Analyzing the periocular biometric-based access control systems

Analyzing the periocular biometric-based access control systems

Chit Su Mon[1], **Amir 'Aatieff Amir Hussin**[1] **and Toh Kai Sin**[1]
[1] Faculty of Business and Information Science, UCSI University, Jalan Menara Gading, 56000 Cheras, Kuala Lumpur, Malaysia

chitsm@ucsiuniversity.edu.my

Abstract. Biometrics is a widely studied topic for security applications or identity identification. This project had focused on primarily on studying a small region around the eye known as the periocular region as a supplementary biometric. This is the region that includes eyelids, lashes and eyebrows. A few previous studies had proven that periocular biometrics has applied as an independent recognition system under unconstrained scenarios. The biometric data for this region can be easily obtained with existing setups used face and iris recognition. In this project, the data and information was gathered mainly through two methods which were the observation and review on other documentations related to the system. The qualitative research was performed through observation and surveys related to the system. The samples was obtained in a way that the cooperation from the subject or participant was informal while interaction with the biometric system was facilitated. the prototype generated alternative way to allow access to the system using the periocular biometric.

1. Introduction

Security and privacy issues have been the major concern in the community in recent years. Increasing security such as signature verification for checks requiring frequent pin number changes for bank account or implementing passwords that use the different types of characters in a unique way to increase security [1]. However, when hackers find ways to create programs to hack account details and sabotage computing systems, these security measures become useless. As a result, numerous biometric recognition technologies have been developed to overcome security problems [2].

The introduction of biometrics provides a remedy for the security issues that have been used more effectively to protect personal privacy. Biometric techniques are generally used as an identity verification factor due to the difficulties of stealing biometric information compared to other non-biometric credentials [3]. A positive effect from the ease and comfort of interacting with a biometric system has contributed to social acceptance. This acceptance is important since many individuals perceive the capture of biometric characteristics without the knowledge of the user as a threat to privacy issues. Legislation is required to ensure that such information remains private and protection law applies in all cases of misuse [4]. Biometric identification is suitable for applications in three main sectors such as commercial, governmental and forensics [5]. Examples of commercial applications include ATM, credit card, cell phone and distance learning identification while the government includes ID card implementation, driver's license, social security and passport control providing better

security for each individual. In addition, forensics applies in the identification of terrorists and the location of missing children. Conventional biometric systems are used to determine human identity based on several biometric characteristics or characteristics such as iris, face, retina, fingerprint, hand geometry, gait, conjunctival vasculature, knuckle joints, etc.[6]. Periodic recognition has the potential to deliver highly promising results based on recent studies among these biometric traits[7].

For iris recognition, the iris texture is obtained by detecting wavelength near infrared (NIR) under restricted scenarios [8]. The iris image quality can be ensured in the NIR spectrum. Biometric data is unique due to difficulties in replicating and stealing. Certain applications such as authentication in highly restricted areas, attendance records in office premises, identification, and verification of citizenships and forensics as well as biometric-based mobile phone authentication have been used highly effectively for biometrics [9]. Despite being part of the same region as the iris, periodic biometrics are preferable to iris recognition due to several reasons published in recent literature [10].

In addition, facial and iris recognition sensors usually obtain the periodic region without additional requirements. From the field of vision of a sensor, a periodic image may include iris, sclera, eyelids, eyebrows, skin and moles, and birthmarks if present [11]. The uniqueness of the ocular region can also consist of eye shapes and prominent skin folds as well as eye corners and location of moles and birthmarks that can be determined as a biometric trait. There is a standard protocol for handling biometric data. The most important thing, however, is not a standard protocol to define the exact region of the periocular.

The result, based on previous studies, found that the biometric identity verification process can be improved to provide a higher level of accuracy for verification under restricted scenarios. Certain effects such as multispectral lighting and significant computing power are used to execute the existing image analysis algorithms to acquire the required accuracy [11-14].The project was aimed to develop an access control system using periocular recognition. A periocular biometric matcher which aims to better encode the periocular features is implemented by exploratory the periocular region in details.

