# SEGMENTATION AND QUALITY ANALYSIS OF LONG RANGE CAPTURED IRIS IMAGE

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***Abstract***
***The iris segmentation plays a major role in an iris recognition system to increase the performance of the system. This paper proposes a novel method for segmentation of iris images to extract the iris part of long range captured eye image and an approach to select best iris frame from the iris polar image sequences by analyzing the quality of iris polar images. The quality of iris image is determined by the frequency components present in the iris polar images. The experiments are carried out on CASIA-long range captured iris image sequences. The proposed segmentation method is compared with Hough transform based segmentation and it has been determined that the proposed method gives higher accuracy for segmentation than Hough transform.***

***Keywords:***
***Segmentation, Quality Score, Long Range Iris Images***

## 1. INTRODUCTION

Due to the stability and high degree of freedom in texture [1] among the biometrics, the iris has been shown to be one of the most precise personalities for human identification. Most of the existing iris recognition systems require users to keep their eyes close to a camera, at close distance of few centimeters, to ensure images of good quality are captured. These systems will fail to work non-cooperative iris images which are captured at a long distance (more than 3 meters). The several research groups are working in facilitate iris recognition to be conducted in less constrained or non-cooperative environments, such as on the move and at a distance. Under non-cooperative environments, the acquired eye images can have specular reflection, occlusion, low contrast, closed eye and eye [2] may not be present in the image. In such conditions, the accuracy of the iris recognition methods [3] [4] will decrease. The precise localization of iris boundary is the key factor in increasing the performance of iris recognition.

A method to locate the pupillary and limbic boundaries using Hough transform is proposed by author in [5]. Integral-differential operator based method to detect limbic and pupillary boundaries was suggested by Huang [6]. Method using Canny edge detector to detect papillary boundary is proposed in [7]. The authors [8] [9] proposes model for iris segmentation in corrupted images. The authors [10] propose quality filter based a video-based non co-operative iris image segmentation method to eliminate images without an eye. A generic methodology is presented in [11] [12] [13] for the quality assessment of biometric image by combining information of image quality and pattern-based quality using the scale-invariant feature transformation (SIFT) descriptor. The author [14] proposes a quality of image by comparing the sharpness loss within regions of iris images against the blurred side of the same regions. This paper contributes two methods. First, an iris segmentation method to extract iris patterns from non-cooperative iris images captured at a distance, which is efficient and robust to specular reflection and variation in pupil sizes. Second, a novel approach is to select good quality iris image from a set of images.

Section 2 discusses iris segmentation method. A method to select good quality image is discussed in section 3. Section 4 discusses results and analysis, followed by conclusion in section 5.

## 2. PROPOSED METHOD

In this section, proposed robust iris segmentation and best quality iris selection algorithms, which are especially applicable for long range captured images is discussed. The basic goal is to correctly locate the pupillary boundary first, then based on the pupillary boundary, estimate the limbic boundary. The thresholding method can be used to locate the pupil, which makes the initial stage of the algorithm efficient and simple. The block diagram of the proposed iris segmentation and selection of best quality polar iris is as shown in Fig.1.

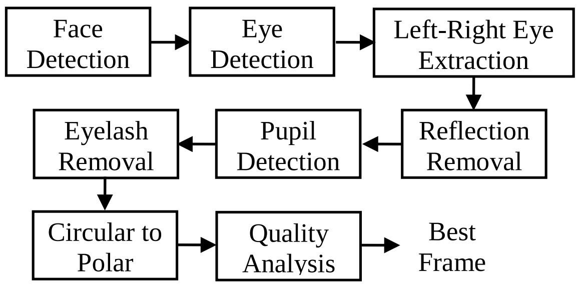



Fig.1. Block Diagram of Proposed Method

### 2.1. FACE AND EYE DETECTION

This block extracts face and eye by using AdaBoost-based [15] [16] face and eye-pair classifiers. This first detects the face region and eye-pair detector is applied on face region. This method improves the robustness to detect the eye region by releasing the region of interest at each level. The output of eye detector is processed further by classifying eye into right or left group. This classification is achieved by partitioning the width of the detected eye region.

