A Proficient Matching For Iris Segmentation and Recognition Using Filtering Technique

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Abstract - ***Iris recognition is raising as one of the important methods of biometrics based identification systems. This project basically explains the Iris recognition system developed by John Daugman and attempts to implement this algorithm in Matlab, with a few modifications. Firstly, image preprocessing is performed followed by extracting the iris portion of the eye image. The extracted iris part is then normalized, and Iris Code is constructed using 1D Gabor filters. Finally two Iris Codes are compared to find the Hamming Distance, which is a fractional measure of the difference. Experimental image results show that unique codes can be generated for every eye image.***

Key Words: **Image acquisition, iris normalization, iris sample, Hough transform, Gabor filter.**

1. INTRODUCTION

Biometrics refers to the identification and verification of human identity based on certain physiological character of a person. The commonly used biometric features include speech, fingerprint, face, handwriting, gait, hand geometry etc. The face and speech techniques have been used for over 25 years, while iris method is a newly developing technique. The iris is the colored part of the eye behind the eyelids, and in front of the lens. It is the only internal organ of the body which is normally externally visible. These visible patterns are unique to all individuals and it has been found that the probability of finding two individuals with identical iris patterns is almost zero. Though there lays a problem in capturing the image, the great pattern variability and the stability over time, makes this a reliable security recognition system. Iris recognition is a biometric recognition technology that utilizes pattern recognition techniques on the basis of iris high quality images.

1.1 Background

Alphonse Bertillon and Frank Burch were one among the first to propose that iris patterns can be used for identification systems. In 1992, John Daugman was the first to develop the iris identification software. Other important contribution was by R.Wildes et al. Their method differed in the process of iris code generation and also in the pattern matching technique. The Daugman system has been tested for a billion images and the failure rate has been found to be very low. His systems are patented by the *Iriscan Inc.* and are also being commercially used in Iridian technologies, UK National Physical Lab, British Telecom etc.

1.2 Outline

This paper consists of six main parts, which are image acquisition, preprocessing, iris localization, normalization, encoding and the iris code comparison. Each section describes the theoretical approach and is followed by how it is implemented.

2. PROPOSED METHOD OF IRIS RECOGNITION

Fig. 1 shows block diagram for a biometric system of iris recognition in unconstrained environments in which each block's function is briefly discussed as follows:

1. Image acquisition: in this stage, a photo is taken from iris.
2. Segmentation: including localization of iris inner and outer boundaries and localization of boundary between iris and eyelids.
3. Normalization: involving transformation from polar to Cartesian coordinates and normalization of iris image.
4. Feature extraction: including noise removal from iris image and generating iris code.
5. Classification and matching involving comparing and matching of iris code with the codes already saved in database.

Concerning the fact that in an unimpeded atmosphere iris may have occlusions caused by upper or lower eyelids or eyes may roll left and rightwards, as the paper goes on, these blocks are introduced and such issues are solved.

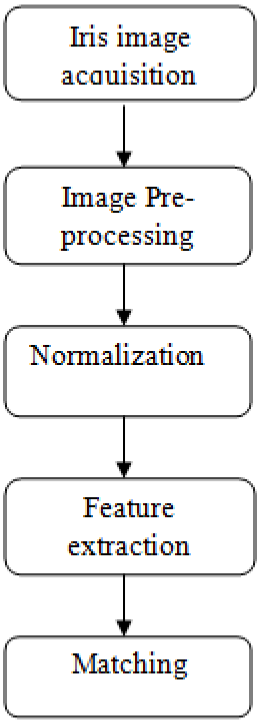

Fig-1: Block diagram of an iris recognition system

2.1 Image acquisition

Taking a photo from iris is the initial stage of an iris-based recognition system. Success of other recognition stages is reliant on the quality of the images taken from iris during image acquisition stage. Images available in CASIA database lack reflections in pupil and iris areas because infrared was used for imaging. Additionally, if visible light is used during imaging for those individuals whose iris is dark, a slight contrast comes to existence between iris and pupil which makes it hard to separate these two areas as shown in the Fig .2

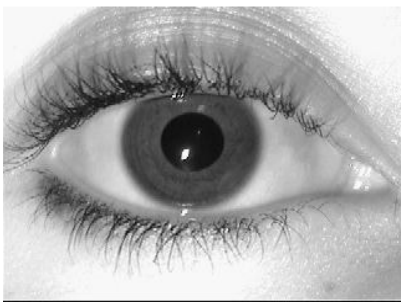

Fig-2: An eye image from CASIA database

2.2 Pre-processing

In pre-processing stage, Canny edge detection is used to improve iris outer boundary that is not recognized well in normal conditions, and a multiplier function is used to enhance Canny iris points, also image difference adjustment is performed to make its pixels brighter.