2. Methodology

In this project, the data and information was gathered mainly through two methods which were observation and review on other documentations related to the system. The qualitative research was performed through observation and surveys related to the system as well.

Observation is conducted to recognize human uniquely by using periocular biometric. Based on the observation, a deep understanding on the periocular was sufficient and necessary for recognition in nowadays. Meanwhile, analysis was carried out to acquire the requirements of the system.

The survey was data collection technique by reviewed existing publication such as reports, program logs, performance ratings, funding proposal, newsletters and marketing materials. Hence, review on other documentations related to the system helps in information gathering about the definition of periocular, other biometrics recognition and some algorithms used for periocular recognition.

3. Synthesis

The developed application model consisted of the following modules such as enrolment, verification, etc. were shown in Figure 1. Based on Figure 1, a new user need to register with their eye images and username during the enrolment. The webcam was captured the eye images which was the periocular biometric from the new user. Next, the system saved the image of the periocular into the database to the corresponding username. The user is considered as registered user once enrolment is completed. The users provide required eye image and username to the system to claim their identity. Furthermore, the system was executed the algorithm in order to calculate the score level from the claimed user identity.

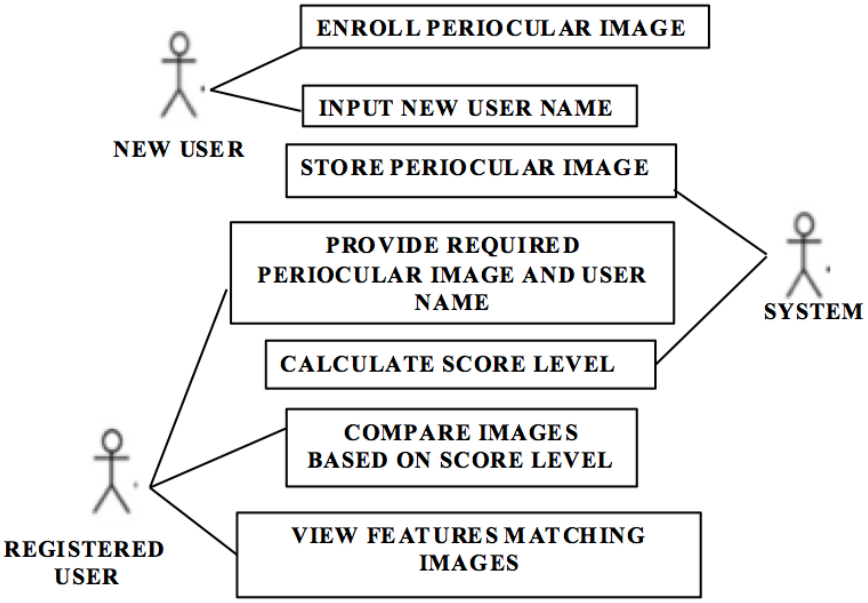


Figure 1. Use case diagram

The user is also able to view the image matching to the feature extraction between the enrolment image and real-time capture. The information such as periocular biometric and username is significant to the system before image is processed with the feature matching and computes the score level.

Besides, system activities were divided in two sections. The first section deals with user enrolment as shown in Figure 2. New user was able to register their username as well as capture the periocular biometric from the webcam. The user was successfully enrolled to this system once the system store their periocular information to their corresponding username.

