A Novel Biometric system for Person Recognition Using Palm vein Images

S.Manikanda prabu
Department of CSE,
Tamilnadu College of Engineering,
Coimbatore, India
smaniprabume@gmail.com

S.N.Sivanandam
Professor, Emeritus
Karpagam College of Engineering,
Coimbatore, India
sns12.kit@gmail.com

***Abstract*-The palm vein is one of the most reliable physiological characteristics that can be used to distinguish between individuals. In recent years, it receives more attention from the researchers. In this paper, we present a new approach for the personal identification using palm vein images. This paper attempts to improve the performance of palm vein based verification system with the help of energy feature based on wavelet transform. Energy feature can reflect the wavelet energy distribution of all veins at different resolutions, thus it can efficiently characterize palm veins. Since, wavelet is robust to translation, rotation and distortion. It is also insensitive to contrast changes. From our experimental results, it is found that the proposed scheme outperforms well by achieving higher true acceptance rate and lower false acceptance rate simultaneously. It also demonstrates the power of the proposed approach and more accurate identification. In conclusion, the scheme can improve the identification performance of palm vein recognition significantly.**

Keywords: Biometrics, Energy feature, Euclidean Distance and Palm vein recognition.

I. INTRODUCTION

Biometrics refers to the use of distinctive anatomical and behavioral characteristics of humans for personal identification and is being increasingly employed for variety of applications such as civilian, forensic and other online applications etc. Many biometric systems have been proposed based on various features or behaviors including fingerprints, palm prints, iris, face and signature to improve the security of user verification system. However, no biometrics traits are perfect for identification. Each has its own merits and demerits. Fingerprint identification is the most well-known biometric method and widely used in personal identification. But, fingerprint capturing devices are expensive and it is difficult to acquire fingerprint features correctly. In recent years, iris based verification have been developed. In this case, user must place their eyes close to the scanner causing uncomfortable feeling.

Palm vein is one of the relatively new physiological biometrics due to its uniqueness, permanence of the vascular pattern, stability and strong immunity to forge of vein pattern characteristics. The rich information of palm vein offers one of the powerful means in person recognition and receives more attention from researchers today. It also offers high secure and reliable features for person identification. Palm vein authentication has high level of accuracy due to the distinctiveness and complexity of vein patterns. Palm vein patterns is internal to the body, it is difficult to forge. The system is contactless and hygienic for public use. So it is more powerful than other biometrics. Palm vein authentication uses an IR beam to penetrate the users hand .The veins within the palm of the user are returned as black lines.

In this paper, we present a novel palm vein recognition method for personal identification .The palm vein is an ideal part of the body, normally it does not have hair which can be an obstacle for photographing the blood vessel pattern and it is less susceptible to a change in color unlike other biometrics.

The rest of the paper is organized as follows: A detailed description of the proposed method for palm vein recognition is given in section 3.Performance of the system has been discussed in section 4 and conclusion is presented in last section.

II. RESEARCH BACKGROUND

A number of studies have been conducted for person authentication using palm vein patterns. Here, a brief review is given in the following:

Lin et al. [1] have discussed personal verification results using palm dorsal images acquired from a thermal imaging. Their approach is based on the combination of multi resolution images obtained from preprocessed thermal vein images. Wang et al. [2] present another approach for personal authentication using hand vein images. The authors have employed Hausdroff distance to generate matching scores between the extracted lines and illustrated promising results. Yingbo Zhou et al. [3] have proposed a method for personal authentication using contactless palm vein imaging. In their approach, hessian phase information and localized radon transform used for feature extraction and representation. Qiang Li et al. [4] have introduced a technique for biometric recognition based on palm vein. The authors employed curvelet transform to extract the features of palm vein patterns. Then Principal Component Analysis (PCA) is applied on curvelet decomposed images for dimensionality reduction and Neural Network (NN) classifier used. Andrzej Drygajlo et al. [5] have proposed a user identification system using palm vein images. It is based on local texture patterns. They have employed Local Binary Patterns (LBP) and Local Derivative Patterns (LDP) for feature extraction. Wang et al. [6] have discussed a multimodal personal identification system where palm print and palm vein modalities were combined in a single image. Locality Preserving Projection (LPP) was used to extract features of the fused images, which they called ‘‘Laplacianpalm’’.Wantanbe et al. [7] provides software for vein pattern authentication. This vein pattern authentication software translates the black lines into a blood vessel pattern of the palm, and then matches the translated vein pattern with a preregistered template pattern, while correction for position and orientation of the palm by a pattern matching method. Mohit soni et al. [8] have proposed a new absorption based vein pattern recognition system. The system has made an attempt to handle issues such as effects of rotation and translation on acquired images and also minimize the manual intervention to decide on the verification of an individual. Yu et al. [9] have proposed a technique for the minutiae features include bifurcation points and ending points are extracted from vein patterns. These feature points are used for geometric representation of the vein patterns shape. A modified hausdroff distance algorithm is provided to evaluate the identification ability among all possible relative positions of the vein pattern shape. Wai Kin Kong et al. [10] have introduced a novel technique for palm print feature extraction. The authors consider the palm print as a piece of texture and apply texture-based feature extraction techniques to palm print authentication. A 2-D Gabor filter is used to obtain texture information and two palm print images are compared in terms of their hamming distance.

