A Review on Localisation Techniques in IRIS Recognition System

Rohit Jain

Abstract-**A review work is presented on the important works done so far for iris localisation techniques in the iris recognition system. Iris localisation is the first step in the recognition system so if the image is mislocalized then the complete normalization and processing is not worthy. The review has been done from as early work of Richard .P. Wildes [3],1997 based on circular Hough transform to the work by Ghassan .J. Mohammad [5] of 2009 based on Angular integral Projection Function(AIPF) through the advance of J. Daugman principles in 2002,2005 and 2008[1],[2].**

Categories and subject descriptors-

[Biometric signal processing]:Advanced signal processing, biometric recognition, iris recognition.

Keywords

Iris recognition, Localization, Specular Highlights, AIPF method. Hough transform

PAGE LAYOUT

Section 1 provides an introduction and a motivation theory behind iris recognition which is then sub sectioned further in explaining the first two steps in the overall iris recognition system. Section 2 focuses on the various challenges in different iris localization techniques. Section 3 highlights the different works previously done in localizing the iris. The next section i.e section 4 provides a tabular comparison of important works done. The last section 5 concludes stating the importance of J. Daugmans work and proposing an improvement model with AIPF methodology.

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1 . INTRODUCTION

Authentication is the damn requirement in today's technological world. The automated systems installed worldwide in various fields like banking, military, museums, various R&D labs of companies are to make sure that their money, equipments, antiques, researches and the important information they want to be in supreme protection For this purpose the conventional methods were kind of automated systems which requires either passwords, key or some sort of cards as used in ATMs. The problem with these security methods are a person sometimes forgets the key or password, may be some one can guess or by hit and trial the passwords may match. Similarly cards can also be stolen or misplaced. With the use of biometric information as the recognition parameter ensures that unless and until the person is not present the access will not be allowed in any case. And also then there is no point of misplacing and forgetting.So the authentication standards are improved with a more user friendly ,fast and accurate add .In biometrics domain there are other methods also like face recognition,fingerprint,voice recognition but the iris exceeds these in terms of its unique physical part easily accessible with maximum information.The image of iris can be easily verified at long distance in no time as well.

1.1 *Iris Recognition*

Now in biometric recognitions there are various others as likes of fingerprint, voice, facial etc. To understand and appreciate the richness of iris as a pattern it is important to have a look on structure of iris[3]The visual appearance of iris is the result of its multilayered structure. For the detailed information on structure of iris the additional biometric literature can be read[4],[5].

Iris recognition is the application of signal processing in biometrics. The complete recognition system is shown in fig 1

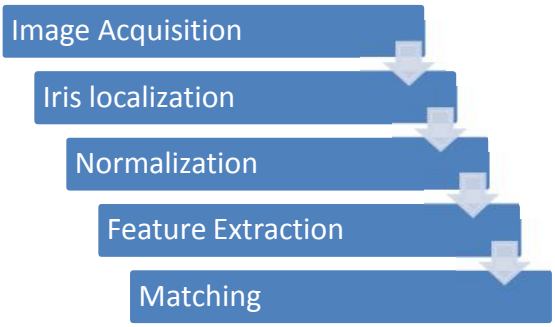

Fig 1.The Iris recognition system

1.1.1 *Image Acquisition-*

Acquiring the image for analysis is an important as the image should be clear with least noise in it .The noise in image acquisition can be due to eyelid and eyelashes occlusion that may occur meanwhile the image is taken. These noises create problem in different localization techniques as well[1][2][3][5].Devices embedded with near infrared light which can resolve minimum 50 pixels in iris radius. There are three kinds of bad quality of iris image. They are defocused iris image, motion blurred iris image and occluded iris image.[6] CASIA, MMU1 and MMU2 are the sources for sample iris images for research purposes.fig 2.These sample images are the first step images which are then given to the localization step which than in this image locates the iris by finding its inner and outer boundary and hence eliminating the rest of the image .The final image after localizing is as shown in fig.3 which has only iris portion in it.

