Biometric Identifier Study of Middle Phalanx Print

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ABSTRACT
The advent of technology has enabled the new way of identifying individuals. Biometrics is one of the emerging technologies designed to identify people through physiological and behavioural characteristics. In order to further improve the existing security infrastructure, research into identifying new ways of identifying an individual is carried out. The middle phalanx print is a region located between the finger joints on the human hand which is rich in texture and fine wrinkles. Research carried out has shown that through image acquisition, pre-processing, feature extraction, and classification, the middle phalanx print were able to be analyzed satisfactorily. The Local Binary Pattern was used as the feature extraction algorithm in combination with the Support Vector Machine as a classification algorithm. Both algorithms were implemented through MATLAB. The LBP-SVM algorithm achieved 100% classification rate from the feature vectors of the middle phalanx print, suggesting that the middle phalanx print can be used to classify and identify a person.

Keywords
Biometric system, Image acquisition and database, Preprocessing

1. INTRODUCTION
The progression of the information age has changed and modernized almost every aspect of our lives. One observable aspect is how technology has revolutionized the way we identify individuals through advancement in identification methodologies and identity management. The identification process where individuals associated with privilege and given access to resources is called Identity Management [1]. Conventionally, identification is done by examining a government-issued identification card containing the person's picture, personal information, and fingerprint data. Today, by virtue of state-of-the-art technology, access towards a new variety of biometric technologies are now available at our disposal. Some of them are the iris, voice, face, and palm-print recognition technology [1-4]. Biometrics technologies use behavioural and/or biological characteristics of an individual for the automated recognition of identity [5]. These complex recognition system utilizes biometric identifiers and/or biometric descriptors to identify an individual. Biometric technologies utilize both physiological and behavioural characteristics for recognition. Thus, two classes of biometric technologies exist for this reason. First is the Physiological Biometric Technology which uses anatomical features for recognition such as the fingerprint, face, and iris structure. Second, are the Behavioural Biometric Technologies which acquires actions or behaviour which is repeated in a personalized unique pattern. This is thereof recognized as a unique trait by the system. In this paper, the feasibility of using middle phalanx print as a biometric identifier is investigated. Fine wrinkles which are observable between the finger joints are defined as the middle phalanx print. The middle phalanx print is located between the phalanges of the and can be observed in Figure 1, highlighted in blue colour, the region on which the middle phalanx prints are located.

Figure 1.: Middle phalanx print

Information security is a great concern to everyone. From enabling privileged individuals to access a laboratory towards the ease of internet banking and usage of automated cashier machine, information security plays a vital role in almost every aspect of the modern life. When information security is compromised especially in the financial sector, huge monetary losses are incurred

2. BIOMETRIC SYSTEM OVERVIEW
The main objective of a biometric system is identifying a user based on the user's biometric trait. This is done by establishing a correct decision to the comparison of similarity score between two biometric traits of the same user. In order to distinguish a person from another, a biometric system typically executes operation in a sequential manner. A biometric system is essentially a pattern recognition engine which utilizes representation of human traits as its input. The generalized operation of a biometric recognition system is illustrated in Figure 2.

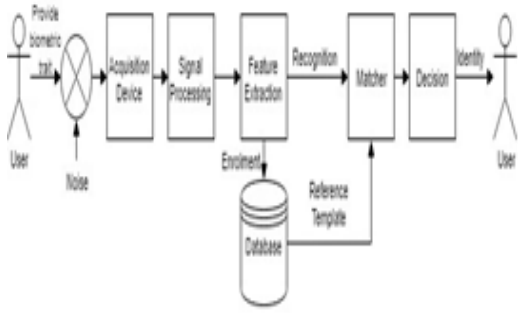


Figure 2: Generalized biometric recognition system operation

As observed in Figure 2, noise which cause interaction error are only introduced in the system through the acquisition device stage, where raw images are captured [1]. This same noise is propagated throughout the entire stage of the biometric recognition system operation. There are a lot of factors which may contribute to the unwanted noise in the input signal of the biometric recognition system. Poorly maintained equipment, defect, sensor noise, channel noise, poor lighting and environmental condition adversely affects and introduces noise to the biometric data [6, 7, 8]. However, the effect of noise towards captured raw image somehow lies in between blurred lines. As image processing is a "visual perception" field, how visually "correct" an image "should be" are very much dependent towards the subjective perception of a researcher, though viewpoints are frequently similar, but never standardized.