III. OVERVIEW OF PROPOSED SYSTEM ARCHITECTURE

The proposed system is divided into two phases, namely the enrollment and verification phase, as shown in Fig. 1.The important tasks contain in the system include the pre-processing, feature extraction as well as feature matching. In the pre-processing stage, each palm vein image is enhanced to improve its quality. Filter is used to remove the unwanted data from an image. In the feature extraction stage, the enhanced image is decomposed to some level. Then the energy feature is extracted from the approximation sub band and finally in the feature matching stage comparison is performed and decision is made whether two palm vein features are from the same person. Detailed descriptions of these steps are introduced in the following section.

A. PREPROCESSING

The palm vein image acquired through a camera contains some unwanted information which is not required to obtain the venal pattern. The first step of the pre-processing is the extraction of the Region Of Interest (ROI).Due to limited translation and rotation, this is eased. Sizes are cut down to 128x128pixels. ROI extraction step is followed by noise removal. We apply the 5x5 average filters on the ROI in order to reduce the noise. After removing the high frequency noise, we need to correct the brightness, which is not uniform. A Gaussian low-pass 51x51 filter is applied 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 is still too bad. We therefore apply a normalization method to improve the contrast of an image. For each image I of size NxN, the mean μ and variance σ are calculated. Equation (1) describes the normalization process applied on the image with μ_d and σ_d, the desired value of the mean and variance.

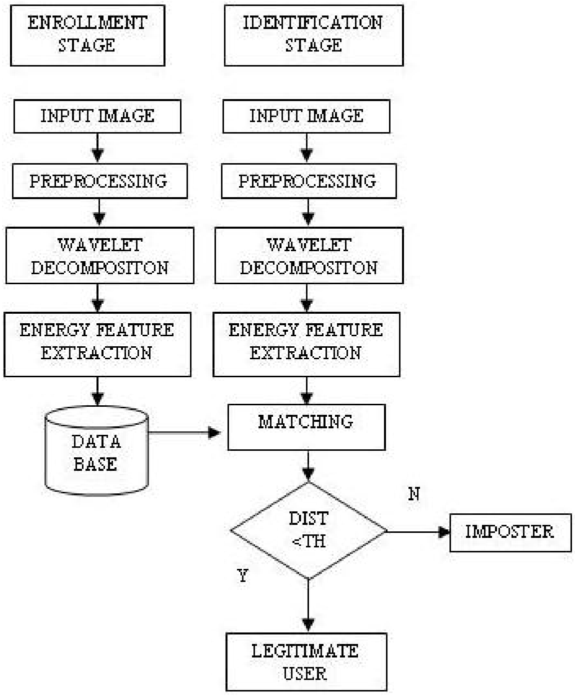

Fig.1.Block diagram of the proposed system

For each pixel, we modify its gray-level with the following formula:

$$I'(x,y)=\begin{cases}\mu_d+\sqrt{\dfrac{\sigma_d^2\,(I(x,y)-\mu)^2}{\sigma_d^2}} & I(x,y)>\mu\\[2ex] \mu_d-\sqrt{\dfrac{\sigma_d^2\,(I(x,y)-\mu)^2}{\sigma_d^2}} & \text{Otherwise}\end{cases} \quad (1)$$

Where $I(x,y)$ corresponds to the gray-level for the pixel located at (x,y) for the original image and $I'(x,y)$ for the resulting one after pre-processing. Fig.2 shows the original image of the palm vein and the corresponding image after pre-processing. For our experiments, we set empirically the values of μ_d to 128 and σ_d to 1600.

