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Iris Recognition System Using Short Length of Texture Features Vector

Hashem BJehlol

Electronic Computer Center, Al-Mustansiriyah University, Baghdad, Iraq

Abstract—This paper aim to introduce a reliable and accurate iris recognition system based on using short length vector of local textural features to achieve high recognition rate. To ensure efficient system performance, many robust and fast algorithms was proposed to accomplish the iris segmentation and recognition tasks using eye images that captured in less controlled circumstances and non- excellent environment. In iris segmentation, the Canny edge detection is used to determine the inner boundary of the iris, where a new method is used to determine the outer iris boundary depending on the ratio of the length of the pupil radius. Daugman's Rubber model is used to transform the iris image from Cartesian coordinates to polar coordinates. To get a good roughness domain to apply texture features extraction process, the second gradient operator is used. The gradient images are divided into 24 blocks along the vertical and horizontal, the second order gradient features are extracted from each block. The highest recognition rate was 98.05% when combining two features of low order norm using CASIA V4.0 database.

Keywords— Iris Segmentation, Inner Iris Boundary, Outer Iris Boundary, Daugman's Rubber, Second Order Gradient

I. INTRODUCTION

The term biometrics points to statistical analysis of physical and behavioral characteristics of humans. There are many types of biometrics such as face, finger, palm, voice etc. but iris is more reliable and stable for identification[1]. Iris recognition is a biometric that used for identification and security. The iris structure offers many properties like stability, uniqueness, easy measurement and high recognition rate, which make the iris authentication so accurate[2]. The recognition of the iris has become one of the most important topics that researchers have been interested in because of the great success achieved in scientific applications Iris. Each iris has a unique texture that distinguishes people from each other. The important feature of the iris is that it is stable along life as well as can take a picture of the iris easily [3].This work proposed an iris recognition method using local textural features to achieve high recognition accuracy, so, a set of textural features have been suggested to represent the iris texture attributes.

II. RELATED WORK

This section of the paper includes some published researches written in the field of recognition of people using the iris area.

In 2013, Lokhande and et al [4] proposed a method for iris recognition system depends on Haar, wavelet. In this method, the iris information is encoded based on the "wavelet packets energy". This work is compared with Gabor and wavelet method. The computational complexity of proposed method is less as compared to Gabor and wavelet method. Combination of 2nd and 3rd appropriate energy packets gave optimum performance with accuracy 97% when using CASIA V4.0 interval.

In 2014, S. A. Ali [5] proposed iris recognition method using different combinations of Haar, Run Length Matrix (RLM) and Gray Level Co-occurrence Matrix (GLCM) for feature analysis and evaluation. The attained recognition rate was 97.35% for left eye and 98.2% for right eye samples belong to CASIAV4.0 database.

In 2015, P. Steffi Vanthana and et al. [6] proposed system which based on the intensity, shape and location information for segmentation iris pupil and iris region. The iris area is normalized by transforming the circular area into a rectangular area. HD (Hausdorff Dimension) and GLCM features are extracted form iris image. A SVM (Support Vector Machine) is considered as classifier.

In 2015, S. Homayon [7] proposed new method depend on a neural network for iris identification. CASIA V4.0-interval database is used with LAMSTAR neural network to classify iris image. The proposed method is performed using 16 different images for both right and left eyes of 8 people. Five different images are used for training for each person, the accuracy was 99.57%.

III. PROPOSED METHOD

Several stages are applied in the proposed method, which are used for recognition the iris image, as such as, pre-processing, segmentation, normalization, features extractionand create the features vector that stored in the database. Fig. 1,shows the major stage of the proposed method.

A. *Iris Image Acquisition*

The first stage in the proposed method is to capture an iris image. The success of the next image recognition stages depends largely on the quality of the images taken for the iris during images acquisition stage. This paper used specific class of iris images dataset that provided from Institute of automation, Chinese academic of science CASIAV4.0 [8], which consist of 249 subjects (person) taken from left and right eye image of the same person, the total number of iris images is 2639.