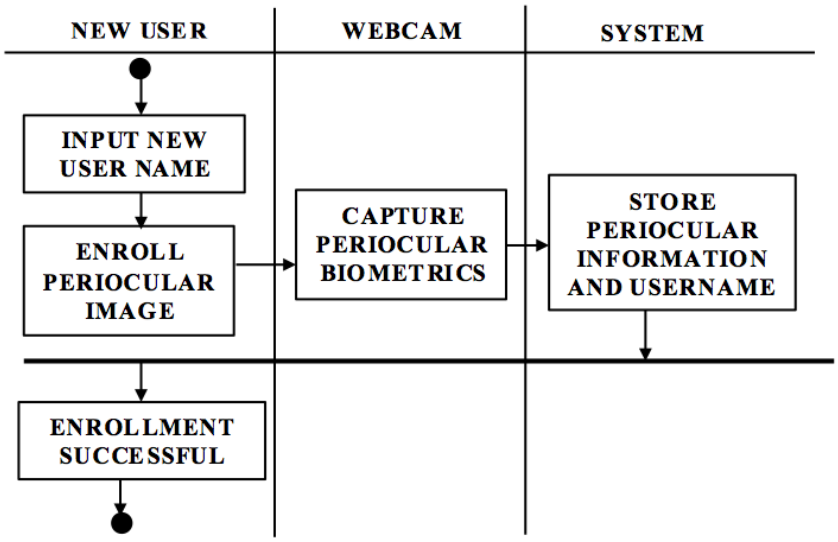


Figure 2. Activity diagram for new user.

Meanwhile, the second module is covered request access, which mean the registered user was asked to enter the username which the user had enrolled before, provided with required periocular biometric as shown in Figure 3. If the username is not registered during the enrolment, the user is considered as unregistered user. The webcam was captured the periocular image from the user

whereas the system was computed feature extraction to perform feature matching. The score level is calculated as well to compare the score from periocular information in the database and current periocular biometric. The user also able to view the feature matching points at simultaneously.

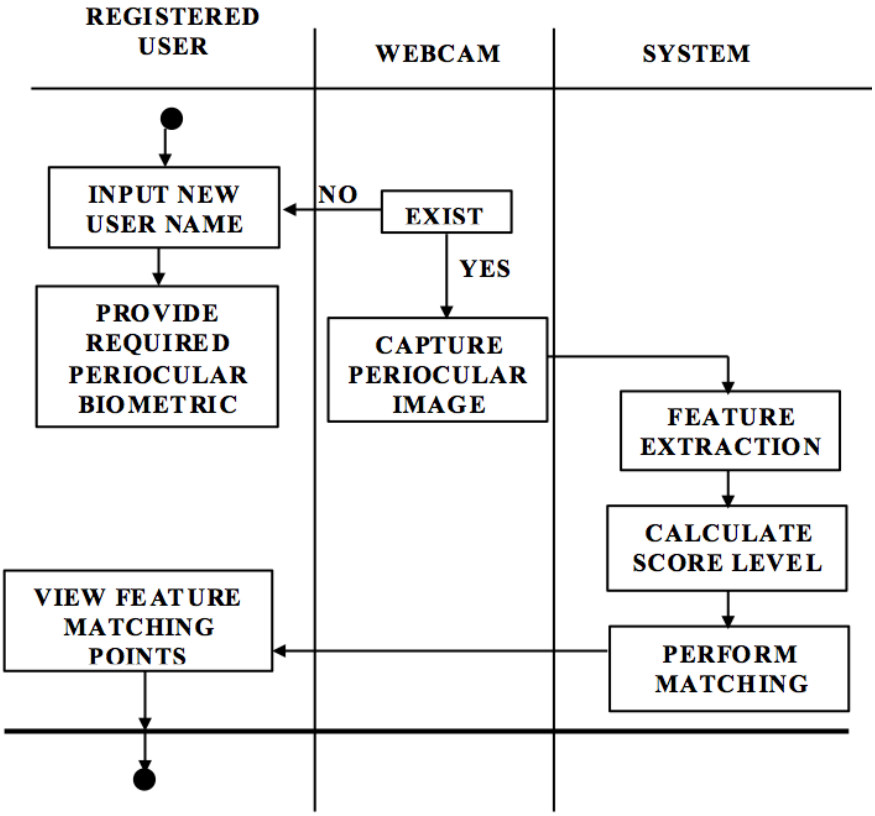


Figure 3. Activity diagram for registered user.

