UTM Computing Proceedings
Innovations in Computing Technology and Applications
Volume: 1 | Year: 2016 | ISBN: 978-967-0194-81-3

Comparative Study between Different Filtering Methods to Remove Reflection in Eye Image for Iris Recognition

Asraful Syifaa' Ahmad[1], Rohayanti Hassan*[2]

Department of Software Engineering, Faculty of Computing, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia
[1]asrafulsyifaa.ahmad@gmail.com, [2]rohayanti@utm.my

Abstract

Research on iris recognition system nowadays focuses on identifying a person by capturing on eye image with the presence of noises. Reflection is one of the noises that available and decreases the quality of iris image. These cause incorrect localization of iris boundary thus affect the rate of accuracy for iris recognition. To address the issue above, the aim of this study are: (i) to analyze and recognize the filtering methods to remove reflection in iris image, (ii) to design and implement filtering methods which improve the quality of image for iris recognition at different angle, and (iii) to evaluate and validate the performance of filtering methods towards the accuracy of iris recognition. This research utilized and compared three different filters namely Median Filter, Gaussian Filter and Lee Filter that are used as reflection removal to increase the iris recognition performance's rate. The data were filtered at the first step before the localization process. In addition, the filters performances were measured by Localization Accuracy Test, Peak Signal to Noise Ratio (PSNR) and also Root-Mean-Square Error (RMSE). The result showed that Median Filter outperforms the other filters. These three methods were then tested against UTM IFM database and the performance of iris recognition was validated by using False Acceptance Rate (FAR), False Rejection Rate (FRR) and Total Success Rate (TSR) and Recognition Accuracy Test. To sum up, the accuracy of localization step improved more than 10% compared to localization of non-filtered iris image while the accuracy of recognition accuracy also improved where these three filters achieved accuracy test more than 75%.

Keywords: Iris recognition, Localization, Reflection, Filter

1.0 Introduction

Present-day, news continues to spread all over the world that old security methods are not excellent enough to protect individuals belongings especially when it involved financial. However, the most common problem faced thru this method is the card went missing or the password being forgotten. To add on, the other problems could happen is shoulder surfing where he or she log to their account, the bad person looks at a person's password over the shoulder.

The biometric recognition system is widely used nowadays as an enhancement in security measures. For instant, the biometric recognition being used for border controls, in airports, for residential entry, financial and attendance. This system recognized individual identity based on physiological or behavioral characteristics (Raffei et al., 2011). Among those traits, iris creates high accuracy in identifying a person as the iris patterns in each individual are unique and higher degree of freedom. Each iris which is right and left is distinctive each to other.

Basically, the images from the digital camera have its own weakness which is noise. Noises also exist in another type of images such as ultrasound image, MRI images, and satellite image. Iris image captured contain noises from the variety of factors such as motion blur, covered by eyelid or eyelash, bad focus, reflection, out of the framework, wearing glasses or contact lenses. Steps in iris recognition start from localization where the iris boundaries are detected. This followed by normalization, feature extraction and lastly is the template matching. The presence of noise affects the process of localization. Thus, cause the template matching process failed. These noises actually increase the False Reject Rate (FRR) and False Acceptance Rate (FAR).

No image is free from the noise but noise can be removed. In order to achieve that, several noise removals already being introduced by the previous researcher. Three common noise removals used in filtering digital image are Median Filter, Gaussian Filter and also Lee Filter. These filters are included in the first step which is pre-processing images. The validation performance of filters is done by the Histogram Image, Peak Signal to Noise Ratio (PSNR) and Root-Mean-Square Error (RMSE), Localization Accuracy Test. While FAR, FRR, TSR and accuracy of recognition were calculated to measure the performance of iris recognition.

2.0 Problem Statement

Biometrics technologies are widely used nowadays in terms of security especially using iris recognition. Iris recognition is one of the most stable and unique biometric. However, the most common noises in iris image which is reflections deduce the accuracy of recognition. Noises may occur in iris images due to the environment or camera burst error. Therefore, the reflection either strong or weak reflection is needed to be distinguished. Moreover, salt-and-pepper noise also exists due to image transmission through the channel is also need to be removed in order to prepare a high-quality iris image for the recognition process. Therefore, in order to overcome reflection in iris image, this study compares the utilization of filters as noises removal in order to increase the performance of iris recognition.

