Intelligent Technique for Human Authentication using Palm Vein

Mona A. Ahmed[1] and Abdel-Badeeh M. Salem[2]

Abstract - **In this paper, we propose a new intelligent technique to authenticate human using palm vein (PV) pattern. We developed an image analysis technique to extract region of interest (ROI) from PV image. After extracting ROI we improve PV images using Homomorphic filter to detect the edges on images. Our smart technique is based on the following intelligent algorithms, namely; principal component analysis (PCA) algorithm for feature extraction and k-Nearest Neighbors (K-NN) classifier for matching operation .This technique has been applied on CASIA Multi-Spectral Palmprint Image Database V1.0 (CASIA database).The experimental results show that the result of (CRR) is 95.20%.**

Keywords - **Biometric, Palm vein, Computational intelligence, Feature extraction, Machine learning.**

1. INTRODUCTION

Biometric recognition refers to the automatic recognition of individuals based on their physiological and/or behavioral characteristics. By using biometrics it is possible to confirm or establish an individual's identity based on "who she is", rather than by "what she possesses" (e.g., an ID card) or "what she remembers" (e.g., a password). Today, it is becoming more and more popular to use biometrics to identify people and authenticate them for access to secure areas and systems [1]. The biometric characteristics could be divided into two types. The first type contains physical features (fingerprint, face, iris, retina, palmprint, hand, face and vein, etc.) and the second type contains behavioral features (e.g. voice, signature, movement characteristics (gait, hands movement or lips, key press, etc.)) [2]. both biological and behavioral, should have the following properties in order to be used as biometrics: universality (everyone in the world should have the feature), permanency (this feature should remain lifelong), collectability (should be a feature that can be read by some process), acceptability (people must accept to undergo the process of reading the feature), avoidance (the system should interfere as little as possible) and uniqueness(feature must be unique for each person) [3].

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 [4].

The rest of the paper is organized as follows. The related works in this step are introduced in section 2.In Section 3; we briefly explain the general architecture of the palm vein system. The explanations of Morphological operations are introduced in section 4. Section 5 introduced the explanation of homomorphic filter. The explanation of PCA algorithm is introduces in section 6. Matching algorithm K-NN is introduces in section 7. Section 8 introduces the details of detection of Region of Interest (ROI). The preprocessing algorithm introduces in section 9. Section 10 discusses the result of algorithm. Finally, conclusion and discussion are presented in Section 11.

2. RELATED WORKS

R. Sasikala et al in [5] preprocessed the PV images using discrete wavelet transform(DWT) the result contains four segment the first image is approximation image and remaining three detailed images. Sobal filter used to detect edges for texture feature extraction. Histogram equalization is employed to obtain the normalized and enhanced PV image. Finally, sharpened PV images using laplacian filter by achieve edge-preserving smoothing, detail enhancement.

D. Smorawa and M. Kubanek applied three operations to improve the quality of images histogram equalization, filter smoothing and image normalization operations. The studies included two ways of verification, the first one based on comparing feature vectors using a Hamming distance and the second method takes into account the verification of identity, based on Hidden Markov Models [6].

S. D. Raut and V. T. Humbe used the Gabor filter to process the image matrices and extract the blood vessel structure. And further filtered image processed under the canny edge detection algorithm. The computed distance used Euclidean distance metric is stored in the form of feature vector set. The binary vector from the set is to be extracted and further will lead to classify the sample set of one subject with another [7].

Abikoye et al in [8] proposed a technique for PV verification enhancement and accuracy using statistical and data mining tools. Histogram Equalization is used for image segmentation and K-means algorithm for image enhancement. Zhang Suen's algorithm is employed for thinning while Euclidean distance is used for inter-distance calculation of intersections hence handling the pattern matching aspect of the system.

