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Study and Comparison of Iris Edge Detection Technique

Ms. Kavita Khobragade
Associate Professor,
Fergusson College,
Pune, India
E-mail: kavitanand@rediffmail.com

***Abstract*— In present era, biometric systems are getting more attention as security is the most important and essential criteria. The security systems demands for more authenticate, reliable and fast algorithms to implement biometric system. To deal with the security, physical and behavioural characteristics play an important role than personal identification number (PIN) and passwords. The human physical characteristics like face, iris, fingerprint, etc and behavioural characteristics like DNA, signature, voice etc are the biometrics traits used to achieve security. In this busy world, the identification and / or verification should be fast and efficient. This paper provides the comparative study of iris edge detection techniques which will help to extract edges as better iris features and get the better recognition results. It has been observed that Canny's edge detection is computationally more expensive but gives better results.**

***Keywords*— Security, Biometrics, Biometric Authentication, Iris Recognition, Edge Detection**

I. Introduction

The increasing requirements of security due to advancement in Information Technology sector especially Cyber security and Border control have led to rapid development of personal identification or verification system based on Biometrics.

Among all the biometric traits such as fingerprint, palm, retina, face, voice, signature etc., iris is the most reliable biometric because of its uniqueness, stability and non-invasive nature. [4]

An E-security is the critical need to find accurate, secure and cost-effective alternative for PIN and password [5] Basic need for every person is to secure data, information and money. Biometric solutions are useful to solve these problems as biometric data is unique and non-transferable. Biometric is the method which identifies and / or verify a person automatically by using either physiological or behavioural characteristics. [6]

Iris is the unique organ which offers highest accuracy in identifying any individual. Two irises are alike between two identical twins and even between left and right eye of an individual. Irises are stable throughout the life and the pattern is formed only ones by ten month of the age of gestation. [7]

Iris has a various features such as pigment frill, collarette, crypts etc. The features of an iris are shown in figure 1. [8]

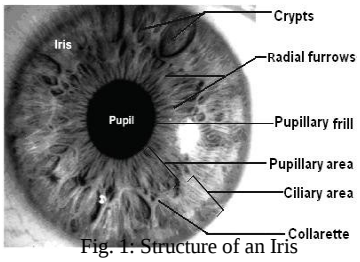

Fig. 1. Structure of an Iris

The iris image may have some irrelevant information such as pupil, eyelashes, reflection etc. The main difficulty in iris recognition is that it is difficult to find perceptible feature points in the image and to keep their representation high with efficient way. Even the identification and/or verification process should provide high accuracy. This is achieved by localizing the iris image correctly. The localization step is crucial as the falsely represented iris may lead to corrupted iris template and generate the poor result. [9]

Iris image acquisition is the first step in digital image processing. It is the most difficult process. Image formation is done with the help of a digital camera or some special device like scanner for fingerprint, CCD camera for iris, face etc. In image formation the radiant energy emitted from the source is converted to 2-dimentional image.

While capturing the image, due to motion or interference some disturbance, blur etc is added automatically in the image. This is called noise. The features can not be extracted correctly from such images. To improve the quality of image, enhancement techniques such as edge sharpening, noise removal etc are used. [1]

To extract the correct features, the correct region of interest is required. This region of interest is segmented for getting meaningful information from it. The specified pattern can be searched through segmented region of interest. Before segmenting the image of an iris, morphological operations are performed on an iris image.

The segmentation process may include edge detection. Sometimes edge detection is used for feature extraction also. In this paper, the iris edge detection techniques are discussed in detail. The content of this paper are as follows. In the following section, literature review is given. Iris localization is described in section III. In section IV, different edge detection techniques

are discussed. Section V shows the practical implementation of this paper. Section VI discusses the results and its analysis. Section VII concludes the paper.

II. LITRATURE REVIEW

Different edge detection techniques were used by various researchers to get better iris recognition. Bodade et al. had detected edges of UBIRIS database successfully and achieved the better recognition with complex wavelet. [4] Nabti et al., used multi-scale edge operator and achieved 99.5% iris recognition rate. [9] Liu et al. had also used Canny edge operator on JLUBR-IRIS database which has 200 images of an iris. They achieved high accuracy and effectiveness in iris recognition. [10] Conjeti et al. used canny operator on CASIA database which has 756 iris images and the recognition rate achieved as 99.82%. [11] Bindra et al., used Sobel operator to analyse the texture information of an iris and achieved recognition rate as90.90%. [12]

The iris recognition rate depends on the iris localization and edge detection techniques used.

III. IRIS LOCALIZATION

Segmentation is a process to partition any image in group of pixels. It can be done locally [i.e. segmenting sub-images] or globally [i.e. segmenting whole image]. The number of pixels available in local segmentation is less than that of global segmentation. There are three views of global segmentation namely region approach, boundary approach and edge approach. [1] Figure 2 shows the original iris image taken from CASIA V.1.0. [16] Figure 3 shows the localized iris image.

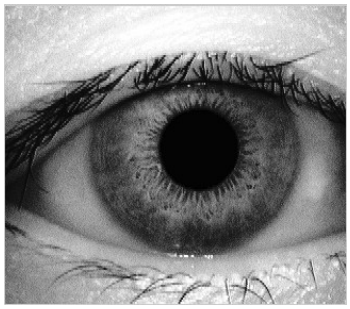

Fig. 2: An Iris Image (CASIA 1.0)

Source : [16]

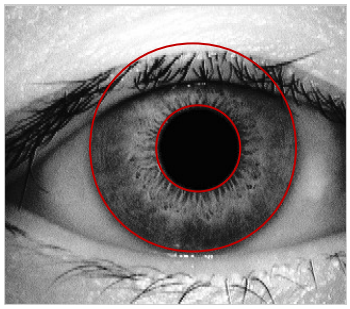

Fig. 3: Result of Localized Iris

IV. EDGE DETECTION

Edge detection is a process of identifying the areas in an iris image where a large change in intensity occurs. There are various methods available for edge detection. Few of them are considered here in this paper.

A. Canny Method

It was invented by John F. Canny in 1986. It finds the edges by looking for the local maxima of the gradient of an image. The gradient is calculated by using the derivative of Gaussian filter. It used first derivative to find / compute the edges and second derivative to compute directions of the edges. This method detects the strong and weak edges. Only those weak edges are detected which are connected to strong edges. This operator is based on three basic objectives i.e. low error rate, well localized edge points and single edge point response. [2]

B. Prewitt Method

It was invented by Judy Prewitt in 1970. This mask is simpler to implement. It is a discrete differentiation operator which computes the approximation of the gradient of the image intensity function. The Prewitt operator is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical direction. Therefore it is relatively inexpensive in terms of computations. But the gradient approximation which it produces is relatively crude, in particular for high frequency variations in the image. [2, 13]

C. Sobel Method

It was invented by Irwin Sobel in 1970. This operator has better noise-suppression [smoothing] characteristics. At each point in the image, the result of the Sobel operator is either the corresponding gradient vector or the norm of this vector. It is similar to Prewitt operator except it uses 3X3 mask called convolution kernel. [2, 14]

D. Robert Method

It was invented by Lawrence Roberts in 1965. It is simple and quick to compute. According to Roberts, an edge detector should have the properties such as the produced edges should be well-defined, the background should have very less amount of noise, and the intensity of edges should correspond as close as possible to what a human would perceive. This operator approximates the gradient of an image through discrete differentiation which is achieved by computing the sum of the squares of the differences between diagonally adjacent pixels. [2, 15]

V. IMPLEMENTATION OF EDGE DETECTION

In this paper, the edge detection technique is used as a pre-processing technique where localization of iris is more important. The iris localization can be done by finding the pupil [inner] boundary and iris [outer] boundary. With edge detection techniques, other algorithms can also be used such as Hough Transform, Integro-differential operator etc to localize the iris.

The implementation is done using MatLab 7.0. The following steps were carried out.

A. Step 1: Acquire Database

The freely available database is considered for implementation i.e. CASIA 1.0 which includes 756 images. The iris image can read from the stored database.

B. Step 2: convert image to gray scale

Read the image and convert it into gray scale. The CASIA images are by default gray in colour. So there is no need to convert them in gray scale.

C. Step 3: Histogram Equalization

It is a technique to evenly distribute the pixels to increase the contrast of an image. It treats an image as a probability distribution and then finds the cumulative distribution. But this method may not always provide the better result. [3]

D. Step 4: Edge Detection By Canny

Edge is detected by Canny with different threshold values. It detects wide range of edges in iris image. It is used for feature extraction also.