### 2.2. SPECULAR REFLECTION REMOVAL

To achieve accurate iris segmentation result, the specular reflections have to be removed before the segmentation process. The proposed scheme reduces or removes strong specular reflections. The steps are as follows: first, apply the thresholding to locate the positions of specular reflections. Secondly, smooth the whole image by applying median filter to remove the boundary artifacts in an image.

## 2.3. PUPIL DETECTION

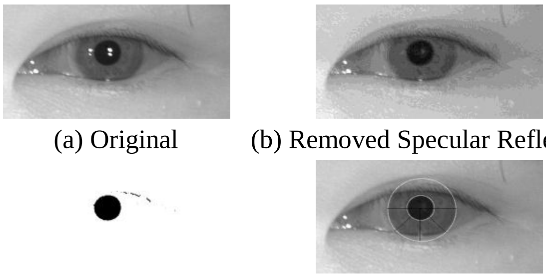
The pupil part in the eye contains more zero frequency components than other part of eye. The pupil is detected by the following proposed method.

- Apply the threshold to extract the pupil.
- Analyze the geometric properties like height and width of the connected components.
- Select the connected component which is having maximum width and height.
- Locate the center of the pupil.

## 2.4. IRIS EXTRACTION

The iris is a region between pupil and sclera. After locating center of the pupil, apply following steps:

- Draw few lines departing from the center of the pupil growing out radially to the sclera region as shown in Fig.2.
- Keep track of the variations in pixel intensity and the location where the intensity of pixels grows most rapidly should be the location where those lines hit the boundary as the sclera appears much brighter than the iris.
- Using fundamental geometry, the few known points from the boundary circle and compute the intersection of the perpendicular bi-sectors of the lines that pass through the pairs of those points.



(a) Original (b) Removed Specular Reflection

(c) Thresholding (d) Detected Iris

Fig.2. Iris detection

## 2.5. DETECTION AND REMOVAL OF EYE LIDS AND EYE LASH

The eyelid region is covered by eyelashes and the shape of the eyelids varies from one individual to another. This makes the localization of the eyelids even more difficult [2] [17] [18]. Iris images captured in non co-operative environments suffer from significant degradation making transition between the iris and eyelid region less distinct. Eye lids are detected by using region growing approach. Initialize the seed points, using the centre coordinates and radius of the iris calculated by above proposed method. Compare unassigned neighboring pixels to the initialized seed points and append to grow the region iteratively. The decision to add region to the growing region is based on the difference between the mean of the region and that of intensity value. If the difference between pixel intensity and region's mean exceeds a threshold, then terminate the procedure. The iris is a connected region and the intensity value can be used as the stopping rule. The following steps explain the removal of eyelashes:

1. Upper part of eyelid detected iris image is converted into polar form. Partition upper part of iris in $n$ blocks with size of $M \times N$ where, $M$ = width and $N$ = Height.
2. Select the block.
3. Find maximum and minimum of 3×3 neighborhood pixels.
4. Replace each pixel with the difference of maximum and minimum.
5. Select the next block.
6. Repeat steps 3 to 5.
7. Enhance the contrast and apply region growing algorithm.

