IMPROVED APPROACH TO IRIS SEGMENTATION BASED ON BRIGHTNESS CORRECTION FOR IRIS RECOGNITION SYSTEM

[1]ABDUL SALAM H. AB., [2]TAHA M. H., [3]NAJI M. S., [4]ALI H F.,

(1, 2, 3 &4)Department of Computer Sciences, College of Science, University of Diyala, Iraq.

[1] slamalqrtghwly@gmail.com, [2] dr.tahamh@sciences.uodiyala.edu.iq , [3] naji@yahoo.co.in, [4] alifoxpro2012@gmail.com,

ABSTRACT

With the increasing need for security systems, security and the authentication of individuals become nowadays more than ever an asset of great significance in almost every field. Iris recognition system provides identification and verification of an individual automatically based on characteristics and the unique features in iris structure. The correct iris recognition system based on the iris segmentation method and how controlled the inner and outer boundaries of iris that can be damaged by irrelevant parts such as eyelashes and eyelid. To achieve this aim, in this paper basically explains the proposed segmentation method [Iris Segmentation Based on Brightness Correction **ISBC**] by addition two brightness **FB**(First Brightness) and **SB**(Second Brightness), which applied on an eye image passed through preprocessing operations to implement this algorithm in C# Programming Language, with a new modifications in iris segmentation stage. The proposed approach testing conducted on the iris CASIA (**C**hinese **A**cademy of **S**cience and **I**nstitute of **A**utomation) dataset (CASIA v1.0 and CASIA v4.0 interval) iris image database and the results indicated that proposed approach has 100% accuracy rates with (CASIA v1.0) and 100% accuracy rates with (CASIA v4.0 interval).

Keywords: *Iris Segmentation, Brightness Correction, First Brightness Correction, Second Brightness Correction, CASIA.*

1. INTRODUCTION

The word biometrics is derived from the Greek words bio (life) and metric (to measure) [1] .It is a general term used alternatively to describe a characteristic or a process. As a characteristic, it is measurable biological and behavioral characteristic that can be used for automated recognition. As a process, it encompasses automated methods of recognizing an individual based on measurable biological and behavioral characteristic. Biometric identification may be preferred over traditional methods (e.g. passwords, smart-cards) because its information is virtually impossible to steal. Iris recognition has a very good balance of all the properties. A number of characteristics are being used in several applications as Uniqueness, Universality, Measurability, Permanence, Acceptability, Performance, and Circumvention [2]. In general, the process of iris recognition system consists of (i) Image acquisition, (ii) Preprocessing the iris image including iris localization, image normalization, and polar transformation, (iii) Iris Feature extraction, and (iv) Iris matching.

2. RELATED WORK

Research in the range of iris recognition has been receiving considerable attention and a number of techniques and processes have been proposed over the last few years.

Flom and Safir first proposed the concept of automated iris recognition in 1987. Since then, a number of researchers have run on iris illustration and matching and have achieved great progress [3].

Du et al., [4], proposed the iris detection method based on the prior pupil segmentation. The image is further transformed into polar coordinates and the iris outer border is detected as the largest horizontal edge resultant from Sobel filtering. However, this approach may fail in case of non-concentric iris and pupil, as well as for very dark iris textures.

S. A. Ali., [5] proposed iris recognition method using different combinations of Haar wavelet, GLCM and Run Length Matrix (RLM)

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

features for feature analysis and evaluation. The attained recognition rate was 99.2% for CASIA,-v1.0, and 97.35% for left eye and 98.2% for right eye samples belong to CASIA,-v4.0 database. For verification, the attained accuracy was 98.8% for CASIA,-v1.0. For left iris samples belong to CASIA,-v4.0 database, the highest verification rate was 98.58% when using Haar features, while for right iris the highest verification rate was 98.7% when using Haar features.

Fatt *et al.*, [6] proposed a segmentation method for iris recognition. The proposed method was tested on "CASIA,-v1.0 databases". The pupil was localized using threading, then morphological operators are applied and finally, the "CHT" method is used. The proposed method depends on two search regions; right search region and left search region to locate the outer boundary of iris. The maximum radius is defined as the distance from the center of pupil to the boundaries of the right or the left search region. The iris outer boundary is the average of the distances from pupil center to right and left iris boundaries. Detection rate of the iris inner and outer boundary are 99.07% and 98.68% respectively.