[1, 2] Computer Science Department, Faculty of Computer and Information Sciences, Ain Shams University, Cairo, Egypt
eng.monaa_cs@hotmail.com, absalem@cis.asu.edu.eg

R. Gayathri et al proposed system to accommodate the rotational, potential deformations and translational changes by encoding the orientation conserving features. They used Wavelet energy calculation (WEF) to decomposed images into elementary forms. Edge detection is performed on the image by using Canny Edge detector. Selection of feature and optimization is done by the Ant Colony Optimization (ACO) technique. The classification is done by using Support Vector Machine (SVM) technique [9].

Pooja et al in [10] proposed a novel approach to utilize image pre-processing in a different way that it is independent of image translational, rotational and scale changes. Firstly binarized image and Region of Interest (ROI) detected then output is taken by using repeated line tracking method and output that is obtained is given to Gabor filter in order to remove noise. Feature extraction is done by using LBP and Principle Component Analysis (PCA) is employed to reduce the size of template. For matching Neural Network method has been used.

S. N. Dere and A. A. Gurjar in [11] proposed a novel biometric system firstly ROI detected then enhanced to improve its contrast using histogram equalization. The canny edge detection method is used for feature extraction such as edges and curves. The palm vein matching module is use in MATLAB.

M.Sayed presented an algebraic method for personal authentication using internal contactless PV images. In order to enhance the quality of obtained PV patterns, different filters are applied on the segmented these patterns such as 2-D Gabor filter, Median filter and undergo morphological operations. Used the local line binary pattern (LLBP) method to generate best bits representations of digitized PV templates and consequently extract feature vectors. Therewith, using coset decomposition algorithm, the PV feature vectors are encoded and stored as registered templates in the system database. Low-density parity-check (LDPC) codes are used first to encode binary feature vector and second to measure the similarity between the extracted and enrolled binary codes [12].

M. C. Villariña and N. B. Linsangan proposed an effective PV recognition system. Firstly, the PV region of ROI was extracted from images; gamma correction and local ridge enhancement (LRE) were applied to the image in order to obtain the correct contrast and sharpness of the image without excessively increasing the noise. The PV features were extracted from the enhanced ROI using Sobel filter. Mean absolute deviation (MAD) is implemented to sub-region as the feature vectors. The recognition of PV images is achieved by using back-propagation neural network [13].

S.Singh and V.K Banga in [14] proposed new method for human authentication based on PV images .First, the PV images ROI segmentation is performed and then enhancement of the image. Then a bank of Gabor filter is being created and convolution on the enhanced images and convolution images are used as a feature vectors. Finally, using nearest neighbor classifier the PV verification has been implemented.

S.Bayoumi et al proposed a system for attendance using PV as biomedical features based on PCA to discriminate the variances between the image features instead of between the whole training set. For classification, Euclidean distance measure used to find the nearest similar pattern [15].

Y. Ali and Z.Razuqi in [16] introduced personal recognition system based on centerline of PV. First, enhance vein pattern and reduce the unwanted information by adjusting the contrast of grayscale image then de-noise image using median filter, thresholding image to extract the vein with binary image and some of morphological operations applied for retaining object with an image .The features were extracted depending on scales of difference-of Gaussian (DoG) function. The matching process is take place to calculate the degree of similarity between two vein patterns the absolute difference between two features is used for matching purpose.

C.WANG et al proposed a method to enhance the palm vein image and visualize the vein pattern under strong shadow effect. First, hyperspectral imager used to acquire PV data in wavebands near the 850nm wavelength. Secondly, images from different bands used to create a normalized image. Thirdly, Retinex method applied to reduce the influences caused by shadow. Additionally, stretch the dynamic range and smoothen the processed image by using histogram equalization and median filter. Finally, set specific threshold value to acquire binaryzation image of PV and remove the unnecessary part of vein [17].

