Methodology of Determination of Uncertainties by Using Biometric Device iCAM 7000

Hana Talandova, Lukas Kralik, Milan Adamek
Faculty of Applied Informatics
Tomas Bata University in Zlin
Zlin, Czech Republic
Email :{talandova, kralik, adamek}@fai.utb.cz

***Abstract* - The iris recognition is known for a long time. Identification by iris is positively perceived by the public, like fingerprinting. Devices for acquiring images are cheaper and smaller, compared with other technologies. This article aims to verify the reliability of the scanner of the iris in different conditions. The measurement is performing on the scanner iCAM7000. The measurement is performing in different lighting conditions, in the artificial lighting, reduction in the lighting conditions and in daylight. Thereafter the percentage of success of authorization is measured during physical activity.**

Keywords - Iris recognition; Identification; iCAM 7000; Percentage of success

I. INTRODUCTION

Biometric analysis of an iris is relatively new and rapidly evolving field, which is primarily used to uniquely identify individuals. Identification by an iris is relatively well known for a long time [2]. A full implementation of this technology in practice was not possible because of low-quality digital sensors. Currently, iris recognition is considered to be one of the most reliable technologies and one of the most secure methods of identification [11] [13] [14] [15].

There are several research publications which deal biometric devices [3] [4] [5]. However, little attention is paid to the effectiveness of these devices. For this reason, in this paper, we address the state of the art in terms of efficiency of biometric equipment.

This paper describes and analyses iris scanner reliability under various lighting conditions and the probability of correct recognition.

The rest of the paper is structured as follows. The Section II contains the Introduction to the iris recognition. The Section III describes the iris scanner iCAM7000. The Section IV contains details of the scanning procedure. While, The Section V explains the methods of measurement and followed by the results. And finally in Section VI, the contribution of our work is described in the conclusion.

II. IRIS

The iris is formed together with the eye in the prenatal development in the third month. Within the structure of the iris (Figure 1) a pattern is formed until the eighth month of gestation, although the pigment will be established in the postnatal period. The iris is composed of collagen fibers which form certain patterns. The color of the iris is different form person to person, and this color is created by the pigment melanin. The size of the iris is about 11 mm. The structure is stable during a person's live and remains similar after mechanical damage too. In our picture, it is possible to detect 266 features [1] [2] [6].

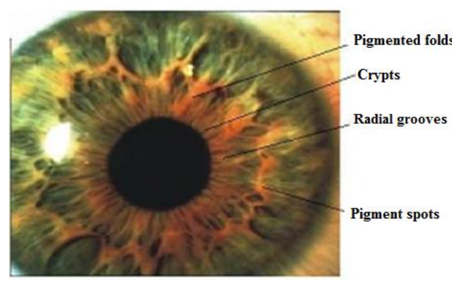

Figure 1. The external features of the iris (adapted from [8])

A. *The external features of the iris*

- Pigment spots - Random clump of pigment cells on the surface of the cornea, ciliary occurrence in the area.
- Crypts – A dark place where the iris is thin, the incidence at the interface between the ciliary and papillary zones.
- Pigmented folds - The bottom layer of the iris around the pupil.
- Radial grooves - Occurrence near the pupil and extending radially towards the edge of the iris.

III. THE IRIS SCANNER ICAM7000

The scanning of an iris was performed by the scanner iCAM7000 (Iris identification Systems; series Iris Access® 7000) [10]. This scanner scans the iris in a fully automatic way and also captures the image of the face

 ISBN: 978-1-61208-493-0

around eyes. iCAM 7000 has a voice and a visual interface, which makes it faster and more accurate to scan the iris and subsequently identify/verify a person. 60 – 70% of iris visibility is sufficient for successful identification of a person [10].