3.0 Objective

The goals of this study are to solve the reflection problem as well as to get a quality eye image and increase the accuracy of the iris recognition. Thus, three objectives are identified which are to analyze the filtering methods to remove reflection in iris image, second is to design and implement filtering methods which improve the quality of image for iris recognition at different angle and lastly is to evaluate and validate the performance of filtering methods towards the accuracy of iris recognition.

4.0 Methodology

The study is focused on removing the reflection and noise from iris image, the UTM IFM database is used. UTM IFM which stands for Universiti Teknologi Malaysia (UTM) Iris and Face Multimodal contains dataset of UTM's students. The iris samples are from Asian with different kind of ethnicity. The UTM IFM datasets was captured by using the USB 2.0 biometric device, Iris Guard-AD100 device which is able to capture eye iris and face images. At the same time, it can determine eye aliveness to prevent spoofs due to contact lenses and uses can use direct and crossed illumination to capture irises through eye glasses. This database consists of facial and iris images. Data acquisition consists of 70 images of 0◦ offset angles (frontal) iris, 33 image of the right –side offset angle (right) iris, 18 images for left-side offset angle (left) and lastly for rotated ellipse with upper angle (upper), 14 images. Table 1 shows the sample taken form the UTM IFM database.

Table 1 Sample of iris image in UTM IFM database

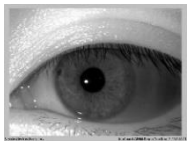
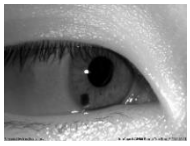
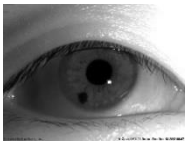
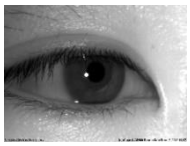
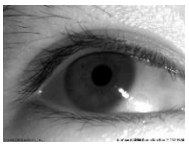
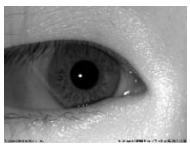
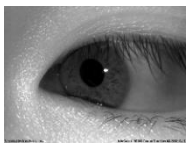
Sample / Eye's Angle	*Examples of iris that contain reflection based on different angle*			
	Frontal	**Right**	**Left**	**Upper**
S1				
S2				
S3				
Total	70	33	18	14

Figure 1 shows the step by step reflection removal process for iris recognition process. Each iris image was cropped to prevent inaccurate gray level reading. Reflections cause the boundaries to be incorrectly detected during the segmentation process. Thus, three different filters were used in removing out the reflection in iris image separately. To evaluate the filter performance, Histogram Image, Peak Signal to Noise Ratio (PSNR) and Root-Mean-Square Error (RMSE) (Kaushik and Sharma, 2012) tests were done. Then the task continued with Hough Transform method which used to detect iris boundaries for iris localization and followed by Rubber Sheet Model is used for normalization. The localization step is evaluated

by Localization Accuracy Test (Raffei et al., 2011). To perform feature extraction, Wavelet Transform method is used. Features are then extracted from these templates to perform the recognition task. Hamming Distance was chosen to match the two iris templates as the method is commonly used for this purpose (Broussard et al., 2008). Lastly, the performance of iris recognition was validated by using False Acceptance Rate (FAR) (Divya et al., 2015), False Rejection Rate (FRR), Total Success Rate (TSR) (Sim et al., 2014) and Recognition Accuracy Test (Badade and Talbar (2014); Anap and Vikhe (2013)). The details of this methodology are provided in the Table 2 while the summary of the evaluation metrics are provided in Table 3.