Basit et al, [7] suggested a method for iris segmentation. At the beginning, the pupil is determined by locating a point inside the pupil's region, after that the center is determined by using the centroid region of the pupil, while the radius is computed depended on the binary region. The circular pupil boundary is divided into a fixed number of points. To obtain exact boundary of the pupil, these pupil's points are repositioned depending on the maximum gradient, after that connected it together. The accuracy attained by this method was 99.6% and 99.21% when applied on "CASIA,-v1.0 databases" and "CASIA,-v3.0 database respectively.

Gupta and Kumar, [8] proposed iris segmentation technique to handle iris images (captured on less constrained conditions) with some types of noise (iris obstructions and specular reflection). The authors started their work implementation by K-means clustering to get the iris region; then delete small blocks and noise; followed by vertical CED for iris region; then CHT to determine iris; remove noise (upper and lower eyelid) and localize and remove pupil. The proposed technique showed the 98.72% accuracy using CASIA-IrisV4 databases samples of iris.

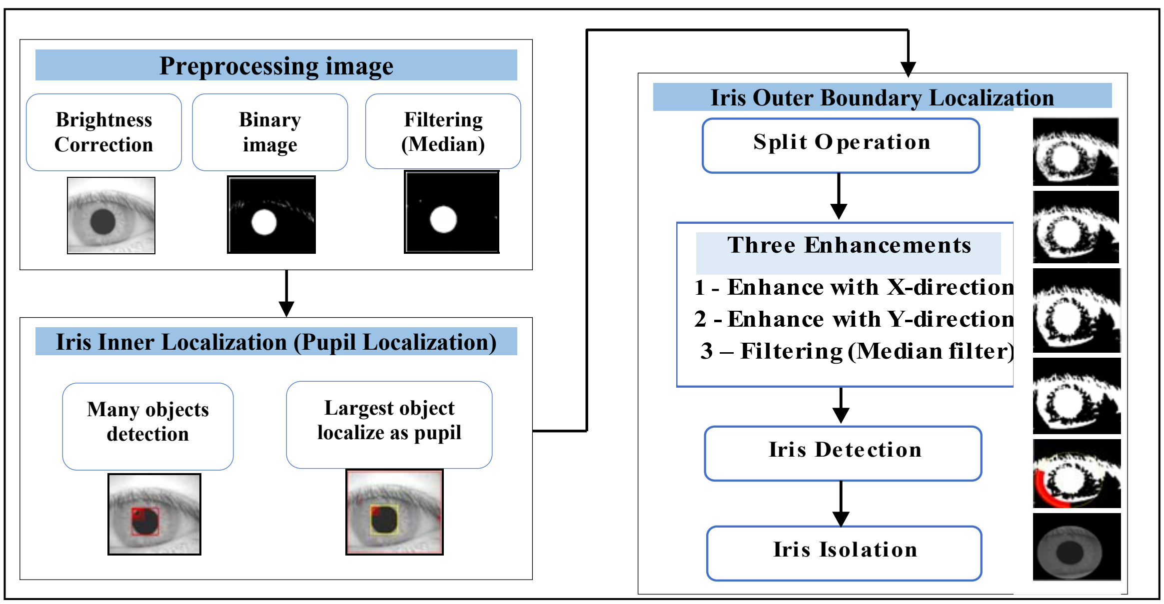


Figure 1: Block Diagram Of The Proposed Iris Segmentation.

3. OVERVIEW OF THE PROPOSED APPROACHES

As mentioned previously accurate iris localization plays a significant role in improving the performance of iris recognition systems. The goal of the iris localization is the precise detection of both inner and outer boundaries of the iris region. In this paper, the proposed iris localization method is based on the brightness correction, it can be divided broadly into four stages: Eye image acquisition, Eye image preprocessing, pupil localization, and iris localization as shown as in the Figure 1.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

3.1 Iris Image Acquisition Stage

This step is one of the most significant and deciding factors for obtaining a good result. A fine and clear image eliminates the process of noise removal and also helps in avoiding errors in calculation. In this case, computational errors are avoided due to the absence of reflections, and because the images have been taken from close proximity. This project uses the image provided CASIA v1.0 and CASIA v4.0 -interval.