Fig 2 Sample iris images from CASIA

1.1.2 *Iris localization*

After an iris image is acquired the next step in the recognition process is to iris localization that is to locate the iris. In this step the inner radius and outer radius of iris is located and hence the portion of iris which contains the information required for the recognition purpose is extracted from it. From the iris image as shown in fig.2 the localised iris image looks as in fig 3

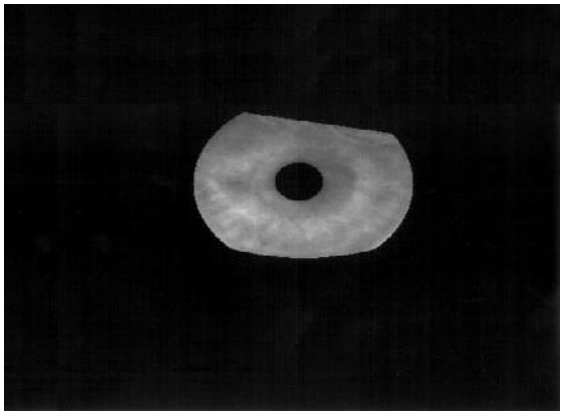

Fig 3 The localised iris image [3]

Now since it has been explained what is there with us before localization step i. e the iris image and what we have after localization step as in fig 3 it seems interesting But there are some challenges in the localization of iris. The next section highlights the challenges faced by different researchers in iris localization process. These are challenges on which different researchers are working out to find methods to overcome. The challenges includes the kind originating from image acquisition step like specular highlights to the kinds of which originates by the eye movements of the person in test. One major challenge is the constrained systems as explained in further detail in next sections.

2 CHALLENGES IN IRIS LOCALIZATION

2.1 *single static threshold fails*

The captured gray scale image is analysed for locating the iris inner and outer radius[1] .By implementing the algorithms[1][3][4][2] which try to find these radius on the basis of change in colour density or intensity fails on the mark that doing so in a global perspective increases the time since the global search for intensity is done. So a single static threshold fails to binarize the captured gray scale iris images with different illuminations. So setting a single threshold has a limitation because the location of iris is not same in different acquired images which causes in the increase in the time of localizing iris boundaries. Daugman [1] proposed a localization technique with integro differential operators for locating the radius which was based on finding the boundaries of iris by scanning for the intensity in gray scale image of iris.

This is somewhat overcome in the work by authors in [7] Maitree Dutta by conditioning the Daugman's principle for a specific image resolution and also conditioning the location of iris in image by fixing the axis. So the problem is

prevented at the image acquisition stage itself. But still that makes the unconstrained image acquisition not possible.

2.1.2 *Iris occlusion-*

Another challenge is that sometimes eyelid and eyelashes causes the occlusion of iris which then makes it very difficult to localize the iris in that kind of image. Authors in [8] Ghassan.J.Mohammad have proposed curve fitting algorithm based on Angular Integral Projection Function(AIPF) which is to overcome the occlusion problem in iris image during localization. Since in an occluded image a clear iris picture is not available it is required that the image should be taken with precaution. The occluded iris is shown in fig 3.[3] If the iris is occluded either by eyelashes or by eyelids the complete iris is not in picture which makes the localization as well as the feature extraction step very difficult to make. Since their will not be lot of information needed to make the decision the system can give the faulty results in this case. Therefore researchers are working so that an algorithm can be made to tackle these issues in recognition systems.

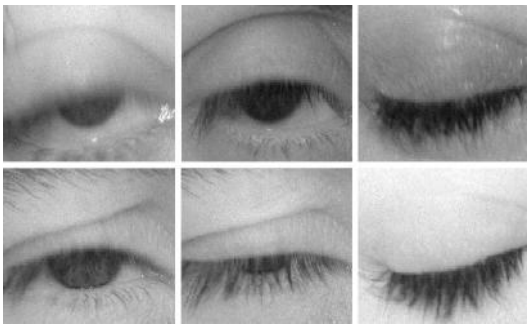

Fig 3 Example of occluded iris

2.1.3 *Specular highlights*

This is yet another challenge which also comes from the image acquisition stage. Specular highlights are the areas of bright light spots which comes on the iris image when flash of the camera or sometimes some other light falling on eye comes into picture.fig 4 shows the images showing specular highlights on iris

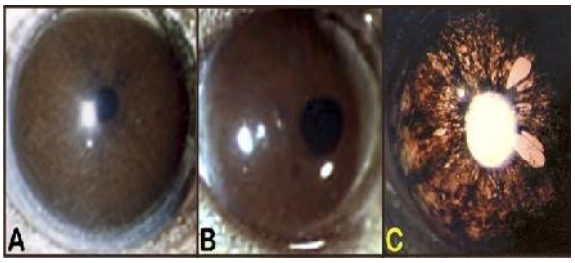

Fig 4 Images A, B and C with increased specular highlights effect

These specular highlights acts as a noise spot during localization[2][5].During intensity analysing these spots confuses whether the iris boundary is here or not. Hough's Transform used by Wildes [3] faces a similar problem .Therefore another work was proposed by authors in[9] provided an improvement to Hough transform for circle to restrict votes for direction of edges.

