RESEARCH ARTICLE OPEN ACCESS

Literature Survey On Contactless Palm Vein Recognition

Roshni C Rahul [1], Merin Cherian [2], Manu Mohan C M [3]
Department of Computer Science [1], Department of Science [2], Department of Electronics [3]
Mahatma Gandhi University
Kerala - India

ABSTRACT
Contactless palm vein recognition is one of the newest biometric techniques which has high level of accuracy as it is located inside the human body and does not change over the life time. In this paper, we present a review of different palm vein recognition techniques that are widely used today. We mainly discuss the technical aspects of recent approaches for the following processes; identification of region of interest (ROI), segmentation of palm vein pattern, palm vein feature extraction, and matching. The analysis mainly focuses on different local descriptors which can efficiently extract vein texture.
Keywords:- *LDN, LBP,* CASIA, EER

I. INTRODUCTION

There are large numbers of biometric technologies available to individuals which can be used by them during their day to day life. The most common among these techniques such as face recognition, finger print recognition, voice recognition and Iris recognition are readily available even for those using smart phones. These authentication techniques are mainly used for security purpose and for enhancing human-machine interaction. But these biometrics information can be easily forged which leads to weak security. Since vein information is internal to the human body, it is very hard to duplicate. A vascular pattern of an individual's palm is used as personal identification data for palm vein authentication. Palm vein pattern is unique biometric identity feature of the human beings which more efficiently secure our data from unlawful intervention compared to other existing biometric techniques. The main application includes banking, government offices, hospitals and passport issuing.

The palm vein recognition can be done using two methods namely touch based design and contactless authentication. The main drawbacks of touch based design includes hygiene issues, latent hand prints which remain on the sensors surface could be copied for illegitimate use, device surface will be contaminated easily and finally some nations may resist placing their palm after a user of the opposite sex has touched the sensor surface. Therefore contactless design is more preferred as it offers more hygiene.

The contactless palm recognition systems consist of four major steps which produce efficient result. First stage is palm vein detection i.e. the region of interest (ROI) is detected from the image so that computation need to be performed only where the required data resides and it increases the computation speed. Along with it, normalization is done which convert data image into a normalized value according to the requirement of the application. Next step is feature extraction which extracts the distinct features and the irrelevant features are eliminated in feature selection process. Final step is palm vein recognition which can be done using supervised or unsupervised techniques.

In this paper, we mainly focus on feature extraction method which can make the recognition system more real time and robust. There are four common approaches to extract vein pattern features: line-based, appearance-based, code-based and texture based methods. Figure 1 shows different feature extraction techniques for palm vein recognition.

In this paper, we made survey mainly on local texture based descriptors are used. Texture is usually defined as the smoothness or roughness of a surface. In computer vision, texture is represented as the visual appearance of the uniformity or lack of uniformity of brightness and colour. There are two types of texture namely Random texture which
cannot be exactly described by words or equations and Regular texture which can be described by words or equations or repeating pattern primitives.

As a literature about different local texture based features, among these methods are Local Features Analysis [1], Gabor features [2], Elastic Bunch Graph Matching[3], and Local Binary Pattern (LBP) [4]. Newer methods tried to overcome the limitations of LBP, like Local Ternary Pattern (LTP), and Local Directional Pattern (LDiP) [5]. The last method encodes the directional information in the neighbourhood, instead of the intensity. However, some methods explored different features, such as, WLBPH [6], to overcome the illumination problem while maintaining the performance under difficult conditions. Adin Ramirez Rivera et al. [7] proposed a face descriptor, Local Directional Number Pattern (LDN), for robust face recognition which encodes the structural information and the intensity variations of the faces texture by evaluating directional information.

Each pixel in the image is encoded as 6 bit binary code. Main drawback of LDN descriptor was that they do not encode contrast information which was overcome by using new texture based descriptor known as Local directional texture pattern(LDTP) [8]. It encodes both contrast as well as directional information of vein textures. Each pixel of the input image is represented as 7 bit binary code.