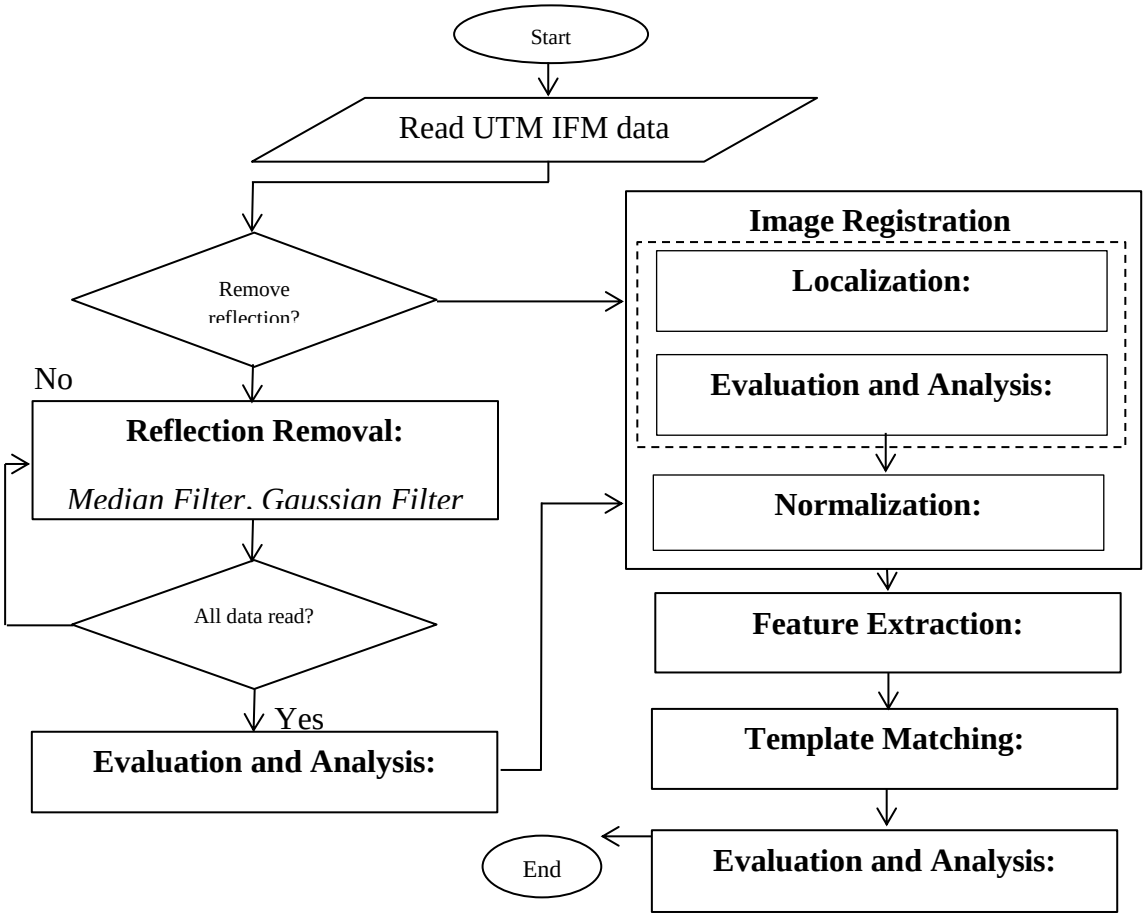


Figure 1 Flow chart of reflection removal process in iris recognition

Table 2 Iris recognition steps explanation.

Steps	Tasks
Step 1:	Data acquisition from UTM IFM database which consist 70 images of frontal iris, 33 image of right iris, 18 images for left iris and lastly for upper iris, 14 images. Each iris image is crop to prevent inaccurate gray level reading.
Step 2:	Reflections cause the boundaries to be incorrectly detected during the segmentation process. Thus, three different filter used in removing out the reflection in iris image separately.
Step 3:	Then the task continued with Hough Transform method which used to detect iris boundaries for iris localization and followed by Rubber Sheet Model is used for normalization.
Step 4:	To perform feature extraction, Wavelet Transform method is used. Features are then extracted from these templates to perform the recognition task.
Step 5:	Hamming Distance chosen to match the two iris templates as the methods is commonly used for this purpose.

Table 3 Summary of the evaluation metrics.

