Evaluation on palm-print ROI selection techniques for smart phone based touch-less biometric system

Salwani Ibrahim[a] Dzati Athiar Ramli[a]
[a] Intelligent Biometric Group (IBG), School of Electrical & Electronic Engineering, USM Engineering Campus, 14300, Nibong Tebal, Penang, MALAYSIA
dzati@eng.usm.my

Abstract. There are many methods have been carried out for human recognition such as personal identification number (PIN), password or ID card but all of these methods can be guessed, hacked or stolen. Palm-print verification system is a biometric technology which is developed to authenticate person based on individual palm-print pattern. This paper presents an initial effort to perform touch-less palm-print recognition system by considering the effective way to extract the palm-print region of interest (ROI). The system starts with hand image collection using smart phone device. This project proposes two hand tracking algorithms i.e. two point method and canny method so as to detect the peak and valley of the palm. Afterwards, the desired ROI is selected and the palm-print ROI is stored in database for the evaluation of their appropriateness to be used for the touch-less palm-print recognition data.

Keywords: palm-print, biometrics, region of interest (ROI), touch-less, smart phone.

1 INTRODUCTION

Biometrics refers to an automatic verification or identification of a person based on his/her physiological and behavioral characteristics (Yih et al., 2009), (Zhang, 2004). Many types of biometric systems have been developed based on traits such as speech, face, fingerprint and many more. A palm-print verification or identification system is one of the biometric systems that use palm-print trait as features to authenticate or identify individuals (Goh et al., 2010).

Palm is the inner surface of a hand between the wrist and the fingers. The palm itself consists of principal lines, wrinkles (secondary lines) and epidermal ridges (Tabejammat and Kangarloo, 2007). It differs to a fingerprint in that it also contains other information such as texture, indents and marks which can be considered as informative features when comparing one palm to another (Yih et al., 2009). It serves as a reliable human identifier because the print patterns are not duplicated in other people (Goh et al., 2010). Most of the palm-print biometric systems utilize scanner or Charge Couple Device (CCD) camera as the input sensor (Tabejammat and Kangarloo, 2007), (Kasturika and Misra, 2011). However, these devices should be handling in controlled or semi-controlled environment. Furthermore, many types of equipment are involved during data collection thus these devices are limited to be used at specific places only (Goh et al., 2010), (Goh et al., 2008). Another weakness of using touch based device is the users must touch the sensor to capture their hand images. Due to the sanity issue, people are concerned to put their hand on the same sensor that may spread virus or bacteria through the device. So, in this study, a touch-less device is proposed for palm image capturing as it will be more comfortable for the users of the system, less equipment are involved during data collection and can be implemented without restriction of certain places.

Today, there are many technology devices that can be used to implement this system. In this project, android smart phone camera is used to capture the palm image where the user does not need to touch any panel or screen to avoid the hygiene and sanity issue (Julio and Shu, 2009), (Meraomia et al., 2011). For this purpose, an android application is developed and some guidelines will be displayed on the smart phone screen. So that the user will be assisted

in term of hand positioning and the correct distance between the user hand and smart phone camera. The application has been built as a user friendly tool for palm image capturing and once captured, the image will be sent via internet to server for database collection. Since this technology device is widely used nowadays, it is easy to be executed by installing the application on the android device (Julio and Shu, 2009). The main requirement is an android smart phone and wireless or 3G network will be used for server connection (Ismail and Sabri, 2010).

The entire process in developing palm-print recognition system is illustrated as in Figure 1. However, this paper only focuses on the data acquisition part for the ROI selection for touch-less palm-print recognition system. The first objective of this paper is to collect palm-print images using smart phone camera for data collection. The second objective is to implement two types of hand tracking algorithms i.e. two point methods and canny method to the palm-print images so as to detect the peak and valley of the palm. Finally, the last objective is to select the ROI of the palm based on the obtained hand peak and valley as the reference point.

