IRIS Recognition by Daugman's Method

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Abstract- **In today's advanced era it is needed to design the system which will give highly accurate results regarding biometric human identification. Iris recognition is considered to be the best biometric human identification system. Daugman's method for iris recognition is considered as the efficient & accurate iris recognition system as per previous research. This technique is discussed in detail in this paper.**

Keywords— Daugman's Algorithm, Daugman's Rubber Sheet Model, Hamming Distance, Iris Recognition segmentation, normalization.

I.INTRODUCTION

In the case of iris recognition as the iris is located at a remote area of eye it is impossible to be copied & main feature of iris is it unique for every individual .Iris pattern of every person is different even the iris of two eyes of the same person are different hence it is ideal feature for recognition. So iris recognition is considered to be most reliable among all existing techniques of biometric recognition.

There are many techniques for iris recognition such as by using combined multi scale method, DCT based method, neural network method, eyelash removal method, Daugman's method. Among all of these methods we have selected Daugman's method for the iris recognition. According to previous research it is considered to be more efficient, accurate & reliable as compared to other existing methods.

The concept of the Iris Recognition was firstly proposed by Dr. Frank Burch in the year of 1939. It was successfully implemented in the year of 1990 when Dr. John Daugman created the algorithms for it.

II. FEATURES OF IRIS

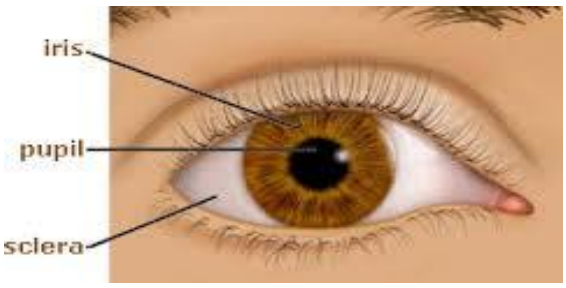

FIG 1: FRONT VIEW OF EYE

The iris biometric mainly deals with the identifying a human being by his/her iris pattern extracted from the images of his/her eye. As shown in Figure , the human eye consists of 3 major parts: pupil (the Innermost black part), iris (the Colored part) and sclera (the white part)as shown in fig. The iris and pupil considered to be non concentric. The radius of the inner border of the iris i.e. it's border with the pupil is also not constant since the size of pupil increases and decreases depending upon the amount of light incident to the pupil. Every individual in the world has a unique pattern of iris. This pattern can be extracted from the image of the eye and it is encoded. This code can be compared to the codes obtained from the images of 14 other eyes or the same eye. The results of this comparison can represent the amount of difference between the compared codes. In this way it can be concluded if the compared eye patterns belong to the same or different eye.

III. FLOWCHART OF IRIS RECOGNITION SYSTEM

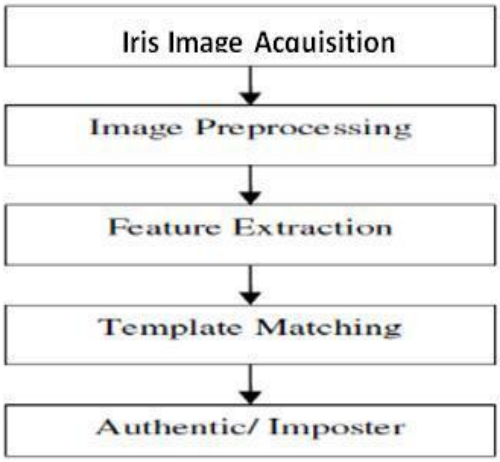

Fig 3.1 Block Diagram of Stages in Iris Recognition

A. *Image Acquisition.*

It consist of acquisition of a high quality image of the iris with high resolution. It deals with the image capturing rigs. It is needed to obtain images with high resolution with sharpness. It should have proper contrast in the iris pattern with proper illumination. Image should be properly centered. Distance of camera should be up to 3 meter. Image capturing should be accomplished with the help of near infrared camera or LED.

CASIA Database

The Chinese Academy of Sciences - Institute of Automation (CASIA) eye image database have 756 grayscale images having 108 unique eyes or classes and 7 different images of each unique eye. These images from each class are taken from two sessions with one month interval between sessions. These images were captured especially for iris recognition research. The specialized feature is that eye images are mainly from persons of Asian descent, whose eyes are characterized by irises that are densely pigmented, and with dark eyelashes. As because of specialized imaging conditions with the use of near infra-red light, features in the iris region are highly visible and there is good contrast between pupil, iris and sclera regions. We have selected 500 images for the further research.