S. D. Raut et al in [18] used Gabor filter and Canny Edge Detector to extract the edges of the blood vessel from a PV image. The technique for feature detection is achieved using the Harris- Stephens Corner detection algorithm.An image matrix processed under feature detection and applied with Euclidean distance metric computation would result into a generation of distance matrix and consist of distance in fraction values for specific recognition.

Table 1 shows our analysis of the existing feature extraction techniques and image enhancement algorithms for palm vein recognition.

3. PROPOSED TECHNIQUE

A typical palm vein biometric system consists of the following phases

- Capture. This stage is related to the acquirement of the palm veins images through a digital capture sensor.
- Pre-processing. This stage respects to the steps for preparing the information to be analyzed from the palm veins. When the palm veins image is stored via a digital image, typical pre-processing steps are: cleaning (noise), contrast enhancement, sharpen, equalization, among other processes. Pre-processing is an important phase since the better quality of information provided to the biometric system the higher recognition rate is achieved.
- Feature extraction. This stage extracts the most relevant descriptive components that describe to the palm veins. The main processes involved in feature extraction are the Region Of Interest (ROI) extraction and segmentation; the goal of both processes is the isolation of the region where there exists relevant and descriptive information.

TABLE 1 ANALYSIS OF PALM VEIN RECOGNITION TECHNIQUES

Author (s)	Method of preprocessing	Method of feature extraction	Method of matching	Database size	Accuracy
R. Sasikala et al	DWT	Sobal filter	-	-	-
D. Smorawa and M. Kubanek	Histogram equalization	Proposed filters	Hamming distance &Hidden Markov Models	800 images	99.69 %
S. D. Raut and V. T. Humbe	Gabor filter	Canny edge detector	Euclidean distance	100 images	-
Abikoye et al	Histogram equalization & Zhang Suen algorithm	k-means	Euclidean distance	800 images	-
R. Gayathri et al	WEF	canny edge detector & ACO	SVM	6000 images	98%
Pooja et al	Gabor filter	LBP & PCA	ANN	500 images	99.5%
S. N. Dere and A. A. Gurjar	Histogram equalization	canny edge detector	-	-	-
M.Sayed	Gabor filter, Median filter & morphological operations	LLBP	Coset decomposition	250 images	99.8%
M. C. Villariña and N. B. Linsangan	Gamma correction & LRE	Sobel Directional Coding	BPNN	400 images	98%
S.Singh and V.K Banga	Gabor filter	Laplacian	k- NN	10 images	95.6%
S.Bayoumi et al	Morphological operations	PCA	Euclidean distance	25 images	70%
Y. Ali and Z.Razuqi	Median filter	DoG	Degree of similarity	6000 images	99.67%
C.WANG et al	Retinex method &	-	-	-	-
S. D. Raut et al	Gabor & Canny filter	Harris-Stephens Corner	BPNN	250 images	95.8%

- Recognition. This is the last stage in a palm veins recognition system and uses the features extracted to person identification / verification. Commonly, classifiers are used in this recognition stage; the main goal of the classifier is to extract patterns from each palm veins images in the dataset which are used for recognition purposes [19].

In our study, we present a proposed intelligent technique to authenticate personal based on palm veins. This technique is used to enhance the accuracy of palm vein authentication. Figure 1 shows processes of the authentication technique using palm veins biometrics. The main characteristics of our technique are;

(1) Using the CASIA Multi-Spectral Palmprint Image Database V1.0 (CASIA database) which has been capture under a NIR infrared radiation.
(2) To detect ROI we used Morphological operations to extract useful structural information from palm veins images.
(3) Using Homomorphic filter to improve palm vein image.
(4) Using PCA method for feature extraction.
(5) Using K-NN classifier, matching was done between CASIA database image and the extracted palm vein image.

