

Iris Localization and Segmentation for Less Constrained and Non Ideal Iris Images

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Abstract – Recognition of iris is one of the fastest identity verification systems. The accuracy of the iris recognition system is also better in comparison of other biometric traits like fingerprint, voice, hand etc. Because of its increased accuracy and uniqueness, it is used in areas which are very security sensitive, medical field, industrial area. The most important process in iris recognition is iris localization because it extracts part of iris which is valid. Iris images are often acquired under less constrained environment which includes near infrared illumination, bad lightning conditions, reflection. The images captured also have noise due to eyelids, eyelashes, eyeglasses. This creates the problem in iris localization and hence decreases accuracy. The goal of this paper is to discuss the literature of recently proposed methods in iris localization and also to compare the performance of these techniques.

Keywords: Iris localization, less constrained environment, non-ideal data, accuracy in pupil and iris localization, a comparison in performance evaluation of different methods.

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I. INTRODUCTION

Reliable recognition of individuals is required at public [1] and government sectors; for example; airports, medical field, border areas. Biometrics tends to accurately recognize each person using physiological or behavioral characteristics [5] which include face, fingerprints, iris, retina, speech recognition. Choice of a feature for biometrics is crucial. There are several elements that can make an impact on this choice which is uniqueness, universality, social acceptance. In this context, the stability and accuracy [14] of iris recognition makes it the most important biometric trait. Every Iris is perfectly distinctive. Even an individual's right and the left iris is different. Another important factor is the stability of iris. Other biometric traits such as fingerprint, facial recognition, hand geometry changes over time. Iris is a thin circle that stretches across the eye's interior portion. The initial stage is iris segmentation which deals with localizing the iris inner and outer borders. The framework from capturing the iris image to its matching is represented in Figure 1. Highly accurate and stable iris recognition requires capturing the image under constrained environment [1]. Full cooperation of the subject is also required. Capturing the image under constrained environment works in a controlled way, such as subject is very close to the camera, wearing no sunglasses [10] or contact lens and also directly sees into the camera. Non ideal data is captured in an unconstrained environment which contains noisy images due to heavy iris occlusions by blurring, non-

uniform illumination, low contrast, eyelids, eyelashes, glass and contact lens. As a result, localization of iris is a challenging task as any inaccuracy can affect the performance of iris recognition.

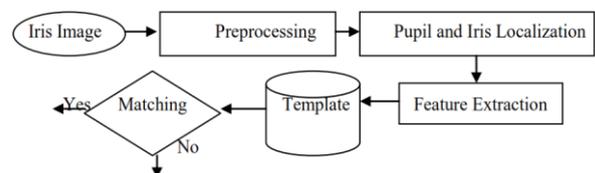


Figure 1 Framework of Iris recognition

Daugman's [2,3] and Wildes' [14] proposed iris recognition methods under constrained environment and for ideal images. Iris localization was based on integro-differential operator technique and circular hough transform. In the next step, the localized iris part was translated into the polar coordinate system. This is called normalization. Based on the extraction of features, approaches used in iris recognition can be separated into three classes: Phase based methods, Zero crossing method and Texture analysis based method. Final stage involves matching between iris image which is normalized and the iris stored in the template, producing dissimilarity value. If there is no match, the image belongs to different subject [10] otherwise if there is a match then both images belong to the same person.

Over the last years, a vast amount of research has been focusing on iris localization and it is considered as a pre-processing step in recognition of iris. Number of iris localization procedures and techniques has been proposed. In this paper, a literature review is made on the recent methods used in iris localization under less constrained environment based on CASIA [15] iris image database V3.0, MMU1 database [16] and their results are compared.

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2. LITERATURE REVIEW

This review paper comprises the iris localization methods under a constrained environment and also less constrained environment and non-ideal data.

2.1 Iris localization under constrained environment and ideal data

From 1992 to 1994, John Daugman [2,3] proposed the first approach in iris recognition system. Daugman [2,3] uses integro- differential operator to segment the center coordinates and radius of iris and pupil region. Eyelids can also be localized using this method. Rubber Sheet approach was used by Daugman [2,3] to map a pixel of iris from Cartesian coordinates into well-defined polar coordinates.

Gradient based edge detection approach was used by Wildes [14] and the image of iris was localized by using hough transform approach derived from inside limbus. Part of iris image which is below to upper eyelid and above to upper eyelid was localized. Wildes [14] uses an image registration technique for normalization.

Li Ma et al. [9] uses nearest feature line for localization. Iris upper and lower boundary can be taken as circles. The exact parameters were obtained by edge detection and hough transform. Li Ma et al. [9] used rubber sheet model and then iris enhancement and denoising for normalization.

2.2 Iris localization under less constrained environment and non-ideal data

F. Jan et al. [7] extracts inner contour of iris and localize iris image with circle approximation. Dark regions such as eyelids, eyelashes, hairs were localized by the approach of multi-valued adaptive threshold. After extracting iris inner contour, next

step is to localize iris outer contour. Apart from eyelids, eyelashes, glasses and below average contrast between sclera and iris, the eye images which are captured from long distance and rotating images of iris also create a big difficulty. Outer contour of iris was localized using edge detection in an image at pupil center. Specular reflection was also suppressed and integro- differential operator (IDO) was used to segment the outer and inner contours of iris. To speed up localization, scaling was used. Inner and outer contours of iris do not preserve any circular or elliptical mould, so these iris inner and outer contours need to be recompensated for their non-circular or non- elliptical shape. To achieve this, points were extracted having maximum radial gradients around the iris inner contours. They tested this technique on CASIA V 3.0 and similar other databases.