B. Iris Localization

Iris localization is a very important process to separate the iris region from the rest of the captured image. We can consider the iris by two circles, one for iris/sclera boundary and another for iris/pupil boundary.

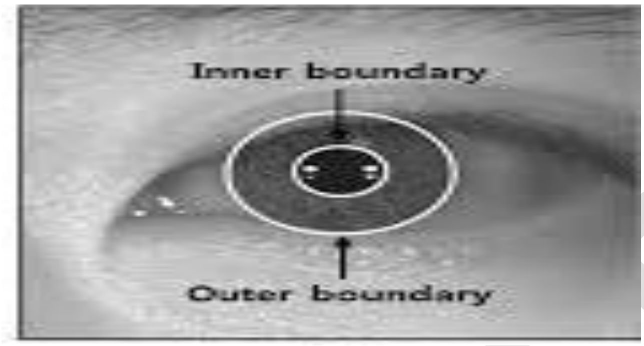

Fig 2: Iris localization

C. Feature Extraction

The process of feature encoding is implemented by convolution of the normalized iris pattern with 1D Log-Gaber wavelet. The 2D normalized patterns are broken up into a number of 1D Signal. In that each row corresponds to a circular ring on the iris region. Here angular direction is taken rather than the radial one, which corresponds to columns of normalized pattern. The features of iris are extracted in codes of 0 and1.

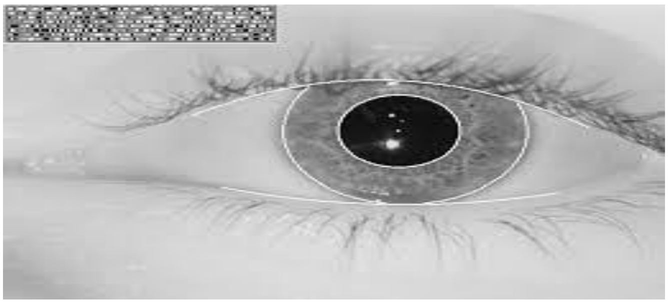

Fig 3: Feature Extraction

D. Template Matching

For the template matching, Hamming distance is chosen as a metric for recognition. Here results of this computation is then used as the goodness of match, in this smaller values indicating better matches. If the two patterns are derived from same iris, the hamming distance between them will be close to 0 which indicates high correlation.

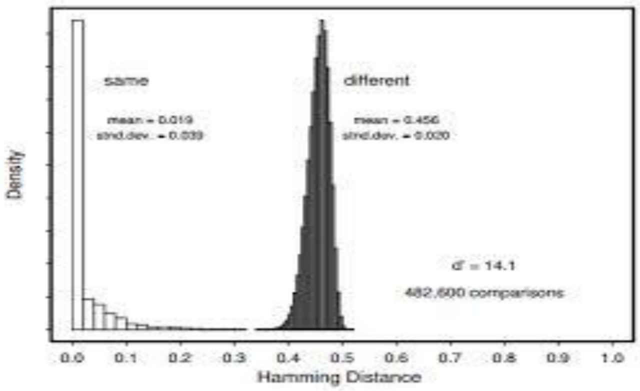

Fig 4: Template matching

IV. METHODOLOGY

A. Segmentation

We have implemented two pre-processing operations for the image contrast enhancement, expecting that they could contribute to the improvement of the results:

A1. Histogram Equalization

This operation mainly improves the contrast between each eyes region, which potentially will contribute to the segmentation task.