B. FEATURE EXTRACTION AND MATCHING

Wavelets are powerful tools of multi-resolution analysis, which have been used widely in biometric system. It is also a best tool for feature extraction at different resolution. Decomposition of an image by 2D wavelet transform as shown in Fig.3. In figure, Ak, Hk, Vk and Dk are approximation, horizontal, vertical and diagonal sub bands of original image. In this paper, the original image is represented by B. After it is decomposed to the J-th level, the original image is represented by 3J+1 sub images:

(a) (b)

Fig.2. (a) Original image (b) Preprocessed image

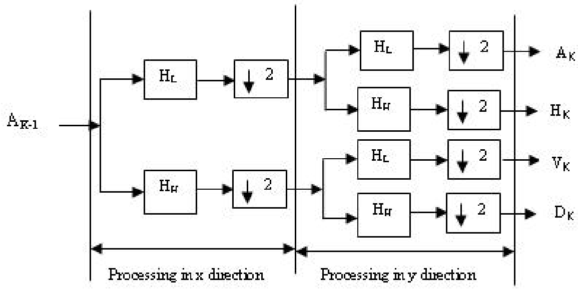

Fig.3. Two Dimensional DWT

{ A_J, [Hi, Vi, Di] i=1,2,3,…..J}

Where A_J is the approximation of original image. Hi, Vi and Di are the wavelet sub bands containing original image details in horizontal, vertical and diagonal directions at different scales.

The energy feature of approximation sub band at i th level is calculated using the equation:

$$E_A(i,j) = \sum_{i=1}^{M} \sum_{i=1}^{N} \{W_{ij}(x,y)\}^2 \qquad (2)$$

The energy reflects the strength of the image information in different scale at the ith wavelet decomposition. According to the above equation (2), we can first divide the whole image into NxN non overlapping blocks equally, and then compute the energy of each block. After that, energies of all blocks are normalized before forming as a feature vector. We use euclidean distance to measure the similarity between two images.

C. ALGORITHM

Wavelet transform is an effective tool for multi resolution analysis. Wavelet transform is adopted on the ROI. It decomposes the ROI into two sub bands. Low frequency sub band is called as the approximation coefficient of original image. It represents the global feature. High frequency sub bands always relate with noise, it describes detail feature. In this paper, we need more low frequency component, we use approximation coefficient only. After k level decomposition, the resolution of the original image is reduced .The data involve in computation is only $2^{2k}$of the original image. The complete process to obtain energy feature of a palm vein can be summarized as below:

1. Convert the original image into binary image using threshold.
2. Remove the unwanted information from an image with the help filters.
3. Enhance the image using equation1.
4. Decompose the original image to the k th scale by 2D wavelet transform.
5. After k level decomposition, the palm vein decomposed into 3k+1 sub bands, that is [Ak,(Hi,Vi,Di) i=1,2…..k}.Ak is the most approximate to the original image. Hi, Vi, and Di are the high frequency component in horizontal, vertical and diagonal direction in the I th level wavelet decomposition respectively.
6. Compute the energy of approximation sub band using the equation (2) and construct the feature vector.
7. Normalize this vector to form energy feature.
8. Compute the euclidean distance between two feature vectors to find the similarity.

IV. EXPERIMENTAL RESULTS

Palm vein recognition involves a training stage and a recognition stage. In training stage, energy features of the training samples are calculated and stored in a template database. In the recognition stage, energy feature of the input vein is computed and then by using euclidean distance, this energy is compared with the stored template to obtain the recognition result. The size of the original palm vein image was 251 x 362 pixels and 256 gray levels. The central 128 x 128 part of the image was cropped to represent the region of interest, using db6 wavelet transform the image were decomposed to the third level. The experiments are conducted in two modes. One is covering aspects of preprocessing in connection with approximation of level3 and the second one dealing with extraction of energy features from decomposed image. The euclidean distance is used to measure the similarity between energy features. The experiments are performed under the Matlab2010a programming environment with windows Xp. False Rejection Rate (FRR), False Acceptance Rate (FAR) and Correct Recognition Rate (CRR) are used for recognition performance measurement. In identification mode, the algorithm is measured by CRR. In verification mode, ROC curve is used to report the performance of the proposed method.ROC curve of the proposed approach is plotted in Fig.4.The equal error rate is 0.73%.This figure shows that the proposed approach has a good performance in palm vein verification.

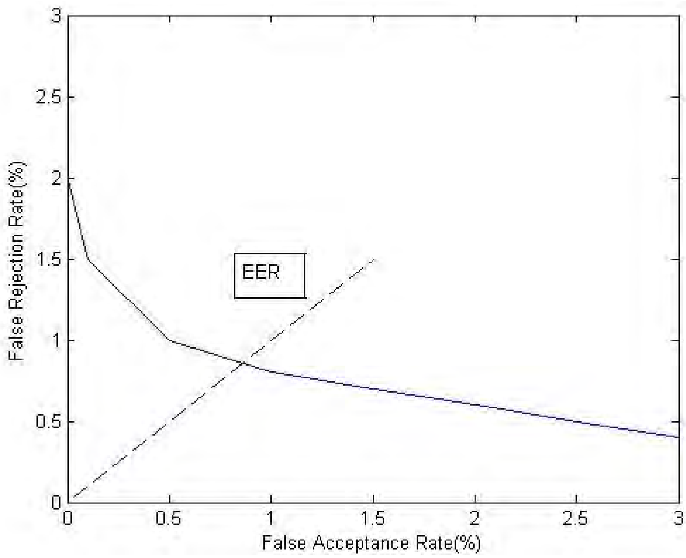

Fig.4.ROC curve of the proposed approach

We compare the traditional palm vein recognition method of Gabor, SIFT, PCA, ICA, PCA+LPP with the method presented in this paper. Table 1 summarizes the recognition results for different algorithms.