4. User Interface Designation

The interface for the new user enrolment is as shown in Figure 4(a). The user was start captured by clicked on the button to capture their periocular. The user also entered the username that was stored inside the database. Meanwhile, the access interface was similar to enrolment process. The registered user was required to enter their username based on previous enrolment interface as shown in Figure 4(b). The users had captured their periocular image and click the “Next” button.

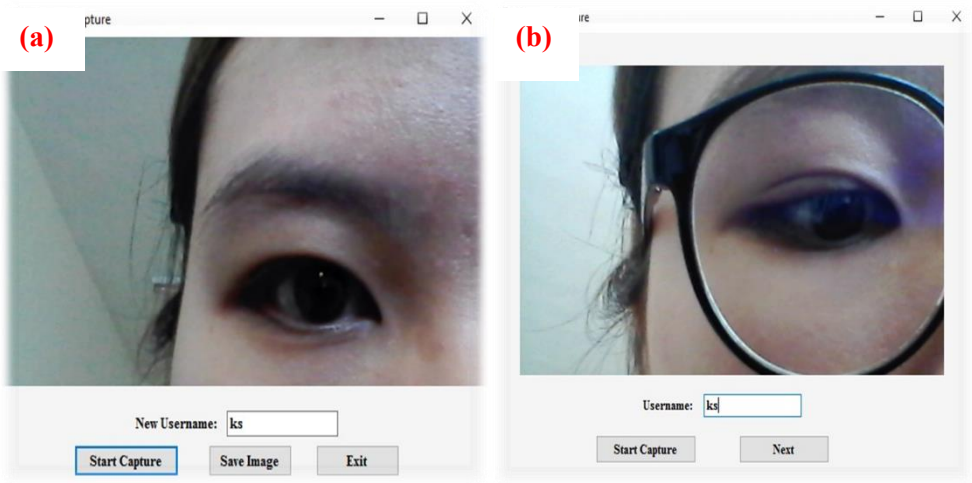


Figure 4. (a) Enrolment for new user interface; (b) registered user request access.

The user is clicked "View image" button and viewing the feature matching point against the periocular image in the database based on the score level as shown in Figure 5(a). Figure 5(b) shows second highest score compared to the current periocular. In Figure 5(c), lowest score was compared to three of the periocular information in the database. If the user entered the unregistered username, the dialog box was prompt out to the user.

