Enhancing Fixed Size Palmprint Region of Interest (ROI) Extraction Algorithm for Personal Identification

Nurzalina Harun, Wan Eny Zarina Wan Abdul Rahman, Sharifah Aliman, Husna Ramena, Nurain Syazana Othman

Abstract*: Identification and verification are the fundamental process in biometrics recognition system. Research indicates that palmprint, as one of the biometric recognitions system is commonly used for human identification. It is because there are many features and information contained inside the palmprint that can be used in the identification process. However, only a small region of the palmprint can be extracted using the existing palmprint region of interest (ROI) extraction algorithms. This has become a problem for identification systems due to negligible and loss of important features which are located outside the ROI. Hence, it is a necessity to improve the palmprint ROI extraction algorithm whereby bigger palmprint ROI can be extracted using this algorithm. Therefore, a larger fixed size extraction algorithm for palmprint ROI is proposed where the extraction region is larger so that more important identification features can be captured inside these ROIs. The performance between proposed and existing extraction algorithms are tested based on two characteristics which are the palmprint ROI extraction area and the comparison of feature creases extracted in a palmprint ROI. The results show that 300x300 fixed size ROI is able to capture 13 out of 14 creases attributes for palmprint identification. This implies that the proposed extraction algorithm shows a promising method of extraction as compared to the existing algorithms.

Keywords* : Biometric, Creases, Extraction, Palmprint, Region of Interest (ROI)

I. INTRODUCTION

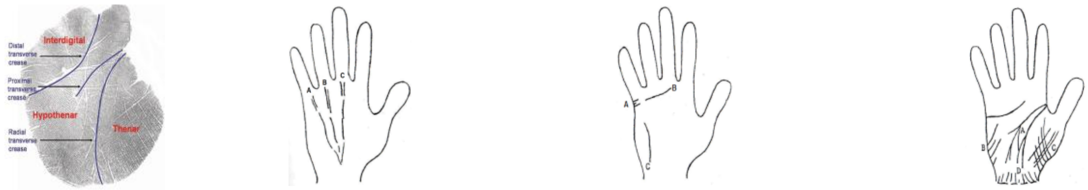
This is the era of digital society where the capability to recognize and identify personal identification in real-time manner is required in various application areas such as international border crossing, computer security and forensics investigation [1],[2]. It is also known that biometric have been recognized as one of the most successful technique for personal identification. The technology behind biometric recognition allows a person to be identified and verified automatically using its behavioral or physiological traits, which displayed substantial advantages compared to traditional personal identification technique, such as using identification card, passwords and keys [3]. An example of biometric traits that have been proven to be successful for recognition in practical application includes the use of fingerprint, face, iris, voice, DNA, signature and palmprint. However, biometric traits using palmprint is starting to gain attention by forensic applications and law enforcement agencies due to its simplicity such as easy self-positioning, less distortion, stable line features, large scale identification, fast processing speed with high recognition rate [2],[4]. In fact, many evidences in a crime scene are in the form of palms. Therefore, law enforcement agencies have begun on collecting palmprints of a suspect during the booking time. That is the reason behind attaching the palmprint modality by the Federal Bureau of Investigation (FBI) in the Next Generation Identification (NGI) system [1].

Palmprint have unique and distinct features such as creases, ridges, wrinkles, pores, textures and minutiae points that are being used for personal identification. Among these features, creases have been widely used for identification purposes because it is easy to locate and identify since the size is larger compared to other palmprint features. There are four types of creases; major flexion, minor finger, minor flexion and secondary creases as in Fig. 1.

Different levels of image resolutions are required to observe palmprint features. The largest palmprint features that can be extracted from a palmprint is the major flexion creases that can be visualized at less than 100 pixels per inch (*ppi*) resolutions. Other features such as ridges, minutiae and thin creases (minor finger creases, minor flexion creases and secondary creases) can be observed using medium of 400 *ppi* and pores can only be detected using medium with greater than 500 *ppi* resolutions [6],[7].