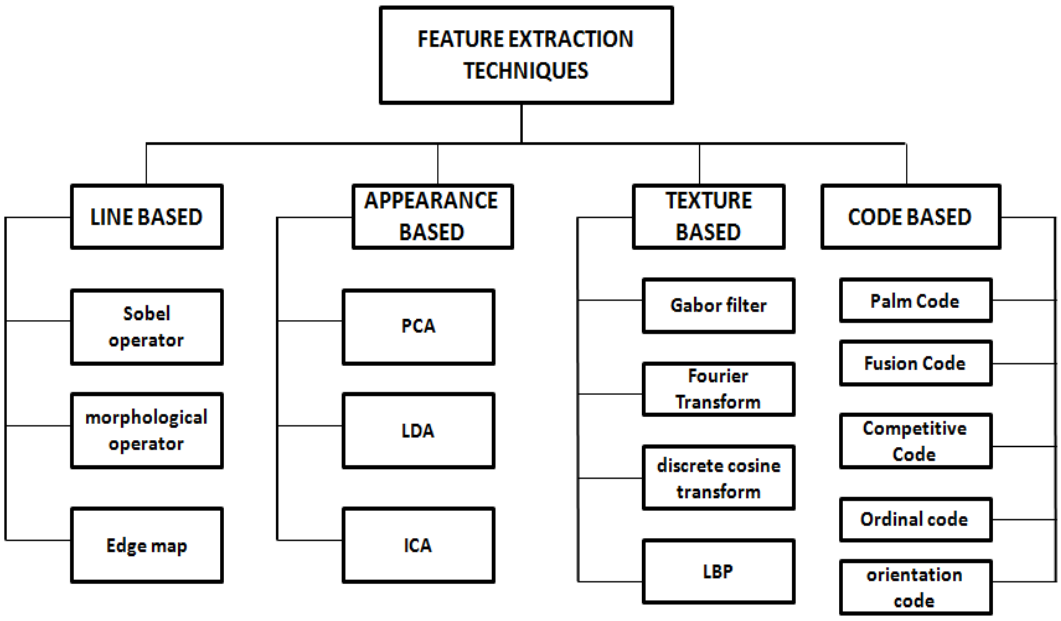

Fig. 1. Different feature extraction techniques for palm vein recognition

II. DIFFERENT PALM VEIN RECOGNITION TECHNIQUES

A paper published by Sahar Bayoumi, et.al [9], introduced a new methodology for Palm Vein recognition by adopting PCA. Inorder to capture Palm vein images of dorsa, infrared camera have been used. PCA is applied to extract distinct features which are generated as vector of features. A matching process is then applied to find the best match from the dataset to recognize and authenticate the person. Experiments show that there system is able to recognize human with accuracy 85% in real-time based on supervised recognition.

Y Hao et. al [10] proposed a new contactless palm print authentication system by using feature level image registration and pixel-level fusion for improving the verification performance. The major steps involved are:

- A sequence of multi-spectral hand images is obtained
- Pre-process each image independently to achieve coarse localization of ROIs
- Each sequence of images are further refined through feature level image registration
- Fused image is produced as output.

The main advantage is that, it can be used for pixel-level fusion of multispectral images and Fast recognition possible as no extra memory consumption required. Drawback of this method is that, it is not efficient while using image registration.

Two new contact-free palm vein representations, namely Hessian phase information from the enhanced palm vein patterns during the preprocessing stage and the orientation encoding of palm vein line-like patterns using localized Radon transform where proposed by Yingbo Zhou, Ajay Kumar [11] which have been used for Forensic, Military based and online business applications. They have also used CASIA Dataset for analysis. This method helped to enhance the efficiency of feature extraction of palm vein patterns. The main steps involved are:

- Preprocessing stage which includes ROI segmentation and Image enhancement
- Feature extraction and representation using Hessian, LRT, LPP and ordinal representation
- Matching score generation using cosine similarity.
- Score combination using the four representations.

Z.khan et.al [12] proposed a Contour Code, a novel orientation and binary hash table based encoding for palmprint recognition. It facilitates simultaneous matching to the database and score level fusion of the multispectral bands in a single step. Main advantage includes normalization of scores which is not required before fusion and this single methodology can be used for the extraction of both the line and vein features. Major steps involved are :

- Preprocessing hand images
- Identifying region of interest
- Contour Code representation derived using a two stage filtering approach to extract only directional features
- Contour Code which is binarized into an efficient hash table structure.

Multispectral palm print verification results on the PolyU and CASIA databases show that the Contour Code achieves an EER reduction upto 50%, compared to state-of-the-art methods.

An automated finger-vein verification system using the mean curvature was introduced by Lin Zhang et al [13]. The mean curvature at a point on a surface is, roughly speaking, the mean of the surface curvatures in all directions. Treating the intensity surface of an image as a geometric object, this method views the vein pattern as valley-like structures. By a valley-like structure we mean a long channel, like a gutter, whose cross-section forms the shape of U or V. Its inversion is referred to as a ridge-like structure. The set of points with negative mean curvature is determined to be a valley-like structure. The mean curvature has been used in other applications for determining the degree of ridge or valley-likeness.

