Applied Information Technology And Computer Science Vol. 4 No. 1 (2023) 1281-1295
© Universiti Tun Hussein Onn Malaysia Publisher's Office

AITCS

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/aitcs
e-ISSN :2773-5141

An Improved Iris Segmentation using Pupil Candidate Bank for Non- Cooperative Iris Recognition

Nurhanim Mohd Kamil[1], Nur Ariffin Mohd Zin[1]*

[1]Faculty of Computer Science and Information Technology,
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/aitcs.2023.04.01.074
Received 14 June 2022; Accepted 07 June 2023; Available online 30 June 2023

Abstract: Iris recognition has been widely known as the most accurate biometric identification technique due to a person's unique characteristics and the permanence of the iris texture. However, the recognition rate drops when the iris is captured in a non-cooperative environment. A non-cooperative environment includes eyelashes occlusion, unbalanced rotation, and other invisibility issues. Therefore, this study proposed a method to segment the iris under the condition of eyelashes occlusion. During this study, the methodology of Analysis, Design, Development, Implementation, and Evaluation (ADDIE) was used. While Pupil Candidate Bank (PCB) was proposed as the technique to address the aforementioned issue. The proposed method has been tested with the Institute of Automation Chinese Academy of Sciences (CASIA) and the Multimedia University (MMU) iris image dataset with cooperative and non-cooperative environment. From the experiment conducted, the proposed method is able to segment the iris successfully under non-cooperative environments and achieve a recognition rate of 98% as compared to state of the art. In future work, to increase the accuracy and robustness, the proposed method can be infused with other biometric traits to become a multimodal biometric system.

Keywords: Circular Hough Transform (CHF), Pupil Candidate Bank (PCB), Iris Recognition

1. Introduction

Biometric systems automatically recognize a person based on some unique trait or characteristic behaviour possessed by an individual [1]. Biometric systems have been developed using traits such as fingerprints, hand geometry, voice, facial features, handwriting, and retina design. Biometric systems have been widely applied to identify individual access control and security and might use in credit cards, system housing and could feasibly be used for boarding verification in airport immigration, national border control, or missing identity card [1]. As compared to other biometrics, iris recognition has three distinguishing characteristics have the most accurate method for identifying individuals. At begin with,

*Corresponding author: ariffin@uthm.edu.my

the biological structure of an iris in the human eye is regarded separate and isolated from the external world. Second, it is essentially difficult to change the structure of the iris without compromising visibility. Third, because of its response to lighting, it is difficult to forge (dilate in low light and shrink in high light). Furthermore, it is proved that having the same iris pattern appear in different persons is impossible. On these characteristics, it makes very safe use as a biometric for identifying individuals [2]. One of the image processing methods that be used to extract the different unique images of the iris, which can store in the database. The probability-based iris recognition is the most all biometric method: considering two people with identical cases, subjects were highly accurate in their categorization of similar and dissimilar images. This aims to study real-life iris recognition security system applications developed to understand their strengths and weaknesses. It also focuses on the steps and phases to be followed to implement iris recognition in a security system.

This aim to present to resolve the common problems issue associated with iris recognition in the latest advance. In Iris recognition biometric, there are four main stages involved which are segmentation, normalization, and feature encoding, and matching (Figure 1 shows the flow phases of iris recognition system). This iris region should be rich in texture as the feature extraction heavily depends on the segmentation accuracy [3]. Even though it also discuss the most advances method that can resolving typical challenges linked with iris recognition. According to this finding, a biometric match score for identical twin or single person left and right iris was not statistically different with the same images and same person. This issues is because eyelashes are relatively dark and compared to the rest of the eye images, even the iris images employed a simple thresholding approach to isolate in CASIA dataset. Furthermore, the eyelashes also relatively black compared to the surrounding eyelid region of the iris region are similarly dark due to the iris with the non- cooperative imaging conditions of the environment [3]. In terms of the main issues this involves in implementing iris recognition in segmentation phases. This iris region should be rich texture in preprocessing heavily in image acquisition then depends on the segmentation accuracy. Besides that, in phase's setup the capture eye images should be high resolution and good sharpness to accurately detect the outer and inner circles of boundaries for successful segmentation [3]. This issues will arise if the image is captured in a non-cooperative environment from sample testing used CASIA dataset, example of non- cooperative include the specular reflections, occlusion, eyelashes and eyelids. It can might cause degradation in recognition performances and inaccurate segmentation.

This study focus on solving the inaccurate segmentation caused of non- cooperative environment iris. Several method have been developed. However it still challenging to localize the iris region. Therefore, the research objectives are to study the existing iris segmentation methods. The rest of the objectives are to propose an improved iris segmentation using the combination of Integro – Differential Operator (IDO) and Circular Hough Transform (CHF) and to evaluate the proposed method with sample iris dataset CASIA and Multimedia University (MMU). Then another part of the article is structured as follows: First, the literature review on comparison method in segmentation phases based on the existing method and needed sample variety dataset. This followed by description of the research method, material and equation used in this study. The results of the accuracy segmentation will be discussed. The perception of proposed has all the characteristic to solve problem. This enhanced will be improve the segmentation phases.