Manuscript published on November 30, 2019.
* Correspondence Author
Nurzalina Harun*, Centre of Mathematics Studies, Faculty of Computer and Mathematical Sciences, MARA University of Technology, Shah Alam, Selangor, Malaysia.
Wan Eny Zarina Wan Abdul Rahman, Centre of Mathematics Studies, Faculty of Computer and Mathematical Sciences, MARA University of Technology, Shah Alam, Selangor, Malaysia.
Sharifah Aliman, Advanced Analytics Engineering Centre of Computer Sciences, Faculty of Computer and Mathematical Sciences, MARA University of Technology, Shah Alam, Selangor, Malaysia.
Husna Ramena, Centre of Mathematics Studies, Faculty of Computer and Mathematical Sciences, MARA University of Technology, Shah Alam, Selangor, Malaysia.
Nurain Syazana Othman, Centre of Mathematics Studies, Faculty of Computer and Mathematical Sciences, MARA University of Technology, Shah Alam, Selangor, Malaysia.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open access article under the CC-BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)



a) Major flexion creases
A. Distal transverse crease
B. Proximal transverse crease
C. Radial transverse crease

b) Minor finger creases
A. Little finger crease
B. Ring finger crease
C. Middle finger crease

c) Minor flexion creases
A. "E" lines
B. Accessory distal transverse flexion crease
C. Hypothenar crease

d) Secondary creases
A. Major accessory creases
B. Hatch creases
C. Checker creases
D. Wrist hatch creases

Fig. 1. Creases features in a palmprint [5],[6]

The palmprint features are extracted using the extracting palmprint region of interest (ROI) process. The process is important because this is the fundamental phase for the process of identification. If the ROI extracted is very small, some of the palmprint features are not contained inside these ROI which can leads to loss and waste of valuable information that can be used for individual identification. The key points between valleys and fingers are used to calculate the palmprint ROI extraction area. It will generate a coordinate system to form a square area at the center or edge of a palmprint. The palmprint ROI extraction area size can be in term of square dynamic size (ROI size change as palm size change; large palmprint produced larger ROI and vice versa) or a square fixed size (ROI size is the same for all palms). Research using square dynamic size palmprint ROI are done by [8] who used two-key-points based, [9] used three-key-points based and four-key-points based are used by [7]. The research using square fixed size palmprint ROI are done by [10], [11] that proposed 128x128 pixels and 256x256 pixels size respectively.

This project is the extension of our previous work using dynamic size palmprint ROI in [7]. The weakness of using dynamic size palmprint ROI is that the size of palmprint ROI is different from one hand to another. Due to this, it is quite difficult to do palmprint verification and identification. Hence, there is a need to develop an extraction algorithm using fixed size ROI algorithm which is more practical compared to dynamic size palmprint ROI. Other than that, the number of features extracted using dynamic [12] are limited because the location of the extraction only focused at the center part of the palmprint. Therefore, there is a need to develop larger fixed size palmprint ROI extraction algorithm so that more features can be captured inside the extracted palmprint ROI.

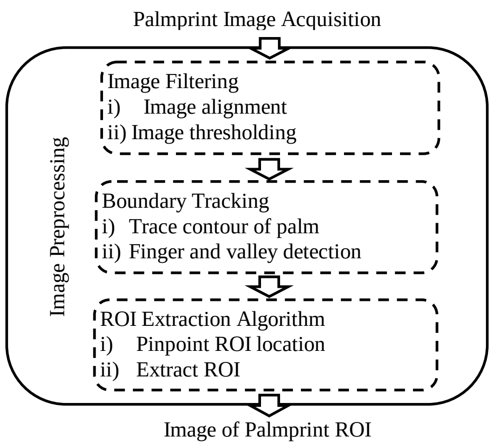


Fig. 2. Palmprint ROI extraction process

II. METHODS

The first step to extract a palmprint ROI is called an image preprocessing. The preprocessing process used in this research follows the procedures by [11] and [13]. The preprocessing module are shown in Fig. 2.

A. Image Filtering

The palmprint image of the right and left-hand will be collected from five (5) respondents between the ages 20 to 24 years old. These age range is chosen based on the report by [14] that indicates this interval age group represents the majority of Malaysian populations. The image will be in 256 RGB colors collected using a platform scanner as depicted in Fig. 3(a).