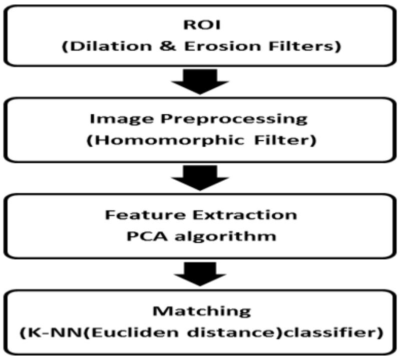


Fig. 1 The processes of authentication model using Palm veins biometrics

4. MORPHOLOGICAL OPERATIONS

Morphological operations are applied on binary images and affecting the form, structure or shape of an object. They are used in pre or post processing (filtering, thinning, and pruning) or used for smoothing, edge detection or extraction of other features. Morphological operations offers a variety of image transformation to eliminate dark (bright) regions from binary images .The two principal morphological operations are dilation and erosion [20].Dilation allows objects to expand, thus potentially filling in small holes and connecting disjoint objects. Erosion shrinks objects by etching away (eroding) their boundaries. These operations can be customized for an application by the proper selection of the structuring element, which determines exactly how the objects will be dilated or eroded [21].

5. HOMOMORPHIC FILTER

Homomorphic filter is a nonlinear enhancement method. Homomorphic filter simultaneously normalizes the brightness across an image and increases contrast. The function of homomorphic filter is likely to decrease the low frequency and increase the high frequency. In general, an image can be regarded as a two-dimensional function of the form I(x, y), whose value at spatial coordinates (x, y) is a positive scalar quantity whose physical meaning is determined by the source of the image. In other words, an image is an array of measured light intensities and is a function of the amount of light reflected of the objects in the scene. The intensity is a product of illumination (the amount of source illumination incident on the scene being viewed) and reflectance (the amount of illumination reflected by the objects in the scene). If we denote illumination as L(x, y) and reflectance as R(x, y), then an image I(x, y) can be expressed as [22]:

$$I(x, y) = L(x, y)\, R(x, y) \qquad (1)$$

In this model, the intensity of L(x, y) changes slower than R(x, y). Therefore, L(x, y) is considered to have more low frequency components than R(x, y). Using this fact, homomorphic filtering technique aims to reduce the significance of L(x, y) by reducing the low frequency components of the image. This can be achieved by executing the filtering process in frequency domain. In order to process an image in frequency domain, the images need first to be transformed from spatial domain to frequency domain. This can be done by using transformation functions, such as Fourier transform. However, before the transformation is taking place, logarithm function has been used to change the multiplication operation of R(x, y) with L(x, y) in (1) into addition operation [23].

$$\text{Ln}\,(I(x, y)) = \ln\,(L(x, y)\, R(x, y)) \qquad (2)$$
$$\text{Ln}\,(I(x, y)) = \ln\,(L(x, y)) + \ln(R(x, y)) \qquad (3)$$

In Homomorphic filtering first transform the multiplicative components to additive components by moving to the log domain .Then use a high-pass filter in the log domain to remove the low-frequency illumination component while preserving the high-frequency reflectance component. The basic steps in homomorphic filtering are shown in figure 2.

Fig. 2 The homomorphic filtering

6. FEATURE EXTRACTION ALGORITHM

Feature extraction plays an important role in palm vein recognition because the performance of feature matching is greatly influenced by its output. We use principal component analysis (PCA) algorithm to extract features from images. PCA is among the most popular algorithm in machine learning, statistics, and data analysis more generally. PCA is the basis of many techniques in data mining and information retrieval, including the latent semantic analysis of large databases of text and HTML documents described in [24]. In our technique, PCA algorithm used to extract features from images. A matching procedure is then applied to locate the best match from the data base to authenticate the individual. It changes various conceivably associated factors into fewer new factors, called as principal components. Since a digital image can be viewed as a two (or more) dimensional function of pixel values and represented as a 2D or 3D data array. More technical details can be found in [25].