A promising new approach based on local texture patterns is proposed in [14]. First, operators and histograms of multi-scale Local Binary Patterns (LBPs) are investigated in order to identify new efficient descriptors for palm vein patterns. Novel higher-order local pattern descriptors based on Local Derivative Pattern (LDP) histograms are then investigated for palm vein description. Both feature extraction methods are compared and evaluated in the framework of verification and identification tasks. Extensive experiments done by L.Mirmohamdsa deghi et.al on CASIA Multi-Spectral Palm print Image Database Vl.O(CASIA database) identify the LBP and LDP descriptors which are better adapted to palm vein texture. Tests on the CASIA datasets also show that the best adapted LDP descriptors consistently outperform their LBP counterparts in both palm vein verification and identification.

A paper published by J.C. Lee [15], developed a reliable and robust palm vein identification system for real-time personal identification by applying a low-cost NIR CCD camera-based palm vein device to capture the palm vein images. A preprocessing algorithm extracts a rectangle area (ROI) from a palm vein image for feature extraction. To represent a low-resolution palm vein image and match different palm vein images, they extend the use of 2-D Gabor filter to represent a palm vein image using its texture feature, and apply a normalized hamming distance for the matching measurement. In addition, they proposed a new technique called directional coding to code the palm vein features in two bits representation. This method represents the biometric features in bit string format which enable speedy matching and convenient storage. Using this representation, the total size of a palm vein feature is reduced to 2520 bits. In their palm vein database of 4,140 palm vein images from 207 different palms, they achieved high recognition rate (greater than 99%), and its equal error rate is 0.4%, which is comparable with all other hand-based biometrics, such as hand geometry and fingerprint verification.

There are different palm vein extraction techniques using texture descriptors. Most commonly used method is using Local Binary Pattern. It extracts contrast information only. Another texture based descriptor called LDP extracts directional information. In order to increase the efficiency, Local directional texture Pattern descriptor[8] is used in our proposed method which extracts both directional as well as contrast information.

TABLE I

COMPARISON STUDY

SL NO:	AUTHOR	TITLE	YEAR	METHOD	ADVANTAGE	DISADVANTAGE
1	Timo Ahonen et al	Face Description with Local Binary Patterns	2006	Using LDP to extract features.	Invariance to monotonic gray-level changes	Very sensitive to noise
2	Ying Hao et al	Multispectral Palm Image Fusion for accurate contact-free palm print recognition	2008	Make use of feature level image registration and pixel-level fusion method	Used pixel-level fusion. No extra memory consumption required	Not efficient while using image registration

3	Lin Zhang et al	Finger-Knuckle-Print Verification Based on Band-Limited Phase-Only Correlation	2009	To align FKP images, local convex direction map used and BLPOC method to register the images	High accuracy, high speed, small size and cost-effective.	Provide only distinctive line features
4	Anil jain et.al	Information fusion in biometrics	2010	Multimodal fusion scheme using face, fingerprint and hand geometry feature	Better verification performance	Lack of dataset for four fusion schemes
5	Yiding Wang et al	Hand-dorsa Vein Recognition Based on Coded and Weighted Partition Local Binary Patterns	2010	CWPLBP-Partition Local Binary Patterns (PLBP) by adding feature weighting and error correction coding (ECC).	Utilize systematic redundancy which help for reliable transmission and reduce influence of insignificant LBP	
6	Ajay Kumar et al	Contactless Palm Vein Identification using Multiple Representations	2010	Two new palmvein representations used : Hessian and localized Radon transform (LRT)	no training is necessary for score combination scheme	Difficult to compute when partial palm vein image is presented.
7	Zohaib Khan et al	Contour Code: Robust and Efficient Multispectral Palm print Encoding for Human Recognition	2011	Contour Code, a novel orientation and binary hash table based encoding for palm print recognition	Facilitates simultaneous matching to the database and score level fusion of the multispectral bands in a single step. Normalization of scores is not required before fusion.	Generic orientation code for line-like features only.
8	Andrzej Drygajlo et al	Palm Vein Recognition with Local Binary Patterns and Local Derivative Patterns	2011	LBP and LDP used	Computational simplicity and efficiency.	Size of the image descriptor high. To overcome need to use bins representing the most discriminative information.
9	W Song et al	A finger-vein verification system using mean curvature	2011	For robust feature extraction, mean curvature method used	Extract the pattern from the images with unclear veins.	Requires the whole finger-vein pattern as the reference template. More secure matching algorithms.
10	Jen-Chun Lee	A novel biometric system based on palm vein image.	2012	2-D Gabor Filter for local feature extraction and bit string representation	More efficient template storage and retrieval.	Size of the device for practical application is large.

