Face detection authentication on Smartphones: End Users Usability Assessment Experiences

Hind Baqeel
Department of Computer Science, College of Computer Science and Information Technology
Imam Abdulrahman Bin Faisal University
Dammam, P.O. Box 1982, Saudi Arabia
2190500152@iau.edu.sa

Saqib Saeed
Department of Computer Information Systems, College of Computer Science and Information Technology
Imam Abdulrahman Bin Faisal University
Dammam, P.O. Box 1982, Saudi Arabia
sbsaed@iau.edu.sa

***Abstract*— New smartphones by Apple and Samsung have used facial features to recognize their users. These smartphone manufacturers claim that this technology is the most secure and reliable biometrics methods. This paper investigates the usability aspects of face identification technique embedded in these smartphones. The results of this survey have shown that more than half of smartphone users are satisfied with the face detection technique while unlocking their phone. However, 59 percent of smartphones don't use face detection technique while doing purchasing in the app store, showing less trust on this feature where financial transactions are involved. Additionally, the result showed wearing head accessories have reduced the efficiency of face detection technique such as glasses and niqab for Muslim women. Despite some usability issues in using face detection technique, majority still believe it is a powerful tool and they are willing to continue using it.**

Keywords*— *Biometrics, Face Recognition, Smartphone Authentication, TAM

INTRODUCTION

As technology is rapidly progressing and evolving, new uses of facial recognition are being developed. In previous years, facial recognition methods were primely used for surveillance and security purpose. For example, they were used by investigators to catch criminals using their face ID's by running it through some specialized databases that contain criminals' records, but nowadays, this technology has extended way beyond this purpose and integrated into our daily lives. One prime example is face recognition feature in smartphones, researchers estimated that 64% of produced smartphones in 2020 will include face recognition systems .

There are various types of biometrics that are used actively for identification purposes such as face detection, fingerprints, voice recognition and many others. Traditionally, the fingerprint was the most famous authentication method because of its high security. However, now, face detection is also heavily used . Despite the major differences in biometric traits, they serve a common goal: Distinguishing authorized users by their unique features that can't be replicated among all people around the world.

Detecting faces is one of the natural visualizations tasks which humans can do effortlessly but for computers, it is not as simple. Face detection technique has emerged as one of the most successful applications in the computer vision field. Recently, face identification has gained a lot of attention. The range of its applications is quite large across industries, institutions and government operations. It has also emerged as an efficient security authentication tool because of its ability to distinguish authorized persons uniquely such as in bank, workplaces, airports and networks. The way face detection works is by finding out whether there are any faces in the image and, if present, return the location and the extent of each face . This process contains segmentation, extraction, and verification of facial features and possibly actual faces from the uncontrolled background. The earliest attempt to face detection implementation was made by measuring specific facial features such as brows thickness, nose length, and forehead space . However, only after 1990s the first viable commercial applications of facial recognition have been officially deployed . Face detection has been implemented in recent smartphones as an identification method. Mobile manufacturers such as Apple and Samsung have already released their latest smartphones models equipped with face identification feature. Despite many pilot studies, there are some functional issues in real life [5]. It still has a long way to be able to identify one person from 50 million face identity.

Acceptability of technology is also dependent on the user's acceptance. Understanding user acceptance of technology plays an important role in explaining the effects of new interaction techniques and the possibility of adoption by users. Researchers have explored and identified several theoretical models to explain technology acceptance and user motivation toward the usage of technology. The degree of easiness of using a technology is termed as usability. There are many usability studies in the literature about different technologies in different contexts [8,9]. The most widely used approach to measure technology acceptance is called the Technology Acceptance Model (TAM). It was originally designed by Davis in 1989. It basically covers all external factors that can affect the perceived ease of use (PEOU) and perceived usefulness (PU) of a technology.

By looking to the basic principles of the TAM model, we can see that user willingness to use Face ID technology on

978-1-5386-8125-1/19/$31.00 ©2019 IEEE

smartphone depends on its individual expectation and perception. [10] has proved that behavioral intention plays an important role in predicting actual usage of technology. For this reason, this paper evaluates end-user's level of satisfaction of the authentication process using face ID on different smartphones to estimate the overall usability.