In the process to determine the location of the palmprint ROI, there exist some variation on calculating the reference points. The existence of these variation are caused by the different degree of stretching among the individual's palm. Nevertheless, the variation on calculating the reference points does not produce substantial effect on the process of feature extraction. Since the majority of the significant palmprint information features are located at the center part of ROI, therefore the process of palmprint ROI extraction will not be affected by these small-scale variations [15].

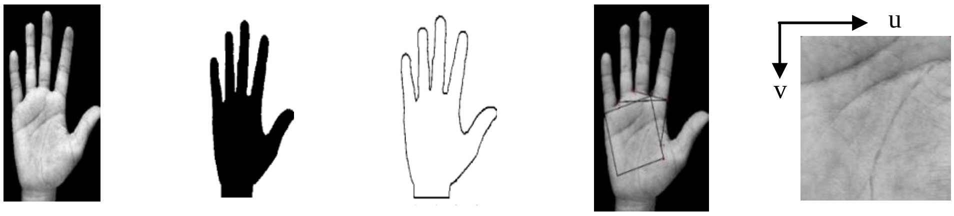
The background color of an image are filtered using image thresholding procedure. It is filtered based on the color components values which are blue, green and red represented by b, g and r. The representation of resultant binary pixel image are C_1, C_2 and C_3. The image thresholding procedures are performed based on the techniques in [13]. The resultant binary pixel image C_1 procedure is:

$$C_1(u,v)=\begin{cases}0 & |r(u,v)-b(u,v)|<T \\ 1 & \text{otherwise}\end{cases} \quad (1)$$

The same procedure will be implemented using resultant binary pixel image C_2 and C_3:

$$C_2(u,v)=\begin{cases}0 & |r(u,v)-g(u,v)|<T \\ 1 & \text{otherwise}\end{cases} \quad (2)$$

$$C_3(u,v)=\begin{cases}0 & |b(u,v)-g(u,v)|<T \\ 1 & \text{otherwise}\end{cases} \quad (3)$$



(a) (b) (c) (d) (e)

Fig. 3. The palmprint ROI extraction process: (a) initial palm image; (b) image in binary form; (c) boundary tracking; (d) mapping coordinate system from palm's image; (e) extraction of a square palmprint ROI.

Generally, the value of local minimal threshold, T is specify between 50 and 100. For this research, since the captured image is in a controlled and stable background, the value of threshold is fixed to be 70 [11]. This threshold value also being used to convert to binary image from the RGB colors. The binary image, I is given as follows:

$$I = \sum_{v=1}^{h}\sum_{u=1}^{w}\bigcap_{i=1}^{3} C_i\left(u,v\right) \quad (4)$$

where h and w are the height and width of image, while v and u represent the screen's coordinates respectively. The palmprint shape image in binary form is shown in Fig. 3(b).

B. Boundary Tracking

In this stage, the contour of palm shape image are traced using the boundary-tracking algorithm from the binary image. The palmprint boundary is calculated to identify the locations of five valleys and fingers so that the area of palmprint ROI can be generated. The traced contour of palmprint image in Fig. 3(a) is represented in Fig. 3(c).

C. ROI Extraction Algorithm

In order to standardise the orientations of different palmprint images rotations, a coordinate system needs to be defined. The coordinate system is determined by building a square parameter based on the locations of fingers and its valleys. The locations of points that will be used to build up a square parameter are selected using palmprint ROI extraction algorithms. The area of palmprint ROI will be calculated based on the length multiply by height of the square parameter. This square parameter will be the area extracted from the palmprint and defined as palmprint ROI as shown in Fig. 3(d). The image of palmprint ROI is extracted from the palmprint image based on the location of these four points as shown in Fig. 3(e).

III. IMPLEMENTATION

This section will propose a modified fixed size algorithm to extract the palmprint ROI based on the algorithm introduced by [10] and [11]. The modification is done based on the location and number of the key points used. [11] proposed using two (2) key points between fingers: the first key point is the valley between ring finger-middle finger while the second key point is the valley between middle finger-index finger. Algorithm by [10] also proposed using two (2) key points between fingers: the first key point is the valley between little finger-ring finger while the second key point is the valley between middle finger-index finger.