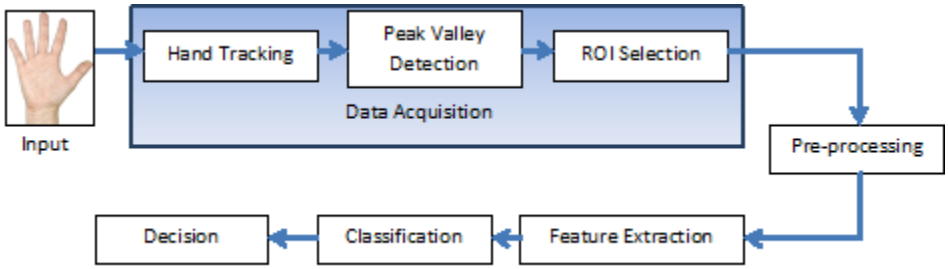


Fig. 1.The processes of the proposed palm-print recognition system.

2 METHODOLOGY

This paper proposes a touch-less palm-print recognition systems and will use phone camera for capturing hand image. On the display screen itself, we provide two points for user to control their hand, align hand into the area and capturing hand image perfectly. After that, ROI will be selected by using peak-valley detection method (Al-Kutabi et al., 2012). Some experiments have been carried out for the evaluation of the propose technique performances. There are a few challenges and limitations that need to take into account before developing the data acquisition module as discussed in the following items:

Distance between hand and input device – In order to capture good quality images, the distance between the hand and device must be in the right distance. This is because if the distance is too far, the images may come out unclear or blurred. This will cause problem while extracting the features from the images. The developed module should provide a function which is able to control the distance during image capturing. In this study, this problem is solved via developing a smart phone application by preparing hand template on the display screen. So users can adjust their hand to fit into the region.

Hand position – Position of the hand is one of the importance steps to ensure the hand tracking and peak and valley detection can be well executed. To overcome this limitation, the user is requested to put their palm in vertical position with the help of reference points on the smart phone application.

Chromatic color background – Due to the data are collected either in indoor or outdoor which may be influent by bad illumination, so the chromatic color background also one of the challenges. So that the developed module must be able to properly differentiate the skin to

background color. Moreover, a busy background should be avoided and set as a limitation to the system.

2.1 Data collection

In this experiment, the lighting and distance between hand and smart phone is set as constant. User only needs to make sure hand is aligned well and follow the point area in phone screen. Sample of 40 individuals hand images has been captured with 60 images for each subject. The experiment set up for the developed smart phone application data acquisition is shown in Figure 2.

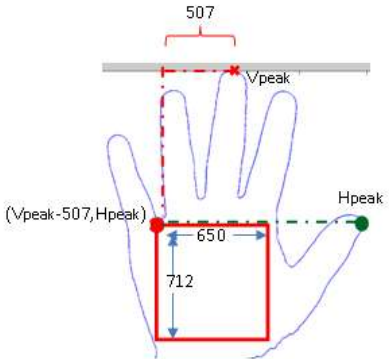


Fig.2. Experiment set up for the smart phone application.

On the smart phone screen, 2 reference points i.e. Vpeak and Hpeak are displayed for the user to control the hand and fit into the point region. This will control distance and ignore the chromatic color background. This task also requires the user to spread apart the fingers. Subsequently, the hand image obtained from smart phone camera is sent via server to the database. A standard PC with Intel Core i5 processor (2.50 Ghz) and 8.00GB random access memories are used to run MATLAB code program for pre-processing steps.

2.2 Hand tracking, peak and valley detection and ROI selection

This step consists of two stages i.e. hand image tracking and peak-valley detection in order to locate the ROI. In this study, two methods i.e. two point method and canny method have been experimented as discussed as follows:

2.2.1 Two point method

Figure 3 shows the whole process for the two point method. Before the process starts, there are few pre-conditions need to be considered:

- The lighting during capturing the image should be saturated.
- Hand position is in straight position and thumb finger should be aligned near to the palm area.