A novel method was proposed by Iman A. Saad et al. [11] for accurate and precise detection of the pupil having the ability to handle bad and unconstrained conditions due to below average contrast or to unvaried brightness because of specular reflection, eyelids and eyelashes. They started their work by enhancement of iris image for improving the bad contrast of devalued image. Contrast stretching approach was used to handle the variation in contrast and unvaried illumination in the image of iris. Eyelids, eyelashes and hairs which constitute the dark part of image were removed to improve the visibility of image. Local integration and image thresholding technique were applied on enhanced image for extracting wanted part of an image and to remove the noise in the image. Seed fill algorithm was used to assign the pupil having a circular black part that contains the largest area in the binary image. To find the initial pupil radius, pupil center was approximated. Then pupil was filled with black color to remove specular reflections which are a major cause of error in segmentation. They applied circle fitting algorithm to find the actual pupil radius and pupil center. More than 2655 images of iris were tested from CASIA Version 3.0 dataset.

Ning Wang et al. [13] proposed a novel iris localization and accurate approach in terms of performance for iris images which are very noisy. The first step was to remove the reflections and reflection spots caused by the glasses using Navier Stokes equations. The NS inpainting technique considers the image intensity function as the stream function. When the spots of reflections were filled, the next approach was used to identify pupil edge by probable boundary edge detection. A more principled approach was provided by this operator to identify edge of pupil which eliminates intrusion of inconsistent illumination and dark parts such as eyelids and eyelashes. Precise circle iris parameters are used to minimize the input space of hough transforms and localization accuracy of iris

was improved. A series of tests were conducted on CASIA-Iris-Thousand dataset.

F. Jan et al. [6] presented a reliable approach. Pupil boundary is localized by using a robust approach that depends on hough transform and gray level image approach to segment and localizes iris part in image of an eye. Specular reflections were suppressed prior to localize the iris. Histogram bisection that depends on bi-valued adaptive threshold was used to segment and localize the boundary of pupil. Next, hough accumulator was developed to localize limbic boundary and to improve the accuracy in localizing iris boundaries an efficient technique comprised of radial gradients and median filtering was used. The proposed approach was tested on the number of iris datasets like CASIA iris version3, CASIA version4 thousand, multimedia university (MMU) V1.0 and V2.0.

Yang Hu et al. [4] presented a new approach to enhance the stability and accuracy of color iris localization. Iris images were captured from mobile devices. Iris segmentation algorithm consists of 3 models, one of them is the circle model and the rest of the two is ellipse model. Iris region was localized that depends on correlated histogram of pixels. A model selection approach was introduced that define optimal localization that depends on ring shaped part throughout outer segmentation boundary recognized by these models. Histogram of oriented gradients distinguished between normalized ring shaped region of good and poor segmentation. SVM based classifier was trained to provide selection decision between good and poor segmentation.

Vineet Kumar et al. [8] proposed iris localization approach for the non-ideal images of iris. Iris localization was achieved by accurately identifying boundary of pupil and limbic. Edge map generation and circular hough transform technique were used for identifying the boundary of pupil. The edge map is produced on intersecting the two binary edge maps acquired using thresholding and sobel edge identification. For limbic boundary detection, adaptive CHT was proposed for circular arc identification on edge map. The adaptive CHT was found beneficial for those images of iris that is obstructed by eyelids, hairs, glasses and eyelashes. Various tests were conducted on CASIA-iris-thousand V4.0 and CASIA-iris-lamp V3.0.

Mousami Sardar et al. [12] proposed a novel soft computing technique for localizing the iris. A rough set entropy approach was used to precisely localize the pupil from non-ideal images of iris. First, the pupil is localized from iris image and then specular reflections are removed by morphological hole filling operations. Iris is localized using Circular Sector Analysis (CSA) and the iris-sclera boundary is detected. The idea of upper and lower estimation, from rough sets, helped to reduce segmentation errors.

3. PERFORMANCE EVALUATIONS OF VARIOUS TECHNIQUES

Table 1 show a comparison of various techniques used in iris localization and also shows the performance evaluation of methods based on accuracy and time taken.

Table 1 Comparison of Performance Evaluations of Iris Localization Method

Iris Localization Techniques	Performance Evaluation
Hough Transform[0]	Suitable for identification but not for recognition, lower matching rate.
Integro-differential operator[0,0]	Faster iris/pupil localization for ideal images, not working on non-ideal images
Nearest Feature Line[0]	Fast localization but not suitable for non-ideal iris images
Multivalued adaptive threshold and integro-differential operator[0]	Iris inner and outer contour localized, specular reflections were suppressed, localization was speeded up.
Contrast stretching, Seed Filling and Circle fitting[0] Probable boundary edge detection and hough transform[0] Hough transform, histogram bisection and eccentricity[0] Model Selection Method[0] Edge generation and adaptive circular hough transform[0] Rough Entropy and Circular Hough Transform[0]	Accuracy in pupil localization and satisfy real time constraints. High recognition performance for noisy iris images. Tolerance to non-ideal issues but accuracy decreases for an image of eye where pupil part is obstructed by covering of eyelashes Improvement in performance of color iris segmentation but drop in performance of segmenting iris images of mobile devices Accurate iris localization, minimal false edges caused by noise, reduced memory requirement Accurate method for non-ideal images

4. CONCLUSION

The physical characteristics such as iris, face, hand, patterns of finger vein and voice are unique

to the individual. This paper discusses a review of the different existing method in iris localization under constrained and less constrained environment. The non-ideal images of iris and constrained environment badly influence the accuracy and performance of recognizing iris. From this literature survey, it is noticed that almost all of the researchers does not meet the accuracy in iris localization under less constrained environment and noisy images. From the performance evaluation of techniques used by various researchers, it is being noticed that there is still a lot of work is required to be done to localize non ideal iris images under less constrained environment.

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