3.2 Image Preprocessing

One of the major issues in the iris segmentation and recognition system is the preprocessing, which can result in accurate iris and pupil localization and thereby leads to excellent iris recognition system performance. In this work, the preprocessing on image consist of the four stages: convert the color image (if the image is color) to the grayscale image, brightness correction, convert to binary image, and enhanced by the median filter to remove some noise around pupil as shown in Figure 2.

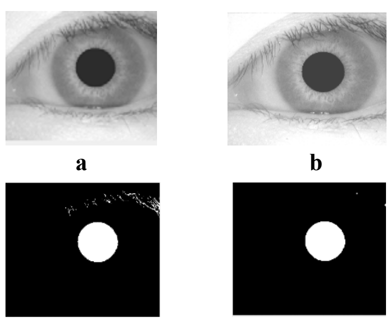


Figure 2: Preprocessing stages, (a) The input image, (b) Apply the brightness correction,(c)Apply the thresholding method (binary image), (d) Removing noise in the image using (median filter) operation.

In brightness correction two brightness values are choosing automatically depending on the average (mean) of the input (original) image:

A - The first brightness (FB) value is an addition to the "grayscale image" - in most cases worth 20, except for some images that have eyelashes and eyelids very close to the pupil and are more than 20.

B - The second brightness (SB) value is an addition to the "original image" most cases are worth 20, except for some images that are high brightness and are less than 20 or do not need to add brightness.

Where the best two brightness (FB and SB) choosing to depend on:

1. Average of a grayscale image from 150 to 159 the best two brightness is [FB=20, SB=20].
2. Average of a grayscale image from 160 to 169 the best two brightness is [FB=15, SB=15].
3. Average of a grayscale image from 170 to 179 the best two brightness is [FB=10, SB=10].
4. Average of a grayscale image from 180 to 189 the best two brightness is [FB=5, SB=5].
5. Average of a grayscale image from 190 to 200 in more cases do not need to add any brightness.

3.3 Pupil Localization

In this paper, the inner boundary (pupil-iris boundary) is detected before the outer boundary (iris-sclera boundary), due to the fact that the pupil region is the darkest region in the eye image and can be detected easily. In addition, this can contribute to improving the accuracy and the speed of detecting the outer boundary as will be explained later. The pupil localization is a process to localize the pupil by transforming the gray scale eye image into a binary image using the threshold method depended on the stable threshold is 126. In this method, all pixels that have values Greater than the threshold are marked as edge points. In this method, there could exist some noise present in the binary image, due to other dark regions, such as eyelashes and eyelids. A filtering operation (median filter) applied to eliminate such noise.

The pupil region is almost completely detected in the binary image after enhanced (median filter) image, then detect many objects contain true value as shown in Figure 3(b). After this operation, using a set of layers, each object detection that is putting in one of the layers as shown in Figure 3(c), and then apply correction on the value of each layer as shown in Figure 3(d).After many object detection and correction in the image, drawing each object finding, as shown in Figure 3(e). Then choose the large box as pupil object. Since it can be modeled as a box shape, the pupil is detected correctly by employing a modified to obtain the center coordinates and radius of the pupil box, as shown in Figure 3(f).

Journal of Theoretical and Applied Information Technology
15th December 2017. Vol.95. No 23

