COMPARE THE TECHNIQUES FOR IRIS LOCALIZATION

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ABSTRACT: *Iris is a desirable biometric representation of an individual for security-related applications. However the iris segmentation process is challenging due to the presence of eye lashes that occlude the iris.Iris localization is an especially important step in the whole iris recognition system, for it determines the accuracy of matching partially. To find a fast, effective and exact iris localization algorithm is the key step of iris recognition. In this paper, compare the different techniques for iris localization. In this paper also, compare processing time of Daugman method and circular hough transfer method to locate the iris by using Microsoft Visual Studio 2010 . In Microsoft Visual Studio 2010,we have implemented algorithm by using c# language.*

Keywords- **Biometric Identification, Iris Recognition, iris segmentation, Integro-differential operator, Circular Hough Transform**

1. INTRODUCTION

Biometrics is the science of automated recognition of persons based on one or more physiological or behavioral characteristics. Biometrics is widely used in many applications, such as access control to secure facilities, verification of financial transactions, welfare fraud protection, law enforcement, and immigration status checking when entering a country. There are many possible biometrics methods include face, fingerprint, iris, hand shape, gait, signature etc. There has been a rapid increase in the need of accurate and reliable personal identification infrastructure in recent years, and biometrics has become an important technology for the security. Iris recognition has been considered as one of the most reliable biometrics technologies in recent years. First, Daugman has proposed an operational iris recognition system in 1994 [1] at Cambridge university. The human iris is the most important biometric feature candidate, which can be used for differentiating the individuals.The iris is so unique that no two irises are alike, even among identical twins, in the entire human population. Iris-based recognition system can be noninvasive to the users. The iris is an internal organ as well as externally visible, which is of great importance for the real-time applications.

In general, the process of iris recognition system consists of:(i) Image acquisition, (ii) Iris localization (iii) Image normalization (iv) Iris Feature extraction and (v) Iris matching

Compared to other biometric systems, iris recognition has been in the limelight for high-security biometric applications.

The first step of Iris recognition consists of images acquisition. This step is one of the most important and deciding factors for obtaining a good result. A good and clear image eliminates the process of noise removal and also helps in avoiding errors in calculation. The part of the eye carrying information is only the iris part and it lies between the sclera and the pupil. Hence the next step is separating the iris part from the eye image. Iris localization is an especially important step in the whole iris recognition system, for it determines the accuracy of matching partially. Once the iris region is segmented, the next stage is to normalize this part, to enable generation of the iris code and their comparisons.

2. IRIS LOCALIZATION METHODOLOGIES

Iris localization is used to separate out the iris part from the eye image. This step is to detect the inner (iris/pupil) boundary and the outer (iris/sclera) boundary in the original image.

Daugman[1] presented one of the most relevant methodologies, constituting the basis for many functioning systems. In the segmentation stage, this author introduced an integro-differential operator to find both the iris inner and outer borders. An automatic localization algorithm based on the circular Hough transform is employed by Ma et al. [2] and C.M.Patil[3]. Lili Pan and Mei Xie[4] proposed a new iris localization algorithm base on edge points detecting and curve fitting. In 1999, Ritter proposed a method based on the concept of active contour models [6]. The method is a circular active contour, which searches for pupil and limbus boundaries by finding the equilibrium of two defined forces: internal forces and external forces.

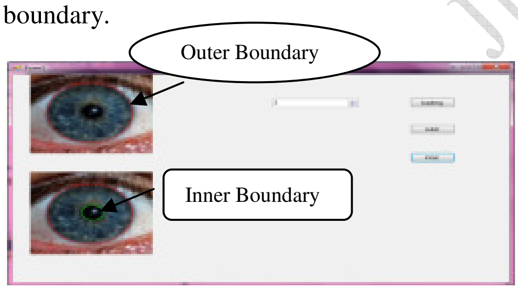
i) Iris Localization Using Daguman's Method

Daugman proposed the use of the Integro-differential operator to detect the boundaries and the radii. Integro-differential operator is given by

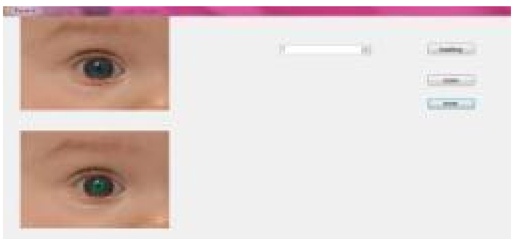
$$max_{(r,x0,y0)} \left| G_\sigma(r) * \frac{\partial}{\partial r} \oint_{r,x0,y0} \frac{I(x,y)}{2\pi r ds} \right| \quad [4]$$

Where * denotes convolution and $G_\sigma(r)$ is a smoothing function such as a Gaussian of scale σ the complete operator behaves in effect as a circular edge detector, blurred at a scale set by σ ,that searches iteratively for a maximum contour integral derivative with increasing radius at successively finer scales of analysis through the three parameter space of centre coordinates and radius (x0,y0,r) depending the path of contour integration.