This paper answers three main questions. The first research question is how smartphones' users evaluate the overall usefulness of the face detection technique based on their personal experience. The second question is what the common problems smartphones' end-user face while using the Face ID technique. The third question enquires about have any concerns related to the existence of this technique in their mobile device.

The rest of the paper is arranged as follows: section 2 discusses related work. section 3 presents the methodology of this research. In section 4, Survey findings are discussed. Finally, section 5 draws the conclusion along with limitations of the study and suggestion for future work.

II. RELATED WORK

When measuring the usefulness' of technology, a careful look at different factors such as accuracy, acceptability, uniqueness, universality, performance is required. Each biometrics identification method has its own strengths and weaknesses as [11] highlighted the major drawbacks for each one as follows: Oily/dry fingers in fingerprints, lightening in face detection, sickness effects on voice such as shivering in voice recognition, the instability of head or eyes in Iris-scan, scars or bandages in hand geometry, the variety of signing positions and angles in signature scan. [12, 13] focused their research on finding the issues related to face detection only, such as capturing quality, pose variation, illumination, multiple faces and aging. [14] have studied the challenges from another side, as he focused his research on the impact of this technology on society. He questioned the privileges of governments to access face ID without a user's knowledge. They are many face detection techniques that were developed using artificial intelligence techniques and deep analytics for accurate face detection. Chauhan and Sakle evaluated the reliability of different algorithms used in face detection [5]. Additionally, [15] have gone to the same research path as they explore the reliability of different algorithms used in face detection in mobile phones. [16] has classified the investigated methods into two classification group which are: image-based approach and feature-based approach. Face Detection technique is being considered as the most reliable, non-intrusive, inexpensive and extremely accurate among the other technique [11]. But it is still the most challenging one as people are concerned about how much their privacy is defended against security breaches. For this reason, researchers have suggested enhanced authentication models that combine both fingerprints and face recognition to increase the reliability and security of a system [17]. Similarly, [18] have suggested another way to secure authentication by using a 3D model of facial features from a photo. In order to achieve more accuracy, the system tends to get more complex [19], that can demotivate people to lock their phones, [20]. As [21] explained that user point of view of the usability of the biometrics model is an important factor in the adaption phase. In their survey of different biometric authentication models, their results define "acceptability of a biometric system as the driving force in that system's success". In all system's development process, the user satisfaction level is the main goal of developers. Many personal and environmental internal plus external factors exist that can determine a user's emotional and cognitive responses to using a specific technology [22]. Therefore, a deep analysis of the end-user experiences is still needed, which is pivotal for the acceptability of any system [23-25]. As a result, this paper focuses on evaluating the usability of face authentication techniques There are a couple of related studies [26, 27], where researchers measured the user satisfaction of touch ID on iPhone and using a different biometric method to unlock their phones. However, Bhagavatula, et al. study didn't cover face detection as it was still not implemented at that time in end users' smartphones. This paper focuses on face detection technique only and it also covers more range of smartphones that support face ID.

III. METHODOLOGY

The primary data of this exploratory research has been collected using an online survey by using Google forms. Online survey was chosen because of its reach. The survey was conducted using two versions: Arabic and English to reach more audience. Majority of the survey questions were quantifiable aiming at measuring user satisfaction of different aspects on face identification techniques employed in smartphones. There were a few open-ended questions to understand the problems faced by end users. The questions were mainly embedded in the technology acceptance model constructs. There were two questions to measure the attitude toward using face identification, five questions to assess user's satisfaction level on performance, five questions to assess perceived ease of use, and five questions to assess perceived usefulness. 5-point Likert scale was used for most of the questions and some were nominal questions. To test the validity of the survey, we mainly used expert review method, we handed over our questionnaire to a colleague and he checked each question of the survey and based on this some questions were rephrased. Finally, Cornbach's Alpha was used to measure the validity of survey responses.

In November 2018, the survey has been distributed to a sample of 100 users of (iPhone X and higher versions) and Android smartphones (Galaxy 8 or higher, LG V30, Huawei P20 and Honor). Those smartphones versions were specifically chosen because they support face unlock feature. The main challenge in collecting the sample was to find users of smartphones that support face detection techniques as it still in its nascent days. For this reason, the sampling was done by snowball sampling method as each participant were asked after finishing the survey to recommend someone that meets the criteria i.e. smartphone users with face identification feature. After data collection, the Statistical Package for Social Sciences (SPSS) program, Version 21 was used to analyze collected data. In addition, Microsoft Excel was used to draw visual charts.