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

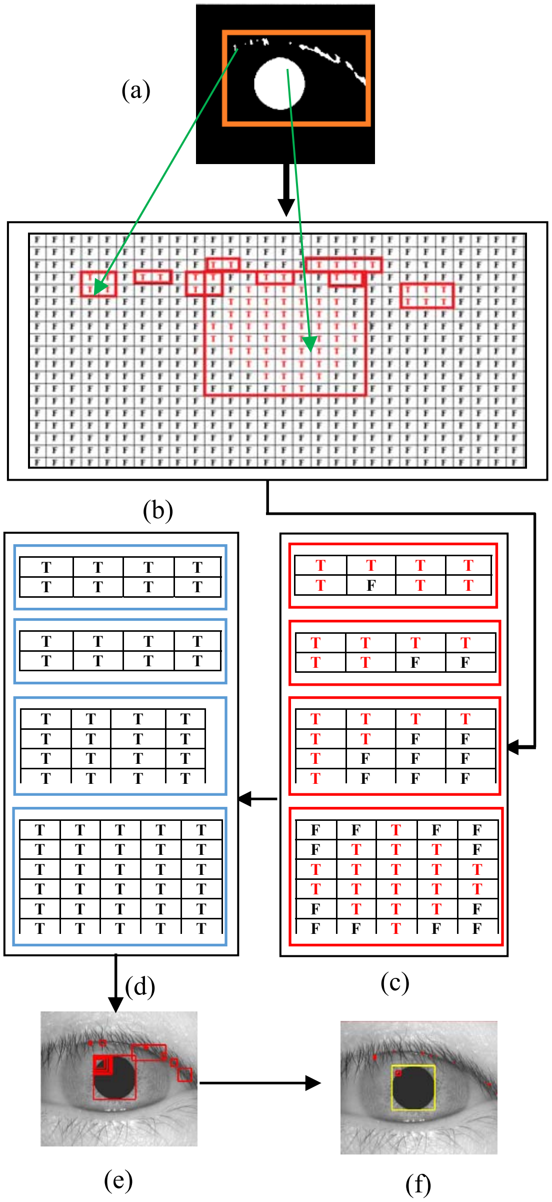


Figure3: Pupil localization(a) Enhanced binary image, (b) Many object detection, (c) Many layers using (each object put in the layer), (d) Correct the value of objects in the layer, (e) drawing the objects, and (f)Choice largest object as the pupil.

Figure 4-5., shows the correct detection of the inner boundary of the iris-pupil region, On CASIA version 1.0 and version 4.0 interval respectively.

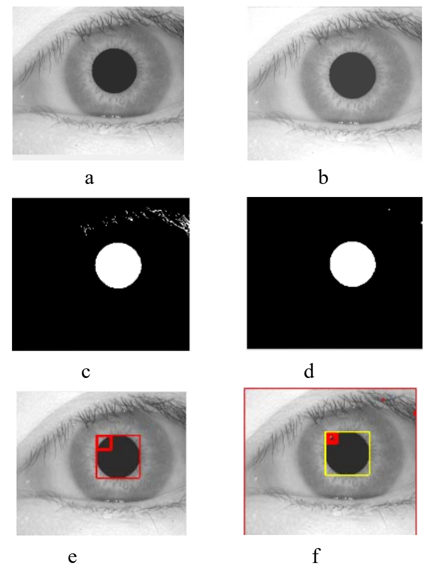


Figure 4: Pupil localization stages in the CASIA version 1.0: (a) The input image, (b) Applying the increasing brightness of the image (c) Applying the thresholding method, (d) The output of the filtering operation (e) Detect many object, (f)Choice large object as the pupil.

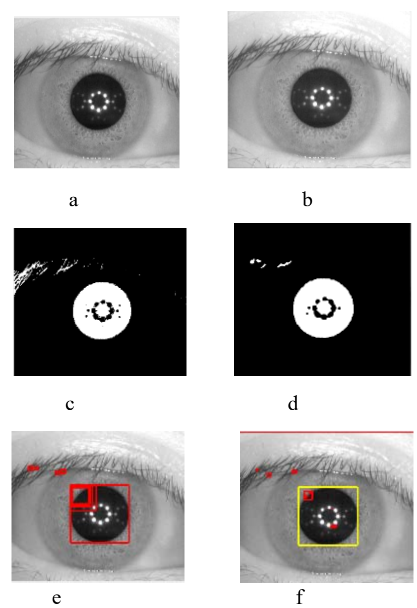


Figure 5: Pupil localization stages in the CASIA version 4.0 interval: (a) The input image, (b) Applying the increasing brightness of the image (c) Applying the thresholding method, (d) The output of the filtering operation (e) Detect many object, (f)Choice large object in the pupil.

But some cases, some images that have eyelashes very close to the pupil that need to the ***FB*** more than 20. *Figure 6-7*, shows the detected inner boundary of the iris-pupil region On CASIA version 1.0, failed and successful case respectively.

A- Failed Case

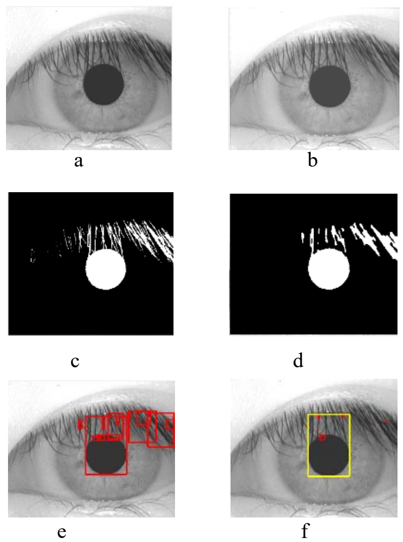


*Figure 6: Examples of the failed case to pupil detection of CASIA v1.0 images. (a) Original iris images, (b) Brightness correction of image With **F.B**=20 and **S.B**=20, (c) Binary iris images, (d) Enhanced image using a median filter, (e) Detect many objects in binary image Enhanced, and (f) Localization the large object as pupil object.*

B- Successful Case

To solve this problem increasing the **FB** equal to 30.