In image, take one pixel $P_1(x,y)$ as center and construct first circle with radius r1. Find out circular Average Intensity. Secondly, again construct circle with same centre but different radius r2 and find circular Average Intensity. Then Calculate Circular average Intensity Difference between first and second circular and Check this Circular average Intensity Difference is greater than max threshold or not. If this Intensity Difference is greater, then set this Intensity Difference as max threshold. Change center and radius value if there is no end of image. Thus, these tasks can be accomplished for row input image $I(x, y)$ by Integro-differential operators that search over the image domain (x, y) and find out maximum difference point, accordingly it find out center and radius of iris and separated iris part from the scalera. Repeat same process for finding papillary boundary.

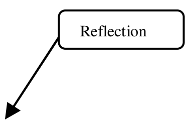


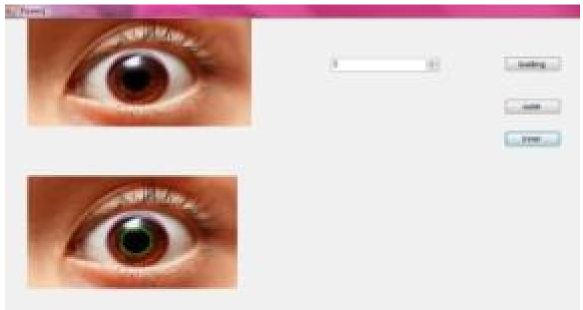
(a)



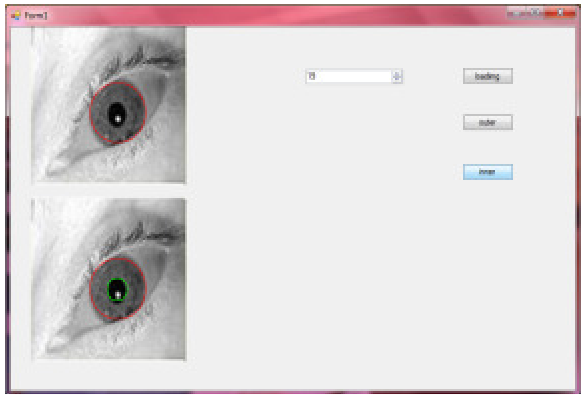
(b)

As shown in Fig1.(a) and Fig1.(b), Integro-differential operator can successfully detect the outer and inner boundary of iris although size of iris is different from.





(c)



(d)

Fig1.Implementation Results of Iris localization using daugman's method (a),(b),(c)&(d) on different eye image

As shown inFig1.(c) this algorithm can also detect the outer and inner boundary of iris successfully in presence of reflection in eye image. In Fig1.(d) even though in Eye Image, upper and lower part of iris is covered by eyelid, iris successfully localized.

***ii)* Iris Localization using circular hough transform**

The Hough transform is a feature extraction technique used in image analysis, computer vision, and digital image processing. The purpose of the technique is to find imperfect instances of objects within a certain class of shapes by a voting procedure. This voting procedure is carried out in a parameter space, from which object candidates are obtained as local maxima in a so-called accumulator space that is explicitly constructed by the algorithm for computing the Hough transform. The Hough transform can be described as a transformation of a point in the x,y-plane to the parameter space. The parameter space is defined according to the shape of the object of interest. The circle is actually simpler to represent in parameter space, compared to the line, since the parameters of the circle can be directly transfer to the parameter space.

The equation of a circle is

$$r^2 = (x-a)^2 + (y-b)^2$$

As it can be seen the circle got three parameters, *r, a* and b. Where a and b are the centre of the circle in

the *x* and *y* direction respectively and where *r* is the radius.
The parametric representation of the circle is