2.1.3 *Need for unconstrained system*

A automated system with whatever power will be appreciated only if it is user friendly.Similarly way the iris recognition system researchers are looking after an unconstrained system.Normally during image acquisition procedure the person is constrained to take a clear image axis are set to make iris at centre.But the better work will be that which allows the person to be free.The caution is taken because the gaze of a person cannot be cantered in an unconstrained situation.

3 PREVIOUS WORK

Very inspiring and diversified works have been done in this domain. The work done by J.Daugman[1] based on the integro differential operator is very important of its kind which uses this operator and first locates the pupillary and limbic boundaries of the iris using the operator that finds the circle in the image where an intensity is changing most rapidly with respect to changes in the radius and once located, the iris image is converted to a Cartesian form by projecting it to onto a dimensionless pseudo polar coordinate system. With 249 degrees of freedom it is eminent that iris recognition based authentication can be done with a confidence[1].Daugman [1] presented the results with 9.1 million comparisons among different eye images required in trials in Britain, USA, Korea and Japan. Daugman with his statistical data and theory proved that iris recognition can be successfully implemented just by a test of statistical independence. as depicted in table1.He used the HD criterion for the iris recognition task.

HD criterion	Odds of false match
0.26	1 in 10^{13}
0.29	1 in 13 billion
0.32	1 in 26 billion
0.35	1 in 133000
0.36	1 in 28000
0.38	1 in 1780
0.40	1 in 170

Table 1 Cumulative giving false match probabilities with integer-o-differential operator method in[1]

But the limitation with this work was that the location of iris varies from image to image, so a global search for iris

reduces the speed of localization step. Work proposed by the authors Maitree Dutta in [7] is an effort to outrank this limitation by conditioning the Daugman's principle. The condition was imposed such that the image taken should be in 320*280 resolution and the eye should be in almost perfect horizontal and Vertical centre along x axis & y axis[7].The accuracy of the recognition increased with this improvement work. Daugman's algorithm was not found good [7]when the images were unclear or are diffused. Authors have also proposed an advancement to the algorithm used by Li Na in [9] which first access the quality of each image in the input sequence and select a clear iris image from such a sequence for subsequent recognition. An alternative solution to J.Daugman's mathematical algorithm for feature extraction is also proposed in [10] which has proposed two innovative changes in localization and feature extraction stages of iris recognition system. But the use of dimensionless polar coordinates and Hamming distance is not disturbed and kept same as done in[10].

W.W.Boles and Boashash[11] have proposed a wavelet transform based work. The algorithm for extracting the unique features from the iris image is fully based on Wavelet transform zero crossing representation. A wavelet function that is the first derivative of a cubic spline is used to construct the representation .Performance of partial iris identification is analysed using the one dimensional LTP approach by Yingi Diu in[12]

A very well known work is done by Richard.P.Wildes [3], The Wildes algorithm locates the iris boundaries by creating a binary edge map using gradient-based edge detection, and then finds the centres and radii of these circles using Hough Transform. The upper and lower eyelids are located similarly using parabolic arcs. Rater than map every iris image to a common system of polar coordinates, the Wildes algorithm compare the two images by geometrically wrapping one image, via shifting and rotation, until it is best fit with the other image, in the sense of minimizing mean square distance[3] A Laplacian pyramid is constructed at four different resolution levels to encode the image data and then the matching is achieved via an application correlated and fisher's linear discriminant. A limitation to the Hough transform is that the location of outer iris boundary becomes difficult because of the edge pixels. Edge pixels which are not from the iris boundary often cause the Hough transform to find incorrect iris boundary [13].Liu in his work[13] have provided an improvement over Hough Transform for circle to restrict votes for centre location based on direction of edges. The pictures in fig 5 and fig 6 depicts the improvement. The detection of outer radius then becomes a much easier by reducing the number of edges. The Hough transform works on a voting criteria to detect a figure in an image ,reducing the edges means reducing those votes so that it does not detects a wrong circle as the outer radius of iris.