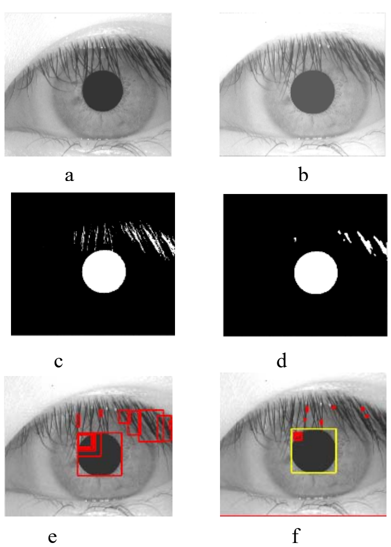


Figure 7: Examples of the successful case to pupil detection of CASIA v1.0 images. (a) Original iris images, (b) Brightness correction of image With F.B=30 and S.B=20, (c) Binary iris images, (d) Enhanced image using a median filter, (e) Detect many objects in binary image Enhanced, and (f) Localization the large object as pupil object.

3.4 Iris Outer Boundary Localization

This stage is to find the outer iris boundary. it aims to find iris region, which is characterized as a color region that is surrounded by white color area (Sclera) from outside and black color area (pupil) from inside. This stage should be accomplished with high accuracy because it significantly affects the success of the system. To make the process simple and accurate.The proposed algorithm of iris outer boundary localization that includes six steps: split operation of an image, enhancing by X-direction, enhancing by Y-direction, applying a median filter, iris localization and fitting circle, and iris isolation as described in the Figure 9-10 On CASIA version 1.0 and version 4.0 interval respectively.

The split operation: applied to find iris outer boundary separately, this operations calculates the average value (Avg) of the points extended along the inclined line in the "Gray Scale Image enhanced by brightness correction", and then compare each point (P) along the inclined line with average value (Avg): if the value of (P) is below Avg then set (P) value to zero, else set (P) value to one , as shown in Figures 8-9(c). The Enhancing image with X – direction : this operation to remove the small gaps or pores (i.e., short runs of zeros or ones) which may found in the binary sequence of (P) in X-direction ; this step will lead to long run of zeros followed by long run of ones as shown in Figures 8-9(d). The Enhancing image with Y – direction: this operation to remove the small gaps or pores (i.e., short runs of zeros or ones) which may found in the binary sequence of (P) in Y-direction; this step will lead to long run of zeros followed by long run of ones as shown in Figures 8-9(e). Median filter: applied to an enhanced images by Y- direction pass through the steps above and not on an original image directly so that to reduce the number of undesired edges in original images, as a result, this will increase the accuracy of edge detection, as shown in Figures 8-9(f). Iris detection: after median filter on the image, Search for transition point (from zero to one) along the inclined scan line; this point will be considered as a boundary point between iris and sclera region, as shown in Figures 8-9(g). Iris isolation: this operation used to isolate the iris from eye image, as shown in Figures 8-9(h).

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

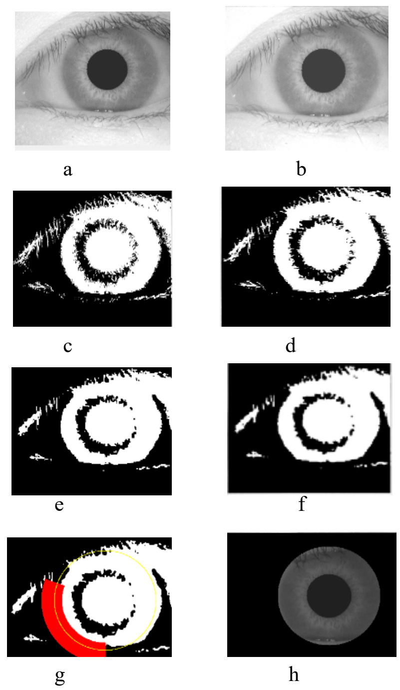


Figure 8: Iris outer boundary localization stage in CASIA version 1.0 : (a)The original image , (b) brightness correction , (c) Applying the split operation on brightness correction image, (d) Applying the enhancement on X-direction on split operation image (e) Applying the enhancement on Y-direction on enhanced image with X-direction, (f) Applying the enhancement using median filter on enhanced image with Y-direction, (g) applying the circle on the enhancing image with median filter,(h)output of the localized iris boundary.