$$x = a + r\cos\theta \quad \& \; y = b + r\sin\theta$$

Thus the parameter space for a circle will belong to R^3 whereas the line only belonged to R^2. As the number of parameters needed to describe the shape increases, as well as the dimension of the parameter space *R* increases, so do the complexity of the Hough transform. Therefore, the Hough transform in general is only considered for simple shapes with parameters belonging to R^2 or at most R^3 . In order to simplify the parametric representation of the circle, the radius can be held as a constant or limited to number of known radii. The process of finding circles in an image using CHT is: First we find all edges in the image. This step has nothing to do with Hough Transform and any edge detection technique of your desire can be used. It could be Canny, Sobel or Morphological operations.
Sobel & Prewitt edge detection perform a 3 X 3 matrix multiplication operation upon all the pixels on the image and their complexity is width * height * 3 * 3. But my method of edge detection finds the difference among the neighbouring pixels and if any difference is greater or equal than the threshold value (normally 100), then consider them as an edge and its complexity is width * height. If we increase the threshold value, then edge will decrease, and if threshold value decreases, then the edge will increase. So, there is an inverse relation among the edge and the threshold value. But in sobel & prewitt, we cannot increase or decrease the edges. For different image, sometime, we need to increase or decrease the edges.
Each pixel has 8 neighbours. If pixel co-ordinate is x & y. Then its neighbouring pixels are (x+1,y+1), (x,y+1), (x+1,y), (x-1,y-1), (x,y-1), (x-1,y), (x-1,y+1) & (x+1,y-1). The color difference of two pixels means RGB difference among the two pixels. In my method of edge detection, 1st takes a bitmap whose height & width is similar to the original image and the color of all its pixels is Black. Then for each pixel of an image, it determines the color difference, of its neighbour's pixels. If any neighbour's color difference is greater or equal than the threshold value, then it is an edge & gives the pixel value White. Normally threshold value is 100. But if we are increasing the threshold value, then the edge will decrease and if the threshold value decreases then the edge will increase.

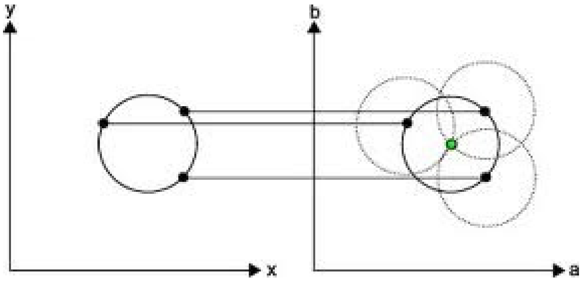


Fig.2.Circular HT from the x,y-space (left) to the parameter space (right), for a constant radius

After finding edge detection point, At each edge point draw a circle with centre in the point with the desired radius. This circle is drawn in the parameter space, such that our x axis is the a-value and the y axis is the b value while the z axis is the radii. At the coordinates, which belong to the perimeter of the drawn circle, we increment the value in our accumulator matrix, which essentially has the same size as the parameter space. In this way, we sweep over every edge point in the input image drawing circles with the desired radii and incrementing the values in our accumulator. When every edge point and every desired radius is used, we can turn our attention to the accumulator. The accumulator will now contain numbers corresponding to the number of circles passing through the individual coordinates. Thus the highest numbers (selected in an intelligent way, in relation to the radius) correspond to the center of the circles in the image.

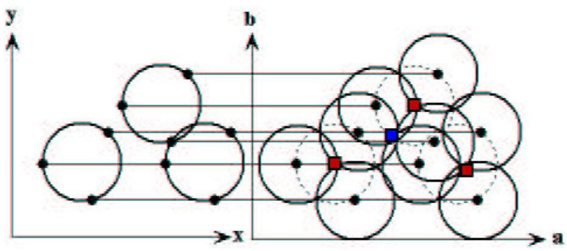


Fig.3 Each point in geometric space (left) generates a circle in parameter space (right). The circles in parameter space intersect at the (*a, b*) that is the center in geometric space

Multiple circles with the same radius can be found with the same technique. The centre points are represented as red cells in the parameter space drawing. Overlap of circles can cause spurious centres to be found, such as at the blue cell. Spurious circles can be removed by matching to circles in the original image. Implementation Result of Localization using Circular Hough Transform method is shown in Result 1,2 &3.

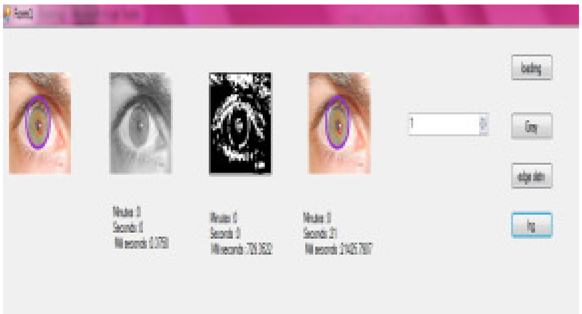


Fig.4(a)Implementation result of iris localization using hough transform when Threshold Value=100