In the proposed algorithm, the number of the key points is still the same with [10] and [11]. The proposed algorithm still used two (2) key points but the difference is on the location of the key points used.

The five (5) steps for these algorithms are listed as follows:

Step 1:
Obtain the boundary of the palm image using boundary tracking algorithm. Identify point *A* which is the valley between little finger and ring finger and point *B* the valley between middle finger and index finger.

Step 2:
Draw the reference line *AB* to connect points *A* and *B*. Extend the line from point *A* to the left and from point *B* to the right to obtain points *C* and *D* respectively.

Step 3:
Assign the midpoint between point *A* and *B* as point *E*. Calculate the distance between point *E* and *B*, and take half of this distance. This distance will be used to form the line *EF* which is perpendicular to the line *AB*.

Step 4:
Draw a line parallel to *AB* that pass through the point *F*. From point *F*, take 150 pixels to the left and 150 pixels to the right and mark these points as *G* and *H* respectively.

Step 5:
Draw a perpendicular line at points *G* and *H* to get the point *I* and *J* respectively of length 300 pixels. Connect the point *I* and *J* to obtain the line *IJ*. These four lines will form a square ROI *GHJI*. The lines *GH* and IJ are parallel to each other. The same thing goes to lines *GI* and *HJ* (refer Fig. 4).