Metrics	Description	Formula
Histogram Image	Determines the distribution on pixels in an image	$histogram\,(r_k) = n_k$
PSNR	Defines the quality of images either good or not	$PSNR = 10\log_{10}(\frac{R^2}{MSE})$
RMSE	Defines the error between two images	$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Original_i - Filtered_i)^2}$
Localization Accuracy	Determines the correctness of iris localization for limbic and pupillary boundaries	$Localization\ = \frac{Total\ correct\ iris\ localization\ images}{Total\ eye\ images}$
FAR	Defines the probability of an individual being wrongly identified	$FAR = \frac{Number\ of\ Falce\ Acceptance}{Number\ of\ Imposter\ Person\ Attempts} \times 100\%$
FRR	Defines the probability of an individual not being identified	$FRR = \frac{Number\ of\ False\ Rejection}{Number\ of\ authorized\ Person\ Attempt} \times 100\%$
TSR	Defines the verification rate of the overall iris recognition system	$TSR = \left(1 - \frac{(FAR + FRR)}{Total\ num\ Access}\right) \times 100\%$
Recognition Accuracy	Determines the accuracy of recognition	$Accuracy = 100 - \left(\frac{FAR + FRR}{2}\right)$

5.0 Result

Below are the tables of three seven performance evaluation done. The performance is done at three different steps which are PSNR and RMSE after filtering process (refer Table 4), Localization Accuracy Test after localization step (refer Table 5) and lastly FAR, FRR, TSR and Recognition Accuracy Test at final step (refer Table 6).

Table 4 Result of analysis on reflection removal performance result

Filters	Median		Gaussian		Lee	
Category	*Performance Measurements*					
	PSNR	**RMSE**	**PSNR**	**RMSE**	**PSNR**	**RMSE**
Frontal	30.801	11.115	26.111	22.267	22.234	17.902
Right	30.832	11.926	26.331	21.754	27.130	10.085
Left	30.278	14.727	26.050	24.804	29.667	10.861
Upper	30.468	12.342	23.969	35.418	22.461	13.849
Average	**30.637**	**12.528**	25.615	26.061	25.373	13.174

Table 5 Result of analysis on iris localization

Criteria	Filters			
	Non Filter	Median	Gaussian	Lee
Total Correct Localization	76	94	91	92
Total Iris Image	135	135	135	135
Localization Accuracy	0.563	0.696	0.674	0.681
Percentage of Localization Accuracy (%)	56.3	**69.6**	67.4	68.1

Table 6 Result of analysis on iris recognition

Filters	FAR	FRR	TSR	Accuracy
Median Filter	6.38 %	29.79 %	**75.06 %**	**81.92 %**
Gaussian Filter	10.64 %	27.66 %	73.59 %	80.80 %
Lee Filter	8.51 %	36.17 %	69.19 %	77.66 %

6.0 Discussion

This section discusses all the result gained from the experiment. From the Histogram Image done, all the filters filtered image and change the pixel distribution pattern. These prove that filters do play their role in filtering the iris images. Frontal images do show big changes after filtered in pixel intensity distribution. The pixels tabulated are more towards the middle of the graph. For Lee filter perform in smoothing the image as for right, left, and upper category, the spike in the graph seem to be remove and smooth. Data tabulated for the graph of images using Median filter seem to be accumulated in the middle of the graph compared to original images. It is been prove by the graph intensity value as the concept of Median filter that sort all the pixels according to window size, then choose the median value and lastly change the value according to the neighbor. For Gaussian filter, it uses Gaussian distribution and random distribution to find the most optimal value or normal distribution. Thus, almost all the graph shows the same shape as original images.

Next, the performances of filters are validated by PSNR and RMSE. PSNR is the ratio between the maximum possibilities of corrupting noise that affect the quality of an image. The high value of PSNR would indicate the high quality of the images. While the RMSE test is done to give a view on how much error between two data. As for that, original images are used as the observed image while filtered images of the iris are used as predicted image. The lower the RMSE value, less error in between two images, thus better filter performed. Median Filter shows the best average value for both performances which are the highest PSNR value and the lowest RMSE value. Moreover, these three filters give the average of RMSE value less than 30 which means that error between original images and filtered images are less. These show that the filters do remove the reflection without causing errors to the pixel value.