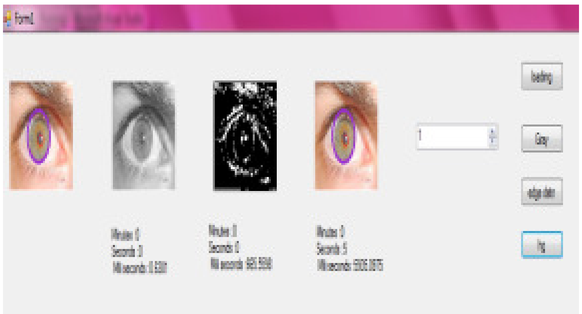


Fig.4 (b) Implementation result of iris localization using hough transform when Threshold Value=100

As shown in above fig4(a) and fig4(b),In both results, iris is successfully localized but localization processing time is different for both results. For edge detection we have selected different threshold value for fig4(a) and fig4(b).we can observe in above results that as threshold value increase edge point decreases and processing time is also reduce.

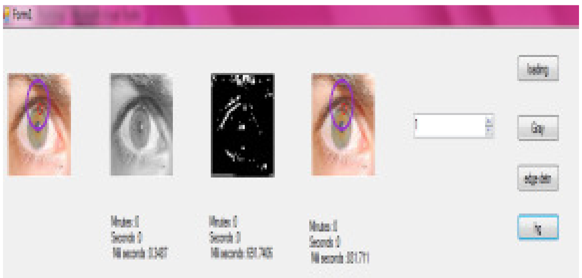


Fig4 (c) Implementation result of iris localization using hough transform when Threshold Value=180

As shown in above fig4(c),If we again increase threshold value processing time is reduced but boundary of iris is not detected because edge points are also reduced.

***iii)* Compare Processing time for of Integro-differential and Circular Hough Transform Method for Localization**

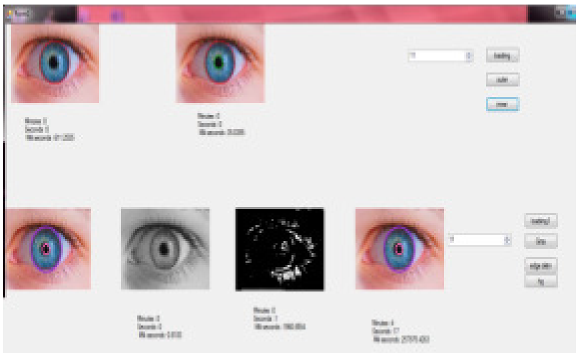
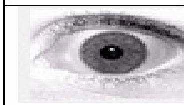
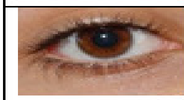
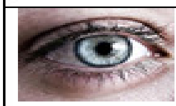
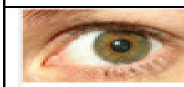
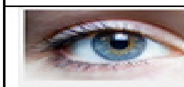
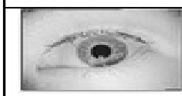


Fig.5 Compare the results of iris localization using integro-differential method and circle hough transform

As, shown in fig.5,Integro differential method takes less localization processing time(within millisecond) compare to circular hough transform method(takes 4 minute).

Input Eye Image	Localization Processing Time by Integro Differential method			Localization Processing time by circular hough transfer method		
	Min.	Sec.	millisec	Min.	Sec.	millisec
	0	0	169.57	2	1	121228.67
	0	0	148.49	0	21	21947.564
	0	0	131.18	3	27	207536.34
	0	0	117.81	0	16	16384.356
	0	0	83.183	0	10	10332.545
	0	0	83.074	0	19	19842.519
	0	0	116.77	2	7	127642.58

As shown in above table, We can also observe localization processing time for different eye images and conclude that integro differential method takes less processing time.

3. CONCLUSION

In this paper, compare the Integro-differential operator method and Circular Hough Transfer method for localization of iris using *Microsoft Visual Studio 2010 have been presented.* Integro-differential algorithm can successfully detect the outer and inner boundary of iris even though some part of iris is covered by eyelid and also in presence of reflection in iris. Iris is successfully localized by circle hough transform but there are numbers of problems with the Hough transform method. First of all, it requires threshold values to be chosen for edge detection, and this may result in critical edge points being removed, resulting in failure to detect circles/arcs. Secondly, the Hough transform is computationally intensive due to its 'brute-force' approach, and thus may not be suitable for real time applications.

we have also compared localization processing time for both methods and conclude that Integro-differential method takes less processing time(within millisecond) compare to circular hough transfer(takes minute).

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