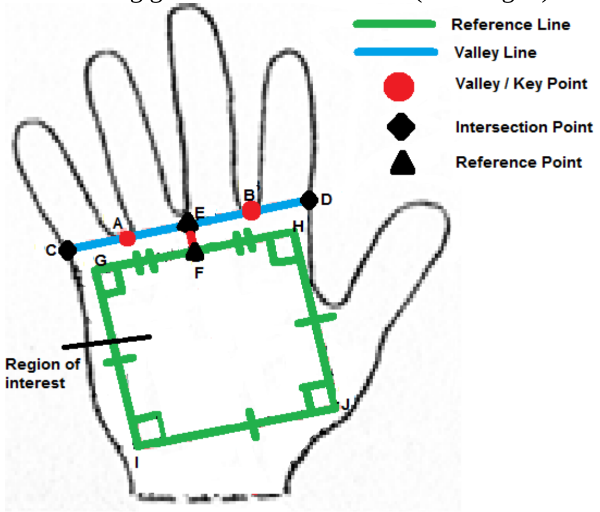


Fig. 4. The proposed fixed size palmprint ROI extraction algorithm

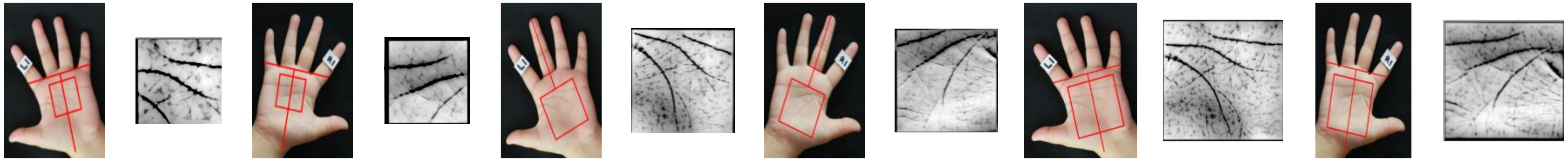
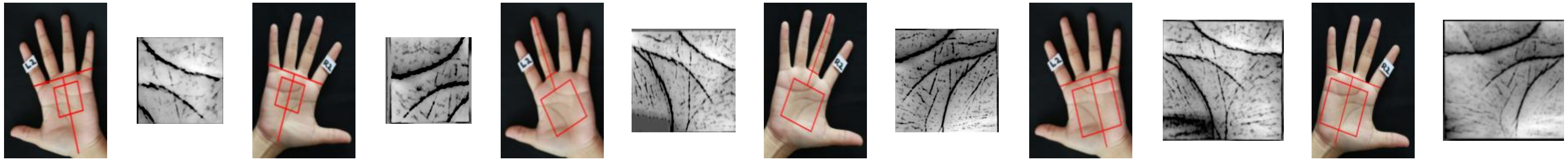
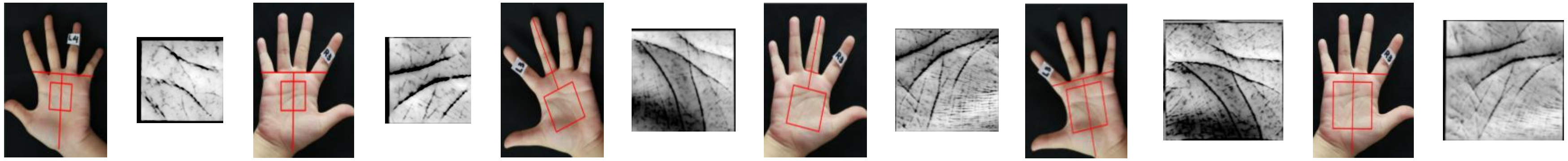
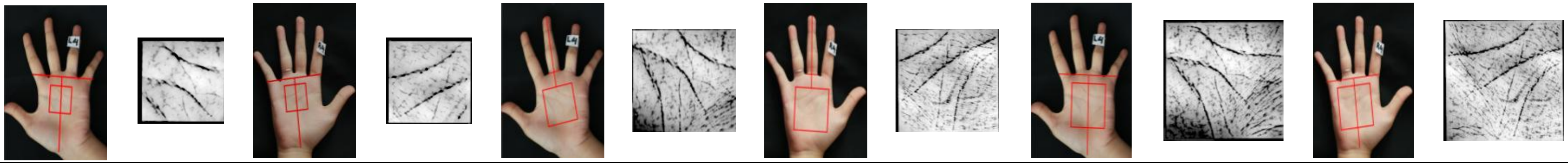
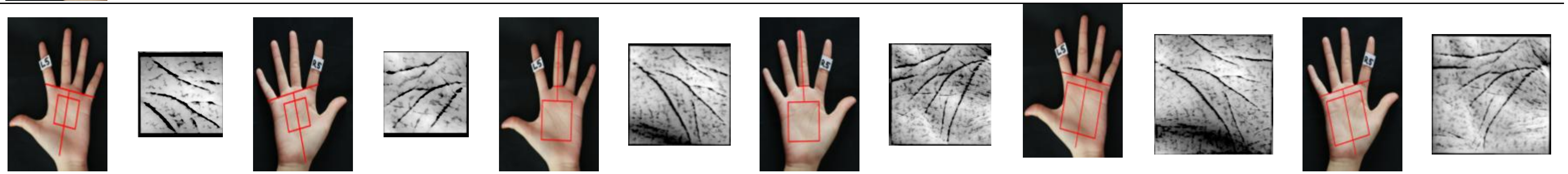
IV. RESULTS AND DISCUSSION

The performance of the proposed fixed size palmprint ROI extraction algorithm is tested using three (3) extraction algorithms; algorithm by [10], algorithm by [11] and the proposed algorithm. For each images, the extraction algorithms will be tested based on two characteristics: i) palmprint ROI extraction area and ii) comparison of feature creases extracted in a palmprint ROI.

A. Palmprint ROI Extraction Area

The process of the palmprint ROI extraction using different algorithms are shown in Table-I.

Table-I: Fixed size palmprint ROI extraction area using different algorithms

Palm	Extraction using [10] - 128x128				Extraction using [11] - 256x256				Extraction using Proposed algorithm - 300x300			
	Left		*Right*		*Left*		*Right*		*Left*		*Right*	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
A												
B												
C												
D												
E												

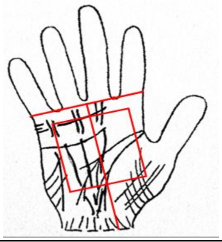
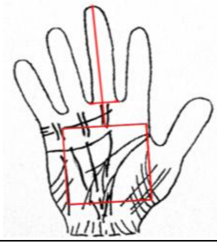
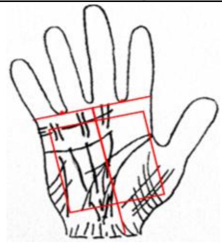
Retrieval Number: D5177118419/2019©BEIESP
DOI:10.35940/ijrteD5177.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

B. Comparison of Feature Creases Extracted in a Palmprint ROI

Palmprint features such as creases, ridges, minutiae and pores are unique and can be used as an identification system. Creases is one of the most visible and easy to extract from a palmprint. Table-II compares the type of creases that can be extracted using three (3) extraction algorithms; [10], [11] and the proposed algorithm.