IV. FINDINGS

The target for the sample size was 100 but only 86 responses passed the validation test and 17 responses were discarded because the respondent has continued answering the survey even though they don't have a face detection in their smartphones. 86 respondents included 70 women, and 16 men. The participants included 57 people with bachelor's degree, 8 people with a post-graduate degree, and 21 participants without high school degree or less. Of all participants, 6% were under 20 years old, 38% were from 20–30, 33% were from 31–40, 16% were from 41 – 50, and the remaining 11% were having age 50 or above. On the responses, a validity assessment was performed to test correlation between survey elements. SPSS was used to accurately calculate Cronbach's alpha for 4 different measurement fields as shown in Table.1. Results arranged between 0.62 to 0.83 which proves that the survey responses have internal consistency.

TABLE I. " INSTRUMENTS RELIABILITY CORNBACH'S ALPHA

Scale	*# of Items*	*Cornbach's Alpha*
Attitude toward Using Face ID	**2**	0.796
Satisfaction on Performance	**5**	0.837
Perceived Ease of Use	**5**	0.656
Perceived Usefulness	**5**	0.621

The results showed that the majority of the participants were owners of iPhone X with 58% percentage. The first part of the survey asked how often the user use face detection technique to unlock their phones and in purchasing apps from the app store or play store or any others task.

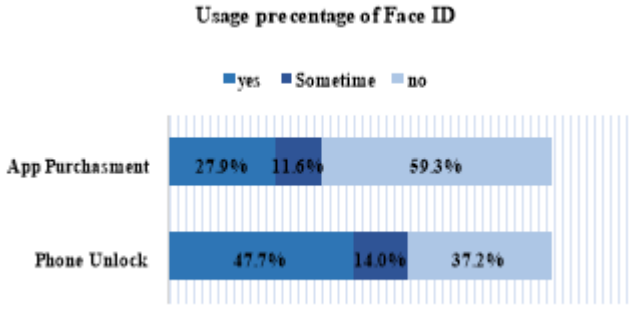

Figure 1: Participants' responses about usage of Face Id when they unlock their phones or purchase apps

Results from Fig.1 were somewhat controversial. Although 47.7% of participants use face Id to unlock their phones, 59% have admitted of not using when they purchase apps. This result might have some relation with user perception of insecurity of the face detection technique. So, even if users can trust this technique to open their phones, they need a higher level of trust to make it responsible for their money transactions. The second part of the survey has investigated user perceptions on the efficiency of face unlocking techniques. More than half of respondents have agreed that face unlocking is convenient, and they are satisfied with its response, as shown in fig.2.

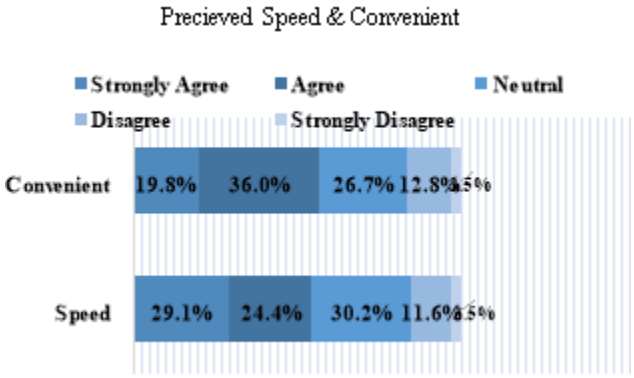

Figure 2: Participants' responses on Face ID ease of use and response speed

The third part of the survey has assessed the user perception on the performance of face detection technique over different circumstances such as position variation, lightning intensity, head accessories. Looking at the result of Figure.3, 33% of the participants have admitted that wearing head accessories such as glasses or hats affects the ability of their smart phone to recognize them. For position variation, 31.4% of respondents have strongly agreed, and 16.3% agreed that their phones can be unlocked even with different positioning such as laying down, walking and sitting. However, responses about lightning intensity were mostly neutral possibly due to the fact they are not sure if these variations are the actual cause of difficulties in the face unlocking process.