<u>The algorithm:</u>

(1) Assume data matrix is B of size m x n. Compute mean μ_i for each dimension.
(2) Subtract the mean from each column to get A
(3) Compute covariance matrix C of size n x n which $C = A^T A$
(4) Calculate the eigenvalues and eigenvectors (E, V) of the covariance matrix C

(5) Project the data step by step onto the principle components $\vec{v_1}, \vec{v_2}, \ldots\ldots$, etc
(6) Select n eigenvectors that correspond to the largest n eigenvalues to be the new basis.

7. MATCHING ALGORITHM

In our technique, we use the K-NN classifier. K-NN algorithm has been used in many applications in areas such as data mining, statistical pattern recognition, image processing. K-NN classifier is an extension of the simple nearest neighbor (NN) classifier system. The nearest neighbor classifier works based on a simple nonparametric decision. Each query image Iq is examined based on the distance of its features from the features of other images in the training database [26]. The nearest neighbor algorithm utilizes K nearest samples to the query image. Every one of these samples belongs to a known class Ci. The query image Iq is arranged to the class CM which has the most of events among the K samples.

8. DETECTION OF REGION OF INTEREST (ROI) STEP

In our study, we used the CASIA Multi-Spectral Palmprint Image Database V1.0 (CASIA database) [27]. In our experiments, we used the images taken under NIR infrared radiation. There are overall 600 images of 100 subjects distributed as: Three right-hand images and three left-hand images subject. The proposed algorithm of ROI extraction of hand vein image includes 5 tasks, as show in figure 3.

(1) Convert image to binary
(2) Estimates the area of the palm in binary image then apply a 201*201 square mask that could perfectly cover the whole region of palm.
(3) After then apply the dilatation filter again to get one point that is the middle point of the hand.
(4) Then apply the erosion filter on the same square mask, this time to get exact square placed at same point where the region of interest is placed in actual image
(5) Then find xmin, ymin, length, and width of this square to crop ROI from original image.

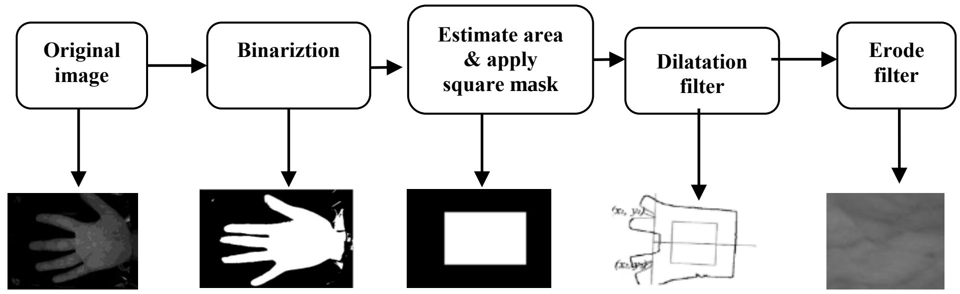


Fig. 3 The steps to detect ROI

9. THE PROPOSED ALGORITHM OF PREPROCESSING PALM VEIN IMAGE

Homomorphic filtering is a generalized technique for image enhancement and/or correction. It simultaneously normalizes the brightness across an image and increases contrast. The Homomorphic filtering can be summarized in steps show following:

1. An image I (x, y) can be expressed as the product of illumination and reflectance components:

$$I(x, y) = L(x, y)\, R(x, y) \quad (4)$$

2. Because the Fourier transform of the product of two functions is not separable, we define

$$Z(x, y) = \ln I(x, y) = \ln L(x, y) + \ln R(x, y) \quad (5)$$

Or

$$Z(u, v) = I(u, v) + R(u, v) \quad (6)$$

3. Doing the Fourier transform, as

$$S(u, v) = H(u, v)\, Z(u, v) = H(u, v)\, I(u, v) + H(u, v)\, R(u, v) \quad (7)$$