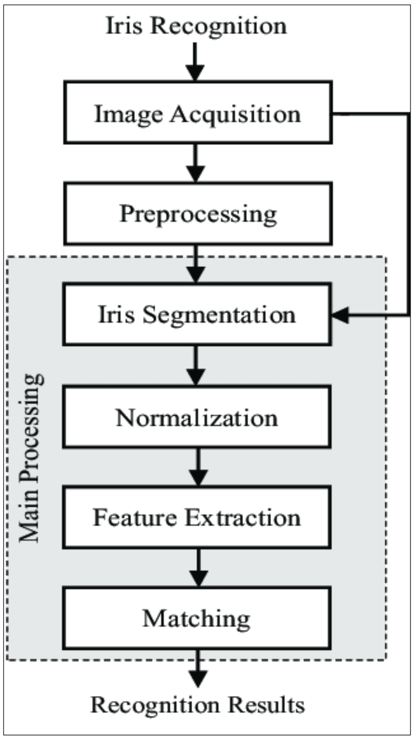


Figure1: The iris recognition system

2. Related Work

Literature has suggested the approach of generated a method for automatic identification of a person based on iris detection. It defines the focusing analysis iris between band within iris image excluding the particular pre-selected portion of position iris likely concluded eyelids, eyelashes or specular reflection from the light illuminator [3]. In this study, we commonly compared the enhance method in which a more precise segmentation procedure is added to an already existing efficient algorithm, boosting iris recognition's overall reliability and accuracy. This is the issues that related to the iris region segmentation. Table 1 shown sample another comparison in segmentation phase with method and the type of non-cooperative environment.

Table 1: The comparison method in segmentation phases

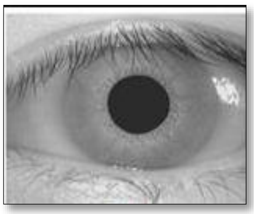
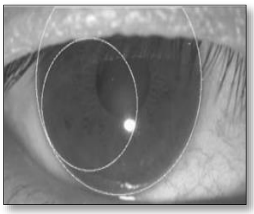
Non-cooperative Environment	Image sample	Method
Upper and lower eyelids		Integro-differential operator
Specular Reflection		Gaussian Filtering

Table 1: The comparison method in segmentation phases (cont.)

Non-cooperative Environment	Image sample	Method
Eyelashes Occlusion		Robust Eyelash Detection (RED) Pathway Kernels and Hair Curve Fitting (HCF)
Absence eyelid		Eyelashes removed using canny edge operator

The basic concepts of eyelid localization was completed in the same manner as previous work. Two existing approaches methods are investigated and analyzed in order to gain new information in order to develop and propose an improved iris segmentation using the Integro-Differential Operator and the Circular Hough Transform. In table 1 shown another existing method that related with this issues. The existing system studied including Pupil Candidate Bank (PCB) [5] and the Circular Hough Transform (CHF) filter improved Integro- Differential Operator Live- wire method [4]. Then, this followed by approach suggested Integro- Differential Operator refers to the process of automatically detecting the pupil and the inner boundaries of an iris in a given image [4]. This process helps in extracting features from the discriminative texture of iris, while including the surrounding environment. Iris segmentation plays the main key in the role performances of iris recognition system. This is because improper segmentation can lead to incorrect feature extraction from less region such eyelids and eyelashes thereby reducing the recognition performances. According to [4] the Integro- Differential Operator and Hough Transform technique has been used as segmentation phases. In general, a pupil boundary a closed, continuous and smooth curve, which is near- circular. To achieve a better performances in the segmentation of an iris recognition. This method comparison has been tested with CASIA-Iris-Interval V3 and using MATLAB software. The issue that reducing the performances because of incorrect feature extraction from less discriminative region such sclera, eyelids, eyelashes, pupil as a result the identification performance is limited [4]. Based on the data results performances it takes longer to segment the grayscale iris photo in database, even the Hough Transform delivers an addition to an overall. The method Integro- Differential Operator approach is not efficient since the search area has restricted in a few phases and reduction errors due to reflections in the ocular picture has not been applied. The next future work target is improved the affective segmentation approach for noisy frontal and view iris images is devised using Fourier spectral density.

Most commercial systems implement an algorithm using iris code comparison which is Hough Transform. The system first assesses the focus of the image in real time by sharpness the target in the middle and upper frequency bands of two- dimensional. The more recent work on segmentation, there have many assumption with the issues of that non- cooperative environment iris image. This method Pupil Candidate Bank (PCB) construct the propose an iris segmentation framework which is simple implement, robust that can work with non- ideal iris image same as non- cooperative without requirement of specific database. This framework method can be refer on figure 2 on illustration of flow proposed method Pupil Candidate Bank (PCB). An overview the method, this iris segmentation consists to fine strategy and adaptive computation of the parameter equation for enhanced iris segmentation to cope the bad quality results such as scaling, translation, irregular shape and etc. [5] This method enhance the widely used Integro- Differential Operator, circular Hough Transform and smoothing spline based method failure to localize exact pupil boundary points in non-ideal images using dataset CASIA Interval-V4, ND-IRIS 0405, and IITD. Our proposed approach without doubt runs faster than other methods which are implemented in MATLAB. To identify proper pupil boundary points create the ROI image to examine the characteristic. Within this choices, it makes occurring as a results of a strong illumination gradient or shadows. However, this approach first estimates it by transforming the image into polar space, which transform the near circular iris contour into near linear structure. From a localization process computationally less expensive, as this results also achieved better localization accuracy in term of segmentation. Besides, this eyelids occultation is a crucial step for high accuracy but highly challenging because of shape irregularity of eyelids and texture variations due to eyelashes [6]. Since the main focus in this research is to propose a segmentation framework, we did not explore other state of phases of the approaches feature process. To do fair comparison, we applied the same steps for all the method phases after segmentation for accuracy in all phases and will do as future work to encouraging performances consistently across all the datasets.