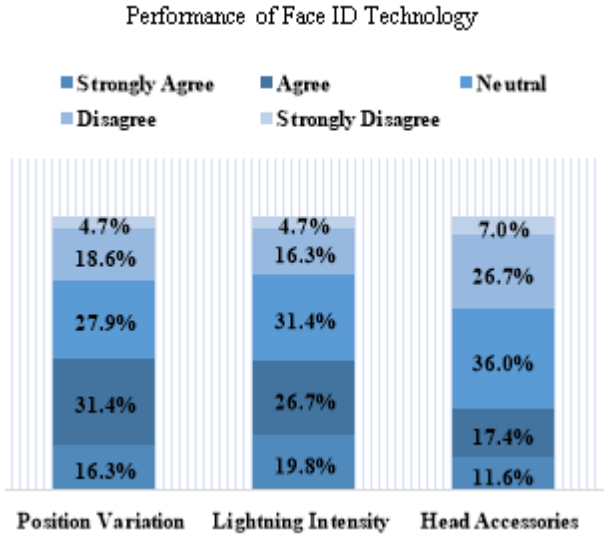

Figure3: Participants' responses on performance under different position, different lightning, head accessories

The fourth Part of the survey investigated the probability of encountering issues while using face ID. It specifically asked difficulties encountered at 3 different places which are: face

ID activation, smartphone unlock, and purchasing apps. These questions have been combined with a qualitative question to understand which specific problems are encounters by the users. To understand which specific smartphone model has the easiest face activation process, a cross-tabulation has been made between the results of difficulties encountered while activating face ID, and smartphones model. iPhone X has strongly led in this comparison as from 50 iPhone X owners only 4 have encountered some issues while activating their face ID. 40% of Samsung galaxy 8 owners reported issues while activating their smartphones for the first time, as shown in figure 4.

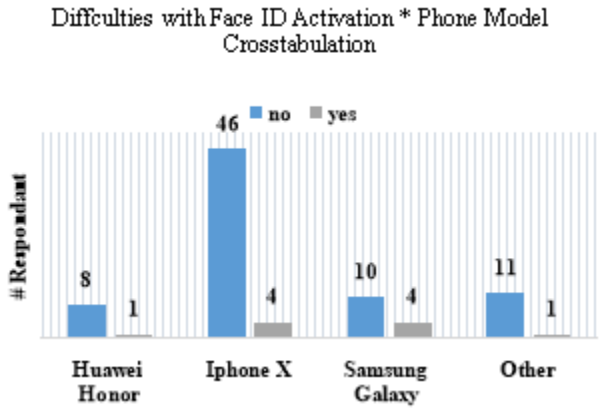

Figure 4: Users' responses on problems encountered with Face ID Activation

Another important observation was noticed when a crosstabulation between the frequency of encountered difficulties and the gender of the participant were drawn. As we can see from figure.5, only female participants have reported having issues with face detection techniques.

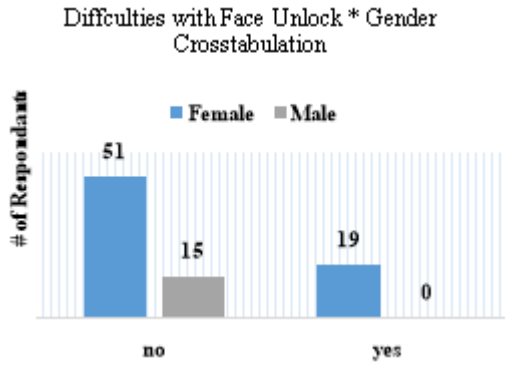

Figure 5: Users' responses on how often they encounter problem when they unlock their phones using Face ID

Most females' participants reported their inability to use face unlocking detection while going outside mainly due to wearing a niqab that covers their face. Some participants have said the head position affects dramatically the ability of their iPhone to recognize them. Some respondents mentioned that these identification problems are forcing them to use the PIN as an easy alternative. Following up from the TAM model, these results mean that the encountered difficulties can affect the users' perceived usefulness of face identification which in turn might affect the actual usage. When the participants were asked to mention if they have any concerns related to security,8% strongly believed and 37% believed that the face detection technique is secure enough and they trust their personal information with this technique. However, some other have reported have security concern as they reported that their family member with similar face features can access their phones specially in twins' condition. The results are shown in figure 6.