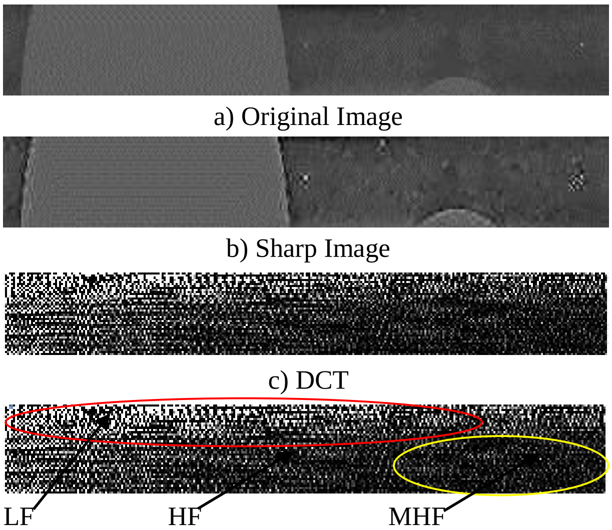
## 2.6 IRIS IMAGE QUALITY ANALYSIS

After the segmentation stage, the quality of iris region is measured. The iris frames with very low quality are discarded, while the others are kept for further processing. Then, normalize the iris region by Daugman's [19] conversion of circular to polar coordinate method. This normalization method is robust to disparity in size and pupil dilation. The quality of the captured image may degrade due to occlusion, change in intensity, Quality change, etc. It is required to select best quality image to set as the template and perform all other operations. The proposed algorithm uses Discrete Cosine Transform (DCT) to select the best quality iris polar image from the set of captured images. The DCT is used to represent the frequency component of image, since the image can be seen as 2D discrete signal. The basic idea is that, the quality of image can be decided by the ratio of high frequency component to low frequency component of DCT image. The proposed algorithm is as below,

1. Preprocess the polar image by applying spatial high pass filter.
2. Apply DCT and mask the DC component, which is the average intensity over the whole image.
3. Mask very high frequency to improve the performance of the proposed method.
4. $LS$ = Energy of low frequency components.
5. $HS$ = Energy of high frequency components.
6. Quality Score ($QS$) = $HS/LS$.
7. Image having low $QS$ represent the best quality image and high $QS$ represent low quality image.

# 3. RESULTS

In this work, CASIA-long range iris database is used for analysis of proposed approaches. It consists of 140 person's faces and 10 images of each person are available. The ages of the people span from 19 to 61. The proposed algorithms are tested for 200 images. Image resolution is 2352×1728. The quality of the few eye images are blurred and do not contain sufficient iris information. The resolution of the extracted iris polar image is 300×20. The algorithms are implemented using Matlab2009a on Intel Core i3 machine with processor speed of 1.8 GHz and RAM size of 4 GB. The average execution time is 0.7 seconds. The detection of pupil and iris using proposed algorithm is compared with Hough Transform ($HT$) as shown in Fig.4. It has been observed that proposed method is more accurate in iris segmentation than that of Hough Transform method for long range captured images.




d) Frequency Selection (LF-Low Frequency, and HF-High Frequency, MHF-Masked HF)

Fig.3. Frequency selection

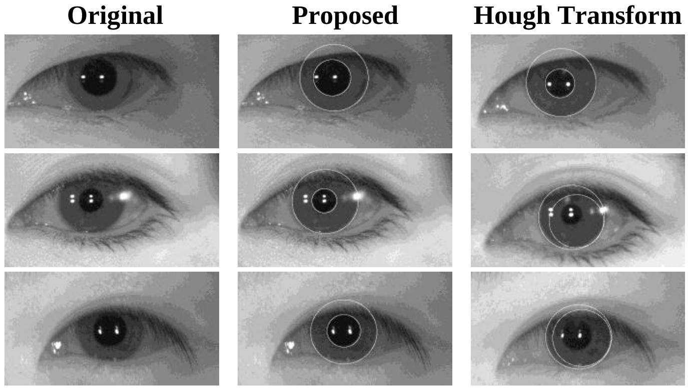



Fig.4. Comparison of proposed method with Hough Transform

The quality of images may degrade because of low contrast, noise, occlusion or unbalanced illumination. The proposed segmentation method is tested for low contrast (*LC*), noise (*N*), occlusion (*OC*) & unbalanced illumination (*UI*) degradation factors. The Fig.5 shows segmentation of iris image at various factors.