Two point method steps:

1. Originally, the hand image is represented using Red-Green-Blue (RGB) format. The image will be threshold to get a binary image (only 0's and 1's) of class logical and the 'hole fill' function is applied to the small hole so as to get the perfect image.
2. Use the' bw boundaries' function to get the connected boundaries from the image and plot the image.
3. Get the horizontal highest peak (Hpeak) and vertical highest peak (Vpeak). The two points is plotted. To get the reference point (Vpeak-507, Hpeak) for cropping the

ROI, the calculation as in figure 2 is followed. Size of the ROI area is fixed to 650x712 pixels and result will same size for all samples.

4. From the calculation, square shape is drawn on the original image and ROI is cropped.

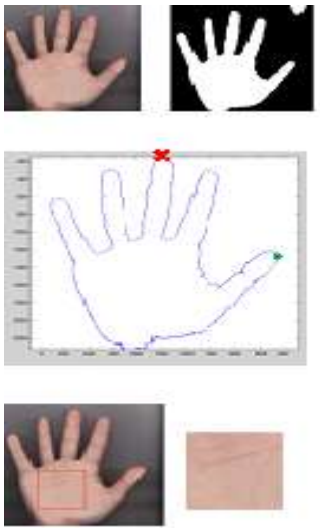


Fig.3. Two point method process.

2.2.1 Canny Method

Canny method only has one pre-condition i.e. all tips must be captured. This is to ensure that 5 peaks and 4 valleys are inside the ROI. Figure 4 and figure 5 show the whole process for the canny method.

Canny method steps:

1. First the RGB image is converted to gray scale then to binary image. Noise is then removed.
2. Use the Canny edge detection algorithm to identify edges in the image. The set of connected pixels with the largest area in the image is then hypothesized to correspond to the hand.
3. Trace hand boundary from the canny processed image. To get smoother hand boundary, the binary image need to filter out the strength noise.
4. Find and mark the peak valley (5 peaks and 4 valleys)
5. To find the peak and valley, use local minima and local maxima method. This method is accurate if the hand boundary image is smooth. Plot the peak and valley in the hand boundary image.
6. Sort peak and valley and name the points. This variable will be used in next step to calculate the ROI of the palm area.
7. For the ROI area calculation, T1, T4, P1 and P3 are used as the reference point. The ROI is located based on the intersection of tangent line drawn between T1 and P1 (first reference point) and between T4 and P3 (second reference point). Draw square shape based on the reference point. As the size of ROI varies from hand to hand (depending on the width of the hand), all images are fixed into 700 x 700 pixels.
8. Auto-crop the ROI and save the image into new database

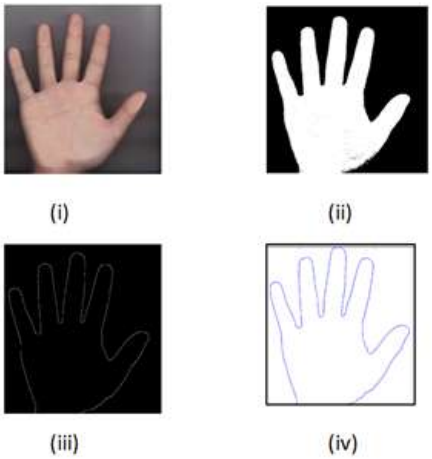


Fig.4. Hand Image Detection, (i) Original hand image, (ii) Binary image, (iii) Hand contour with Canny method, (iv) Perfect hand boundary plot.