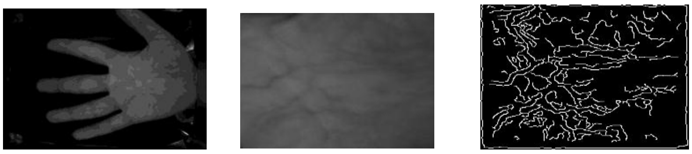
4. Taking inverse Fourier transform of S (u, v) brings the result back into natural log domain

$$S(x, y) = F^{-1}\{S(u, v)\} = F^{-1}\{H(u, v)\, I(u, v)\} + F^{-1}\{H(u, v)\, R(u, v)\} \quad (8)$$

5. So the output image can be expressed by the function [28]

$$g(x,y) = e^{s(x,y)} \quad (9)$$

Figure 4 show the result of applied algorithm (a) the original image (b) the result of extract region of interest (ROI) then (c) the result of applied preprocessing step to enhance the image quality.



(a) (b) (c)

Fig. 4 Illustration of image enhancement: (a) The original image (b) Extraction of ROI (c) Extraction of PV pattern

10. RESULTS AND DISCUSSION

Palm vein recognition includes training and recognition phases. In training phase, features of the training samples are calculated and stored in a database template. In the recognition phase, features of the input vein are determined and then matched by using K-NN matching classifier. After this, these features are compared with the stored template to obtain the recognition result. We do our experiment by divided the database to 5 Cases as table 2 shows:

TABLE 2 DATA BASE FOR 5 CASES

Case No.	Training	Testing
1	One image for every person (100 images)	Five images for every person (500 images)
2	Two images for every person (200 images)	Four images for every person (400 images)
3	Three images for every person (300 images)	Three images for every person (300 images)
4	Four images for every person (400 images)	Two images for every person (200 images)
5	Five images for every person (500 images)	One image for every person (100 images)

By applying the PCA algorithm with K-NN (Euclidean distance) the result is 100% for all training cases and testing result of every case showed in table 3 and figure 5. We have two potential results, the first result is where the user that is unauthorized which means that his/her template is not found in the database, and the other result is the user is authorized, i.e. a template similar to his/her is found in the database. The experimental results show that the result of recognition Correct Recognition Rate (CRR) is 95.20%.Hence this method can be successfully used for recognition.

TABLE 3.THE TESTING RESULT OF EACH CASE

Case No.	CRR
1	94
2	94
3	95
4	96
5	97

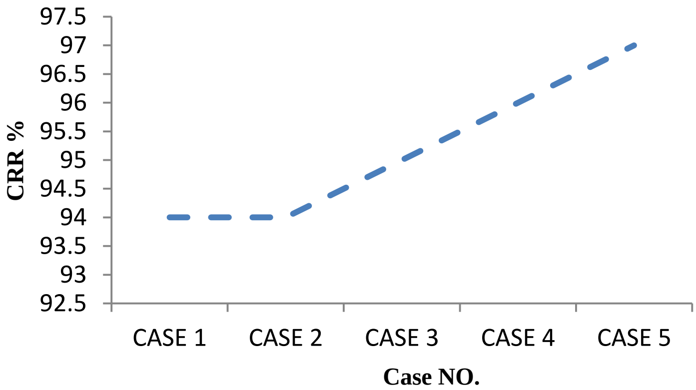


Fig. 5 Result of cases

11. CONCLUSION AND FUTURE WORK

In this paper, we have developed a new practical and intelligent technique for biometric recognition based on CASIA Multi-Spectral Palmprint Image Database V1.0 (CASIA database). The technique consists of the following steps: Image acquisition and pre-processing, determining the region of interest, extracting the palm vein pattern features and recognition. The developed technique achieves a good performance proved by perfectly extract ROI from 594 image from 600 palm vein images used in our experiments with 99.3% correct recognition rate. In particular, this method has many advantages such as it can overcome the problem of rotation and shift and this method is relatively simple and practical. In this paper, a complete biometric system based palm veins has been developed. We proposed an original method based on the PCA algorithm to extract features and using KNN classifier in matching. The experimental results show that the result of recognition CRR is 95.20%.Hence this method can be successfully used for recognition. The vein pattern identification can proceeded in a perfect way using the method proposed in this paper which is accurate, simple, practical and fast.