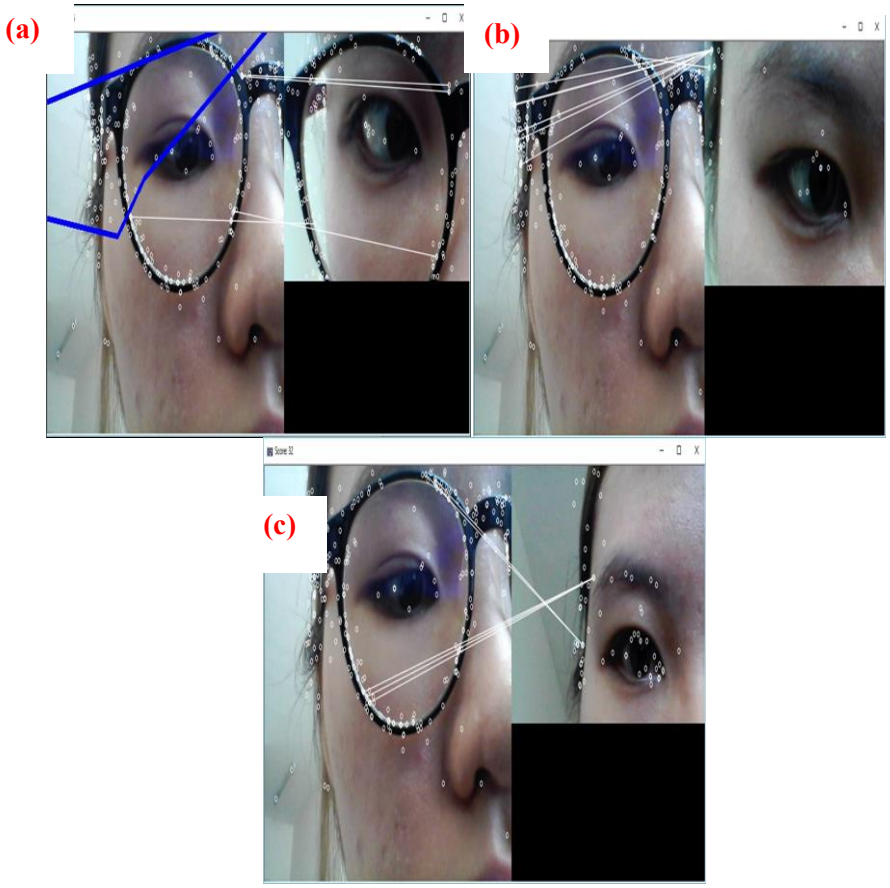


Figure 5. (a) First image verification; (b) second image attempting for access; (c) third image attempting for access.

5. User Acceptance Test

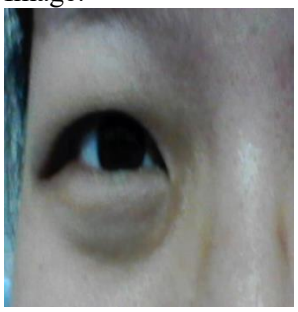
After integration test was conducted successfully, the user acceptance test was conducted. Black box testing approach was used during this testing due to an approach that user did not had the knowledge on the internal structure, design, development and implementation of the proposed system work. Table 1 represents the result for functional requirement user acceptance test. The purpose user acceptance test was conducted for the evaluation as needed to determine whether the user acceptance to the prototype delivered. Furthermore, the user acceptance was significant since the user were the end user of this proposed system. Table 2 represents on unit acceptance test result.

Table 1. Functional requirement user acceptance test.

Description	Outcome	Pass/Fail
User was able to request enrolment to the system.	User was able to determine the task that user wanted to perform.	Pass
User was able to insert new username	User was able to enter the new username	Pass
User was able to capture their periocular biometric	User was able to capture their periocular image by accessing to the camera of the proposed system	Pass
User was able to save their periocular image	User was able to store their periocular image to the system database	Pass
User was able to request access	User was able to determine the task they wanted to perform	Pass
User was able to access based on the registered username	User was able to access to the system with required username	Pass
User was able to view the score level	User was able to view the score level in descending order	Pass
User was able to view image of feature matching point	User was able to observe the periocular image's feature matching against the current periocular image	Pass
User was able to quit the prototype by pressing the Exit button	User was able to quit the prototype by pressing the Exit button	Pass

Table 2. Unit acceptance test result.

Test cases	Pass/Fail
New User Test Procedure: Enrolment with periocular biometric. Username: Xiao Han Image:	Pass

 Expected Results: Save the periocular image and username, respectively.		
Registered User Capture the periocular for feature matching. Username: Xiao Han Image:  Expected Results: An error will be displayed for the wrong username.		Pass

The project was successfully completed by using the tools and methods. The major components used for building the prototype system was Emgu CV, which is a cross-platform .NET wrapper to the OpenCV (Open Source Computer Vision Library) image processing library which compatible with several different languages such as C#, VB, C++ and IronPython. This functioning mainly aimed at real time computer vision to .NET developers. One of the advantages was the image class consists with Generic Color and Depth and the Generic was operations on image pixels. In other words, it can be the choice to either use the Image class or direct invoke functions from OpenCV.