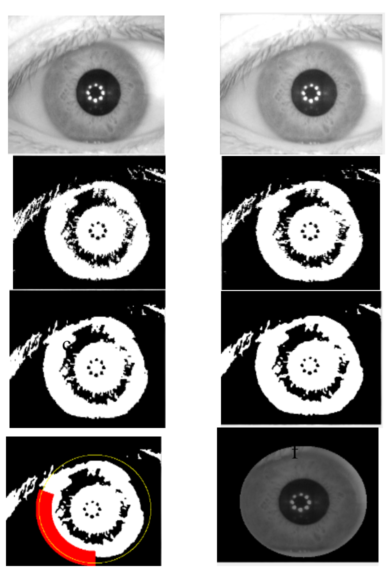


Figure 9: Iris outer boundary localization stage in CASIA version 4.0 interval: (a)The original image , (b) brightness correction , (c) Applying the split operation on brightness correction image, (d) Applying the enhancement on X-direction on split operation image (e) Applying the enhancement on Y-direction on enhanced image with X-direction, (f) Applying the enhancement using median filter on enhanced image with Y-direction, (g) applying the circle on the enhancing image with median filter ,(h)output of the localized iris boundary.

In some cases, the outer edges of the iris are not determined due to the high right of the image and a part of the iris is eliminate, so these images do not need to addition **S.B** often, Figures 10-11, shows the detected outer boundary of the iris-sclera region On CASIA version 1.0, failed case and successful respectively.

A- Failed Case

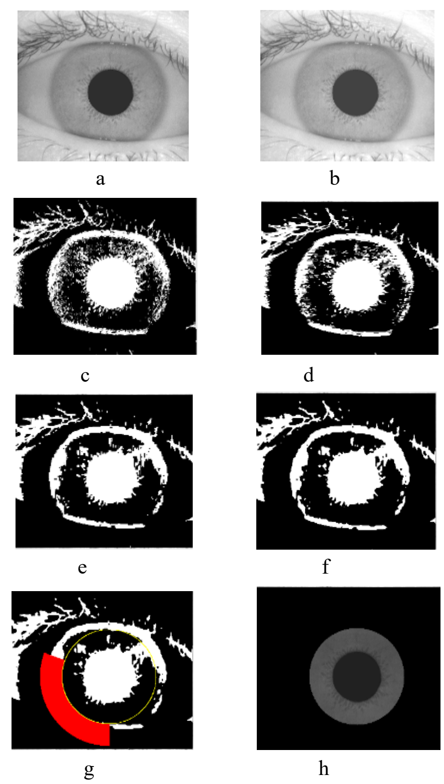


Figure 10: Iris outer boundary localization stage in CASIA version 1.0 : (a)The original image , (b) brightness correction with F.B = 20 , S.B=20 , (c) Applying the split operation on brightness correction image, (d) Applying the enhancement on X-direction on split operation image (e) Applying the enhancement on Y-direction on enhanced image with X-direction, (f) Applying the enhancement using median filter on enhanced image with Y-direction, (g) applying the circle on the enhancing image with median filter,(h)output of the localized iris boundary.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

B- Successful Case

Some times, the image is high bright, there for do not need addition S.B or add the small number less than 20, as shown in Figure 11.