In our opinion, this developed improvement increases the usefulness and usability of this efficient technique, especially as regards its application in all security tasks and domains. Future work may involve applying additional/ alternative pattern recognition algorithms or turning it into a multimodal system where other additional biometrics traits are considered and making the system more invariant to illumination conditions.

REFERENCES

[1] E.Sridevi, B.Aruna and P. Sowjanya, "An Exploration of Vascular Biometrics", International Journal of Electronics & Communication Technology, IJECT Vol. 2, SP-1,pp.181-184, Dec 2011.

[2] Norah A. Al-johania and Lamiaa A. Elrefaei, "Dorsal Hand Vein Recognition by Convolutional Neural Networks: Feature Learning and Transfer Learning Approaches", International Journal of Intelligent Engineering and Systems, Vol.12, No.3, pp.178-191, 2019.

[3] Ricardo Janes and Augusto Ferreira Brand˜ao J´unior, "A Low Cost System for Dorsal Hand Vein Patterns Recognition Using Curvelets", First International Conference on Systems Informatics, Modelling and Simulation, IEEE Computer Society Washington,pp.47-52, 2014.

[4] S.Manikanda prabu and S.N.Sivanandam,"A Novel for Person Recognition Using Palm vein Images Biometric system", International Journal on Computer Science and Engineering (IJCSE), Vol. 5, No. 08, pp.692-697, Aug 2013.

[5] R. Sasikala , S. Sandhya , Dr.K. Ravichandran and Dr.D. Balsubramaniam, "A Survey on Human Identification using Palm-Vein Images using Laplacian Filter" International Journal of Innovative Research in Computer and Communication Engineering, Vol. 4, Issue 4., April 2016.

[6] Dorota Smorawa and Mariusz Kubanek, "Biometric Systems Based on Palm Vein Patterns", Journal of telecommunication and information technology, Vol. 10, No24, pp.18-22, Feb. 2015.

[7] Shriram D. Raut1 and Dr. Vikas T. Humbe, "A Distance Metric Computation Model for the Design and Development of Palm Vein Recognition System"International Journal of Bio-Science and Bio-Technology, Vol.7, No.6, pp.201-206, 2015

[8] A.O. bikoye, C.Chukwu, Michael and B.Akinbowale Nathanie,"An Improved Palm Vein Based Recognition System", International Journal of Computing and ICT Research, Vol. 10, Issue 1,pp.9-18, June 2016.

[9] R. Gayathri, L. Jayalakshmi, K. Mahalakshmi and K. S. Nevethitha, "multispectral palmprint recognition using ant Colony optimization", ARPN Journal of Engineering and Applied Sciences, VOL. 10, NO. 14, pp.5934 -5940, AUGUST 2015.

[10] Pooja,Vinay Bhatia and Tanuja Dogra,"Palm Vein Recognition: An Advanced Biometric Technique for Authentication", International Journal of Innovative Research in Computer and Communication Engineering, Vol. 4, Issue 8, pp.14882-14888, August 2016.

[11] Swapnali N. Dere and A. A. Gurjar, "Identification of Human using Palm-Vein Images: A new trend in biometrics", International Journal of Engineering and Computer Science, Vol. 6, Issue 1, pp.19867-19871 , Jan.2017.

[12] M. Sayed, "Palm Vein Authentication Based on the Coset Decomposition Method", Journal of Information Security, Vol.6, pp. 197-205, July 2015

[13] M.C. Villariña and Noel B. Linsangan, "Palm vein recognition system using directional coding and backpropogation neural network", Proceedings of the World Congress on Engineering and Computer Science 2015 Vol 2, 2015.