A 2. Binarization

The image binarization based on a threshold is a very important operation that maximizes the separability between the iris regions and the remaining part of the eyes. The binarization consists of one of the Daugman's method. Daugman's algorithm is mainly based on applying an integro-differential operator to properly find the iris and pupil contour.

$$\max(r, x_o, y_o)\left|G_\sigma(r) * \frac{\partial}{\partial r} \oint_{r, x_o, y_o} \frac{I(x,y)}{2\pi r} ds\right|$$

Equation 1. Daugman's Integro-Differential Equation

Here X0, Y0, ro: the centre and radius of coarse circle. Gσ(r) indicates Gaussian function. Δr indicates radius range for searching for. I(X, Y) indicates the original iris image. Gσ(r) indicates a smoothing function, the smoothed image is further scanned for a circle that has a maximum gradient change, which indicates an edge in image. This algorithm is done twice, first to get the iris contour then to get the pupil contour. It is worth mentioning that in this procedure the problem is that the illumination inside the pupil is a perfect circle with very high intensity level. So, we have a problem of sticking to illumination as the max gradient circle. That is because minimum pupil radius should be set. Another issue in this process is in the determining pupil boundary, the maximum change should occur at the edge between the very dark pupil and the iris, which is relatively darker than the bright spots of the illumination. So, while scanning the image one must take care that a very bright spot value could deceive the operator and may result in a maximum gradient. This simply nothing but the failure to localize the pupil

A 3. Optimized Daugman's Algorithm:

As a solution to the above mentioned problem, modification to the Integro - differential operator is mainly proposed to ignore all circles if any pixel on this circle has a value higher than a certain threshold. This threshold is determined as a 200 for the grayscale image. This confirms that only the bright spots values usually higher than 245 will be cancelled. As another solution we considered is to treat the illumination by truncating pixels higher than a certain threshold –bright spots –to black. But here this method failed in many images, because when the spot hits the pupil illumination spreads on pupil so as we treat the illumination spots it will leave behind a maximum change edges that can't be determined and the mainly the operator will consider it the pupil boundary. The false acceptance rate for the iris recognition system is 1 in 1.2 million, which is statistically better than the average fingerprint recognition system. The real and important benefit is in the false rejection rate, a measure of authenticated users who are rejected. According to study fingerprint scanners have a three percent false rejection rate, whereas iris scanning systems boast rate at the 0% level.

B. Upper and Lower Eyelid Detection

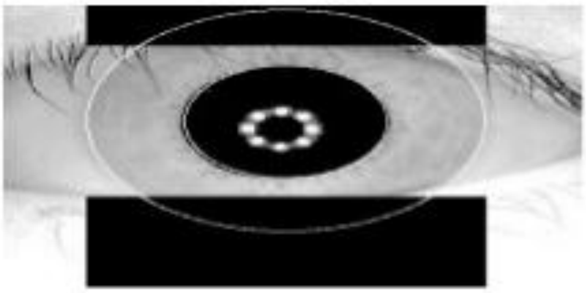

Fig 5: Upper and lower eyelid detection.

As similar to iris outer boundary localization, the proposed technique selects two search regions to detect upper and lower eyelids. The pupil centre, iris inner and outer boundaries are here mainly used as reference to select the two search regions. Here the search regions are confined within the inner and outer boundaries of the iris. The width of the two search regions is remains same with diameter of the pupil. Here sobel edge detection is applied to the search regions to detect the eyelids. In order to mainly reduce the false edges detection caused by eyelashes, here sobel kernel is tuned to the horizontal direction. After the edge detection step, the edge image gets generated. The eyelids get detected using linear Hough Transform method. This method calculates the total number of edge points in every horizontal row inside the search regions. Here the horizontal row with maximum number of edge points is selected as eyelid boundary. If the maximum number of edge points is less than the predefined threshold, it is assumed that the eyelid is not present in the search regions. In the proposed technique, the eyelid boundaries are approximately modeled as straight lines. Edge detection can't be able to identify all the pixels along the eyelid boundaries. The boundaries of the eyelids are normally occluded by the eyelashes. So, boundaries of eyelids are modeled with straight lines approximation.

C. Normalization

When the iris region is successfully segmented from eye image, the next stage is mainly to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional inconsistencies between eyes images are mainly are because of the stretching of the iris, which is caused by the dilation of pupil from varying levels of illumination. Other sources of the inconsistency includes the varying imaging distance, camera rotation, head tilt, eye rotation within the eye socket. The normalization process will produce iris regions, which mainly have the same constant dimensions, so that two photos of the same iris under different conditions will have the characteristic features at the same spatial location. Another point to be noted is that the pupil region is not always concentric within the iris region, and it is usually slightly nasal. This must be taken into account while trying to normalize the doughnut shaped iris region to have constant radius.