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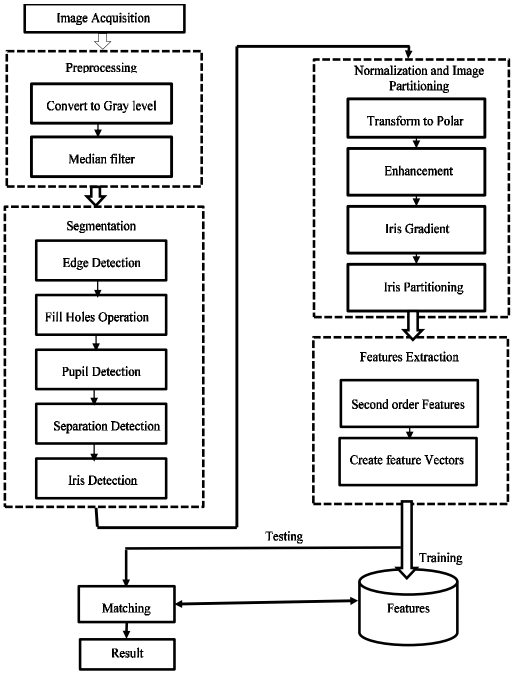


Fig. 1. The layout of proposed method

B. *Iris Segmentation*

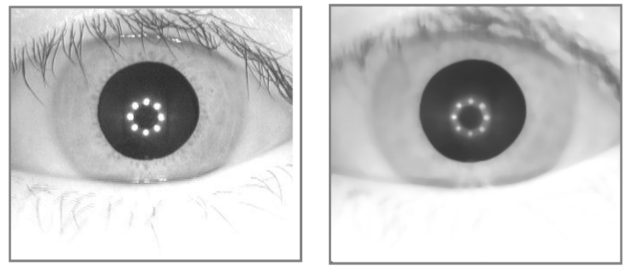
The second stage is the segmentation process which responsible to find the actual iris region from the eye image. The iris region consists of approximated two circles outer and inner boundary. The outer circle represents the boundaries between the iris region and the sclera, while, the inner circle represents the iris region boundaries with the pupil. The segmentation process begins by finding the boundary of the pupil (inner boundary of iris) and extracting the information such as the pupil center and radius, which assists in the segmentation of iris region. The next step is determined the boundary of the iris (outer boundary of iris). In the following, there are seven steps to find actual iris region from a digital eye image with low ratio of noise such as eyelashes and eyelids.

Step 1: Grayscale Image

After acquiring the image, if it is colored (3 layers) it must be converted to grayscale (2 layers) by calculating average of (R, G, B) channels of the image. The reason for converting the color image to grayscale type is to reduce data and information which should be provided for all pixels,thus, making image processing faster in the next stages.

Step 2: Median Filter

For reducing a certain types of image noise, median filter, a well-known non-linear mechanism is used [9]. The mask of median filter moves over the image and the average value of data in the window is taken as the output and placed in the center of the window. This paper used median filter with window 9-by-9 neighborhood. Fig.2, show the image result from median filter.

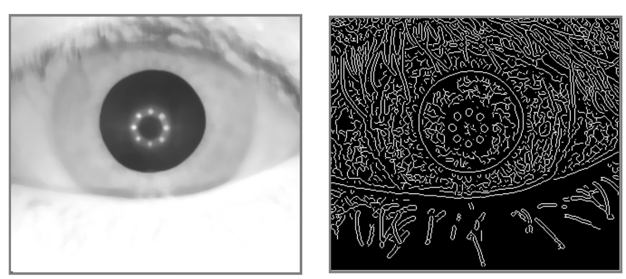


(a) (b)

Fig. 2. The Result image after applying the median filter

Step 3: Edge Detection

The edge that considered as a set of interconnected pixels is combining to form a boundary edge between two regions. One of the important initial processing steps in many computer vision algorithms is using the Edge detection [10]. There are many techniques developed to extract the edges of the digital image.The pupil area is usually darker than the iris, depending on the sudden rate of change of gray level between neighboring pixels in pupil and iris image, the edges can be strong and can find regions boundaries of an image easily. Canny edge detection method is better than some other edge detection methods because it detects the two slow changes of gray level. In order to carry out Canny edge detection algorithm there are several steps that implemented to detect iris boundary.First step is (the smoothing); the image must blur to remove the noise. Second step is (the gradient); the large gradient must have detected in the image and it marks as edges.Third step is (the non-maximum suppression); the local maxima must search to markit as edges. Fourth step is (applying threshold) to specify potential edge. Finally, all edges that are not associated with a strong edge must neglect. Fig. 3, show Canny edge detection result.