Table-II: Comparison of creases inside palmprint ROI based on different algorithms

		Algorithm by [10]	Algorithm by [11]	Proposed Algorithm
				
Size (Pixel)		*128x128*	*256x256*	*300x300*
Major flexion creases	- Distal transverse crease	√	√	√
	- Proximal transverse crease	√	√	√
	- Radial transverse crease	√	√	√
Minor finger creases	- Little finger crease	√	X	√
	- Ring finger crease	√	√	√
	- Middle finger crease	√	X	√
Minor flexion creases	- “E” lines	X	X	√
	- Accessory distal transverse flexion crease	X	X	√
	- Hypothenar crease	X	√	√
Secondary creases	- Major accessory creases	√	X	√
	- Hatch creases	X	X	√
	- Checker creases	X	√	√
	- Wrist hatch creases	X	X	X

From Table-II, the number of creases extracted by [11] are fewer compared to the other two algorithms. Han et. al [11] extracted the whole part of major flexion creases region and only one part of minor finger, minor flexion and secondary creases region respectively. It can be seen that the extracted algorithm by [10] also extracted the whole part of major flexion and the minor finger creases, none from the minor flexion creases and only one part of secondary creases. Even though the extracted region by [10] is the smallest (128x128 pixels), the number of creases extracted are more than the algorithm by [11]. However, the proposed algorithm has successfully extracted most of the creases that contained inside a palmprint except the wrist hatch creases. This shows that the proposed algorithm has successfully extracted additional information compared to the other two existing algorithms.

V. CONCLUSION

This paper has proposed a modified algorithm of extraction of palmprint ROI that can be used for features extraction. The performance between extraction algorithms are compared using [10] and [11]. In terms of palmprint ROI extraction size, it is observed that the proposed extraction algorithm has succesfully extracted a larger area of palmprint. Bigger palmprint ROI means extra information can be gathered compared to a smaller ROI. Consequently, this improves the possibility of capturing the right criminal or verifying individual identity

ACKNOWLEDGEMENTS

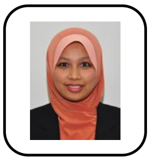
This project is funded by Faculty of Computer and Mathematical Sciences (Universiti Teknologi MARA (UiTM)).

REFERENCES

1. A. K. Jain, K. Nandakumar, and A. Ross, “50 years of biometric research: Accomplishments, challenges, and opportunities”, Pattern Recognition Letters, vol. 79, 2016, pp. 80-105.
2. Q. Xiao, J. Lu, W. Jia, and X. Liu, “Extracting Palmprint ROI From Whole Hand Image Using Straight Line Clusters”, Special Edition on Biologically Inspired Image Processing Challanges and Future Directions, vol. 7, 2019, pp. 74327-74339.
3. B. Jiang, J. Yang, Z. Lv, and H. Song, “Wearable Vision Assistance System Based on Binocular Sensors for Visually Impaired Users”, IEEE Internet Things, vol. 6(2), 2019, pp. 1375-1383.
4. D. Zhong, F. D. Xue, and K. Zhong, “Decade progress of palmprint recognition: A Brief Survey”, Neurocomputing, 2018, pp. 1-13.
5. D. R. Ashbaugh, “Quantitative-Qualitative Friction Ridge Analysis An Introduction to Basic and Advanced Ridgeology”, CRC Press, 1999, pp. 177-180.
6. A. K. Jain, and J. J. Feng, “Latent Palmprint Matching”, IEEE Transactions on Pattern Analysis and Machine Inteligence, 2008, pp. 1-35.
7. N. Harun, W. E. Z. W. A. Rahman, S. Z. Zainal Abidin, and P. J. Othman, “Modified Algorithm of Extraction of Region of Interest (ROI) For Palmprint Identifcation”, International Journal of Advanced Computer Technology, vol. 7(11), 2018, pp. 2909-2915.
8. D. Zhang, K. K. Wai, J. You, and M. Wong, “Online Palmprint Identification”, IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 25(9), 2003, pp. 1041-1050.
9. T. Connie, A. Jin, M. Ong, and D. Ling, “An Automated Palmprint Recognition System”, Image and