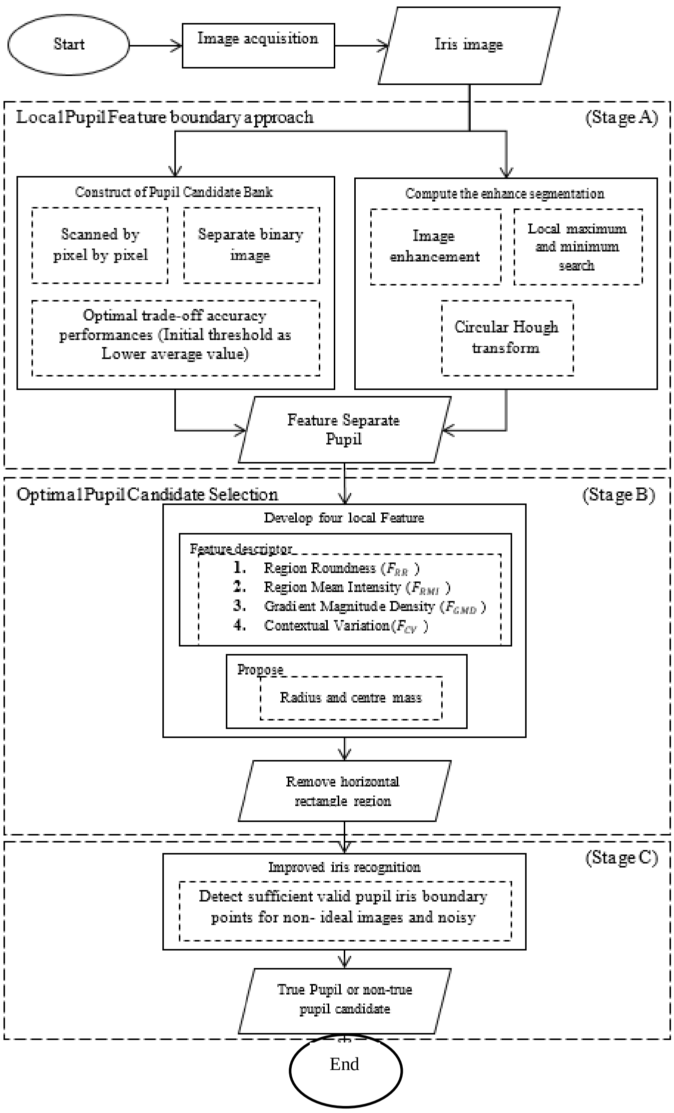


Figure 2: Illustration of flow proposed method Pupil Candidate Bank

3. Methodology

This study was image processing research design. The types of processing image are recognition iris image design comparing two methods of segmentation phases. Both methods will be simulation and tested on MATLAB software. According to research by Daugman's which makes this stage an important part of iris recognition. The accuracy of iris localization, decides the iris texture to be used for feature extraction and thus accuracy of overall recognition system [5]. These classical and other similar approaches achieve excellent accuracy when iris images are of high- quality. However, the real applications images may contain some types of challenges such as occlusion, illumination variation and specular reflections. Due to the issues of iris recognition in segmentation phases there are several method available. In this study, the information is collected within other methods and the efficient, accuracy may select as proposed method to recover the effect of noise iris segmentation.

The data analysis covers the evaluations within the research domain which involves identifying challenges, problem, factors and objectives that form of structure. Phases of study are the processes that will serve as the initial step and as the foundation for all subsequent actions. In this step, figuring out the segmentation process need CASIA developed by group (Institute of Automation Chinese Academy of Sciences) and MMU (Multimedia University) iris dataset which appear to be the primary data source, the data selection will be in characteristic by cooperative environment shown in Figure 3(a) and non-cooperative environment shown in figure 3(b). As moved further, the objectives is to propose an improve iris segmentation combination between the Hough Transform and Integro-differential Operator were employed to execute system operation using two types of datasets for iris recognition. The results of the analysis were the suggested approach in segmentation, which serves as a framework for the proposed iris recognition method in segmentation.

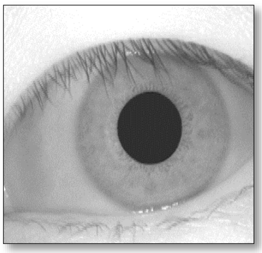


Figure 3(a) A cooperative Iris image.

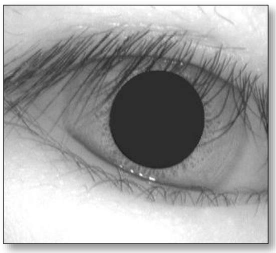


Figure 3(b) A Non-cooperative Iris image.

To ensure that this phase functions as a process that leads to the design of the project's purpose method of this project, the analysis The software program, instrument to assess the enhancement approach in MATLAB Software with the Integro-Differential Operator with Circular Hough Transform (CHF) to improve the structure and determined the method. In this phase, a segmentation method was developed to address the issues. To avoid difficulties and achieved the objective, the segmentation accuracy must identify the sharpness pupil center, solving the iris with occlusion eyelid and eyelash as noisy image iris was performed. The issues was related to the non- cooperative environment. The solution in this study was the outcome of the analysis stage, which attempted to explain the comparative segmentation phases. The first issue, the accuracy of detected pupil center related to the issues iris, is substantially obstructed by the eyelids and eyelashes; the iris boarder may not correspond to a circular shape. The second issue, eyelashes more relatively dark due to the non- cooperative environment. As a result, a circular Transform technique was implemented acting as a feeder to ridge detection algorithm detection in order to automatically process distinct essential uncertain conditions on segmentation.