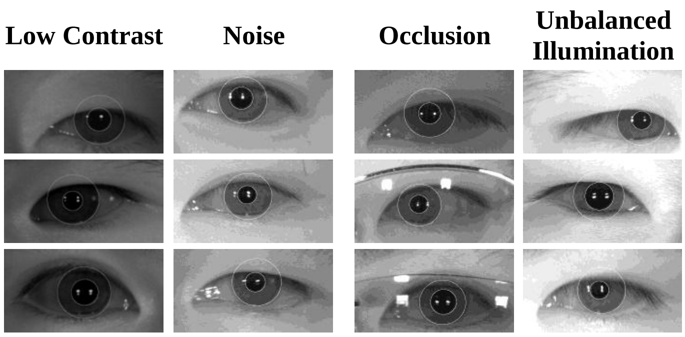



Fig.5. Segmentation for degraded images

The proposed method is compared with Hough transform for the image degradation factors, as show in Table.1.

Table.1. Segmentation Accuracy

| Method | Accuracy (%) | | | | |
|---|---|---|---|---|---|
| | **Standard** | **LC** | **N** | **OC** | **UI** |
| Proposed | 82.45 | 80.3 | 80.14 | 75.3 | 71.9 |
| HT | 69.67 | 65 | 68 | 61.7 | 63.2 |

From the Table.1, it can be seen that the proposed segmentation method is more accurate than the Hough transform. The proposed segmentation method gives more than 80% accuracy for non-degraded (standard) image. For the degraded images, the performance of proposed algorithm is not good but shows good accuracy compared to Hough transform approach.

The proposed image quality analysis algorithm selects best frame from a set of images of a person. The Fig.6 shows the QS of 3 people (3 images per person) polar images obtained using proposed algorithm.

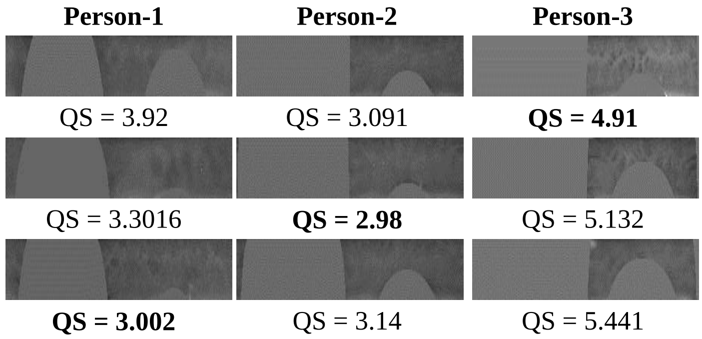



Fig.6. Quality Score

It can be seen that the lowest QS image contains maximum number of iris patterns. The QS of best frame for person-1 is 3.002, person-2 is 2.98 and person-3 is 4.91.

## 4. CONCLUSION

In this paper, long range captured iris image segmentation method by removing eyelid and eyelashes is proposed. The proposed segmentation method is compared with Hough transform based segmentation. It has been observed that the proposed method gives better segmentation accuracy than Hough transform based segmentation for various degraded iris images. The proposed eyelid detection and eyelash removal technique helps in accurate detection of eyelid and removal of eyelashes. This paper also proposed a method to select good quality iris frame from a set of images of a person. This method rejects the low quality frame and select only good quality frame which contains more information. This method helps to increases the recognition rate. In future, the work can be extended to recognize the person by using proposed methods.

## REFERENCES

[1] A.K. Jain, A. Ross and S. Prabhakar, “An Introduction to Biometric Recognition”, *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 14, No. 1, pp. 4-20, 2004.

[2] Yooyoung Lee, Ross J. Micheals, James J. Filliben and P. Jonathon Phillips, "Vasir: An Open-Source Research Platform for Advanced Iris Recognition Technologies", *Journal of Research of the National Institute of Standards and Technology*, Vol. 118, pp. 218-259, 2013.