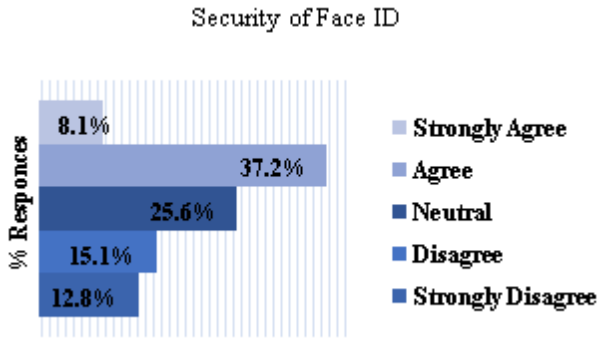

Figure 6: User perception of Security level of Face ID

The last part of the questionnaire was designed to measure the user overall satisfaction of the face detection technique. By looking at the result of the rating scale, the computed mean has shown that face detection has an average score of 6.3 out of 10 with 10 means highly satisfied and 1 means extremely unsatisfied. This result of the ratio scale shows that the average of participants is satisfied with what face detection offers to its users. Majority of the participants believe that this technique needs more enhancement in the future. The future enhancement can include combining face unlocking with another biometrics technique such as a fingerprint. Face detection and fingerprint are both very powerful techniques, but each has their own weaknesses. So, the two techniques should complement each other rather than competing. This merge will allow the greater possibility for interoperability between systems. Iris ID can also be combined as it can be used to overcome the problem of face cover for Muslim women in general and specifically Saudi women. This suggestion is specially going to iPhone X as it is only including two option for identification which is face detection and PIN.

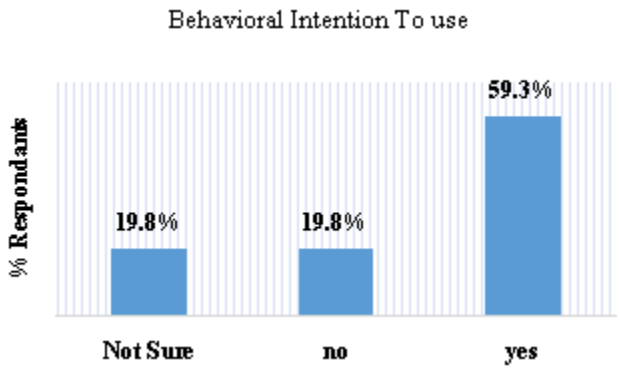

Figure 7: Users' Responses on their willingness to have Face ID when they purchase next Smart phones

The last question of the survey has investigated the user's willingness to use Face ID and the results showed that 59.3% of participants have the intention to still use the Face ID technique in the future. As shown in figure 7, 19.8% of the participants reported they don't want their next smartphones to have this feature.

V. CONCLUSION

The face detection technique is an evolutionary development in the field of biometrics. It has provided a faster and reliable way for the smartphone to recognize their users. This research investigated whether smart phones users are satisfied with this feature or not. The results showed that the majority of users are satisfied with this technique and they believe that their smartphones are locked safely and securely because of it. However, most users still don't trust it with very sensitive information such as money transactions. Another finding of this study highlights that females' users who wear head covers have identification issues. We can overcome this specific limitation by including more than one biometrics types in smartphones. To conclude, even if smartphone users encounter some usability issues, the majority still believes it is a powerful tool and they are willing to continue using it. This research was limited due to research period. It was only conducted on a small sample size. Because of the small sample size, the result of this research might not accurately reflect the actual usability statistics of the entire population. A future improvement to this study can be made by increasing the sample size to deliver a better generalization of the population. Another future improvement can be made by conducting a qualitative study using interviews and lab experiments to get specific details on people perceptions and views of face detection technique.

REFERENCES

[1] S. Mitter, "How facial recognition will become a standard feature on smartphones by 2020," 2018. [Online]. Available: https://yourstory.com/2018/02/facial-recognition-will-become-standard-feature-smartphones-2020/.