Vision Computing, vol. 23(5), 2005, pp. 501-515.
10. Z. H. Guo, D. Zhang, L. Zhang, and W. H. Liu, "Feature Band Selection for Online Multispectral Palmprint Recognition", IEEE Transactions on Information Forensics and Security, vol. 7(3), 2012, pp. 1094-1099.
11. C. C. Han, H. L. Cheng, C. L. Lin, and K. Fan, "Personal Authentication using Palm-print Features", Pattern Recognition, vol. 36, 2003, pp. 371-381.
12. N. Harun, W. E. Z. W A Rahman, S. Z. Zainal Abidin, and P. J. Othman, "New Algorithm of Extraction of Palmprint Region of Interest (ROI)", Journal of Physics: Conference Series, vol. 890, 2017, pp. 1-6.
13. M. Ong, T. Connie, A. Jin, and D. Ling, "A Single-Sensor Hand Geometry and Palmprint Verification System", Proceedings of the 2003 ACM SIGMM Workshop on Biometrics Methods and Applications, 2003, pp. 100-106.
14. Department of Statistics Malaysia, O. P. (2016). Current Population Estimates, Malaysia, 2014 - 2016.
15. G. Badrinath, N. Kachhi, and P. Gupta, "Verification System Robust to Occlusion Using Low-Order Zernike Moments of Palmprint Sub-Images", Telecommunication Systems, vol. 47(3), 2011, pp. 275–290.

AUTHORS PROFILE



Nurzalina Harun is a Mathematic Senior Lecturer at the School of Computer and Mathematical Sciences. She obtained her Dip in Computer Science and BSc (Hons) degree in Computational Mathematics from MARA University of Technology, MSc in Mathematics from University of Science Malaysia. Her research interest is in image processing and computational mathematics. Currently, she is a Postgraduate Student in MARA University of Technology.

Wan Eny Zarina Wan Abdul Rahman is an Associate Professor in Mathematics at the School of Computer and Mathematical Sciences. She obtained her BSc (Hons) degree in Mathematics from Universiti Malaya, Kuala Lumpur, MSc in Applied Mathematics from University of Newcastle upon Tyne, United Kingdom and PhD in 2006 in the field of Applied Mathematics from Universiti Teknologi Malaysia. Her research interest is in image processing and its application in medical image segmentation.

Sharifah Aliman is a Computer Science Senior Lecturer whose interests are in social computing, information and society, social media analytics as well as scientific and Information visualization. Currently, she is Postgraduate Research Coordinator at Faculty of Computer and Mathematical Sciences, UiTM Shah Alam. Her professional memberships are Malaysia Board of Technologists (2018-2019), IEEE Member, IEEE Computer Society Member and Microsoft Certificate Application Development (2007-2008). She received her PhD in IT and Quantitative Sciences (2017) from UiTM, MSc. in IT (2001) from Universiti Putra Malaysia and BSc. in Computer Science and minor in Mathematics (1991), Midwestern State University, Texas, USA. She continues training teachers as she got the certified trainer for Computational Thinking and Computer Science Teaching in 2017 by Malaysia Digital Economy Corporation.

Husna Ramena is a Graduate Student in BSc (Hons) degree in Pure Mathematics from MARA University of Technology. Currently, she is doing her practical training. Her research interest is in pure mathematics.

Nurain Syazana Othman is a Graduate Student in BSc (Hons) degree in Pure Mathematics from MARA University of Technology. Currently, she is doing her practical training. Her research interest is in pure mathematics.

Retrieval Number: D5177118419/2019©BEIESP
DOI:10.35940/ijrteD5177.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication