ANALYSIS OF IRIS RECOGNITION ON BASIS OF MATRIX MATCHING

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ABSTRACT

Abstract: Iris recognition is a well-known biometric technique. Iris recognition is regarded as the most reliable and accurate biometric identification system available. Most commercial iris recognition systems use patented algorithms developed by Daugman, and these algorithms are able to produce perfect recognition rates. In this work, we evaluate, modify and extend John Daugman's method. However, published results have usually been produced under favorable conditions, and there have been no independent trials of the technology. The work presented here involves developing an 'open- source iris recognition system in order to verify both the uniqueness of the human iris and also its performance as a biometric. Iris recognition systems capture an image from an individual's eye. The iris in the image is then segmented and normalized for feature extraction and matrix matching process. The iris recognition system consists of an automatic segmentation system, and is able to localize the circular iris and pupil region, excluding eyelids and eyelashes, and reflections. The extracted iris regions were normalized into a rectangular block with constant dimensions to account for imaging inconsistencies. This method can successfully detect all the pupil boundaries in the IIT Delhi Database and CASIA database and increase the recognition accuracy.

Keyword – *Iris Recognition, Matrix Matching, MATLAB, Feature Extraction*

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1. INTRODUCTION

Within the biometrics context, the IRIS is commonly accepted as one of the most accurate biometric traits and has been successfully applied in such distinct domains as airport check-in or refugee control. However, for the sake of accuracy, present IRIS recognition systems require that subjects stand close (less than two meters) to the imaging camera and look for a period of about three seconds until the data is captured. This cooperative behaviour is required to capture images with enough quality for the recognition task. However, it simultaneously restricts the range of domains where IRIS recognition can be applied, especially those where the subject's cooperation is not expectable (e.g., criminal/terrorist seeks, missing children). Therefore, we are using IR images of eye. And this is readily available from IIT-D and CASIA database. Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edges in images are areas with strong intensity contrasts – a jump in intensity from one pixel to the next. Edge detecting an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. Auto-segmentation is an integral part for extracting region of interest. Daugman's rubber sheet model is used for normalization.

1.1 Objective

1. To design a MATLAB based Human Iris Recognition System.
2. To develop an open source implementation of Daugman's system and Masek's Principle.
3. To automate the segmentation and normalization of the iris along with the pre-processing of iris image.
4. To perform Feature Extraction and Matching of Iris Images.
5. To test and analyse the application Iris Image Database (CASIA and IIT Delhi Iris Database).
6. To use MATLAB rapid application development and design an iris recognition system with a GUI for making it easy-to-use and understandable for a layman.

1.2 Iris Databases

CASIA Iris Image Database (CASIA-Iris) developed by our research group has been released to the international biometrics community and updated from CASIA-IrisV1 to CASIA-IrisV3 since 2002. More than 3,000 users from 70 countries or regions have downloaded CASIA-Iris and much excellent work on iris recognition has been done based on these iris image databases. Although great progress of iris recognition has been achieved since 1990s, the rapid growth of iris recognition applications has clearly highlighted two challenges, i.e. usability and scalability. Usability is the largest bottleneck of current iris recognition. It is a trend to develop long-range iris image acquisition systems for friendly user authentication.

Fig -1CASIA Iris Database: Sample Iris Image

The IIT Delhi Iris Database mainly consists of the iris images collected from the students and staff at IIT Delhi, New Delhi, India. This database has been acquired in Biometrics Research Laboratory during Jan - July 2007 (still in progress) using JIRIS, JPC1000, digital CMOS camera. The image acquisition program was written to acquire and save these images in bitmap format and is also freely available on request. The currently available database is from 224 users, all the images are in bitmap (*.bmp) format. All the subjects in the database are in the age group 14-55 years comprising of 176 males and 48 females. The database of 1120 images is organized into 224 different folders each associated with the integer identification/number. The resolution of these images is 320 ´ 240 pixels and all these images were acquired in the indoor environment.

Fig -2IIT Delhi Iris Database: Sample Iris Image

2. LITERATURE REVIEW

Alice Nithya A. et. al. (2016), here author is presenting Feature Extraction technique for improve the efficiency and accuracy of Human identification and recognition. The iris based biometric system is only one stable and reliable system compare to any other biometric system. In this paper biometric system of iris has various methods that are image segmentation, image normalization, image feature extraction and matching. It is plays an important role in improving the system performance, accuracy and reliability [1].

Mr. P.P.Chitte, et. al. (2014) of J.N.E.C Aurangabad have done work for the performance evaluation of iris recognition algorithms to construct very large iris databases. However, limited by the real conditions, there are no very large common iris databases now. An iris image synthesis method based on Principal Component Analysis (PCA), Independent component analysis (ICA) and Daugman's rubber sheet model is proposed. Iris Recognition is a rapidly expanding method of biometric authentication that uses pattern-recognition techniques on images of iris to uniquely identify an individual [2].

In Liu et al. (2014) proposed a video sequence based iris recognition system which works based on bionic recognition and distance distribution histogram. Same technique was tested against still images as well and resulted with more robustness and stability. Experimental results were tested using JLUBRIRIS database with videos of 78 subjects and CASIA V1 and V4 databases [3].

In Rai et al. (2014) proposed a technique to perform code matching based on combination of two techniques to achieve better accuracy rate. Circular Hough transform is used to isolate the iris image followed by finding the zigzag collarette area and then detecting and removing the eyelids and eyelashes using parabola detection technique and trimmed median filters. Haar wavelets and 1-d Log Gabor filters are used to extract features from the zigzag collarette region of iris. Extracted patterns were recognized with the help of combination of techniques called support vector machine and hamming distance approach [4].

In Song et al. (2014) proposed a method based on sparse error correction model, since the noise factors like eyelid and eyelash occlusion and specular and pupil reflections are mainly spatially localized. In this approach training sets of all iris images are considered as a dictionary used for the purpose of classification of simple test sample and finally converted to a huge size dictionary. To make this error correction model efficient, a K-SVD algorithm is implemented. It is proved that the dictionary when learned with help of this algorithm is said to have a better representation [5].

In Pillai et al. (2014) proposed a cross sensor based iris recognition system which works on kernel learning technique. This paper proposes a recognition framework which works on multiple sensors and provides better cross sensor recognition rate. LG2200, LG4000, Iris on the Move portal system by Sarnoff, Combined Face and Iris Recognition System (CFAIRs) by Honeywell, HBOX system by Global Rainmakers Inc., and Eagle-Eyes system by Retica are some popular systems used to acquire iris images. A kernel based learning approach is used for sensor adaptation [6].

In Sun et al. (2014) provided an iris image classification framework based on texture information using a representation technique called Hierarchy Visual Codebook (HVC). HVC is based on two techniques called Vocabulary Tree (VT), and Locality-constrained Linear Coding (LLC), for representing iris textures sparsely. Experimental results show that this method helps in achieving better image classification for iris liveness detection, race classification, and coarse-to-fine iris identification methods. Gabor filter and ordinal filters are used to extract features from the segmented iris image [7].

In Z.Z. Abidin et al. (2013) proposed a feature extraction technique based on the epigenetic traits using several edge detection operators. Edge detection operators like Sobel, Prewitt and Canny were applied to extract the features from the iris. Among them Canny operator was found to provide a more accurate results. By applying these operators, the PSNR values of iris texture information before and after processing were calculated [8].

In Zhou et al. (2013) proposed a new code matching technique. During segmentation stage following steps were followed: (i) to localize pupil boundary histogram analysis and morphological processing were performed, (ii) Outer boundary was considered to have twice the size of pupillary boundary and (iii) To detect and remove upper and lower eyelids, Canny edge operator followed by polynomial curve fitting algorithm were used. After segmenting the iris, it was unwrapped to a rectangular block of fixed size with the help of a convolution operator.1-d Log Gabor filter were applied to extract the texture information and were then store in a k-dimension tree structure [9].

Ashish Kumar Dewangan et. al. (2012) have developed a biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Iris recognition is regarded as the most reliable and accurate biometric identification system available. The iris recognition system consists of an automatic segmentation system that is based on the Hough transform, and is able to localize the circular iris and pupil region, occluding eyelids and eyelashes, and reflections. The extracted iris region was then normalized into a rectangular block with constant dimensions to account for imaging inconsistencies [10].

3. METHODOLOGY

The first stage of iris recognition is to isolate the actual iris region in a digital eye image. The iris region can be approximated by two circles, one for the iris/sclera boundary and another, interior to the first, for the iris/pupil boundary. The eyelids and eyelashes normally occlude the upper and lower parts of the iris region. Also, specular reflections can occur within the iris region corrupting the iris pattern. A technique is required to isolate and exclude these artefacts as well as locating the circular iris region. The success of segmentation depends on the imaging quality of eye images. Images in the CASIA Iris Database and IIT Delhi Database do not contain specular reflections due to the use of near infra-red light for illumination.

3.1 Segmentation

Hough Transforms: The Hough transform is a standard computer vision algorithm that can be used to determine the parameters of simple geometric objects, such as lines and circles, present in an image. The circular Hough transform can be employed to deduce the radius and centre coordinates of the pupil and iris regions. Firstly, an edge map is generated by calculating the first derivatives of intensity values in an eye image and then thresholding the result. From the edge map, votes are cast in Hough space for the parameters of circles passing through each edge point.

Daugman's Integro-differential Operator: Daugman makes use of an integro-differential operator for locating the circular iris and pupil regions, and also the arcs of the upper and lower eyelids. The operator searches for the circular path where there is maximum change in pixel values, by varying the radius and position of the circular contour. The integro-differential can be seen as a variation of the Hough transform, since it too makes use of first derivatives of the image and performs a search to find geometric parameters. Since it works with raw derivative information, it does not suffer from the thresholding problems of the Hough transform.

MATLAB Functions for Segmentation

Following are the MATLAB functions involved in segmentation technique are:

1. createiristemplate: generates a biometric template from an iris eye image.
2. segmentiris: performs automatic segmentation of the iris region from an eye image. Also isolates noise areas such as occluding eyelids and eyelashes.
3. addcircle: circle generator for adding weights into a Hough accumulator array.
4. adjgamma - for adjusting image gamma
5. circlecoords: returns the pixel coordinates of a circle defined by the radius and x, y coordinates of its centre.
6. canny: canny edge detection - function to perform canny edge detection.
7. findcircle: returns the coordinates of a circle in an image using the Hough transform and canny edge detection to create the edge map.
8. findline: returns the coordinates of a line in an image using the Hough transform and canny edge detection to create the edge map.
9. houghcircle: takes an edge map image, and performs the Hough transform for finding circles in the image.
10. hysthresh: Hysteresis Thresholding: Function performs hysteresis thresholding of an image.
11. linecoords: returns the x and y coordinates of positions along a line.
12. nonmaxsup: Function for performing non-maxima suppression on an image using an orientation image. It is assumed that the orientation image gives feature normal orientation angles in degrees (0-180).

3.2 Normalization

Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional inconsistencies between eye images are mainly due to the stretching of the iris caused by pupil dilation from varying levels of illumination. Other sources of inconsistency include, varying imaging distance, rotation of the camera, head tilt, and rotation of the eye within the eye socket. The normalization process will produce iris regions, which have the same constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location.

Daugman's Rubber Sheet Model

The homogenous rubber sheet model devised by Daugman remaps each point within the iris region to a pair of polar coordinates (r, θ) where r is on the interval [0, 1] and θ is angle [0,2π]. The rubber sheet model takes into account pupil dilation and size inconsistencies in order to produce a normalized representation with constant dimensions. In this way the iris region is modelled as a flexible rubber sheet anchored at the iris boundary with the pupil centre as the reference point.

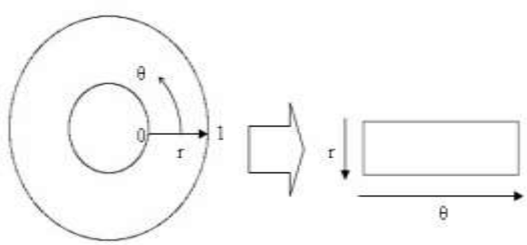


Fig -3 Daugman's Rubber Sheet Model for Iris Normalization

MATLAB Functions for Normalization

Following are the MATLAB Functions involved in Normalization technique are:

1. normaliseiris: normalization of the iris region by unwrapping the circular region into a rectangular block of constant dimensions.
2. encode: generates a biometric template from the normalized iris region, also generates corresponding noise mask
3. gaborconvolves: function for convolving each row of an image with 1D log-Gabor filters.

3.3 Feature Extraction and Matching

Feature Extraction: The feature vector is converted to a binary vector. The value of the vector changes from 1 to 0 at each feature location. Final result: a binary vector with the same length as the original normalized image.

Matching: Use the Hamming Distance (HD) between two iris codes which is a fraction of No. of different bits upon total no. of bits done by matrix matching for two images one from database and the other selected for match input. Test the database on IIT-Delhi Database and CASIA Database and compare the results for both databases.

4. RESULTS AND DISCUSSION

4.1 Recognition Result Status Tabulation IIT Delhi Iris Database

Table -1 IIT Delhi Database (Left Eye)

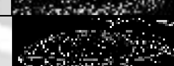
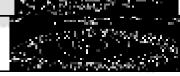
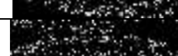
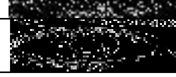
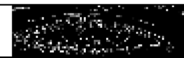
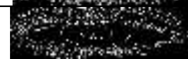
Sample No.	**Input Image**	**Edge Detection**	**Recognition Status (-1 No/1 Yes)**	
			Same Input	Different Input
1	aeval1		1	-1
2	bryanl1		1	-1
3	chingycl1		1	-1
4	chongpkl1		1	-1
5	christinel1		1	-1
6	chualsl1		1	-1
7	eugenehol1		1	-1
8	fatmal1		1	-1
9	yannl1		1	-1
10	zaridahl1		1	-1

Table -2 IIT Delhi Database (Right Eye)

Sample No.	**Input Image**	**Edge Detection**	**Recognition Status (-1 No/1 Yes)**	
			Same Input	Different Input
1	aevar1		1	-1
2	bryanr1		1	-1
3	chingycr1		1	-1
4	chongpkr1		1	-1

5	christiner1		1	-1
6	chualsr1		1	-1
7	eugenehor1		1	-1
8	fatmar1		1	-1
9	yannr1		1	-1
10	zaridahr1		1	-1

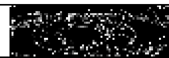
4.2 Recognition Result Status Tabulation CASIA Iris Database

Table -3 CASIA Iris Database (Sample Eye 1)

Sample No.	Input Image	Edge Detection	Recognition Status (-1 No/1 Yes)	
			Same Input	Different Input
1	**001_1_1**		**1**	**-1**
2	**002_1_1**		**1**	**-1**
3	**003_1_1**		**1**	**-1**
4	**004_1_1**		**1**	**-1**
5	**005_1_1**		**1**	**-1**
6	**006_1_1**		**1**	**-1**
7	**007_1_1**		**1**	**-1**
8	**008_1_1**		**1**	**-1**
9	**009_1_1**		**1**	**-1**
10	**010_1_1**		**1**	**-1**

Table -4 CASIA Iris Database (Sample Eye 2)

Sample No.	Input Image	Edge Detection	Recognition Status (-1 No/1 Yes)	
			Same Input	Different Input
1	**001_2_1**		**1**	**-1**
2	**002_2_1**		**1**	**-1**
3	**003_2_1**		**1**	**-1**
4	**004_2_1**		**1**	**-1**
5	**005_2_1**		**1**	**-1**
6	**006_2_1**		**1**	**-1**
7	**007_2_1**		**1**	**-1**
8	**008_2_1**		**1**	**-1**

9	**009_2_1**		**1**	**-1**
10	**010_2_1**		**1**	**-1**

4.3 Recognition Status IIT-D Vs CASIA for Same Input Iris Image

The figure shows comparison status for same input image on IIT-D and CASIA iris databases. Each data set consists of 10 images of each eye. The results are tabulated for values +1 for every exact match. The results on testing the application on the said databases for same input image show that matrix matching results in exact match for each input image from both the databases and the graph shown below depicts the same.

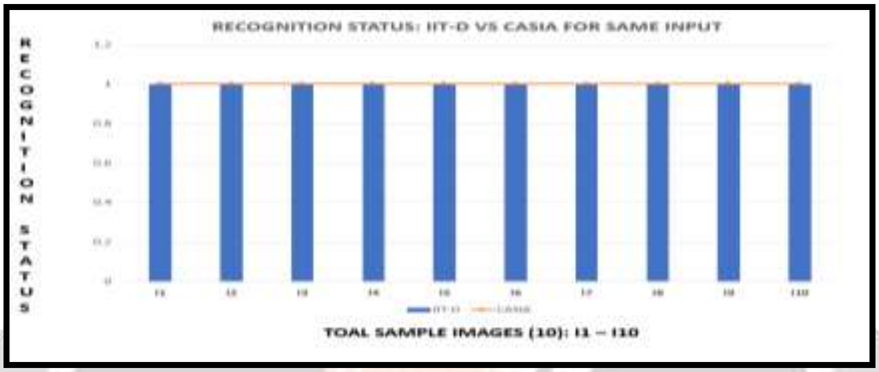


Chart -1 IIT Delhi Vs CASIA (Same Input)

4.4 Recognition Status IIT-D Vs CASIA for Different Input Iris Image

The figure shows comparison status for different input image on IIT-D and CASIA iris databases. Each data set consists of 10 images of each eye. The results are tabulated for values -1 for every no match. The results on testing the application on the said databases for different input image show that matrix matching results in exact match for each input image from both the databases and the graph shown below depicts the same.

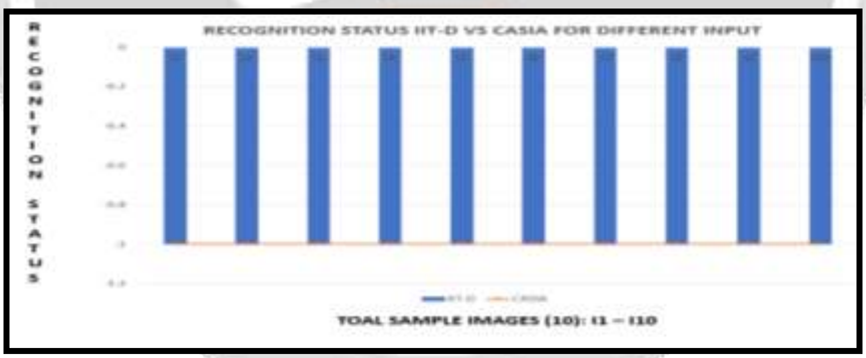


Chart -2 IIT Delhi Vs CASIA (Different Input)

4.5 Recognition Status IIT-D Same Input Vs Different Input

The figure shows comparison status for same input image versus different input image outputs on IIT-D iris database. Each data set consists of 10 images of each eye. The results are tabulated for values +1 for exact match for same input image and -1 for every exact no match for different input image. The results on testing the application on the said databases for both input image systems show that matrix matching performs with high accuracy showing exact matches for all same input images and no match for all different input images and the graph shown below depicts the same.