[14] Sandeep Singh and V.K Banga, " Human identification using palm vein images", International Research Journal of Emerging Trends in Multidisciplinary, Volume 1, Issue 7,pp.7-11, September 2015.

[15] S. Bayoumi, A. Aldayel, M. Alotaibi, M. Aldraihem,S. Alrashed and S. Alzahrahi, "Class Attendance System Based-on Palm Veinas Biometric Information", Journal of Theoretical and Applied Information Technology, Vol.77. No.2, pp.266-272, July 2015

[16] Yossra H. Ali and Zahraa Naji Razuqi, "Palm Vein Recognition Based on Centerline", Iraqi Journal of Science, Vol. 58, No.2A, pp: 726-734,2017.

[17] C. Wang, M. Peng, Lingfeng X and T.Chen, "A single scale retinex based method for palm vein extraction", US National Library of Medicine National Institutes of Health, May 2014

[18] S. D Raut, V.T Humbe and A. R Shinde, " A validation of biometric palm vein recognition system using neural network approach palm vein biometrics", International Journal of Advanced Science and Research ,Vol 3,Special Issue 1,pp. 1-3, Mar. 2018.

[19] Ignacio Irving Morales-Montiel, J. Arturo Olvera-López, Manuel Martín-Ortíz and Eber E. Orozco-Guillén, " Hand Vein Infrared Image Segmentation for Biometric Recognition", Research in Computing Science , Vol. 8, pp. 55–66, 2014.

[20] Mariusz Jankowski, "Erosion, dilation and related operators", 8th International Mathematica Symposium,pp:1-10, Avignon , June 2006.

[21] M. Van Droogenbroeck and M. Buckley, "Morphological erosions and openings: Fast algorithms based on anchors" Journal of Mathematical Imaging and Vision, pp1-35 , 2005.

[22] K. Delac, M. Grgic, T. Kos, "Sub-Image Homomorphic Filtering Technique for Improving Facial Identification under Difficult Illumination Conditions" International Conference on Systems, Signals and Image Processing (IWSSIP'06),pp95-98, September 21-23, 2006.

[23] Sami Abdulla Mohsen Saleh, and Haidi Ibrahim, "Mathematical Equations for Homomorphic Filtering in Frequency Domain: A Literature Survey", International Conference on Information and Knowledge Management, vol.45, pp.74-77, 2012.

[24] Nathan Halko, Per-Gunnar Martinsson, Yoel Shkolnisky and Mark Tygert," An algorithm for the principal component analysis of large data sets" ,Siam journal on scientific computing ,vol. 33, No. 5 , pp.1-12, October 2011.

[25] Aleš Hladnik, "Image Compression and Face Recognition: Two Image Processing Applications of Principal Component Analysis", International Circular of Graphic Education and Research, No. 6 , 2013.

[26] Muhammad Naufal Mansor,Sazali Yaacob, Hariharan Muthusamy, Shafriza Nisha Basah,Shahrul Hi-fi Syam bin Ahmad Jamil,Mohd Lutfi Mohd Khidir,Muhammad Nazri Rejab,Ku Mohd Yusri Ku Ibrahim,Addzrull Hi-fi Syam bin Ahmad Jamil,Jamaluddin Ahmad ,Ahmad Kadri Junoh," PCA- Based Feature Extraction and k-NN algorithm for Early Jaundice Detection", International Journal of Soft Computing And Software Engineering (JSCSE),Vol.1,No.1,pp25-29,2011.

[27] CASIA MS Palmprint V1 Database[Online].Available:http://www. cbsr.ia.ac.cn/MS_Palmprint.

[28] Wenli Liu, Peng He, Hui Li, Hongbo Yu, "Improvement on the Algorithm of Homomorphic Filtering" International Conference on Electrical and Computer Engineering Advances in Biomedical Engineering, vol.11, pp120-124, 2012.