2.1 Project Framework

A typical biometric recognition system requires registered or enrolled biometric identifier in the form of biometric template in order to compare against a newly captured biometric sample for verification tests. Two types of operating mode in biometric recognition system are the identification and verification mode [9]. Biometric Recognition System in identification mode are also often referred to as the one-to-many matching operation as the system aims to identifies a person from the entire population of the database by looking for a decision match solely based on the biometric sample. Another mode available, which is the verification mode, often referred as one-to-one matching, verifies a person's claimed identity from their previously enrolled pattern. The verification mode is illustrated in Figure 3 and Figure 4

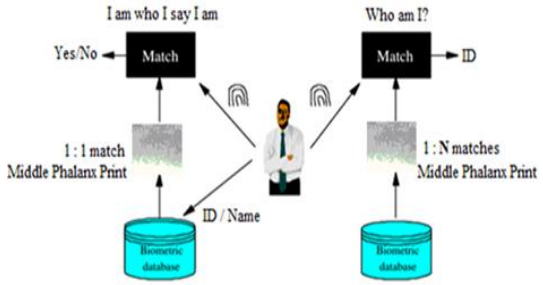


Figure 3: The difference of identification and verification mode

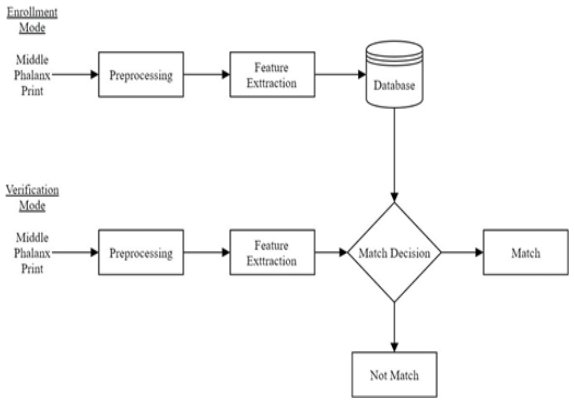


Figure 4: Typical biometric recognition system in verification model

2.2 Image Acquisition and Database

The image acquisition of the middle finger of the right hand was done over 2 sessions. From 10 volunteers, 6 images of the Right Middle Finger (RMF) were captured from the first session and another 6 images was captured from subsequent second session. A total of 120 RMF images was captured. Images captured in the first session are used as training image for the SVM classifier while images captured in the second session is used as the test image of the classifier. Images obtained in this stage is stored in database systematically with individual name label on the folder containing the images.

2.3 Preprocessing

Data preprocessing is a necessary step to be taken in order to ensure that the raw images which were captured in the image acquisition step are optimized and deemed "visually" accepted to a satisfactory standard. Thus, the preprocessing step is the measures taken in order to reduce noise or increase the quality of an image to improve the performance of the feature extraction algorithm which will subsequently follows the preprocessing step. An illustration of the preprocessing steps can be observed in Figure 5

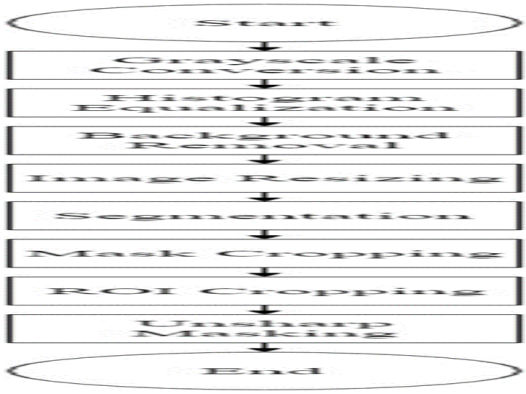


Figure 5: Preprocessing workflow

3. RESULT AND DISCUSSION

An image acquisition system was designed and developed in in order to obtain and analyze the region of interest, the Middle Phalanx Print which located between the phalanges of the finger. In order to reduce difficulty and complexity during the preprocessing stage, design solutions by heuristic approach was made to the design to improve quality of the captured image. Illustration of the design issues faced such as poor illumination and bad contrast can be observed on Figure 7 while improvements to the design issues can be observed on Figure 8.