Moreover, RAD was a great designing approach as can adapt to any changes and good for rapid prototyping for this project which can be easily customized for any other organization or industry. Hence, the RAD was suitable for fast development of the remaining components of the proposed system. Besides, the research approaches being used in this project were survey and observation which a lot of information is able to be gathered and contributed in building the prototype. Hence, the tools and methods used were essential that lead to successful of the project.

6. Conclusion

In conclusion, the prototype generated alternative way to allow access to the system using the periocular biometric. In additions, the prototype has achieved the aims and expected outcome. The project had success enrolling a person in the access control system by capturing user periocular, stored periocular user image in the database, access for registered user by capturing user periocular. Besides, the system also calculated the matching score based on current periocular image against the periocular information that stored in the database and allowed user to view the feature matching points from both image sources.

References

[1] Aboobucker, I., & Bao, Y. (2018). What obstruct customer acceptance of internet banking? Security and privacy, risk, trust and website usability and the role of moderators. *The Journal of High Technology Management Research*, *29*(1), 109-123.

[2] Conejar, R. J., Jo, J., Bae, J., & Kim, H. K. (2015, November). A study of different biometrics recognition technology and its application. In *2015 8th International Conference on Bio-Science and Bio-Technology (BSBT)* (pp. 12-15). IEEE.

[3] Douglas, M., Bailey, K., Leeney, M., & Curran, K. (2018). An overview of steganography techniques applied to the protection of biometric data. *Multimedia Tools and Applications*, *77*(13), 17333-17373.

[4] Wang, Q., Hu, S., Ren, K., He, M., Du, M., & Wang, Z. (2015, September). CloudBI: Practical privacy-preserving outsourcing of biometric identification in the cloud. In *European Symposium on Research in Computer Security* (pp. 186-205). Springer, Cham.

[5] Ruiz-Blondet, M. V., Jin, Z., & Laszlo, S. (2016). CEREBRE: A novel method for very high accuracy event-related potential biometric identification. *IEEE Transactions on Information Forensics and Security*, *11*(7), 1618-1629.

[6] Ahmed, N. U., Cvetkovic, S., Siddiqi, E. H., Nikiforov, A., & Nikiforov, I. (2017). Combining iris and periocular biometric for matching visible spectrum eye images. *Pattern Recognition Letters*, *91*, 11-16.

[7] Barroso, E., Santos, G., Cardoso, L., Padole, C., & Proenca, H.(2016). Periocular recognition: how much facial expressions affect performance? *Pattern Analysis and Applications,* 19(2), 517-530.

[8] Thavalengal, S., Bigioi, P., & Corcoran, P.(2015). Evaluation of combined visible/NIR camera for iris authentication on smartphones. Paper presented at 2015 IEEE Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), Galway, Ireland.

[9] Zhao, Z., & Kumar, A. (2016). Accurate periocular recognition under less constrained environment using semantics-assisted convolutional neural network. *IEEE Transactions on Information Forensics and Security*, *12*(5), 1017-1030.

[10] De Marsico, M., Petrosino, A., & Ricciardi, S. (2016). Iris recognition through machine learning techniques: A survey. *Pattern Recognition Letters*, *82*, 106-115.

[11] Jillela, R., & Ross, A.(2016). Ocular and periocular biometrics. *Wiley Encyclopedia of Electrical and Electronics Engineering,* 1-14.

[12] Bowyer, K.W., & Flynn, P.J.(2016). Biometric identification of identical twins: a survey. Paper presented at IEEE 8th International Conference on Biometrics Theory, Applications and Systems (BTAS).

[13] Barotova, S., Drahansky, M., & Pernicky, R. (2016). Detection of Ridge Damages in Fingerprint Recognition Caused by Skin Diseases. *International Journal of Signal Processing, Image Processing and Pattern Recognition*, *9*(11), 125-146.

[14] Ramaiah, N. P., & Kumar, A. (2016). On matching cross-spectral periocular images for accurate biometrics identification. In *2016 IEEE 8th International Conference on Biometrics Theory, Applications and Systems (BTAS)* (pp. 1-6). IEEE.