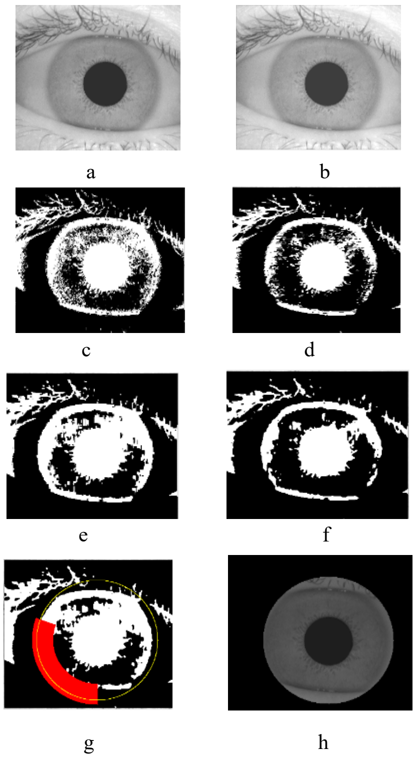


Figure 11: Iris outer boundary localization stage in CASIA version 1.0 , (a)The original image , (b) brightness correction with F.B = 20 , S.B=10 , (c) Applying the split operation on brightness correction image, (d) Applying the enhancement on X-direction on split operation image (e) Applying the enhancement on Y-direction on enhanced image with X-direction, (f) Applying the enhancement using median filter on enhanced image with Y-direction, (g) applying the circle on the enhancing image with median filter,(h)output of the localized iris boundary.

4. RESULTS AND DISCUSSION

The proposed iris segmentation approach tested on the iris databases (CASIA v1.0 and CASIA v4.0 interval). The eye image inputted into iris recognition system and pass through all stages as described in the following stages:

Stage1: select eye image from the database mentioned above as shown in Figure 12, to pass through the iris boundary localization steps.

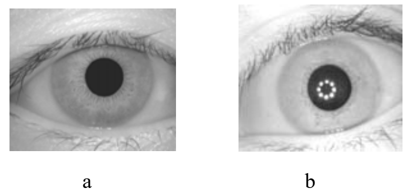


Figure 12: Original eye images: (a) CASIA v1.0 , (b) CASIA v4.0 interval.

Stage2: The results of pupil and iris boundaries localization steps in CASIA V 1.0 and CASIA V 4.0 interval are shown in Figures 13-14 respectively.

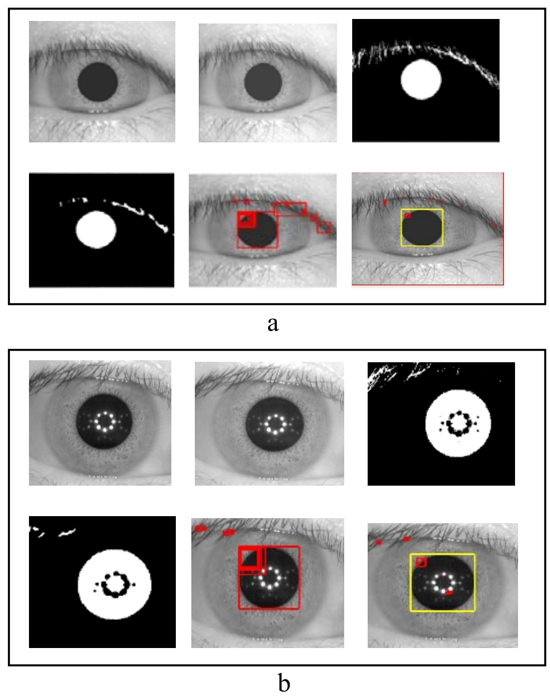
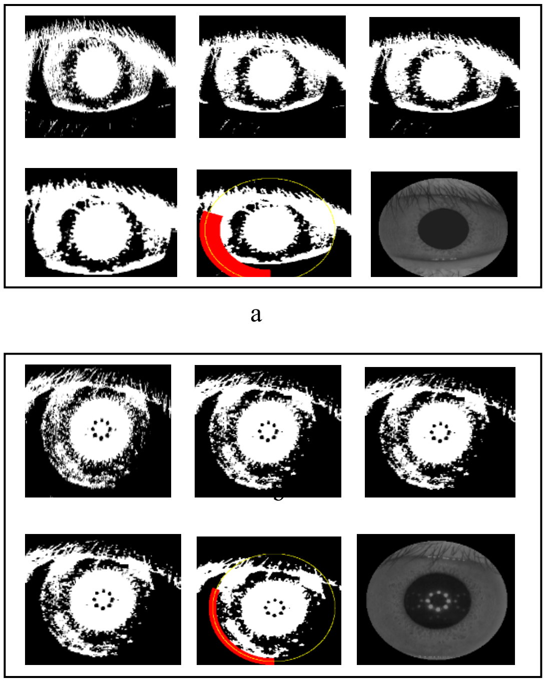


Figure 13: Pupil localization stages, (a) On CASIA version 1.0 and (b) On CASIA version 4.0 interval.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195



a

b

Figure 14: Iris outer boundary detection stages, (a) On CASIA version 1.0 and (b) On CASIA version 4.0 interval.