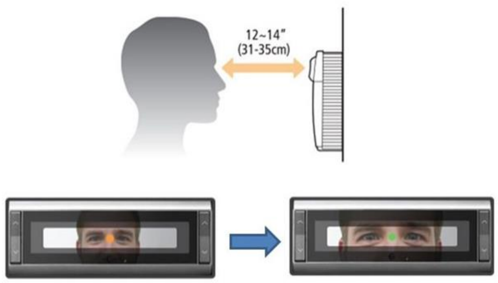

Figure 2. The necessary distance for capturing an image (adapted from [10])

The iCAM is activated when the user approaches or provides the identification card. The scanner is able to take a picture from the distance of 31 – 35 cm (Figure 2). The scanner uses the dot indicated in Figure 2, which is projected on the root of the nose; this helps the user adjust and correct the eye position. When the user is in the correct position, the orange dot is changed to green. The whole process is completed with a voice command to easier capture the image [10].

IV. IRIS SCANNING

The processing procedure is divided into four parts: segmentation, normalization, extraction and comparison (Figure 3).

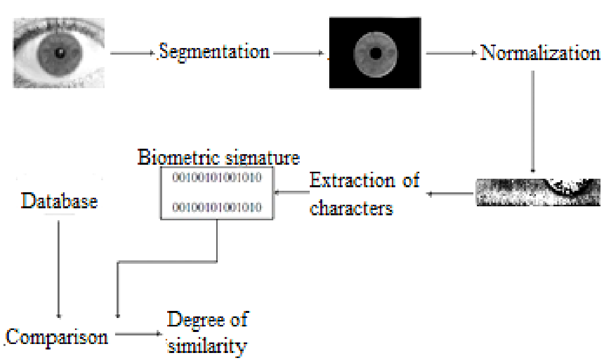

Figure 3. The processing procedure of iris (adapted from [9])

1) *Capturing an image*

Various negative factors may occur during the image capturing from the sensor. They can result in deterioration of image processing. There are many negative influences (for examples: noise, blur, etc.) After the elimination of these effects, the accuracy of the biometric system is increased. The sensor transforms all colour images into grey spectrum and it eliminates tone colour aberration.

Color aberrations can arise as a result of charge-coupled device sensors (CCD sensors) used. After this process, it is necessary to normalize the colour spectrum of the captured image for better edge enhancement [3] [4].

2) *Segmentation*

The second step is segmentation, which determines the position of the iris and the pupil (Figure 4). This part of analysis is among the slowest processes in the whole system. This is caused by the necessity to determine the position of the iris and the pupil, and to correct all the edges of the captured image.

Various algorithms exist to detect edges of the image, such as Cannes's edge detector algorithm. This algorithm is based on identification of gradient among nearby pixels [8] [9].

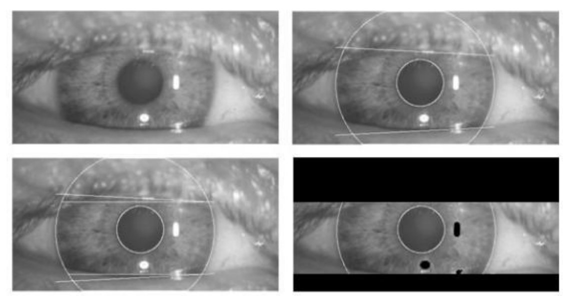

Figure 4. Segmentation with eye image (adapted from [7])

3) *Normalization*

The coordinates of points from the scanned iris and its centre are the basis of normalization. The method works by converting the annulus shaped iris into a rectangular shape. The resulting image is a rectangle with coordinates of radiuses and angles. On the short side of the rectangle i.e. vertical axis, there are radiuses of a circle and on the long side i.e. horizontal axis, angular coordinates. This is a transfer of Cartesian coordinates into polar coordinates [7] [9].

4) *Extraction of characters*

The following step is an extraction of characters, when the input data are extracted and encoded in major characters. The result is a two-bit piece of information that contains the coordinates of the iris [7] [9].