E. Step 5: Edge Detection By Prewitt

It is the operator based on convolving the image with small, separable and integer value in horizontal and vertical direction. It uses two different masks for x direction and y direction.

F. Step 6: Edge Detection By Sobel

It uses the convolution kernel to detect the edge. It is the operator based on convolving the image with small, separable and integer value in horizontal and vertical direction. It uses single mask.

G. Step 7: Edge Detection By Robert

It approximates the gradient of an image through discrete differentiation which is achieved by computing the sum of the squares of the differences between diagonally adjacent pixels.

VI. RESULTS AND ANALYSIS

The implemented iris recognition system is tested with different images. It has been observed the results are similar with different images. This section displays the results to ensure the effect of each step.

A. Step 1: Reading the Image from Database

The iris image had been read from the directory where the CASIA database is stored. The original image of an iris is shown in figure 2. The histogram of the original image is shown in figure 4.

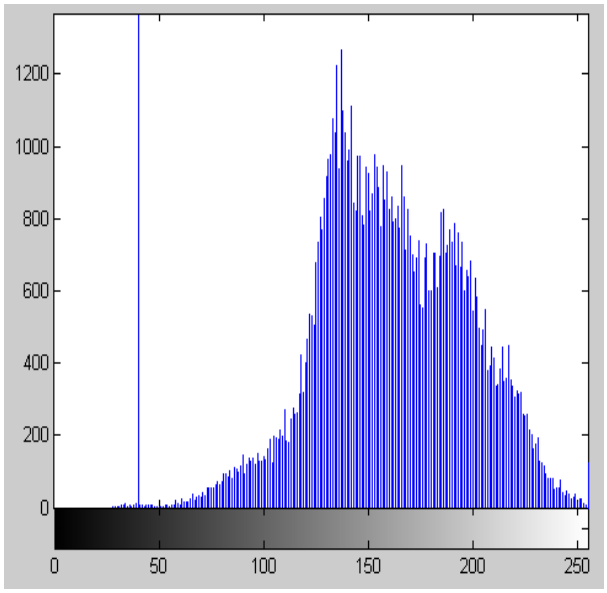

Fig. 4: Histogram of Original Iris Image

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B. Step 2: Converting into Gray Scale

This step is used to convert image into gray scale. Coloured image take more time for computation and more space for storage. But Gray scale image takes less memory space for storage and less computation time. Here it is not required as CASIA database provides gray scale images.

C. Step 3: Increase the Contrast

The contrast is increased by histogram equalization. It is done by probability density function and cumulative distribution calculation. For all the gray levels, uniform histogram is given. The histogram of equalization is shown in figure 5.

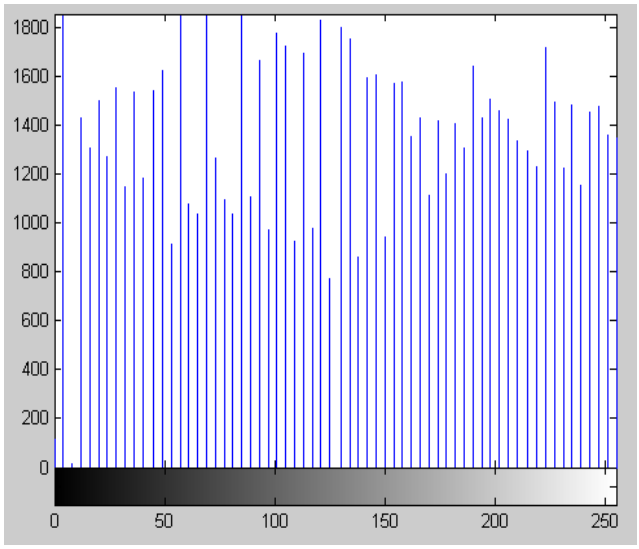

Fig. 5: Histogram of Equalization

D. Step 4: Edge Detection with Different Operators

Different types of edge detection operators are applied on the same image such as Canny operator, Prewitt operator, Sobel operator and Roberts operator. I have applied different threshold values with trial and error basis. From these trial and error results, it is clear that the obtained result of Canny is better than all other three techniques. The result of Canny with threshold 0.09 is shown in figure 6. The result of Prewitt with threshold 0.06 is shown in figure 7.

