Volume 4, Issue 9, September 2014 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

EfficientIris Recognition System Using 2-DCT Algorithm

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Abstract- Iris recognition has been acknowledged as one of the most accurate biometric modalities because of its high recognition rate. Accuracy and reliability of the system makes it more superior than all the other existing biometric systems such as face, fingerprint and face recognition [3]. In this paper, brief description about biometrics and iris recognition technology along with the steps involved in its implementation is given. In iris recognition using 2-DCT process, there are four steps- Segmentation, Normalisation, Feature extraction and Matching. Segmentation and Normalisation steps are implemented as the mid-term work in this paper. In Segmentation and Normalisation steps Canny edge detector, Hough circular Transform and Daugman rubber sheet model are used. These algorithms are helped to obtain better normalized and segmented image results with high speed. Further, in Feature extraction and Matching steps 2-DCT algorithm and Hamming distance algorithm will be used, which will help to store previous iris image results into a biometric template. The biometric template is compared by hamming distance with the other templates stored in a database until a matching template is found and if no match is found then, the subject remains unidentified.

Keywords- Iris recognition, Canny Edge Detector, DCT, Hough Circular Transform, Hamming Distance.

I. INTRODUCTION

In recent years, accurate automatic personal identification is becoming more significant to the operation of security purposes. Biometric employs physiological or behavioral characteristics to accurately identify each person's identity. A commonly used biometric feature includes different characteristics such as face, fingerprints, voice, iris, retina, gait, palm print, hand geometry. Iris recognition is a newly emergent approach to person identification in last decade.The iris is a thin diaphragm which lies between the cornea and the lens of the human eye. A front on view of iris is shown in figure 1. The iris is present close to its centre by a circular aperture known as pupil [5]. The function of the iris is to control the amount oflight entering through the pupil. The average diameter of the irispart is 12mm and the pupil size can vary from 10% to 80% of the iris diameter.

II. BIOMETRICS

Biometrics refers to 'measurement of life'. It is the methodology of measurement and analyses of the biological or physiological data of the living body for identification of an individual for authentication purpose. It makes use of the unique traits of human for the identification [7].Identification means one to many, whereas verification is one to one. Firstly, a sensing device such as a camera captures the raw biometric data. Then this captured raw biometric sample is processed and the unique biometric sample is extracted from it which is sometimes called match sample or biometric sample or template.Biometric systems are broadly divided into two categories as shown in table a:

Table a. Types of Biometric Systems

Physiological biometrics	**Behavioral biometrics**
Finger print	Signature
Iris	Speech
Hand print	Keystroke
DNA	
Facial pattern	

Advantages of Using Biometrics:
- Easier fraud detection.
- Better than password/PIN or smart cards.
- No need to memorize passwords.
- Require physical presence of the person.
- Physical characteristics are unique.
- It provides accurate results

Table b. Comparision of biometric techniques

Biometrics	Universal	Unique	Performance
Face	High	Low	Medium
Fingerprint	Medium	High	High
Iris	High	High	High
Signature	Low	Low	Low
Voice	Medium	Low	Low

III. HUMAN IRIS

Iris is the highly protected internal organ of the human body that is externally visible to the naked eye. This makes it capable to be used for identification of an individual. In iris recognition technology, the eye image is processed to extract the unique iris pattern (called template or match code). This template is compared with the stored templates.

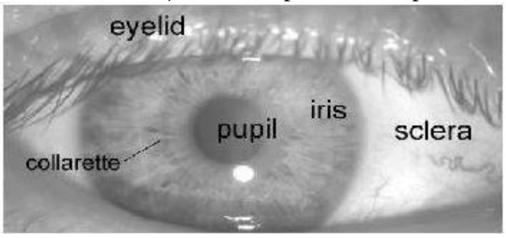

Figure 1 Frontview of eye [21]

If the newly captured template is matched with the previously stored template then the result is positive otherwise, the person is not registered in the database.