2.2.1 Image localization

The part of the eye carrying information is only the iris part. It lies between the scalera and the pupil. Hence the next step is separating the iris part from the eye image. The iris inner and outer boundaries are located by finding the edge image using the canny edge detector.

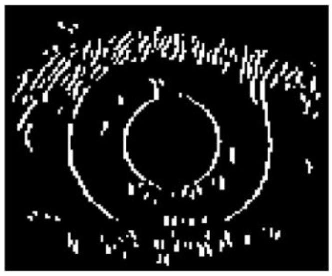

Fig-3: Canny edge image

2.2.2 Image Segmentation

Properly detecting the inner and outer boundaries of iris texture is significantly important in all iris recognition systems. Pupil and limbus are often modeled as circles and the two eyelids are modeled as parabolic arcs [9]. However, according to our observation, circles cannot model pupil boundary accurately. Irregular boundary of pupil is the motivation to create an accurate pupil detection algorithm so circular Hough transforms.

- **Circular Hough Transforms**

The Hough transform is another way of detecting the parameters of geometric objects, and in this case, has been used to find the circles in the edge image. For every edge pixel, the points on the circles surrounding it at different radii are taken, and their weights are increased if they are edge points too, and these weights are added to the accumulator array. Thus, after all radii and edge pixels have been searched, the maximum from the accumulator array is used to find the center of the circle and its radius. The Hough transform is performed for the iris outer boundary using the whole image, and then is performed for the pupil only, instead of the whole eye, because the pupil is always inside the iris.

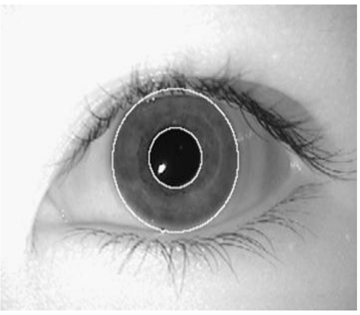

Fig-4: Image with boundaries

2.3 Image Normalization

Once the iris region is segmented, the next stage is to normalize this part, to enable generation of the iris code and their comparisons. Since variations in the eye, like optical size of the iris, position of pupil in the iris, and the iris orientation change person to person, it is required to normalize the iris image, so that the representation is common to all, with similar dimension. Normalization process involves unwrapping the iris and converting it into its polar equivalent. It is done using Daugman's Rubber sheet model. The center of the pupil is considered as the reference point and a remapping formula is used to convert the points on the Cartesian scale to the polar scale. The modified form of the model is shown in the fig 5.

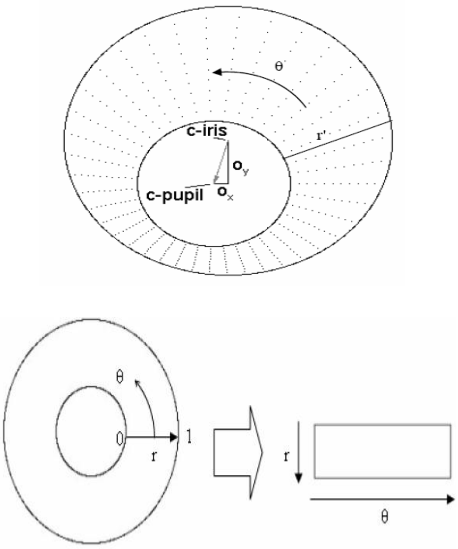

Fig-5: Unwrapping the iris

$$r' = \sqrt{\alpha}\beta \pm \sqrt{\alpha\beta^2 - \alpha - r_I^2}$$

Where r1 = iris radius

$$\alpha = o_x^2 + o_y^2$$

$$\beta = \cos\left(\pi - \arctan\left(\frac{o_y}{o_x}\right) - \theta\right)$$

2.4 Feature Extraction/Encoding

The feature of one person's iris is not same with the other person iris's features. In order to recognize the individual person accurately, the required discriminating features that present in the iris region must be extracted. Only the important features of the iris must be encoded so that comparisons between iris templates can be made.