(a) (b)

Fig. 3.Canny Edges Detection Method to Find Image Edges

Step 4: Fill Holes Operation

A hole is a set of background pixels that cannot be reached by filling in the background from the edge of the image[11]. This paper is used Inbuilt Matlab operation known as hole filling to fill the pupil region. The dataset used is CASIA iris version 4.0, where the images contain reflection light spots caused by illumination, therefore, the process of filling the holes into the pupil area is down to fill

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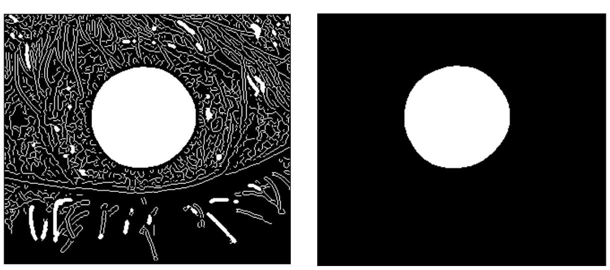
all reflection light spots. Fill Holes is important to make pupil region appear as one region and clearer to facilitate the process of isolate the pupil region especially when lighting spots lie on the pupil boundary. Hole filling makes centroid detection easier by reducing the false detection rate of centroid detection. Usually holes in pupil are filled by gradients of adjacent pixels[10]. Fig. 4, show the result of applying the Fill holes' process to determine pupil region.

(a) (b)

Fig. 4. Fill Holes operation to fill the pupil region

Step5: Isolate the Pupil Region

In the image that resulted from previous step, the object that represented as pupil must be extracted from other objects. Morphological processing is carried out to isolate the foreground pixels (pupil) from the background of the image. Matlab command (i.e., Regionprops), is used to measure the size area of all the connected regions. The advantage from find all connected regions in image and calculate its size to see if they achieve the conditions of size pupil or not. By knowing the approximate size of the pupil we can set the threshold. The connected regions that contain pixels larger than the threshold is consider as pupil. Then, apply the morphological processing to ignore other objects that have size less than threshold. Fig.5, show the result of applying this step.



(a) (b)

Fig. 5. Isolate the Pupil object from other objects

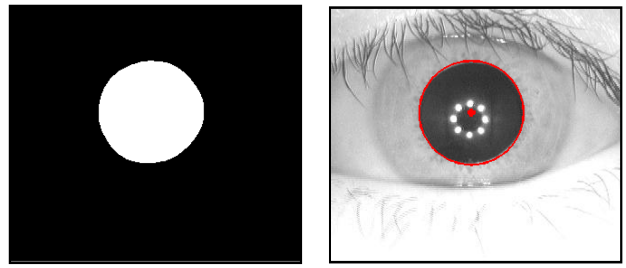
Step 6: Determine the Pupil Boundary

The center and the radius of the pupil should be compute. The radius of pupil represents the inner boundary of iris. Morphological operations will do to extract the center and radius of pupil. The pupil center and radius could be found using the Matlab function (Regionprops). The center and radius of pupil are using for drawing the iris inner boundary.In parametric form, the points on the of a circle can be written as in the equations 1 and 2 [12]:

$$x = a + r\cos(\theta) \quad (1)$$

$$y = b + r\sin(\theta) \quad (2)$$

Where (*a* and *b*) are the centercircle and (*r*) is the radius of the circle.Fig. 6, show the circle pupil boundary.