[3] Kevin W. Bowyer, Karen Hollingsworth and Patrick J. Flynn, "Image Understanding for Iris Biometrics: A Survey", *Computer Vision and Image Understanding*, Vol. 110, No. 2, pp. 281-307, 2008.

[4] Y. Du, "Review of Iris Recognition: Cameras, Systems, and their Applications", *Sensor Review*, Vol. 26, No. 1, pp. 66-69, 2006.

[5] R.P. Wildes, "Iris Recognition: an Emerging Biometric Technology", *Proceedings of the IEEE*, Vol. 85, No. 9, pp. 1348-1363, 1997

[6] Ya Ping Huang, Si Wei Luo and En Yi Chen, "An Efficient Iris Recognition System", *Proceedings of International Conference on Machine Learning and Cybernetics*, Vol. 1, pp. 450-454, 2002.

[7] Yuanning Liu, Senmiao Yuan, Xiaodong Zhu and Qingliang Cui, "A Practical Iris Acquisition System and a Fast Edges Locating Algorithm in Iris Recognition", *Proceedings of 20th IEEE Conference on Instrumentation and Measurement Technology*, Vol. 1, pp. 166-168, 2003.

[8] Nitin K. Mahadeo, Andrew P. Paplinski and Sid Ray, "Model based Pupil and Iris Localization", *Proceedings of International Joint Conference on in Neural Networks*, pp. 1-7, 2012.

[9] Saiyed Umer and Bibhas Chandra Dhara, "A Fast Iris Localization using Inversion Transform and Restricted Circular Hough Transform", *Proceedings of 8th IEEE International Conference on Advances in Pattern Recognition*, pp. 1-6, 2015.

[10] Yingzi Du, "Video-Based Non-cooperative Iris Image Segmentation", *IEEE Transactions on Systems, Man, and Cybernetics-Part B: Cybernetics*, Vol. 41, No. 1, pp. 64-74, 2011.

[11] Mohamad El-Abed, Christophe Charrier and Christophe Rosenberger, "Quality Assessment of Image based Biometric Information", *EURASIP Journal on Image and Video Processing*, Vol. 3, No. 1, pp. 1-15, 2015.

[12] Nathan D. Kalka, Jinyu Zuo, Natalia A. Schmid and Bojan Cukic, "Estimating and Fusing Quality Factors for Iris Biometric Images", *IEEE Transactions on Systems, Man, and Cybernetics Part A: Systems and Humans*, Vol. 40, No. 3, pp. 509-524, 2010.

[13] Nitin K. Mahadeo, Andrew P. Paplinski and Sid Ray "Automated Selection of Optimal Frames in NIR Iris Videos", *Proceedings of IEEE International Conference on Digital Image Computing: Techniques and Applications*, pp. 1-8, 2013.

[14] Craig Belcher and Yingzi Du, "Information Distance based Selective Feature Clarity Measure for Iris Recognition", *Proceedings of SPIE*, Vol. 6494, pp. 1-12, 2007.

[15] Gary Bradski, "The Opencv library", *Dr. Dobb's Journal*, Vol. 25, No. 11, pp. 120-126, 2000.

[16] Unsang Park, Raghavender Reddy Jillela, Arun Ross and Anil K. Jain, "Periocular Biometrics in the Visible Spectrum", *IEEE Transactions on Information Forensics and Security*, Vol. 6, No. 1, pp. 96-106, 2011.

[17] Zhaofeng He, Tieniu Tan, Zhenan Sun and Xianchao Qiu, "Robust Eyelid, Eyelash and Shadow Localization for Iris Recognition", *Proceedings of 15th IEEE International Conference on Image Processing*, pp. 265-268, 2008.

[18] Kevin W. Bowyer, Karen Hollingsworth and Patrick J. Flynn, "Image Understanding for Iris Biometrics: A Survey", *Computer Vision and Image Understanding*, Vol. 110, No. 2, pp. 281-307, 2008.

[19] John Daugman, "How Iris Recognition Works", *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 14, No. 1, pp. 21-30, 2004.