IV. STEPS INVOLVED IN IRIS RECOGNITION PROCESS

A. *Eye image*: The initial step is to capture the eye image, which can be done either by using a still camera or a video camera.

B. *Segmentation*: Iris region has to be isolated from the eye for the unique code extraction. For this segmentation is done so as to localize the iris region in the eye. Many segmentation techniques were used by various researchers such as Daugman applied integro-differential operator, Boles and Boashash used edge detection technique, Wildes combined the edge detection and Hough transform and many more techniques were used by other researchers for localizing the iris in the eye image.

C. *Normalization*: After the location of the iris is detected in the eye image, the normalization of the iris is done in order to remove the inconsistency because of the circular shape of the iris. So, the circular iris is converted into a rectangular shape. It can be done by using various methods, one of the most famous method for normalization is Daugman's Rubber Sheet Model.

D. *Feature Extraction*: The next step is to extract the unique features of the iris and to encode them intoa code which is sometimes called match code/ template. For this some mathematical operator is allowed to pass through and store the unique features in a binary code using binarization techniques.

E. *Code Matching*: During the authentication mode, the newly taken code is matched with the previously stored codes in the database. If the code matches with any of the stored codes, the person is authenticated otherwise not. The matching can be done by various methods, such as by calculating the Hamming Distance between the codes or by calculating the Euclidian Distance.

Table c. Related work

RESEARCHER NAME	YEAR	ALGORITHM USED	DRAWBACKS
John G. Daugman	1994	Integro-Differential, Daugman Rubber Sheet Model, 2-D Gabor Filter, XOR operator Hamming Distance.	Integro-differential operator fails in case of noise and total execution time is also very high.
W. W. Boles and B. Boashash	1998	1-D wavelet transforms, Edge detection technique, Zero crossing representation.	Algorithms are tested on few number of Iris images, Correct recognition rate is 92%, Equal Error rate is 8.13%.
Zhonghua Lin and Bibo Lu	2010	Morlet wavelet transforms Polar co-ordinate transform.	Recognition rate is low of the system.
Bimi Jain, Dr. M.K. Gupta and Prof. Jyoti Bharti	2012	Fast Fourier transform, Euclidean distance for matching.	Algorithm tested only on 10 images, FAR and FRR are also not declared and Euclidean distance technique make computational slow.

Mohd . T. Khan	2013	1-D Log Gabor filter, K-dimensional tree technique for matching.	Search efficiency is decreased by large tree size and FAR, FRR, ERR are not mentioned in results.

V. BENEFITS OF IRIS RECOGNITION TECHNOLOGY

A. *Non-invasiveness*: Iris is an internal body part still it can be used for authentication purpose without inserting any instrument into the body. Moreover, it is very hygiene than other biometric system like fingerprint, handprint which need body touch.

B. *Stability:* When the person is at the age of eight months or so, his/her iris texture gets fully developed and it does not change across one's lifetime.

C. *Uniqueness*: The rings, freckles, corona, stripes, furrows, connective tissuemakes the iris pattern unique. Iris details of every person in this world have unique iris pattern. No two persons in this whole world can have similar iris pattern. Moreover, iris pattern of twins, triplets and that of two eyes of same person are not identical. It's the pattern of iris that makes it informative and reliable biometric trait.

D. *Scalability:* Iris recognition is suitable for large scale authentication applications as it is scalable in the way that it can be easily resized and re-shaped.

E. *Security*: This biometric system is highly secured because of the difficulty of live iris forgery. Moreover, it is difficult to get clear iris image of a person without his awareness.

VI. APPLICATIONS

A. *Airport security system*:Iris recognition is used to identify the crew and personnel working in airport to identify the person at security checkpoint more quickly and easily.

B. *Access control*: Access to system can be allowed by recognizing the iris of an authorized or registered user. This makes the system highly secured against unofficial access.