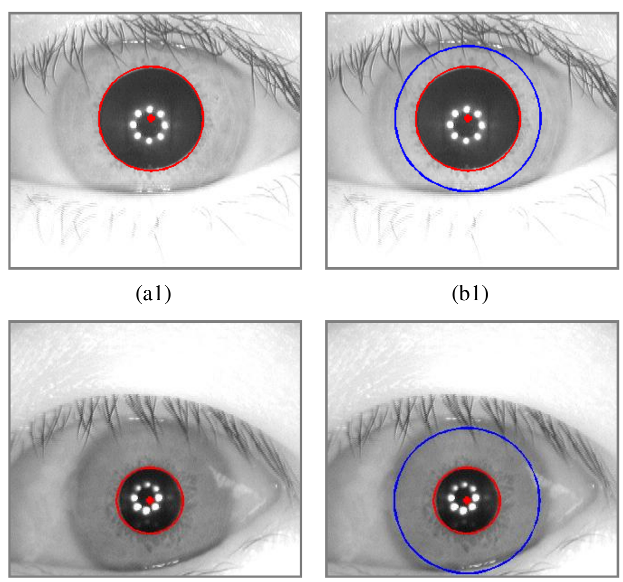


(a) (b)

Fig. 6.Draw circle to determine the Pupil boundary

Step7: Determine the Iris Boundary

The proposed method depends on the results of the inner boundary localization to be a guide to determine the outer boundary.Finding the outer boundary leads to detect the actual region of iris that contains all features which used for iris recognition. This paper introduces a new method to draw a second circle that representing the outer border of the iris where center of the second circle is the same as pupil center and the radius is the pupil radius multiply by (*f*), where (*f*) is a ratio of the pupil radius (80/radius). The radius of outer boundary (iris) will increase if the size of pupil is small and decrease if the size of the pupil is large. As shown in fig. 7, image (a1 and b1) show the area of pupil is large while the area of iris is small, while, in image (a2 and b2) show the area of pupil is small while the area of iris is large.



(a1) (b1)

(a2) (b2)

Fig. 7. The Area of Iris

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The mathematical equations (3, 4) used to draw theouter borders of the iris.

$$x = a + f \times r \ con(\theta) \quad (3)$$

$$y = b + f \times r \ \sin(\theta) \quad (4)$$

Where (a and b) are the center of the circle, r is the radius and *f* is ratio of the pupil radius (80/radius).

C. Normalization and Image Partitioning

In this stage, four steps are executed to improve the recognition accuracy such as Polar Transformation, Image enhancement, Iris Gradient and image Partitioning.

Step 1: Polar Transformation

After detecting the actual area of the iris in the previous step, the resulting image must converted from Cartesian coordinate to polar coordinate using a model known as the Daugman's Rubber model[13]. This model used to convert the image from a circular shape to a rectangular shape. The height of the resulting rectangle image will be equal to the radius of the irisarea minus the radius of the pupil area, while the width of the rectangle is about 360 pixels, which represents the angle of full rotation 2π of the polar image. That means the height is not fixed for all iris images, therefor, after finishing the normalization process, the height of the rectangle must have unified and fixed for all iris images.Through experiments, the height of rectangle of the iris image is determinedby (55x360) pixels. Fig. 8shows the polar transformation results.

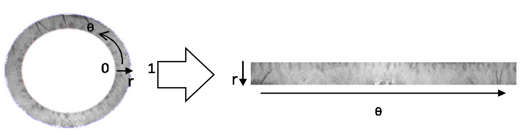


Fig. 8. Convert Cartesian Coordinates to Polar Coordinates

Step2: Image Enhancement

Before features extraction process, the quality of the normalized iris image should be improved because the low quality image has a negative effect on the features extraction process.Improving the normalized iris image through using contrast stretching that makes it has uniform distributed brightness will be well to provide more suitable image for features extraction stage. This paper used mean ( ) and standard deviation (σ) to improve the iris image contrast. The following equations compute the mean and standard deviation:

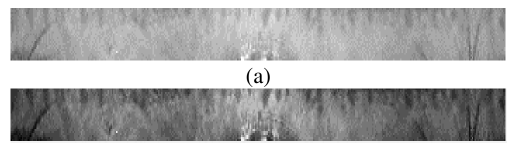
$$\mu = \frac{1}{n}\sum_{i=1}^{n} f_i \quad (5)$$