To acceptance the development phase segmentation, this must concentrated on evaluating by proposed method. On the other hand, this will be configured and tested with two sample dataset. For this phase, the data will be used as CASIA iris image database developed by the group (Institute of

Automation Chinese Academy of Sciences) and the MMU (Multimedia University) iris dataset taken from. Several suggestions have been introduced, but this study needs to be proven by non-cooperative and noisy images characteristic to makes comparison for enhanced the method to solve the problem. This data set collects its implications for the comparative analysis phases. In algorithm segmentation phases, the study comprises is used the Integro- Differential Operator and Hough Transform by algorithm Masek and propose method to enhance the segmentation approaches namely Pupil Candidate Bank (PCB) to test the dataset. The method implemented in software MATLAB and it generate the enhanced performances simulation. Thus, the training and testing dataset are loaded into comparison to obtain results simulation. The proposed of iris recognition, to ensure the quality of segmentation must accurate in the centre coordinates of pupil and iris region and one at time to improve method Circular Hough Transform. Overall the issues need to solve in aspect of non- cooperative images characteristic. The result of accuracy improved from the previous method.

This step implementation involves the installation and testing of a proposed enhanced division algorithm using two different data sets. The Pupil Candidate Bank (PCB) is inspired by the most ordinary and commonly used the Hough Transform. In this propose method, we used Pupil Candidate Bank (PCB) to target of enhanced of perform the fail to locate specific pupil boundary point in non-ideal images. During this phases, the proposed method of segmentation iris detection recognition is performed to classify between iris images of with and without enhancing based on the results. The testing results will evaluate the local algorithm and highly successful pupil identification templates followed by best candidate selection using several local characteristic. Therefore, there are three components stages approaches for Pupil Candidate Bank (PCB) which is; Stage A is proposed local feature pupil approach which is split the image acquisition into compute the enhance segmentation of image enhancement, local maximum and minimum search to improve Circular Hough, the enhance the method will scanned by pixel and pixel, separate binary image to trade off accuracy to get lower average value. In solve in term of feature separate pupil. When this phases develop four local feature to make propose radius and centre mass accomplish. Stage B is optimal pupil candidate selection approach and Stage C is refinement of the pupil approach to identify sharpness accurate iris border points for non-ideal and noisy. According this approach, the simulation involved the equation of confusion matrix as accuracy measure. The data collection will get from hamming distance simulation results. The following equation is performances matrix that will be used in the experiment namely accuracy, sensitivity, specificity, and error rate.

- **Accuracy:** It is defined as the ratio of correctly predicted example by the total examples.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

Eq. 1

- **Sensitivity:** It is calculated as the number of correct positive prediction divided by the total number of positive. It is also called recall.

$$Sensitivity = \frac{TP}{(TP + FN)}$$

Eq. 2

- **Specificity:** It is calculated as the number of correct negative prediction divided by the total number of negative.

$$Specificity = \frac{TN}{(TN + FP)}$$

Eq. 3

- **Error rate (ERR)**: It is calculated as the number of all incorrect predictions by divided by the total number of the dataset.

$$Error\ Rate\ (ERR) = \frac{FN + FP}{(P + N)}$$

Eq. 4

Table 2: The description of Confusion matrix function

Metrics	Description
True positive (TP)	The part that subject iris correctly segmented as the iris recognition.
True negative(TN)	Non-subject iris that were correctly marked.
False positive(FP)	The part that subject iris incorrectly segmented as the iris recognition.
False negative(FN)	Non-subject iris that were incorrectly marked.

The presented Eq.1 to Eq. 4 above is the base formula in confusion matrix for analyzing the data for accuracy. The equation works by calculating the percentages of performances detection the data in the part of inter class (between other individual irises) or intra class (between the same iris different angel capture irises). Thus, it works by first calculating the probability of first method and probability second method calculation same as in the equation shown. So, the same concepts used in this study. The results will be shown as the sharpness in term accuracy. The dataset will undergo testing process for both method implemented templates. The data stored in the dataset will be test based on its accuracy. Through the testing and training of the dataset, the difference between the two chosen approach in segmentation phases and compared. As a results, with three stages that be mentioned this propose will be improve this projects in term of dataset with cooperative and non- cooperative to finding achieved better accuracy with calculation with four equation that related.

This is the phase in which the impact of the instruction is assessed, and the goal of achieving results is evaluated to enhance the quality of the segmentation phase of iris recognition. The evaluation phases utilized Pupil Candidate Bank (PCB) templates iris recognition system improve the iris segmentation, and recover the effect of noise due to iris texture magnificent caused by Masek's template segmentation phases. The conclusion of the comparison will be conclude with the equation of results accuracy from confusion matrix. This will be determined the percentages of familiarity between the predicted value between inter class (between other individual irises) or intra class (between the same iris different angel capture irises) where the highest accuracy indicates the best performances. As a result, the comparison will only be used towards the very end of the methodology development process. This segmentation will be solved using one of many methods, the proposed method which is Pupil Candidate Bank (PCB) has recovered and improved round-based segmentation, Integro- Differential

Operator, and Circular Hough Transform with all failures present in the previous phase segmentation method.