5. CONCLUSIONS

In this paper, a new approach to iris segmentation is presented, the idea of this paper is based on finding iris boundaries of the accurate method using (brightness correction of eye image by adding two brightness).

The iris segmentation stage is very critical and affects the iris recognition system results. In addition, the proposed iris segmentation stage divided into two parts (preprocessing & edge detection) to increase the accuracy and speed. Experimental results show that this approach has a good iris segmentation performance. The proposed approach has an average high accuracy in segmentation, first, as shown in Table 1 and Table 2 for inner boundary localization with CASIA V1.0 and CASIA V4.0-interval database images respectively, second, as shown in Table 3 and Table 4 for outer boundary localization with CASIA V1.0 and CASIA V4.0-interval database images respectively.

The proposed approach system test; and process have been implemented using a lap-top computer (processor: Intel Core i5 CPU 2.40 GHz with 3.00 GB RAM), the operating system is Windows 10. The programming language Visual C# is used to build and develop the required software.

Table 1: Detection performance of pupil boundary for some methods introduced by different researchers using CASIA v1.0 database."

Reference of Method	*Accuracy rate*
R.Y. Fatt Ng [6]	99.07%
A. Basit [7]	99.3%
Du et al [4]	99.07%
Proposed (756 images)	**100%**

Table 2: Detection performance of pupil boundary for some methods introduced by different researchers using CASIA v4.0 interval database."

Reference of Method	*Accuracy rate*
S. A. Ali [5]	99.1%
A. Basit [7]	99.3%
A. A. Jarjes [9]	98.85%
Proposed (1100 images)	**100 %**

Table 3: Detection performance of outer iris boundary for some methods introduced by different researchers using CASIA v1.0 database."

Reference of method	*Accuracy rate*
R.Y. Fatt Ng [6]	98.68%
A. Basit [9]	99.6%
Du et al [4]	99.07%
Proposed (756 images)	**100%**

Table 4: Detection performance of outer iris boundary for some methods introduced by different researchers using CASIA v4.0-interval database."

Reference of method	*Accuracy rate*
A. Basit [7]	99.21%
S. A. Ali [5]	99.5%
Gupta [8]	98.72%
Proposed (1100images)	**100 %**

REFERENCES:

[1] Bhalchandra, A., Deshpande, N., Pantawane, N. and Kharwandikar, P., "Iris Recognition‖", Proceedings Of World Academy Of Science, Engineering And Technology, Vol. 36, 2008, pp. 1073-1078.

[2] Jain, A., Flyn, P., and Ross, A., "Handbook of Biometrics‖", Michigan State University, USA, Flynn University of Notre Dame, West Virginia University, USA, 2008, pp. 79-98.

[3] L. Flom and A. Safir., "Iris recognition system", U.S. Patent 4,641,349, 1987.

[4] Y. Du, R. Ives, and C. Chang, "A new approach to iris pattern recognition," Proceedings of the SPIE European Symposium on Optics/Photonics in Defence and Security", vol. 5612, pp. 104–116, 2004.

[5] S. A. Ali, "Irregular Iris Identification and Verification Using Texture Methods", Ph.D Dissertation, Babylon University, College of Science, Iraq, 2014.
[6] R.Y. Fatt Ng, Y.H. Tay and K.M. Mok, "An Effective Segmentation Method for iris Recognition System", Computer Vision and Intelligent System (CVIS) Group, University Tunku Abdul Rahman, Malaysia, 2008.
[7] A. Basit, M.Y. Javed and S. Masood, "Non-Circular Pupil Localization in Iris Images", IEEE, International Conference on Emerging Technologies (ICET), Rawalpindi, Pakistan, pp. 228-231, 2008.
[8] R. Gupta and A. Kumar, "Performance Evaluation of Proposed Segmentation Framework with Existing Techniques for Noisy Iris Images", International Journal of Computer Applications (0975 – Vol. 114, No. 1, 2015.
[9] A. A. Jarjes, K. Wang and G. J. Mohammed, "Iris Localization: Detecting Accurate Pupil contour and Localizing Limbus Boundary", 2nd International Asia Conference on Informatics in Control, Automation and Robotics, 2010.