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(f_i - \mu)^2} \quad (6)$$

Where n is represented the number of pixels, f_i is represented value of i^{th} pixels. The contrast stretching is applied through using the following equation:

$$g'(x,y) = \frac{B}{\sigma}(g(x,y) - \mu) + 128 \quad (7)$$

Where, g′(x,y)is the mapped pixel value and g(x,y) is the intensity of pixel, (B) is the suitable value of parameter which controls the strength of stretching, which set to 80 in the conducted tests, the result of enhancement is shown in Fig. 9.



(a)

(b)

Fig. 9. The Iris Image after Using Contrast Enhancement

Step 3: Iris Gradient

In this step, the second order gradient operator is applied on the iris image to get a good domain to extract a set of texture features. The gradient operator measures the intensity change that occurs in pixels' value in different directional. The local textural for iris image is captured by using the second order gradient (i.e., gradient the second degree of the intensity change). The resultant image from second order gradient is less sensitive to changes in image brightness. This paper introduces six directions of second order gradient according to the equations in Table (1).

TABLE ( ): SECOND ORDER GRADIENT OPERATOR

Gradient image	Direction	Equation
	Horizontal	gxx(x, y) =2P(x, y)-P(x-1, y)-P(x+1, y)
	Diagonal	gdd(x, y) =2P(x, y)-P(x-1, y-1)-P(x+1, y+1)
	The mean of vertical gradient	gyx(x, y) =P(x, y) + P(x+1, y) - P(x, y+1) - P(x+1, y+1)
	Vertical	gyy(x, y) =2P(x, y)-P(x, y-1)-P(x, y+1)
	Gradient of gradient along horizontal direction	gxy(x, y)=P(x, y) - P(x+1, y) - P(x, y+1) + P(x+1, y+1)
	Gradient d1 of the gradient d2	gd2(x, y) =P(x, y) - P(x+1, y) + P(x, y+1) - P(x+1, y+1)

Step4: Iris Partitioning

At this stage, the resulting image of the gradient is divided into 24 blocks, this means (8 × 3) blocks along the horizontal (x) and vertical (y) orientation. The height and width of the block is determined by testing a set of values to obtain the appropriate dimensions that lead to the best results. The dimensions of the iris are not equal therefore the dimensions

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of the block are not equal too. Fig. 0, illustrate the process of dividing of the gradient image.

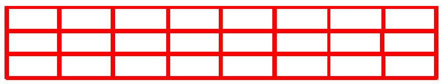

Fig. 10.Image gradient Partitioning

D. *Feature Extraction*

Feature extraction is the principal task in any authentication system; this task is applied in both training and testing stage. Once the iris image is divided, the next stage is to extract features from these blocks. The features that extracted from the iris image must be strong enough to distinguish iris image from others. For each iris image block the set of statistical moments are calculated as iris features. The statistical moments depend on the spatial variation of image signal. The 1st moment and the norm (norm 0.5, norm 0.75), have been utilized depended on second order gradient. They provide full description of the spatial distribution of the iris block. After determining these moments of all training images, they are analyzed to choose the proper feature(s) that lead to best recognition rate. The values of the norm gradient density are calculated as iris features, the features that depend on second order gradient are calculated using the equations (,).

$$M_{gc} = \frac{1}{N} \sum_{p(x,y)} |gc(x,y)|^n \qquad (8)$$

$$M_{gc} = \frac{1}{N} \sum_{p(x,y)} sign(gc(x,y)) \, | gc(x,y) |^n \qquad (9)$$

Where gc is either of second gradient density (Mgxx, Mgyy, Mgdd, Mgxy, Mgyx and Mgd2) which represent the gradient of the horizontal, vertical and diagonal gradient components, gradient of gradient along horizontal direction, the mean of vertical gradient and the gradient (d1) of the gradient (d2) respectively. N is the total number of iris belong to the block; (n) is the order of the moment and n= [1, 0.5, 0.75].For each iris image the vector features is created and stored in database.