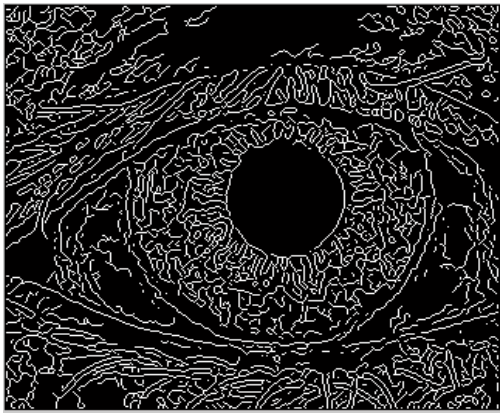

Fig. 6: Canny Method

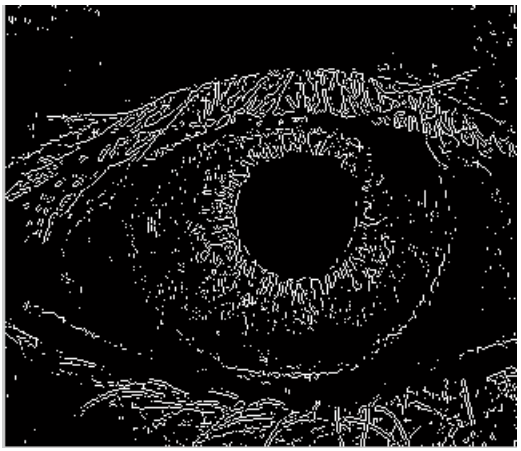

Fig. 7: Prewitt Method

The result of Sobel with threshold 0.06 is shown in figure 8 and Roberts with threshold 0.06 is shown in figure 9.

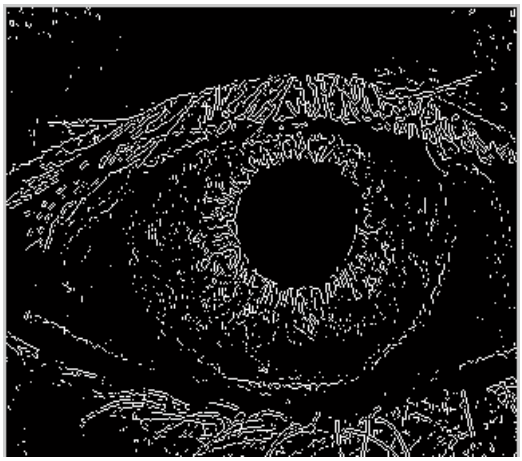

Fig. 8: Sobel Method

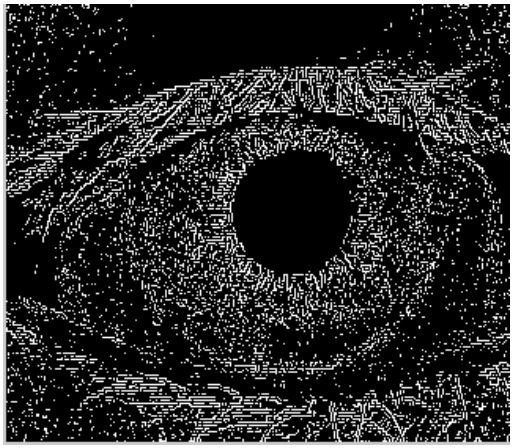

Fig. 9: Roberts Method

VII. Conclusions

Since edge detection is the initial step in any recognition technique, it is important to know the differences between various edge detection techniques. In this paper, I studied the most commonly used edge detection techniques such as Canny, Prewitt, Sobel and Roberts. The implementation is done using MatLab 7.0.

The Prewitt operator has a major drawback that it is very sensitive to noise. And it does not consider the high frequency variation. The Roberts operator works well only when the acquired image has very less noise and well defined edges. The Sobel operator is having noise-suppression [smoothing] capability, which smoothen all the edges. So it is difficult to find the edges correctly. Canny operator finds all the strong and weak edges those are connected to strong edges only. Therefore, edge features can be extracted easily and correctly

with Canny operator. Computationally Prewitt, Sobel and Roberts operators are simple whereas Canny is more expensive, even though it provides better results.

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