V. CONCLUSION AND FUTURE SCOPE

According to theoretical analysis & experimental work Daugman's algorithm for the iris recognition gives maximum efficiency as compared to other methods.
As a future scope the system can be implemented with other biometric recognition assembly.

VI. RESULTS

I have taken 50 images for the experimental work out of 756 images from CASIA database. After the performance of experimental work of Iris recognition I got FAR as 0%., FRR as a 1.04% and RR as a 98.96%.

REFERENCES

[1] Prateek Verma, Maheedhar Dubey, Praveen Verma , "Comparison of Various Segmentation Techniques in Iris Recognition" LAMBERT ACADEMIC PUBLISHING (LAP), GmbH & co. KG, Dudweiler Landstrabe, Saarbrücken, ISBN 13: 978-3-6 59-13597-2, Germany,MAY-2012.

[2] Segmentation Techniques for Iris Recognition System, Iinternational Journal of Scientific & Engineering Res V volume 2, Issue 4, April-2011 , ISSN 2229-5518 IJSER © @ 2011 BY Surjeet Singh, Kulbir Singh.

[3] J. Daugman. How iris recognition works. Proceedings of 2002 International Conference on Image Processing, Vol. 1, 2002.

[4] Chinese Academy of Sciences –Institute of Automation. Database of 756 Grayscale Eye Images. http://www.sinobiometrics.com Version 1.0, 2003

[5] "Recognition of Human Iris Patterns for Biometrics Identification"-This project is submitted for the Bachelor of Engineering degree of the School of Computer Science and Software Engineering, The University of Western Australia, 2003 BY LIBOR MASEK

[6] "An Segmentation Method for Iris Recognition System", Computer Vision and Intelligent Systems (CVIS) Group University Tunku Abdul Rahman, Malaysia, 2006 BY RICHARD YEW FATT NG, KAI MING MOK

[7] "Iris Biometric Recognition for Person Identification in Security System"-International Journal of Computer Applications (0975 –8887) Volume24 – No.9, June 2011 BY Dr. L. M. WAGHMARE, Vanaja Roselin.E.Chirchi, E.R.Chirchi.

[8] "Accurate and Fast Iris Segmentation" - International Journal of Engineering Science and Technology Vol. 2(6), 2010, 1492-1499 BY G. ANNAPOORANI, R. KRISHNAMOORTHI, P. GIFTY JEYA

[9] Daugman, John (January 2004). "How iris recognition works"(PDF). IEEE Transactions on Circuits and Systems for Video Technology 14 (1): 21–30.doi:10.1109/TCSVT.2003.818350.http://www.cl.cam.ac.uk/users/jgd1000/irisrecog.pdf

[10] Daugman, John (2003). "The importance of being random: statistical principles of iris recognition"(PDF). Pattern Recognition 36 (2): 279–291. doi:10.1016/S0031-3203(02)00030-4. http://www.cl.cam.ac.uk/~jgd1000/patrec.pdf

[11] Daugman, John (June 2005). "Results from 200 billion iris cross -comparisons" Technical Report UCAM-CL-TR- 635. University of Cambridge Computer Laboratory. http://www.cl.cam.ac.uk/TechReports/UCAM-CL-TR-635.html

[12] Zhaofeng He, Tieniu Tan, Zhenan Sun and Xianchao Qiu (15 July 2008). "Towards Accurate and Fast Iris Segmentation for Iris Biometrics". IEEE Trans Pattern Anal Mach Intell 31 (9): 1670–84. doi:10.1109/TPAMI.2008.183. PMID19574626. http://www.cbsr.ia.ac.cn/ users/zfhe/publications.html

[13] Zhaofeng He, Tieniu Tan, Zhenan Sun and Xianchao Qiu (June 2008). "Boosting Ordinal Features for Accurate and Fast Iris Recognition". Proc. of the 26th IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'08).pp.1–8. http://www.cbsr.ia.ac.cn/users/zfhe/publications.html

[14] PrateekVerma, Maheedhar Dubey, Praveen Verma, SomakBasu ―'Daughman's algorithm method for iris recognition-a biometric approach' International Journal of Emerging Technology and Advanced Engineering ISSN2250-2459, Volume 2, Issue 6, June 2012

[15] Oad Percy, Ahmad Waquas- 'Iris localization using Daugman's algorithm'