4. Results and Discussion

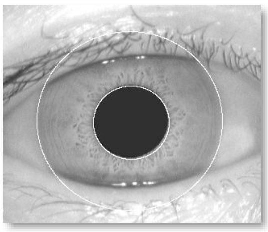
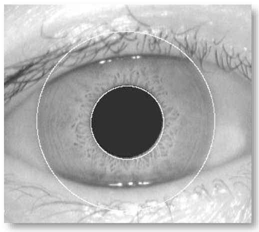
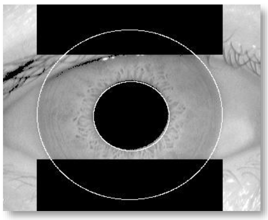
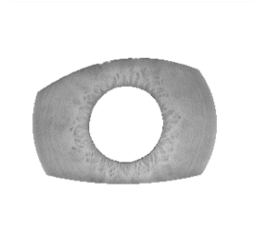
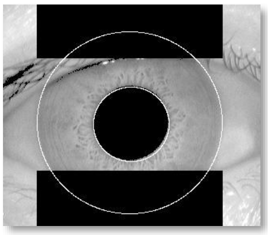
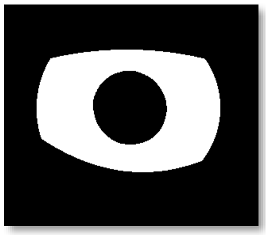
All evaluation experiments used the latest version of CASIA- Iris V4. This process of distributions of hamming distances which are generated by comparing between different methods templates of the same iris are shown in table 3**.** Without the method proposed of segmentation, accuracy resulted in the positive true is lower score. With Pupil Candidate Bank (PCB) proposed method, the score increased, leaving it in a huge score gap. Pupil Candidate Bank (PCB) stands out by resulting in the highest true positive score of accuracy with an increase over from Integro- Differential Operator (IDE) and Circular Hough Transform (CHF). As the true negative score, CHF has maintained the highest, followed by PCB with over increment from CHF. In table 3 also shown comparing two different method segmentation of whether an iris image is under the category of cooperative and non-cooperative iris requires the implementation of a pattern recognition approach. In this study, the concatenation of Local pupil feature and Optimal Pupil Candidate selection is proposed as the feature descriptors that resemble multi-algorithmic implementation. It is dedicated to previous studies in the field of pupil region pixel detection of each block. To find average value, pixels combine two feature descriptors yet deliver satisfying results is in separate binary image to provide optimal accuracy. It improved the accuracy that invariant to scale, rotation and illumination. While have achieved the highest accuracy in their study through the combined enhance method technique CHF and PCB.

Table 3 depicts a Pupil Candidate Bank (PCB) segmentation strategy that is required once the contrast has been raised in able to locate the pixels that correlate to the elimination of specular reflections. This framework is used to provide a technique and adaptive estimation of parameters for improving iris segmentation in the presence of less quality characteristics such the image of the iris does not only contain the outer boundary (sclera, eyelashes, and iris), but it also contains pupil and data produced from the eyelids detection and inner boundary (the boundary between pupil and iris) detection that surrounds the eye area, such sclera, eyelid, and eyelashes as well characteristic cooperative environment.

The main limitation of the region detection approach is that the binary image iris must be scanned pixel by pixel and divided into components. It is for the removed and remaining components labels assigned to each one to compute the binary attributes from that distinct binary image. To compute this first threshold image, divide it into block sizes and average each one. The outcome will be the optimal trade between accuracy and computation performance. Yet, manual parameters adjustment is impractical for a real-time application. Therefore, removing the horizontal rectangle region is utilized as a removal non-cooperative images detection algorithm for construction of PCB, whether it is proposed for local features for pupil Candidate Selection.

Enhancements to the proposed PCB segmentation become necessary due to poor segmentation performance in the dark area of iris images of Hough Transform. For that reason, local maximum and minimum search is to remove the processing method to approximate the pixels with high average contrast in the dark area of iris images that correspond to the PCB. This preference is made due to its robustness to inconsistent image processing while having better performance in the dark area of images compared to Masek methods CHF. Another enhancement is carried out to resolve the inevitable eyelashes occlusion. To solve this issue, the circular Hough transform is employed as a reference to enhance the method. It focuses on finding the circular-based shape of the segmentations method; hence, it is robust to occlusion of the non-circular object such as eyelashes.

Table 3: Comparison of Proposed Framework (a) Segmentation in method Circular Hough Transform; (b) Segmentation on propose method using Pupil Candidate Bank.

a. Circular Hough Transform	b. Pupil Candidate Bank
	
	
	
	

4.1 Experimental Result

In this experiments phase, the performance evaluation is conducted based on proposed algorithm which are Pupil Candidate Bank (PCB). In these experiments the True Positive (TP), True Negative (TN), False Positive (FP), False Negative (FN) is the used results from the hamming distance results that classifier while analyzing the confusion matrix table. This classifier that analyzing form the results of dataset is tabulated with the total amount within the classes of confusion matrix with its then will proceed to percentages of accuracy for confusion matrix. So, this research project is titled comparison robust analysis of proposed method for two datasets to classify the accuracy of the result Hamming distance using sample data set, and the result is viewed based on two method performance measurement: accuracy, sensitivity, specificity, and error rate. Tables 2 shows the experimental result using Masek Template of method Circular Hough Transform (CHF) method. Simulation is carried out by with MATLAB software image (IP) toolbox. Figure 4 shows the simulation graph after generate the totally data from the dataset. The figure below shown the result simulation graph based in two types of classed which Intra- class and Inter- class. Figure 4(a) shows the Intra- class simulation graphs and figure 4(b) shows the Inter- class simulation graph for the results hamming distance matching and frequency.