[2] H. Huseman, "Fingerprint sensors are still better than facial recognition," 2018. [Online]. Available: https://www.androidcentral.com/fingerprint-sensors-are-still-better-facial-recognition. [Accessed 24 11 2018].

[3] C. Zhang and Z. Zhang, "A survey of recent advances in face detection," 2010.

[4] Carrera and P. F. de, "Face Recognition Algorithms," 2010.

[5] M. Chauhan and M. Sakle, "Study & Analysis of Different Face Detection Techniques," International Journal of Computer Science and Information Technologies, pp. 5(2), 1615-1618, 2014.

[6] T. Mansfield and M. Rejman-Greene, "Feasibility study on the use of biometrics in an entitlement scheme," National Phys. Lab., Teddington,, UK, 2003.

[7] D. Mainenti, "User Perceptions of Apple's Face ID," Human Computer Interaction, 2017.

[8] S. Saeed, F. Wahab, SA Cheema, S. Ashraf "Role of usability in e-government and e-commerce portals: an empirical study of Pakistan" Life Science Journal. 10(1):8-13, 2013.

[9] S. Saeed, and S. Shabbir "Website usability analysis of nonprofit organizations: a case study of Pakistan". International Journal of Public Administration in the Digital Age (IJPADA), 1(4):70-83. 2014.

[10] P. Z. Heshan Sun, "A Methodological Analysis of User Technology Acceptance," in Proceedings of the 37th Hawaii International Conference on System Sciences , 2004.

[11] R. Bhatia, "Biometrics and face recognition techniques," International Journal of Advanced Research in Computer Science and Software Engineering, p. 3(5), 2013.

[12] A. Ramchandra and R. Kumar., "Overview of face recognition system challenges," International Journal of Scientific & Technology Research, pp. 2(8), 234-236., 2013.

[13] T. Ko and R. Krishnan, " Fingerprint and face identification for large user population.," Journal of Systemics, Cybernetics and Information, pp. 1(3), 87-92., 2003.

[14] D. Benson, "The Impact of Facial Recognition Technology on Society," 2017.

[15] G. Dave, X. Chao and K. Sriadibhatla, "Face recognition in mobile phones," Department of Electrical Engineering Stanford University,USA, 2010.

[16] E. Hjelm˚as and B. K. Low, "Face Detection: A Survey," Gjøvik University College, Norway, 2001.

[17] M. P. Mote, P. H. Zope and S. R. Suralkar, "finger And Face Recognition Biometric System," International Journal of Scientific & Engineering Research Volume 3, Issue 10, 2012.

[18] Y. Taigman, M. Yang, M. A. Ranzato and L. Wolf, "Deepface: Closing the gap to human-level performance in face verification," in In Proceedings of the IEEE conference on computer vision and pattern recognition, 2014.

[19] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," 1989.

[20] S. Egelman, S. Jain, R. S. Portnoff, K. Liao, S. Consolvo and D. Wagner, "Are you ready to lock?," in In Proceedings of the 2014 ACM SIGSAC Conference on Computer and Communications Security, 2014.

[21] A. K. Jain, A. Ross and S. Prabhakar, "An introduction to biometric recognition," IEEE Transactions on Circuits and Systems for Video Technology, pp. vol. 14, no. 1, 2004.

[22] D. L. Amoroso and S. Hunsinger, "Measuring the Acceptance of Internet Technology," DigitalCommons@Kennesaw State University, 2009.

[23] S. Saeed, YA Bamarouf, T. Ramayah, SZ Iqbal, "Design solutions for user-centric information systems." IGI Global; 2016.

[24] S Saeed, T Ramayah, Z Mahmood "User Centric E-Government: Challenges and Opportunities" Springer, 2017

[25] S. Saeed and C.G., Reddick, "Human-Centered System Design for Electronic Governance." IGI Global 2013.

[26] A. A. Al-Daraiseh, D. A. Omari, H. A. Hamid, N. Hamad and R. Althemali, "Effectiveness of Iphone's Touch ID: KSA Case Study," (IJACSA) International Journal of Advanced Computer Science and Applications, 2015.

[27] C. Bhagavatula, B. Ur, K. Iacovino, S. M. Kywey, L. F. Cranor and M. Savvides, "Biometric Authentication on iPhone and Android: Usability, Perceptions, and Influences on Adoption," 2015.