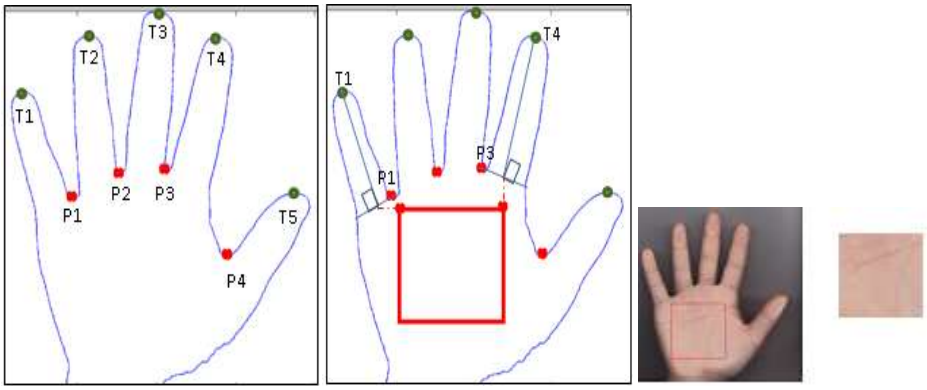


Fig.5. Five peaks and four valleys that represent the tips and roots of the fingers and the ROI

3 RESULTS AND DISCUSSIONS

Problem of the two point method:

Problem 1: If the lighting of the image is not saturated, the threshold image is missing more information due to only the brighter area is captured. So the boundaries of the image will be also affected.

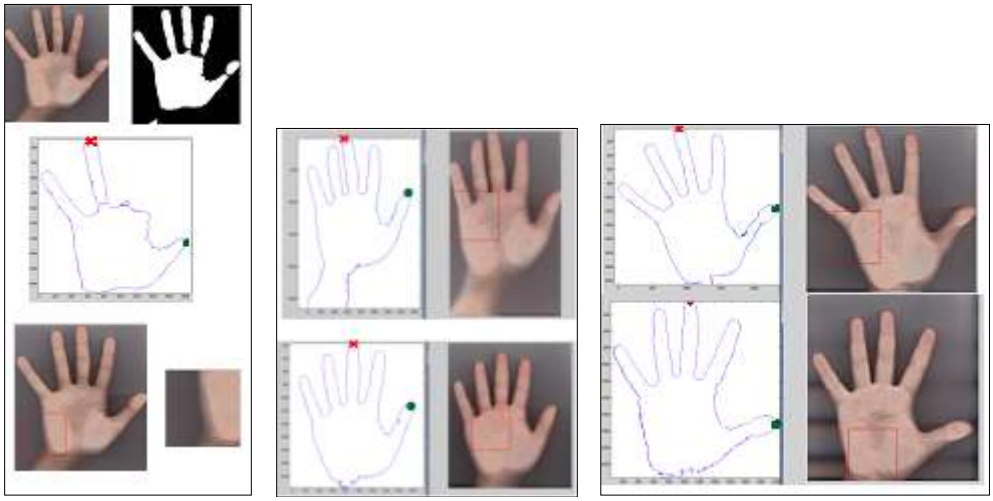
Problem 2: The hand boundary image is not smooth enough and for some image, it is hard to get the perfect two points.

Problem 3: Besides, these two points method also have problem with hand positioning. If the position of the hand is too wide or the thumb finger does not align well, the wrong ROI is found.

The examples of wrong ROI obtained as discussed above are illustrated in figure 6.

Problem of the Canny method:

Problem 1: if the image captured is missing one or more fingers due to image is too closed, it will give an error because this technique requires 5 peaks and 4 valleys to be detected As an example, figure 7 below shows the ROI obtained when only 3 peaks and 2 valleys are successfully detected by the system.



(i) (ii) (iii)

Fig.6. Problem with Two Point Methods (i) Problem 1 (ii) Problem 2 (iii) Problem 3

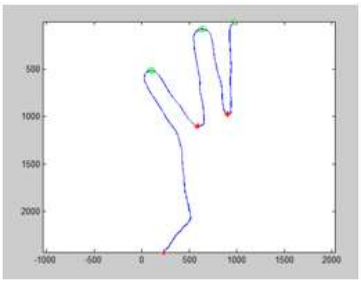


Fig.7. Problem with Canny method.