Figure 4(a) is the simulation on the first method using Masek Template of method Circular Hough Transform (CHF) dataset to be trained and tested. The results shown in figure graph below. The results hamming distance gives a measure of how many bits are the same between two-bit patterns. In comparing the bit pattern of iris image person A and person B, the Hamming distance is defined as the sum of disagreeing bits from Hamming distance results sum of the pattern iris image A and B over N, the total number of bits in the bit pattern. Overall, simulation to generate the graph of Intra-class in figure 4(a) shows in range frequency 76 to 79 is the Hamming distance highest with 0.32 above. It shows the result is a bit higher because the result nearest of 0.35 is not validated with cooperative and non-cooperative images. The shape of the graph in figure 4(a) shows the highest pattern on the red line. Figure 4(b) shows inter-class distribution with the CASIA dataset tested with Masek's method. The result indicates that the range in Hamming distance from 0.45 to 0.48 correctly increased in the highest frequency, while the other also shows correctly above 0.35.

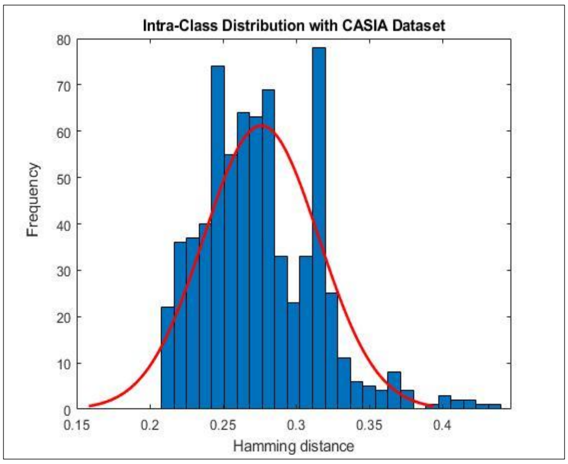


Figure 4(a): Intra Class of comparison Masek's template on dataset CASIA

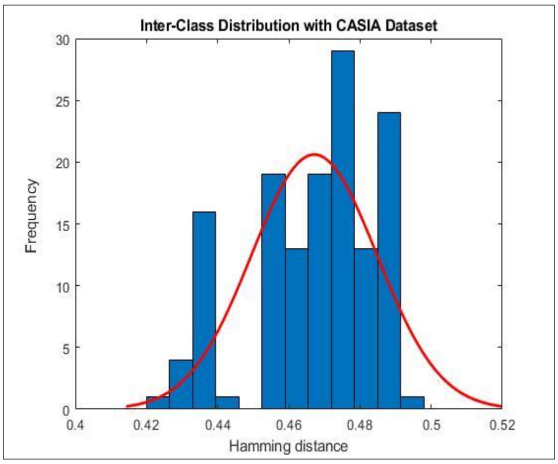


Figure 4(b) Inter Class of comparison Masek's template on dataset CASIA

Figure 5(a) shows intra- class distribution with MMU dataset using Masek templates for Hamming distance results are higher in range 0.24 to 0.28 that shows of the data are correctly result in their frequency, while the result after 0.35 above also almost reach in the frequency 10. The results accuracy will be low, and the percentage will raise the error rate. Next, figure 5(b) shows the inter-class distribution with the dataset. Inter-class is comparing the different person of iris image. The results show graphs the highest in data tested in frequency between 28 and 30 in Hamming distance 0.47 to 0.50. It is shown as the simulation is correct based on the point that needs to reach.

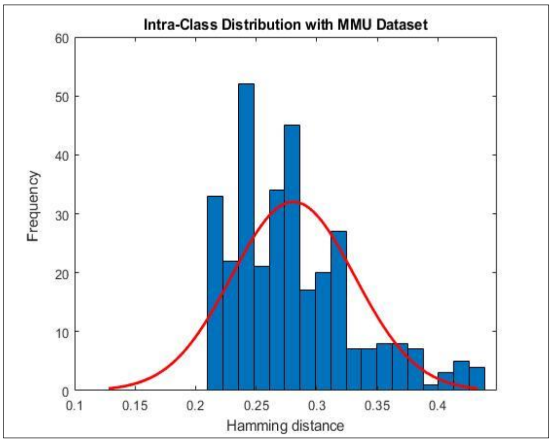


Figure 5(a): Intra Class of comparison Masek's template on dataset MMU

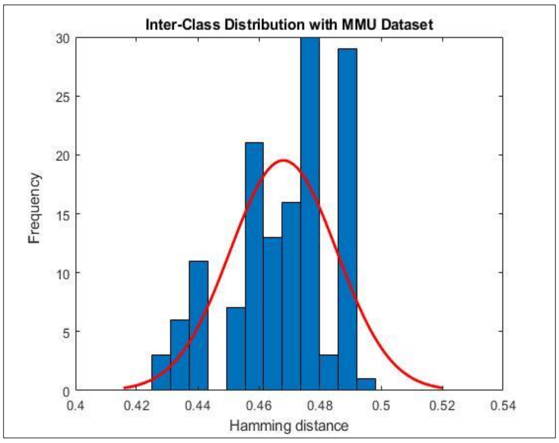


Figure 5(b): Inter Class of comparison Masek's template on dataset MMU

In this subsection, the analysis and design have discovered the accuracies and results of the study depicted in the tables below. The research from the simulation is the accuracy of the segmentation phases that have been compared within samples used in two datasets in Masek. Therefore, this simulation will focus on the accuracy of the iris recognition system in terms of phase segmentation. This Masek algorithm uses Circular Hough Transform (CHF) to indicate different datasets for calculating its normal distribution. Table 4 summarizes the results of the datasets used in this simulation with different type of comparison for training this recognition system, and the first dataset CASIA are trained initially using 700 total datasets. Each has seven mixed left and right iris image with 100 people. The second dataset was trained using 280 complete datasets, and each has seven left and right iris with 46 people.