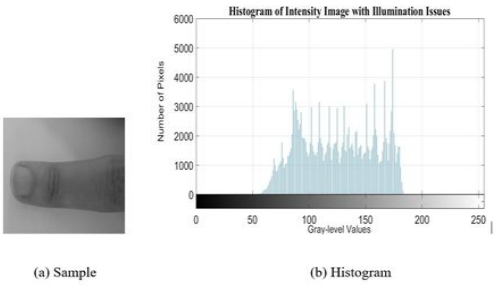


Figure 6: Effect of poor illumination to the acquired sample

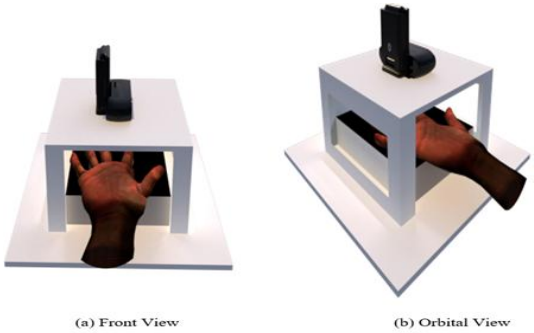
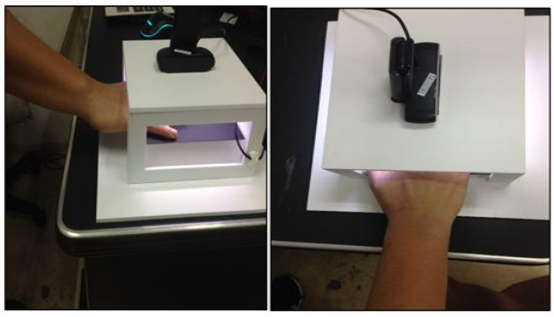


Figure 7: Finalized 3D rendered pilot prototype design

As observed in Figure 7(a), it shows an acquired sample finger of a volunteer that is affected by poor illumination. The picture is seen to be predominantly dark. This is contributed due to the absence of an internal illumination source in the system. An observation of the picture's histogram in Figure 6 further solidifies this assertion. Based on the histogram in Figure 7(b), it can be seen that the distribution of the image's pixels has a concatenating band distribution of gray-level clustered within the narrow region ranging from gray-level of 52 towards 183, suggesting inadequate illumination level and poor contrast.



(a) Front View **(b) Orbital View**

Figure 8: Developed Image Acquisition System Prototype

Adjustments are made to the design by integrating an internal illumination source to the system together with a change from white to black background. Improvement to the volunteer's sample may be seen in Figure 8.

As observed in Fig. 7(a) and Fig. 7(b), both the sample and histogram showed improvements after an internal light source is integrated into the system. The sample are more perceptible, and visually-comfortable due to the added brightness. Furthermore, histogram improvements were made as seen from the histogram having concentrating cluster-distributed pixels in a narrow region as observed in Fig. 7(b) towards a bi-modal distributed histogram in Fig. 8(b).

4. CONCLUSION

Research has demonstrated analysis of the middle phalanx print by extracting features through the LBP algorithm and authentication using SVM algorithm. The middle phalanx print is found to be able to distinguish an individual to another. The research objective has been achieved through the design and development of the image acquisition prototype. This image acquisition prototype was used to create a small database consisting of 120 images of the right middle finger from 10 volunteers.

5. ACKNOWLEDGMENT

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6. REFERENCES

[1] Modi, S. K. (2011). Biometrics in identity management: Concepts to applications. Artech House.

[2] Sim, H. M., Asmuni, H., Hassan, R., & Othman, R. M. (2014). Multimodal biometrics: weighted score level fusion based on non-ideal iris and face images. Expert Systems with Applications, 41(11), 5390-5404.

[3] Wu, X., Zhang, D., Wang, K., & Huang, B. (2004). Palmprint classification using principal lines. Pattern recognition, 37(10), 1987-1998.

[4] "Florida team invent voice recognition system," Biometric Technology Today, vol. 2018, p. 2, 2018/01/01/ 2018.

[5] Vacca, J. R. (2007). Biometric technologies and verification systems. Elsevier.

[6] H. Li, L. Li, and K.-A. Toh, Advanced Topics in Biometrics. Singapore, UNITED STATES: World Scientific Publishing Co Pte Ltd, 2014.

[7] J. T. Elsworth, Design and Performance of Biometric System. Hauppauge, UNITED STATES: Nova Science Publishers, Incorporated, 2010.

[8] C. Wilson, Vein Pattern Recognition: A Privacy-Enhancing Biometric: CRC Press, 2010.

[9] Yanushkevich, M. S. Nixon, S. N. Srihari, and P. S. P. Wang, Image Pattern Recognition: Synthesis and Analysis in Biometrics. Singapore, SINGAPORE: World Scientific Publishing Co Pte Ltd, 2007.