. Y.-B. Zhang, Q. Li, J. You, and P. Bhattacharya, **Palm vein extraction and matching for personal authentication**, in Lecture Notes in Computer Science. Springer, pp. 154–164. , 2007.
11. Qiang Li, Yan'an Zeng , Xiaojun Peng and Kuntao Yang **, Curvelet-based palm vein biometric recognition** CHINESE OPTICS LETTERS / Vol. 8, No. 6, pp.577-579,June 2010.

12. Pierre-Olivier Ladoux, Christophe Rosenberger and Bernadette Dorizzi , **Palm Vein Verification System based on SIFT matching** Third International Conference on Advances in Biometrics, pp. 1290-1298, June 2009.
13. D. Zhang, Z. Guo, G. Lu, L. Zhang, and W. Zuo, **An online system of multispectral palmprint verification,** IEEE Trans. Instrum. Meas., vol. 59, no. 2, pp. 480–490, Feb. 2010.
14. J.-G.Wang,W.-Y. Yau, A. Suwandy, and E. Sung, **Person recognition by fusing palmprint and palm vein images based on "Laplacian palm representation"** Pattern Recognit., vol. 41, pp. 1514–1527, Oct. 2007.
15. Y. Hao, Z. Sun, T. Tan, and C. Ren, **Multispectral palm image fusion for accurate contact-free palmprint recognition,** International Conference on Image Processing, pp. 281–284, 2008.
16. Suleyman Malki, Yu Fuqiang, Lambert Spaanenburg, **Vein Feature Extraction Using DT-CNNs,** 10th International Workshop on Cellular Neural Networks and Their Applications, Istanbul, Turkey, pp.1-6, August 2006.
17. M.Deepamalar and M.Madheswaran**An Enhanced Palm Vein Recognition System Using Multi-level Fusion of Multimodal Features and Adaptive Resonance Theory,** International Journal of Computer Applications (0975 - 8887) vol. 1 – No. 20, pp.95-101, 2010.
18. B.Prasanalakshmi , A.Kannammal, B.Gomathi,K.Deepa, R.Sridevi**,Biometric Cryptosystem Involving Two Traits And Palm Vein As Key,** International Conference on Communication Technology and System Design , 2011, Procedia Engineering, vol. 30, pp. 303 – 310, 2012.
19. Yingbo Zhou and Ajay Kumar**,Contactless Palm Vein Identification using Multiple Representations**, in 4th IEEE international conference on biometrics: Theory applications and systems (BTAS), pp. 1-6, September 2010
20. David Zhang, Zhenhua Guo, Guangming Lu, Lei Zhang, Yahui Liu, Wangmeng Zuo, **Online joint palmprint and palmvein verification ,** Expert Systems with Applications, No.11, pp. 2621-2631 , 2010.
21. Leila Mirmohamadsadeghi and Andrzej Drygajlo, **Palm Vein Recognition with Local Binary Patterns and Local Derivative Patterns ,** International Joint Conference on Biometrics, pp. 1-6, 2011
22. Masaki Watanabe, Toshio Endoh,Morito Shiohara, and Shigeru Sasaki, **Palm vein authentication technology and its applications**, The Biometric Consortium Conference, pp. 1-2, September 19-21, 2005.
23. CASIA MS Palmprint V1 Database [Online]. Available: http://www. cbsr.ia.ac.cn/MS_Palmprint.