The table 4 shows the accuracy reach between 96% using dataset CASIA with Error Rate (ERR) in 4% and 89% using dataset MMU with Error Rate (ERR) 11% is the highest error in term of intra-class, which is with the same person and compare with left and right iris. The method is more elevated and does not improve the segmentation phases while not detecting the same iris. The highest is because of non-cooperative characteristics that have been described in chapter 2 about the issues of non-cooperative characteristic not seen in detail.

Table 4: Experimental results Accuracy for Masek's template

Iris Recognition System Masek's						Accuracy for confusion matrix			
Dataset	Types of comparison	TP	TN	FP	FN	Accuracy	Sensitivity	Specificity	Error
CASIA	Intra-Class	674	0	0	26	96%	96%	0%	4%
CASIA	Inter-Class	0	140	0	0	100%	0%	100%	0%
MMU	Intra-Class	250	0	0	30	89%	89%	0%	11%
MMU	Inter-Class	0	140	0	0	100%	100%	100%	0%

This is method proposed by the Pupil Candidate Bank (PCB). This method also uses the same data set as the simulation in CASIA and MMU above. The simulation would like to show success in iris recognition in cooperative iris images and non -cooperative environments. The simulated results will be compared with Masek's method and will expect the proposed solve the problem in the iris segmentation phase. Figure 6(a) shows intra-class distribution with CASIA dataset tested with the proposed method Pupil Candidate Bank (PCB). The result indicates that the graph correctly expanded the range in Hamming distance from 0.25 to 0.31 in the maximum frequency 120 above. The other also results incorrectly above 0.35 in frequency ten within the same iris recognition. Next, figure 6(b) below, shows inter-class distribution with dataset CASIA. The results should be above 0.35, indicating graphs the highest in data tested in frequency between 25 and 30 in Hamming distance 0.45 to 0.50. It is proved that the simulation is entirely correct based on the point that results must reach.

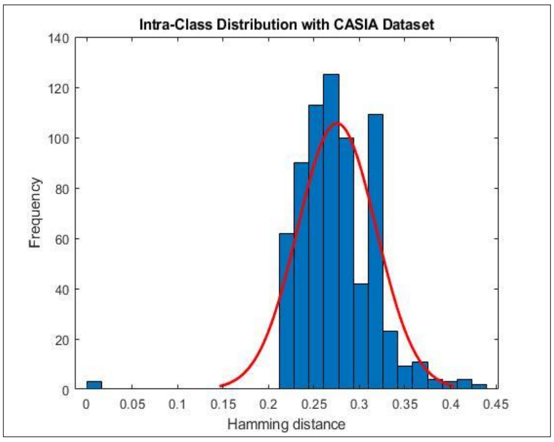


Figure 6(a): Intra Class of comparison PCB template on dataset CASIA

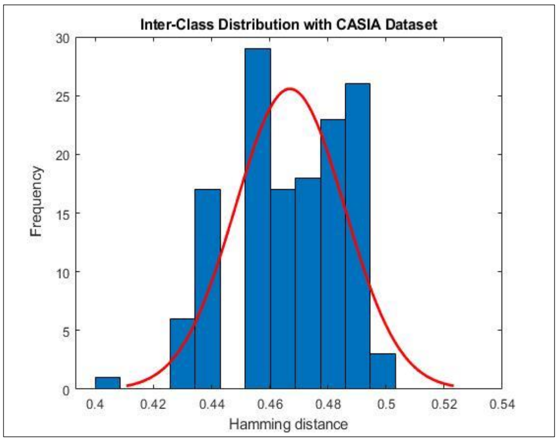


Figure 6(b) Inter Class of comparison PCB template on dataset CASIA

Figure 7(a) shows intra- class distribution with the Multimedia University (MMU) dataset. The Hamming distance results are more significant from 0.20 to 0.30, indicating that the data appropriately results in their frequency, while the consequence above 0.35 virtually reaches the frequency below 10. The accuracy of the results will be high, and the error rate will decrease. Furthermore, figure 7(b) shows inter-class distribution with the dataset Multimedia University (MMU). The results should be above 0.35, with graphs indicating the highest and moderate data tested in frequency between 20 and 25 in Hamming distance 0.46 to 0.49. The simulation is entirely correct depending on the point to be reached based on objectives needed.