5) *Comparison*

This is the last step where the comparison of characters with the template stored in the database takes place and the result is called the degree of similarity. The degree of similarity shows the similarity between the code templates

 ISBN: 978-1-61208-493-0

and the code of the iris. If the characters match the template stored in the database, the system allows the access and in the opposite case the access is denied. The comparison was carried out using the Hamming distance between two points [9].

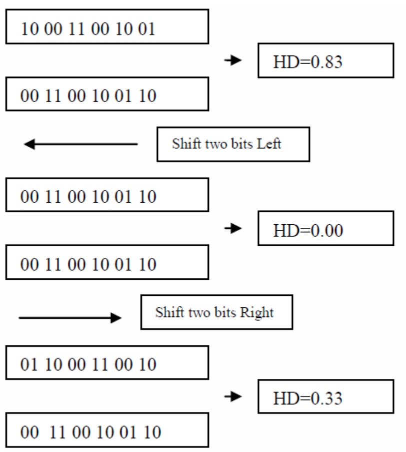

Figure 5. Shifting process (adapted from [7])

The Hamming distance of two templates is calculated, one template is shifted left and right bit-wise and a number of Hamming distance values are calculated from successive shifts (Figure 7). One shift is defined as one shift left, and one shift right of a reference template. In this example, one filter is used to encode the templates, so only two bits are moved during a shift. The lowest Hamming distance, in this case zero, is used since this corresponds to the best match between the two templates [7].

V. METHODS OF MEASUREMENT AND RESULTS

Several measurements were carried out in various conditions to verify the reliability of the iris scanner:

- Visibility in poor lighting - The measurement was performed in daylight, in poor light conditions and under artificial lighting.
- During physical exertion - The measurement was performed after physical exertion.

Six subjects were used for the measurements. Each time there were 10 measurements. The success percentages of these measurements were recorded in result tables.

The first measurement was performed in various light conditions in order to investigate the success percentage of authorization under these circumstances. Furthermore, the influence of glasses and contact lenses was investigated. Thereafter, the measurement of success percentage of authorization was performed during physical activity.

TABLE I. THE MEASUREMENTS IN VARIOUS LIGHT CONDITIONS

	Daylight	Low light conditions	Artificial light
Subject 1 - Without glasses	100%	100%	100%
Subject 2 - Without glasses	100%	100%	100%
Subject 3 - Without glasses	100%	100%	100%
Subject 4 - With glasses	60%	90%	90%
Subject 5 - With glasses	80%	90%	90%
Subject 6 - Contact lens	100%	100%	100%

Table 1 shows a comparison of measurements in different light conditions. There are measurements in daylight, in poor light conditions and in artificial lighting. In the case of subjects without glasses, the success rate is 100%. In the case of subjects wearing glasses, the success rate was between 60% - 90%. This may be due to the number of diopters of the subject. As can be seen in the case of subject 6, contact lenses have no effect on identification.

TABLE II. MEASUREMENT DURING PHYSICAL EXERTION

	Physical exertion
Subject 1	100%
Subject 2	100%
Subject 3	100%
Subject 4	100%
Subject 5	100%

In Table 2, we can see the success percentage of authorization after physical activity. The measurement was performed on 3 subjects who put a physical strain on their bodies, and subsequently used the scanner for identification. In all subjects, the physical exertion had no effect on authorization. However, in the case of subject 5, who had run for 5 minutes up the stairs, the identification took much longer in order for the person to be recognized.

VI. CONCLUSION

Iris recognition methodology is known for a long time, but its full implementation in practice was possible only with the extension of high-quality digital sensors.

Identification by iris is positively perceived by the public, like fingerprinting. Compared to other technologies, devices for taking pictures are smaller and cheaper.

The main objective of this paper was to create comparative measurements for future work. The measurements were performed on the scanner iCAM7000. The measurements were carried out in different light conditions, in artificial lighting, poor light conditions and in daylight. In the daylight, it was found that the measured data showed a lower percentage of success in measuring with a lot of diopters. The use of contact lenses was found to have no effect on the device function. Another measurement was focused on the effect of physical activity on authorization. Based on the measurements, we conclude that physical activity has almost no effect on user authorization to access.