C. *UIDAI*: Unique identification authority of India has also used the iris pattern for identifying the person for providing unique ID.

VII. IMPLEMENTATION OF SEGMENTATION AND NORMALISATION STEPS

1. *Segmentation*: In the segmentation process, firstly the captured eye image which is in form of coloured eye image is converted into a greyscale eye image. Luminance of the coloured eye image is converted into grey shade. In segmentation process Canny edge detector and Circular Hough Transform algorithms are used. Canny edge detector works on four steps:

a) *Image smoothing*: Image smoothing is the first stage of the Canny edge detecter. The pixel values of the input image are convoluted with predefined operators to create an intermediate image. The process is used to reduce the noise within an image or to produce a less pixilated image. Image smoothing is done by convoluting the input image with a Gaussian filter [22].

b) *Calculation of strength and direction of edges*: The blurred image obtained from the image smoothing stage is convoluted with a 3x3 Sobel operator [23]. The Sobel operator is a discrete differential operator that generates a gradient image. Horizontal and vertical Sobel operators that are used to calculate the horizontal and vertical gradients.

c) *Non maximum suppression*: Non-maximum suppression (NMS) [25] is used normally in edge detection algorithms. It is the process in which all pixels whose edge strength is not maximal are marked as zero within a certain local neighborhood. This local neighborhood partcan be a linear window at different directions [24] of length 5 pixels. The linear window considered in accordance with the edge direction of the pixel under consideration [24] for a block in an image.

d) *Thresholding with hysteresis*: Thresholding with hysteresis is the last stage in Canny edge detector step, which is used to eliminate spurious points and non-edge pixels from the results of non-maximumsuppression. The input image for thresholding with hysteresis has gone through Image smoothing, Calculating edge strength and edge pixel, and the Non-maximum suppression stage to obtain thin edges in the image. Results of this stage should give us only the valid edges in the given image, which is performed by using the two threshold values, T1 (high) and T2 (low), for the edge strength of the pixel of the image. Edge strength which is greater than T1 is considered as a definite edge. Edge strength which is less than T2 is set to zero. The pixel with edge strength between the thresholds T1 and T2 is considered only if there is a path from this pixel to a pixel with edge strength above T1.

Segmented eye images obtained after Canny Edge Detector algorithm step

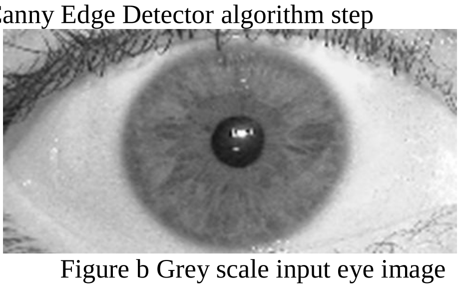

Figure b Grey scale input eye image

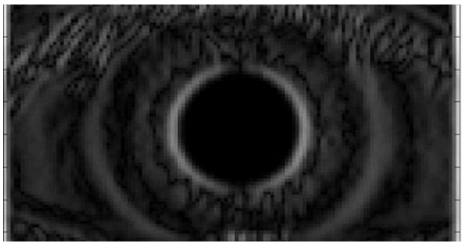

Figure c Gradient image

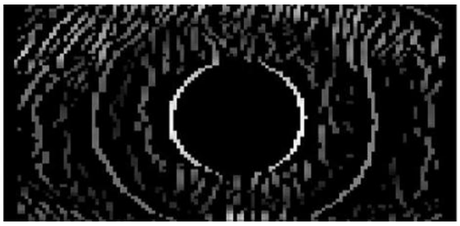

Figure d After non maximum suppression

Figure e Edge image after hysteresis threshoding

Hough Circular Transform: One of the most commonly used algorithms to recognize different shapes in an image is Hough Transform [26]. Hough Transform was introduced by Paul Hough in 1962 and patented by IBM. In 1972 Richard Duda and Peter Hart modified Hough Transform, which is used universally today under the name Generalized Hough Transform [27]. An extended form of General Hough Transform, Circular Hough Transform (CHT) [26], is used to detect circles. The edge detected from the Canny edge detector forms the input to extract the circle using the Circular Hough Transform.In Circular Hough Transform, voting procedure is carried out in a parameter space. The local maxima in accumulator space, obtained by voting procedure, are used to compute the Hough Transform. Parameter space is defined by the parametric representation used to describe circles in the picture plane.