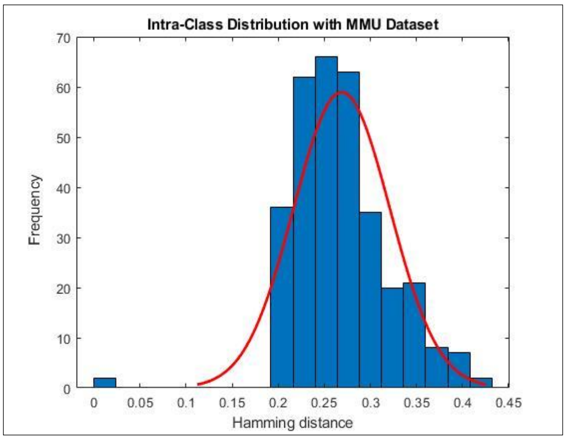


Figure 7(a): Intra Class of comparison PCB template on dataset MMU

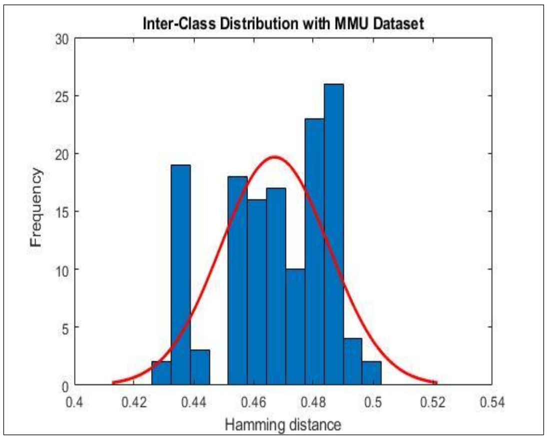


Figure 7(b): Inter Class of comparison PCB template on dataset MMU

The accuracy method propose achieved 98% utilizing dataset CASIA with an Error Rate (ERR) of 2% and 93% using dataset MMU with an Error Rate (ERR) of 3%, according to table 4. Error Rate (ERR) in terms of intra-class, which is with the same individual and compares left and right iris, the inaccuracy is 8% compared to the table 4 Masek is 11%.

Table 5: Experimental results Accuracy for Pupil Candidate Bank template

Iris Recognition System Pupil Candidate Bank (PCB)						Accuracy for confusion matrix			
Dataset	Types of comparison	TP	TN	FP	FN	Accuracy	Sensitivity	Specificity	Error
CASIA	Intra-Class	686	0	0	14	98%	98%	0%	2%
CASIA	Inter-Class	0	140	0	0	100%	0%	100%	0%
MMU	Intra-Class	259	0	0	21	93%	93%	0%	8%
MMU	Inter-Class	0	140	0	0	100%	0%	100%	0%

This proposed method is very accurate and improves the segmentation phases while detecting the same iris. The reduced error is caused to previously non- cooperative characteristics, which have been resolved using the following findings from this study: it comes to non-cooperative detected iris segmentation, one of the main reasons of occlusion is eyelash and shadow detection. Eyelashes and shadows are often darker than the eyelids and iris. Conclusion, the result proposed method approved the issues for the non-cooperative iris, and it identified accuracy with a more significant percentage than the error rate.

5. Conclusion

This study proposed to improve comparability of the Hough Transform Algorithm in phase segmentation with the Daugman integro- differential operator. After the end of this research, a new method segmentation, Pupil Candidate Bank (PCB), will be evaluated to enhance iris segmentation and recognition. Otherwise, this approach enhanced technique may assess the high-speed accuracy scheme demands issued in the iris biometric system. Furthermore, the method must be compatible with future iris devices in iris scan or non-contact scanning from vast distances and segmentation approaches based on provided a means to overcome all types of noises to get a higher accuracy rate. The four noises in the normal iris area are eyelids, eyelashes, pupil, and reflection. Indeed, the tests that we carried out showed the interest of the fusion at the level of the scores. The integration of the data at the correspondence scores by the calculations method gives the best result and enhances the method for performances. Confusion matrixes for the recognition process have been evaluated dataset in 7 different captures in the same individual iris and seven other individual iris in a cooperative environment with accuracy 100%. While, overall accuracy for recognizing the proposed method Pupil Candidate Bank template the results of accuracy used CASIA dataset result is 98% improved than Masek's 96% performance with a 2% error rate compared to 4% on Masek's simulation results. The MMU dataset improved accuracy by 92% compared to 89%. This research has various limitations, one of which is that both data sets include a few non-cooperative iris image environments. Also, the data set makes each is hard to perform very accurately each method, where usually each method can achieve the result in the Hamming distance very well. The overall sensitivity for iris recognition is similar to precision for iris image cooperative has results 100%.

The proposed technique Pupil Candidate Bank (PCB) biometric identification has improve, the method may be used for future significant approach for further implementation in the next research study is to obtain greater accuracy with the new method approach. To improve accuracy and robustness, a multimodal biometric system could be used to improve system recognition. Using a Log filter and zero crossings, develop a fast and accurate iris segmentation method. As a result, that method could be used instead. The smoothed image is acceptable. Furthermore, sample iris recognition could utilize the most recent CASIA dataset or another dataset in the test. Furthermore, in real-time camera with high resolution also may be used. This method suggestion, if implemented, will achieve a complete, fast, and robust iris recognition system.

Acknowledgment

The authors would like to thank the Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia for its support. Thank too Libor Masek for making his work on the iris recognition system as an open source.

References

[1] J.G.Daugman. How iris recognition works, IEEE Transactions on Circuits and Systems for Video Technology, Vol. 14, No. 1, pp. 21–30, Jan. 2004.

[2] Kaur, B., Singh, S., & Kumar, J. Robust iris recognition using moment invariants. Wireless Personal Communications, Vol. 99, No. 2, pp.799-828. 2018.

[3] Masek L., and Kovesi P., MATLAB Source Code for a Biometric Identification System Based on Iris Patterns. The School of Computer Science and Software Engineering, the University of Western Australia. 2003.

[4] Radman A, Jumari K, Zainal N. Fast and reliable iris segmentation algorithm. IET Image Processing. Vol.7 (1), pp. 42-9. Mar. 2013

[5] Gangwar, Abhishek, et al. IrisSeg: A fast and robust iris segmentation framework for non-ideal iris images. International Conference on Biometrics (ICB). IEEE, 2016.

[6] .Yao P., Li J., Zhuang Z., and Li B. Iris Recognition algorithm Using Modified Log-Gabor Filters". Proceeding of the 18th International Conference on Patterns Recognition (ICPR'06). 2006