- **Gabor filter**

Gabor filters are able to provide optimum conjoint representation of a signal in space and spatial frequency. A Gabor filter is constructed by modulating a sine/cosine wave with a Gaussian. This is able to provide the optimum conjoint localization in both space and frequency, since a sine wave is perfectly localized in frequency, but not localized in space. Modulation of the sine with a Gaussian provides localization in space, though with loss of localization in frequency.

- **Log Gabor Filter**

The Log-Gabor function is a modification to the basic Gabor function, in that the frequency response is a Gaussian on a log frequency axis. The log-Gabor function has the advantage of the symmetry on the log frequency axis. The log axis, as pointed out is the optimum method for representing spatial frequency response of visual cortical neurons. The Log-Gabor filters spread information equally across the channels.

$$G(f) = \exp\left(\frac{-(\log(f/f_0))^2}{2(\log(\sigma/f_0))^2}\right)$$

An easier way of using the Gabor filter is by breaking up the 2D normalized pattern into a number of 1D wavelets, and then these signals are convolved with 1D Gabor wavelets.

Gabor filters are used to extract localized frequency information. But, due to a few of its limitations, log-Gabor filters are more widely used for coding natural images. It was suggested by Field, that the log filters (which use gaussian transfer functions viewed on a logarithmic scale) can code natural images better than Gabor filters (viewed on a linear scale). Statistics of natural images indicate the presence of high-frequency components. Since the ordinary Gabor filters under-represent high frequency components, the log filters.

2.5 Matching

The template that is generated in the feature encoding process will also need a corresponding matching metric, which gives a measure of comparison between two iris templates. This metric should give one range of values when comparing templates generated from the same eye. In this paper we use the hamming distance as a matching metric. The advantage of hamming distance is fast matching speed because the templates are in binary format. The execution time for exclusive-OR comparison of two templates is approximately 10μs. The hamming distance is suitable for comparisons with millions of templates in large database.

3. RESULTS

The proposed iris recognition system has been implemented in the form of Graphical User Interface that provides very simple and user friendly control for iris identification and verification. The implemented GUI is shown in the Fig. 6.

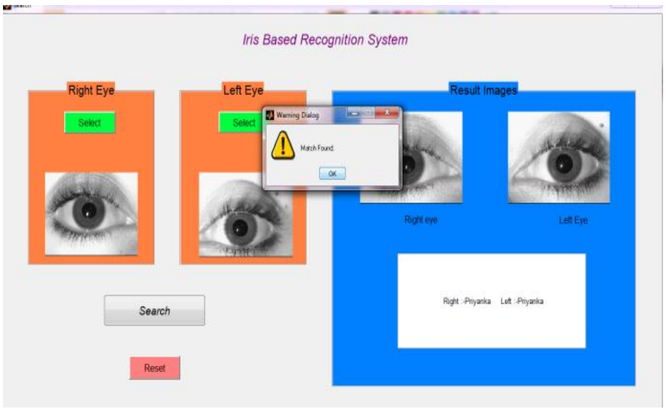

Fig-6: Proposed Iris Recognition System's GUI

The iris inner and outer boundaries also perfectly detected that is compulsory for 100% accuracy. In table 2 we compare our proposed method with other methods like: R. Rizal Isnanto accuracy is 84.37%, Boles 92.64%, Li MA 94.9%, and A.T. Zaim 95%. Our method greatly improves accuracy to 99.95%

Table -1: Shows Accuracy and Time

No. Of Images	Accuracy	Time
5	99.95	36.19 sec
10	75.0	32.79 sec
15	99.94	34.63 sec
20	99.9	32.85 sec
25	99.9	34.08 sec
30	99.94	34.64 sec
35	99.9	33.65 sec
40	87.5	37.64 sec

Table -2: The Accuracy Achieved By Our Proposed Method

Sr.no.	Different Approaches	Accuracy (%)
1	R. Rizal Isnanto	84.37
2	Boles	92.64
3	Li MA	94.9
4	A.T. Zaim	95
5	Proposed method	99.95

4. CONCLUSIONS

This paper presents an effective method to recognize iris boundaries by performing Canny edge detection and Hough transforms. After applying our proposed method, we will get exact input image of the database image which is given as an input with accuracy to match and also time needed to match. We find that when database create of 5 no. of images we found 99.95% or 100% accuracy and time needed is 36.19 sec.

5. ACKNOWLEDGMENT

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