				called Vein Code for extracting pattern of palm vascular		
11	D. R. Kisku et al	Human Identity Verification Using Multispectral Palmprint Fusion	2012	Use Gabor wavelet followed by colony optimization. Training done using SVM	Better performance than other well known systems.	Accuracy of recognition high for medium size database.
12	Sahar Bayoumi et al	PCA-based Palm Vein Authentication System	2013	Applying PCA on each image	Helps to identify unknown patterns in real-time.	Number of images in the dataset is less. Features extracted is minimum, thus accuracy is low.
13	Wenxiong Kang et al	Contactless Palm Vein Recognition Using a Mutual Foreground-Based Local Binary Pattern	2014	Improved MF-LBP method used. Normalized gradient-based MPC algorithm and k-means method utilized for texture extraction.	Useful distinctive information for identification extracted, while eliminating interference by excluding the background	Directional information of vein texture are not extracted
14	Adin Ramirez Rivara et. al	Local Directional Texture Pattern Image Descriptor	2014	Texture feature extraction using LDTP descriptor	Both contrast and directional information can be obtained	

III. CONCLUSION

After studying the research papers, we analysed different Palm Vein Authentication and its corresponding method. Further in literature, each technique is summarized with the advantages and shortcomings. Besides a number of palm vein recognition techniques are already been developed, there is still a scope of further improvements. So we have chosen this topic for my research. The future works should include feature extraction methods which can efficiently extract important features. Also they can introduce a new technique with higher accuracy and robustness.

ACKNOWLEDGMENT

I am thankful to Ms Merin Cherian, Assistant Professor of Computer Science department, FISAT Kerala for her keen interest and useful guidance in my paper

REFERENCES

[1] Penev and J. Atick, Local feature analysis: A general statistical theory for object representation, Netw., Comput. Neural Syst., vol. 7, no. 3,pp. 477-500, 1996

[2] D. D.Gabor Theory of communication, J. Inst. Electr. Eng. III, Radio Commun. Eng., vol. 93, no. 26, pp. 429-457, Nov. 1946.

[3] P. L Wiskott, J.-M. Fellous , N. Kuiger , and C. von der Malsburg,, Face recognition by elastic bunch graph matching , IEEE Trans. Pattern Anal.Mach. Intell., vol. 19, no. 7, pp. 775-779, Jul.1997.

[4] T. Ahonen A. Hadid, and M. Pietikinen, Face description with local binary patterns: Application to face recognition, IEEE Trans. Pattern Anal. Mach. Intell., vol. 28, no. 12, pp. 2037-2041 Dec. 2006.

[5] T. Jabir, M. H. Kabir, and O. Chae, Local directional pattern (LDP) for face recognition, in Proc. IEEE Int. Conf. Consum. Electron.,Mar. 2010, pp. 329-330.

[6] Z. Xie and G. Liu, Weighted local binary pattern infrared face recognition based on Webers law, in Proc. 6th Int. Conf. Image Graph.,Aug. 2011, pp. 429-433.

[7] Adin Ramirez Rivera, Jorge Rojas Castillo, and OksamChae, Member, IEEE, Local Directional Number Pattern for Face Analysis: Face and Expression Recognition, IEEE Trans. on Image Processing, Vol. 22, No. May 2013.

[8] Adin Ramirez Rivera, Jorge Rojas Castillo, and OksamChae, Member, IEEE, Local Directional

Texture Pattern imag descriptor, Elsevier. on Pattern Recognit. Lett., pp. 94-100, Jan. 2014.

[9] Sahar Bayoumi, Sara Al-Zahrani, Afnan Sheikh, Ghada Al-Sebayel, Sulaf Al-Magooshi, Sara Al-Sayigh (2013) "PCA-based Palm Vein Authentication System" IEEE Conference.

[10] Y. Hao, Z. Sun, T. Tan, and C. Ren, Multispectral palm image fusion for accurate contact-free palm print recognition, in Proc. 15th IEEE Int. Conf. Image Process., Oct. 2008, pp. 281-284.

[11] Y. Zhou and A. Kumar, Human identification using palm-vein images, IEEE Trans. Inf. Forensics Security, vol. 6, no. 4, pp. 1259-1274, Dec. 2011.

[12] Z. Khan, A. Mian, and Y. Hu, Contour code: Robust and efficient multispectral palmprint encoding for human recognition, in Proc. IEEE Int. Conf. Comput. Vis., Nov. 2011, pp. 1935-1942.

[13] W. Song et al., A finger-vein verification system using mean curvature, Elsevier. on Pattern Recognit. Lett., pp. 1541-1547, May. 2011.

[14] Leila Mirmohamadsadeghi, and Andrzej Drygajlo, Palm vein recognition with local textures patterns, in Proc. IEEE Int. Conf. Biometrics, vol. 3, no. 4, pp. 198-206, Dec. 2014

[15] J.C Lee, A novel biometric system based on palm vein image, Pattern Recognit. Lett., vol. 33, no. 12, pp. 1520-1528, Sep. 2012.