Consequently, as observed from the experimental results, the major different between these two methods is the hand boundary image processed by canny method is smoother than the two point method. This is because the two point method is directly traced the boundary from the binary image. But for canny method, the boundary is traced from the set of connected pixels with the largest area in the image. Figure 8 shows the different of the hand boundary image between the two point method and canny method. Evaluation on the overall data collection, the two point method gives 70 % while for the canny method is 89 %.

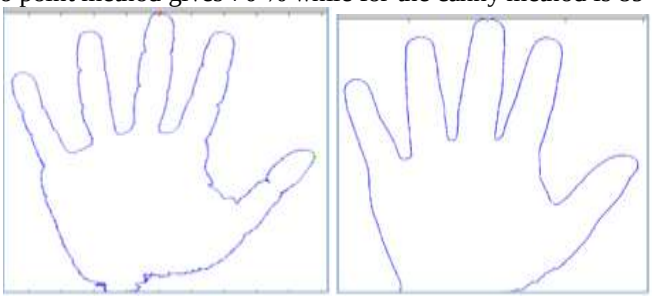


Fig.8. Image selected using the two point method (left) and canny method (right).

4 CONCLUSION

This paper presented step by step process in developing the automated palm-print ROI selection for touch-less palm-print recognition system. Two methods namely two point method and canny method have been implemented and evaluated. Due to the capability of the canny method to trace the hand boundary image smoothly hence can detect the 5 peaks and 4 valleys correctly; the desired palm-print ROI can be obtained without facing many problems. So that, the canny method can be a viable technique in selecting the accurate ROI for the use of touch-less palm print biometric system. Future research will be devoted to the complete process of the implementation of palm-print based touch-less biometric system using smart phone device.

Acknowledgments

The authors would like to thank the financial support provided by Universiti Sains Malaysia Short Term Grant, 304/PELECT/60311048, Research University Grant 814161 and Research University Grant 814098 for this project.

References

Yih, E. W. K., Sainarayanan, G. & Chekima, A. (2009). Palmprint based biometric system:a comparative study on discrete cosine transform energy, wavelet transform energy and sobelcode methods. *Biomedical Soft Computing and Human Sciences, 14*(1), 11-19.

Zhang, D. D, (2004). *Palmprint authentication* (Eds). Massachusetts, USA: Kluwer Academic Publishers.

Goh, M. K. O., Tee, C. & Teoh, A. B. J. (2010). Bi-Modal Palm-print and Knuckle Print Recognition System", *Journal of IT in Asia, 3*, 53-66.

Al-Kubati, A. A. M., Saif, J. A. M., & Taher, M. A. A. (2012). Evaluation of canny and otsu image segmentation. *International Conference on Emerging Trends in Computer and Electronics Engineering (ICETCEE'2012),* March 24-25, 2012 Dubai.

Julio, A. & Shu, W. (2009). Exploring touch-screen biometrics for user identification on smart phones. *Proceeding of the 2009 IEEE/IFIP nternational Conference on Dependable System*, 1-14.

Tabejamaat, M. & Kangarloo, K. (2011). A Multibiometric system based on hand geometry and palmprint features. *2011 International Conference on Signal, Image Processing and Applications with Workshop of ICEEA, 21*, 111-115.

Goh, M. K. O., Tee, C. & Teoh, A. B. J. (2008). Touch-less palm-print biometrics: novel design and implementation. *Image and Vision Computing, 26*, 1551-1560.

Meraomia, A., Chitroub, S. & Bouridane, A. (2011). Fusion of finger-knuckle-print and palmprint for an efficient multi-biometric system of person recognition", *IEEE Communication Society for IEEE ICC 2011*, 1-5.

Ismail N. & Sabri, M. I. M. (2010). Mobile to server face recognition: A system overview, *World Academy of Science, Engineering and Technology*, *69*, 2010, 761-765.

Kasturika, B. R. & Misra, R. (2011). Palmprint as a biometric identifier. *International Journal of Electronics and Communication Technology, 2*(3), 2011, 12-16.