E. *Matching Stage*

In the image matching process, the query image is initially described and then the closest component of the image is searched in the database for the best match. Certain measurements are relied upon to link the query sample image with the appropriate class In the proposed method, Euclidean distance is used to compare query input image features with stored images features, and it would be classifying according to the subject (person) of its closest neighbor (image) in the feature space. Euclidean distance is calculated by using the equation (10) it computes the square root of the sum of the squared absolute differences.

$$d = \sqrt{\sum_{i=1}^{k} (|R_i| - |D_i|)^2} \qquad (10)$$

Where R represents vector features of query image and D represents vector features of database features.

IV. Experimental Results

For examining the recognition performance of the proposed algorithm, CASIAV4.0 image dataset is used which contains 249 persons and total number of iris images for all persons are 2639. The number of images that used for training part are about (80%) of each person and the remaining images are used in the testing part. Table (2) is divided into two parts; the first part shows the results when using the best one feature from the total features (30 features) which extracted from each block and the second half describes the results when using combination of best two features. The results listed in Table (2) indicate that the recognition performance is improved by increasing the number of training images, and it reaches the highest recognition rate (i.e., 98.05%) when using 5 images from each person for training with combining of two features of low order norm [|Mgd2|^0.5, Mgyx^0.75].

Table (2): Show the recognition rate for deferent number of training image.

No. of training image for each person	One Feature			TwoFeatures		
	Type of Feature	Power	Recognition Rate	Type of Feature	Power	Recognition Rate
1 image	M_{gyx}	0.75	54.07%	$\|M_{gyx}\|$ $\|M_{gd2}\|$	0.5 0.5	52.86%
2 image	$\|M_{gd2}\|$	1	62.14%	M_{gyx} M_{gxy}	0.5 0.75	56.04%
3 image	M_{gyx}	0.5	81.96%	M_{gd2} M_{gyx}	0.5 0.75	88.74%
4 image	M_{gyx}	0.5	89.77%	$\|M_{gd2}\|$ M_{gyx}	0.75 0.75	96.55%
5 image	**M_{gyx}**	**0.5**	**90.82%**	**$\|M_{gd2}\|$ M_{gyx}**	**0.5 0.75**	**98.05%**

Fig. 11 shows the effect of the number of training images on recognition rate when using one and two features.The results indicate that using combination of two features get recognition rate better than using one feature.

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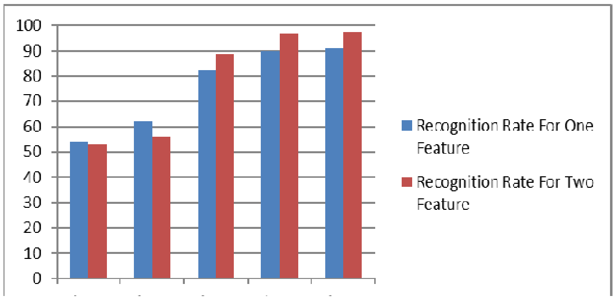

Fig. 11. Recognition rate for one and two features when using different number of image training

Table (3) lists the recognition rates attained by our proposed method compared with those given in previous studies, taking into consideration that in these studies same datasets have been used. The listed results demonstrate that the proposed method in this dissertation outperforms other methods applied on the same database (CASIAV4.0).

TABLE (3):COMPARISON BETWEEN THE PERFORMANCE RESULTS OF PROPOSED METHOD AND OTHER METHODS

Reference	Accuracy Rate	No. of Person or Images
[5]	97.35% For Left Eye 98.2% For Right Eye	Used 100 Person
[14]	99.4% For FOS Method 86.67% For SOS Method	Used 360 Iris From 30 Person
[15]	97.21 %	Used 100 Iris Images
[16]	99.57%	Used 8 Person
[17]	99.75%	Used 100 Person
Proposed Method	98.05%	Used All Database (249 Persons, 2639 Iris Image)

V. CONCLUSIONS

In this paper, the Canny edge detection method was chosen for iris segmentation because it creates single pixel thick and continuous edges. The proposed method provided a new method to determine the outer borders of the iris that depend on ratio of the pupil radius. It has proven successful in obtaining the largest area of iris containing a low percentage of noise such as eyelashes and eyelids. Using second gradient operator gave best domain to extract robust features with low order norm (0.5, 0.75). The benefit of dividing iris region into 24 blocks had improved the recognition accuracy; because it helped to gain local features of each iris region. The experimental results indicate that although each individual feature is not powerful by itself, the combined of two features had led to good recognition performance (98.05%). As a future work, can be use a combination of three or more features, which are expected to give better results.