To be further, analysis on localization step is done to determine the correctness of iris localization for limbic pupillary boundaries. Basically, the presence of reflection would affect the localization process as the iris boundaries were falsely detected. These due to the pixel value of reflection that prevents affect the localization of pupillary boundaries. However, three filters that act as reflection removals displays the good result compared to non-filtered iris images. The difference between Localization Accuracy of non-filter images percentages with all filter's percentage is more than 10%. This shows a good improvement to the current methods with an addition of reflection removals to remove the reflections especially by using Median Filter.

Lastly, the iris recognition is validated. First, the FAR and FRR values were calculated. FAR value is the probability of the iris recognition system identified the wrong person while FRR value is the probability of iris being rejected by the system. Next, the accuracy of iris recognition is calculated by using two tests which are TSR and Recognition Accuracy Test. TSR determines the rate of success recognition after removes the FAR and FRR while the Recognition Accuracy test computed the accuracy of the system itself. In this experiments, the calculation of FAR and FRR is based on the frontal category only. The reason is the frontal category gave the most circle iris shape which is much accurate than another category as other categories gave ellipse shapes which actually affect in template matching process as the template and mask produced not accurate.

From the research, Median filter shows the lowest FAR value which is 6.38% followed by Lee filter and Gaussian which are 8.51% and 10.64% respectively. However, the different

result goes to FRR where Gaussian filter perform the lowest which is 27.66% followed by Median filter (29.76%) and lastly Lee filter (36.17%). Nevertheless, either FAR or FRR can affect the result of TSR (Sim et al., 2014). Thus, the TSR value gets for Median filter is the highest compared to other. Gaussian and Lee filter also perform well by getting more than 50% of TSR value. While the accuracy value gained by these three filter are 81.92%, 80.80% and 77.665 respectively to Median filter, Gaussian filter and Lee filter.

The result of FRR is actually depended on the accuracy of template matching. Thus, more accurate template matching algorithm, the lower the FRR value gained. Same goes to the FAR value. False authentication value raises up if the algorithm of the template matching weak. Based on PSNR, RMSE and Localization Accuracy test, all filters implemented in iris recognition performs well. Median Filter performs better compared to Gaussian and Lee Filter in removing the reflection in the iris image. As reflection been removed well, the localization process would be excellent. Strong algorithms of template matching also bring to the best performance rate of iris recognition.

7.0 Conclusion

Implementation of filtering method as reflection removal at the first step of iris recognition improved the accuracy of iris recognition process. The filters did not remove all the reflection but the high pixels value that being recognized as reflection is filtered by the reflection removals. Based on the experiment done, the accuracy of recognition for Median Filter, Gaussian Filter and Lee Filter are 81.92%, 80.80%, and 77.66% respectively. As stated, Median filter is the best reflection removals compared to Gaussian filter and also Lee filter.

References

Anap M. B. and Vikhe, P. S. (2013). Advanced Security System for Iris Recognition.

Bodade R. M., & Talbar S. N. (2014). Iris Analysis for Biometric Recognition Systems. Springer.

Broussard R. P., Kennell L. R., Ives R. W., & Rakvic R. N. (2008, February). An artificial neural network based matching metric for iris identification. In Electronic Imaging 2008 (pp. 68120S-68120S). International Society for Optics and Photonics.

Divya R., & Vijayalakshmi V. (2015). Analysis of Multimodal Biometric Fusion Based Authentication Techniques for Network Security. International Journal of Security and Its Applications, 9(4), 239-246.

Kaushik P., and Sharma Y. (2012). Comparison of different image enhancement techniques based upon PSNR and MSE. International Journal of Applied Engineering Research, 7(11), 2010-2014.

Raffei A. F. M., Asmuni H., Hassan R., and Othman R. M. (2013). Feature extraction for different distances of visible reflection iris using multiscale sparse representation of local Radon transform. Pattern Recognition, 46(10), 2622-2633.

Sim H. M., Asmuni H., Hassan R., and Othman R. M. (2014). Multimodal biometrics: weighted score level fusion based on non-ideal iris and face images. Expert Systems with Applications, 41(11), 5390-5404.