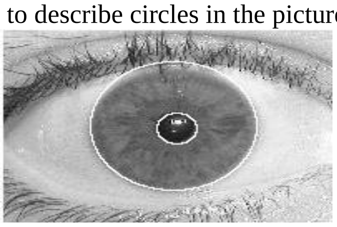

Figure f Eye image obtained after segmentation process

2. *Normalisation*

Once the segmentation module has estimated the iris's boundary, the normalization process will transform the circular iris region into another shape which will have the same constant dimensions [8]. We can be using Daugman's Rubber Sheet Model for normalization. This model transforms the iris texture from Cartesian to polarcoordinates. This process is called as iris unwrapping, which have a rectangular entity that is used for further subsequent processing. The transformation of normal Cartesian to polar coordinates is recommended which maps the entire pixels in the iris area into a pair of polar coordinates (r, θ), where r and θ represents the intervals of [0 1] and [0 2π].

Resulted Iris images after normalisation process

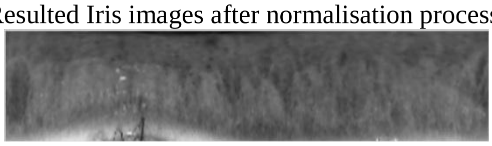

Figure g: Normalized Iris image

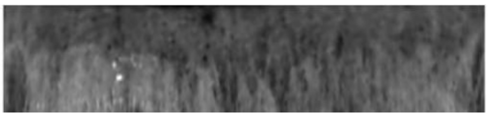

Figure h: Cropped Iris image

Figure i: Final enhanced Iris image

VIII. RESULTS AND DISCUSSIONS

This paper implements an iris recognition system by using 2-DCT algorithm to recognize the identity of a person, by working on iris part by matching the template data with stored data in the database. In this paper, segmentation, Normalisation, feature extraction are performed by using different algorithms on the image data provided by UBIRIS dataset. Study of this paper has provided quantitative template data to demonstrate performance levels in terms of ROC curve. Matching process is done on 54 images taken from UBIRIS dataset, which helps to implement the work in robust conditions in terms of noise. ROC curve includes False Positive Rate and True Positive Rate parameters which helps toconclude the performance of system.FAR (False Acceptance Rate), FRR (False Rejection Rate) and Recognition Rate are also concluded in the work and are given below.

Table d: Different parameter results

FAR	0.0094%
FRR	0%
Recognition Rate	99.995%

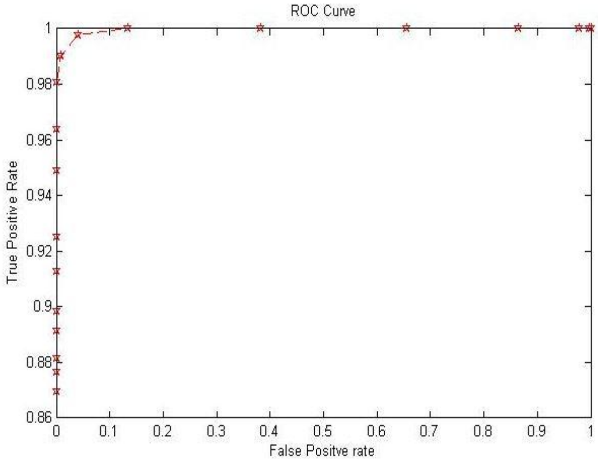

Figure j ROC (Receiver Operating Characteristic) curve

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