REFERENCES

[1] Y. Li, Y. Ma, Z. Zhang, L. Zhou, and W. Zhang, “A design of iris recognition system at a distance,” in 2013 IEEE International Conference on Robotics and Biomimetics, ROBIO 2013, 2013, pp. 2297–2302.

[2] S. Shah and A. Ross, “Iris Segmentation Using Geodesic Active Contours,” IEEE Transactions on Information Forensics and Security, vol. 4, no. 4, pp. 824–836, 2009.

[3] Z. Sun, H. Zhang, T. Tan, and J. Wang, “Iris image classification based on hierarchical visual codebook,” IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 36, no. 6, pp. 1120–1133, 2014.

[4] S. Lokhande and V. N. Bapat, “Wavelet Packet Based Iris Texture Analysis for Person Authentication,” An International Journal (SIPIJ), vol. 4, no. 2, 2013.

[5] S. A. Ali, “Irregular Iris Identification and Verification Using Texture Methods,” Ph.D Dissertation, Babylon University, College of Science, Iraq, 2014.

[6] P. Steffi Vanthana and A. Muthukumar, “Iris authentication using Gray Level Co-occurrence Matrix and Hausdorff Dimension,” 2015 International Conference on Computer Communication and Informatics, ICCCI 2015, vol. 133, no. 8, pp. 29–34, 2015.

[7] S. Homayon, “Iris Recognition for Personal Identification Using LAMSTAR Neural Network,” International Journal of Computer Science and Information Technology, vol. 7, no. 1, pp. 1–8, 2015.

[8] http://www.biometrics.idealtest.org.

[9] T. Koik and H. Ibrahim, “Exploration of Current Trend on Blur Detection Method Utilized in Digital Image Processing,” Journal of Industrial and Intelligent Information, vol. 1, no. 3, p. 143, 2013.

[10] A. Ks and V. S. Dharun, “Method to Remove the Noisy Data DROM Captured Image of Iris and Identifying the Pupil by Detecting Its Centroid,” vol. 12, no. 15, pp. 5127–5130, 2017.

[11] V. Borges, M. C. Ferreira de Oliveira, T. Silva, A. Vieira, and B. Hamann, “Region Growing for Segmenting Green Microalgae Images,” IEEE/ACM Transactions on Computational Biology and Bioinformatics, vol. 13, no. 9, pp. 1–1, 2016.

[12] C. Houston, “Iris Segmentation and Recognition Using Circular Hough Transform and Wavelet Features,” pp. 5–8.

[13] V. R. E. C, “Pupil detection and feature extraction algorithm for Iris recognition,” AMO-Advanced Modeling and Optimization, vol. 15, no. 2, pp. 141–160, 2013.

[14] S. J. Mohammed, "Iris Recognition System Using Statistical Measurement", M.Sc thesis, University of Technology, Computer Science Department, 2014.

[15] S. Homayon, "Iris Recognition For Personal Identification Using Lamstar Neural Network", International Journal of Computer Science & Information Technology (IJCSIT) Vol. 7, No 1, February 2015.

[16] K. Roy , P. Bhattacharya and C. Y. Suen," Iris recognition using shape-guided approach and game theory", Pattern Anal Applic14:329–348 DOI 10.1007/s10044-011-0229-7 (Springer), 2011.

[17] A. Nigam and P. Gupta, "Iris Recognition using Consistent Corner Optical Flow" 11th Asian Conference on Computer Vision (ACCV 2012), Daejeon, Korea, November 5-9, 2012.