Year	Author	Approach	Remarks
1997	Richard P wildes..[3]	Edge detection & circular Hough Transform	94.02% on good data set & 93.81% on noisy data set
2002	J.G.Daugman..[1]	Integro differential operator	overall 95.8% (98.5% for subjects without glasses and 64.6% for subjects wearing glasses)
2005	Dr.(Ms) Maitryee Dutta ..[2]	Conditional Daugman Principle	97%(correct result matching)
2006	Xiaomei Liu..[4]	Improved Hough Transform	97.08%
2008	J.G.Daugman	Gabor wavelet Transform	Basis of all commercially available iris recognition systems 98.02% Min time 1.1 s
2009	Ghassan J. Mohammed[5]	Angular Integral Projection function (curve fitting)	Min time 0.33s Max time 0.66s

Table 2 Comparisons of different works

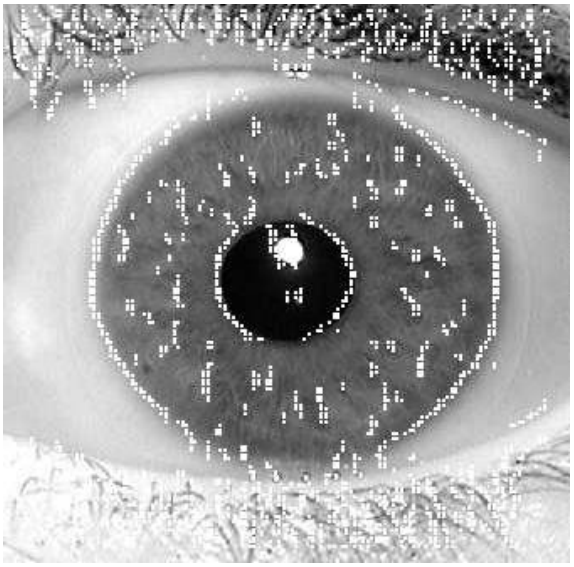

Fig 5 Before reducing edge points in Hough Transform[13]

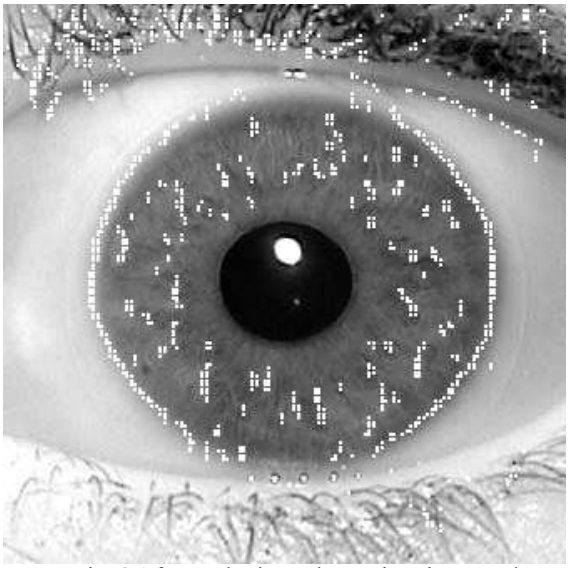

Fig 6 After reducing edge points in Hough transform.[13]

Authors in [8

] use methods which overcomes the drawback of traditional iris localization approaches that are affected by eyelid occlusion and are time consuming. This method uses boundary point detection and curve fitting, In the process the approximate pupil size is obtained and using AIPF two sets of radial boundary is detected for inner and outer radius. The iris boundaries are achieved by fitting a circle for each of the two obtained sets. The next action explains the comparison of the different work for the localization purpose.

4. COMPARISON

A comparison on the important work done in the various localization techniques is tabulated in the table 2.Which compares the accuracy percentage with year of publications of work and the algorithms used by various authors .J.Daugman's work is of vital importance in the field of biometrics specially in the iris recognition domain. His work based on Gabor wavelet transform is the basis for commercially available iris recognition system. Also is important the work done by Wildes [3] using Hough transform.

5. CONCLUSION

It can be concluded that J.Daugman's principle [1]is basis for many other works. The Hough transform alone is not successful in finding the outer radius of iris but has an improvement with reducing the number of edges[13].The Daugman's work on Gabor wavelet transform can be improved if AIPF(Angular Integral Projection Function) is used .The AIPF function has a better time of localizing time within 0.33 seconds[14].Also one of the major challenge of eyelid and eyelashes occlusion of iris image is removed by AIPF method.

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