The future work will be related to artificial intelligence and utilization of neural networks for recognizing and identifying persons by iris. The results from artificial intelligence measurements and from the measurements performed in this work (iCAM7000) will be compared. The goal of this work is to increase efficiency of biometric identification by iris in various light conditions.

ACKNOWLEDGMENT

With support by grant No. IGA/FAI/2016/027 and IGA/CebiaTech/2016/006 from IGA (Internal Grant Agency) of Thomas Bata University in Zlin. This work was supported by the Ministry of Education, Youth and Sports of the Czech Republic within the National Sustainability Programme project No. LO1303 (MSMT-7778/2014).

REFERENCES

[1] R. Rak, V. Matyas, and Z. Říha, Biometrics and identity of a person in forensic science and commercial applications. 1. Praha: Grada Publishing, a.s., 2008. ISBN 978-80-247-2365-5.

[2] H. Li, L. Li and K. Tok, "Advanced topics in biometric," New Jersey: World Scientific, 2012, xv, pp. 500, ISBN 978-981-4287-84-5.

[3] L. Ma, T. Tan, Y. Wang, and D. Zhagn. "Efficient iris recognition by characterizing key local variations," IEEE Transactions on image processing: a publication of the IEEE Signal processing Society, 2004, vol. 13, pp. 739–50. ISSN 1057-7149.

[4] M. Elgamal and N. Al-biqami, "An efficient feature extraction method for iris recognition based on wavelet transformation," International Journal of Computer and Information Technology, 2013, vol. 2, iss.3, s. 521-527. ISSN 2279-0764.

[5] C. L. Tiesse, L. Martin, L. Torres, and M. Robert, "Person identification technique using human iris recognition," In Proc. Vision Interface. May 2002, pp. 294-299.

[6] A. K. Jain, A. A. Ross, and K. Nandakumar, "Introduction to biometrics," 1., New York: Springer, 2011, pp. 311. ISBN 9780387773261.

[7] S. Gupsa, V. Doshi, A. Jain, and S. Iyer, "Iris Recognition System using Biometric Template Matching Technology," International Journal of Computer Applications 2010, vol. 1, pp.4 . ISSN 0952-8091.

[8] H. Talandova, Study about application of biometric systems in the industry of commercial security. Zlin, 2010. Bachelor thesis. UTB in Zlin.

[9] M. Luzny, The Reliability of iris scanners for the biometric indetification if individuals. Zlin, 2015. Bachelor thesis. UTB in Zlin.

[10] Iris ID, Inc. iCAM 7000: User Manual.USA [2012].

[11] M. Faundez-Zanuy, "Biometric security technology," IEEE A&E Syst.Mag., Jun. 2006 vol. 21, no. 6, pp. 15–26.

[12] J. Mansfield and J. L. Wayman, "Best practices in testing and reporting performance of biometric devices," U.K. Government Biometrics Working Group, 2002. [Online]. Available:http://www.npl.co.uk/upload/pdf/biometrics_bestprac_v2_1.pdf [retrieved June 2016]

[13] P. Phillips, W. T. Scruggs, A. J. O'Toole, P. J. Flynn, K. W. Bowyer, C. L. Schott, and M. Sharpe, "FRVT 2006 and ICE 2006 large-scale results," Nat. Inst. Standards Technol., 2007. [Online]. Available: http://www.frvt.org/FRVT2006/docs/FRVT2006andICE2006LargeScaleReport.pdf [retrieved June 2016]

[14] Independent Biometric Group, "Comparative biometric testing round 6 public report," 2006 [Online]. Available: http://www.biometricgroup.com/reports/public/comparative_biometric_testing.html[retrieved June 2016]

[15] K. Bowyer, K. Hollingsworth, and P. Flynn, "Image understanding for iris biometrics: A survey," Comput. Vision Image Understand, 2008, vol. 110, no. 2, pp. 281–307.