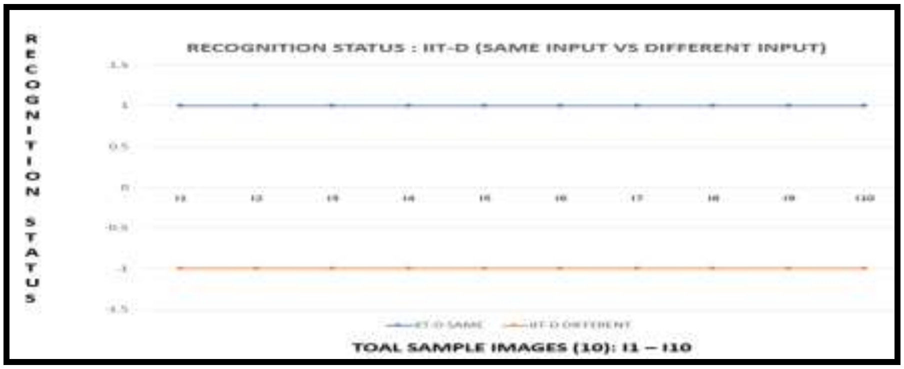


Chart -3 IIT Delhi (Same Input Vs Different Input)

4.6 Recognition Status CASIA Same Input Vs Different Input

The figure shows comparison status for same input image versus different input image outputs on CASIA iris database. Each data set consists of 10 images of each eye. The results are tabulated for values +1 for exact match for same input image and -1 for every exact no match for different input image. The results on testing the application on the said database for both input image systems show that matrix matching performs with high accuracy showing exact matches for all same input images and no match for all different input images and the graph shown below depicts the same.

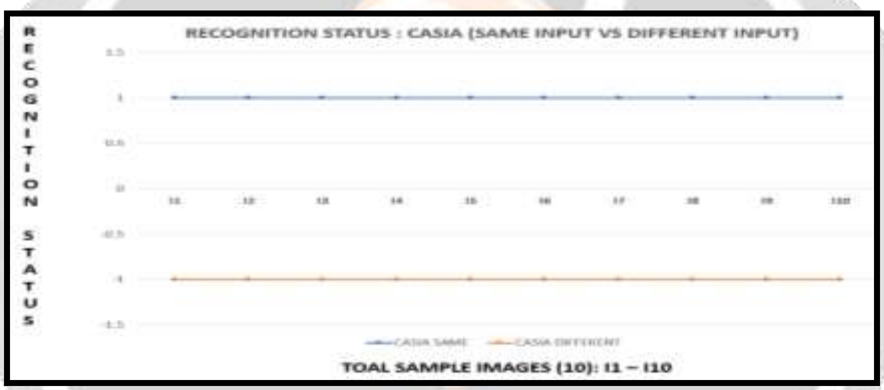


Chart -4 CASIA (Same Input Vs Different Input)

5. CONCLUSION

The system presented in this paper was able to perform accurately, however there are still a number of issues which need to be addressed. First of all, the automatic segmentation was not perfect, since it could not successfully segment the iris regions for all of the eye images in the IIT Delhi and CASIA databases. In order to improve the automatic segmentation algorithm, a more elaborate eyelid and eyelash detection system could be implemented.
An improvement could also be made in the speed of the system. The most computation intensive stages include performing the Hough transform. Since the system is implemented in MATLAB, which is an interpreted language, speed benefits could be made by implementing computationally intensive parts in accordance with the system. Speed was not one of the objectives for developing this system, but this would have to be considered if using the system for real-time recognition.

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