Table.1.Comparison of different algorithm

Algorithm	CRR (%)	Time(s)
Gabor	91.09	0.1519
SIFT	95.93	0.0002
PCA	94.72	0.00151
ICA	93.29	0.00404
PCA+LPP	95.61	0.00224
Wavelet + energy feature	96.66	0.1214

V. CONCLUSION AND PERSPECTIVE

Palm vein verification is a promising technique for the authentication of an individual. This biometric modality is also difficult to copy that makes it a good candidate for many applications. In this paper, a complete biometric system based palm veins has been developed. We proposed an original method based on the energy feature extracted from the approximation coefficient of third level for the enrollment and the verification steps. One of the main benefits of the proposed approach is that only one image is needed for the enrollment. The efficiency of the proposed method is promising even if the test database used in the experiments is quite small. The vein pattern identification can proceeded in a perfect way using the method proposed in this paper which is accurate, simple, practical and fast.

REFERENCES

[1] Lin.C.L,Fan.K.C.,"Biometric verification using thermal images of palm dorsa vein patterns",IEEE Transactions on circuits systemsvideotechnology",Vol.14(3),2004,pp:199-213.
[2] Wang.L,Leedham.G,and ho.D.S,"Infrared imaging of hand vein patterns for biometric purposes",Inst.Eng.Technol.,Comput.vision.1,2007,pp:113-122.
[3] Yingbo Zhou,Ajay Kumar,"Contactless palm vein identification using multiple representations", IEEE International Conference on Biometrics: Theory, Applications, and Systems - BTAS , 2010.
[4] Qiang Li,Yan'an Zeng,Xiaojun peng and Kunto Yang,"Curvelet-based vein biometric recognition",Chinese Optics letters,2010,pp:577-579.
[5] Andrzej Drygajlo and Leila Mirmohamasadeghi," Palm vein recognition with local binary patterns and local derivative patterns",

[6] Jian-Gang Wang ,Wei-Yun Yau and Suwandy,and Sung, E.," Fusion of Palm print and Palm Vein Images for Person Recognition Based on Laplacianpalm Feature", IEEE conference on computer vision and pattern recognition,2007,pp:1-8.
[7] Watanabe.M,endoh.T,Shiohara.M and Sasaki.S,"Palm vein authentication technology and its applications",In biometric consortium conference,USA,2005.
[8] Mohit Soni,Sandesh Gupta, M.S.Rao and Phalguni Gupta,"A new vein pattern-based verification system",International Journal of computer science and information security,2010,Pp:58-63.
[9] Yu.C.B,Qin.H.F,Zhang.L and Cui.Y.Z,"Finger vein image recognition combined modified hausdroff distance with minutiae feature matching",J.Biomed.Sci.Eng.2,2009,pp:261-272.
[10] Wai Kin Kong, David Zhang*and* Wenxin Li," Palmprint feature extraction using 2-D Gabor filters", Pattern Recognition 36 (2003),pp: 2339 – 2347.

About the Authors

Mr.S.Manikandaprabu completed his B.E. (Computer Science and Engineering) in 2003 from Madurai Kamaraj University, Madurai and M.E. (Computer Science and Engineering) in 2008 from Sathyabama University, Chennai Currently he is pursuing PhD degree. He is working as a Assistant Professor, Department of Computer Science and Engineering at Tamilnadu College of Engineering, Coimbatore. His research areas include Pattern Recognition, Signal and Image processing and Neural Networks and having 8 years of teaching experience in Engineering Colleges.

Dr. S. N. Sivanandam completed his B.E. (Electrical Engineering) in 1964 from Government College of Technology, Coimbatore, and MSc (Engineering) in Power Systems in the year 1966 from PSG College of Technology, Coimbatore. He acquired PhD in control systems in 1982from Madras University. He received best teacher award in the year 2001 and Dhakshina Murthy Award for teaching excellence from PSG College of technology. He received the citation for best teaching and technical contribution in the year2002, Government College of Technology, Coimbatore. His research areas include Modeling and Simulation, Neural Networks, Fuzzy Systems and Genetic Algorithm, Pattern Recognition, Multidimensional system analysis, Linear and Non linear control system, Signal and Image processing, Control System, Power System, Numerical methods, Parallel Computing, Data Mining and Database Security. He is a member of various professional bodies like IE (India), ISTE, CSI, ACS and SSI. He is a technical advisor for various reputed industries and engineering institutions.