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EFFECTIVENESS OF EDGE DETECTION OPERATORS ON THE PERFORMANCE OF IRIS BIOMETRIC RECOGNITION

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Abstract— **Iris recognition is the most accurate biometric identification system on hand. Most iris recognition systems use algorithms developed by Daugman. The performance of iris recognition is highly depends on edge detection. Canny is the edge detectors which commonly used . The objective of the research are to a) Study the edge detection criteria and b) Measure the PSNR values in estimating the noise between the original iris feature and new iris template. In this paper Daugman's rubber sheet model is employed for iris normalization and unwrapping, descriptive statistical analysis of different edge detection operators is performed. Results show that the PSNR values of iris feature before and after the process of extraction, was 24.93 and 9.12. For Sobel and Prewitt, both give 18.5 after the process. The impact of edge detection techniques produces higher accuracy in iris recognition system.**

Index Terms— **Edge detection, Feature extraction, Iris recognition system, PSNR.**

I. INTRODUCTION

A biometric system offers an individual recognition based on unique features or behaviours. Iris recognition system is a reliable method for identity authentication, such as access control, e-commerce, banking online transactions and logistics. In comparison with other biometric technologies, such as face and finger recognition, iris pattern is the most reliable for identifying individuals because the iris is unique due to epigenetic factor [2] that remains stable throughout adult lifetime. The process of feature extraction is important in acquiring the information of an individual. The process comes after the segmentation and normalization phases. The application of feature extraction is mainly in iris recognition, for identification which is a combination of edge detection and classifiers, to measure the speed of time in recognition. To remove noise, such algorithm is useful as salt and pepper, assist in noise removal in iris accuracy performance. Feature extraction creates new template from the original features and simplifiers the large data set into smaller sizes. The large data set consists of redundant and irrelevant information.

Therefore, it produces higher cost and hassle in maintenance to the existing system. In fact, obtaining important information from the iris template, demand algorithms of feature extraction. Feature extraction is based on boundary detection, shape transform, template matching and thresholding, which make it a unique problem.

The authenticity of the person's iris, need to be based on an algorithm in finding the most accurate iris key feature during extraction and matching phases. Therefore, the operators of edge detection such as Canny, Sobel and Prewitt are applied in this study. It helps the iris recognition system and human detection, based on physical and genotypic and epigenetic traits. The biometric data or templates belong only to a person and neither is used by other person, nor forgotten.

The purpose of this study is to investigate whether the edge detection helps in iris recognition in biometric systems. Another objective is to get the PSNR values of human iris before and after the process of edge extraction.

The experiments are undergo in determining whether performing the edge detection gives better PSNR value before and after the edge processing. In order to determine the PSNR value, the noisy iris feature has been reduced to extract the most important information in the iris region. This process produced the value of PSNR value at certain threshold.

II. METHODOLOGY

The unique iris pattern from a digitized image of the eye is extracted and encoded into a biometric template using the image processing techniques. The unique information in the iris is represented as objective mathematical representation. This is checked against templates for resemblances. When a person wishes to be authorized by an iris recognition system, their eye has to be first photographed, and a template is created for their iris region. The template is compared with the other templates in the knowledgebase. The comparison can be made till a matching template is found and the person is recognized, or no match is found and the person is overruled.

There are five main steps for the iris recognition process. The first step is the enrolment, where the eye image is captured. The next step is the segmentation of the iris from the other parts of the eye image. Normalization is the third step, in which the iris pattern is scaled to a constant size. Iris is represented as iris code in the fourth step. The Classification phase is the final step, where a matching technique is used to find out the similarity between the two

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iris code.Figure1 depicts the schematic for an Iris recognition system.

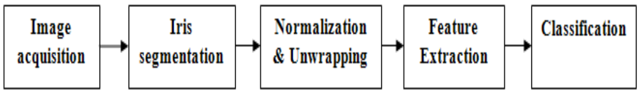

Figure 1. Schematic of Iris Recognition system

III. FEATURE EXTRACTION IN IRIS RECOGNITION

Iris recognition is a method of biometric authentication which involves pattern recognition techniques on iris codes of a human's eyes. The iris pattern may look like rings, furrows and freckles in shapes. Meanwhile, the information inside this iris pattern or called as iris feature is processed from the eye image, converted into a rectangular shape and stored into the database using the information processing technique. The stored iris features is a unique matching process. Typical iris recognition involves three main phases:

- Segmentation

The assumption which is iris in circular boundaries of region has been a frontier in iris segmentation algorithms, even though the iris boundaries not constrained to be circles. A number of researches considered various approaches to segmenting iris through finding the center of pupil, the inner and outer iris boundaries. Daugman [3] implements integro-differential operators to detect the limbic and pupil boundaries. Another method which is proposed by Wildes [4] introduces an edge detection operator and Hough Transform in iris segmentation. The iris texture is represented with a Laplacian pyramid constructed with four different resolution levels and has used the normalized correlation to determine whether the input image and the model image are from the same class. asek [5] implements Canny edge detection and Hough transform to segment the iris. The same approach has been developed by other researches with a small variation [6-9]. The direction of research in feature extraction has progressed to thresholding and morphological transformations areas In this study, Hough transform and the edge detection operator which consists of Canny, Sobel and Prewitt are employed in segmenting the iris boundaries in producing the normalized iris feature as in the next section.

- Normalization

After the iris region is successfully segmented from an eye, the next phase is to transform the iris region to a 20x240 dimensions of matrix for further verification. The dimensional between eye images are due to the stretching [10] of the iris caused by pupil dilation which is from varying levels of illumination. It produces iris regions which have the constant dimensions in different conditions and location. The selected region of iris feature is transformed into a Daugman's rubber sheet model as in Fig. I.

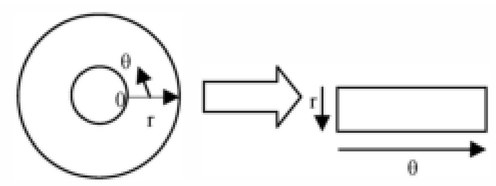

Figure 2.Daugman's rubber sheet model

The Daugman normalization method transforms the Cartesian model in iris texture from Cartesian to polar coordinates.[11] The method is capable of compensating the unwanted variations due to distance of eye from camera and its position with respect to the camera. The Cartesian to polar transform is defined as:
Where

$$x_p(\theta) = x_{p0}(\theta) + r_p * \cos(\theta),$$
$$y_p(\theta) = y_{p0}(\theta) + r_p * \sin(\theta),$$
$$x_i(\theta) = x_i(\theta) + r_i * \cos(\theta),$$
$$y_i(\theta) = y_{i0}(\theta) + r_i * \sin(\theta),$$

The process is in fewer dimensions in the angular direction. In the radial direction, the texture is assumed to change linearly, which is known as the rubber sheet model. The rubber sheet model linearly maps the iris texture in the radial direction from pupil border to limbus border into the interval [0 1] , and creates less dimension transformation in the radial direction as well.

- Feature Extraction

The feature extraction is a key component of iris recognition system since it acquires the most valuable information in iris and determines the system's performance. It performs accurate results through the iris feature extraction of input images and matching these features with the iris patterns in the database. The boundary detection, shape transform, thresholding and template matching are the techniques for feature extraction. Here, the edge detection is focused and experiments are conducted to extract the iris information. Further explanation on edge detection using Sobel, Prewitt and Canny operators is elaborated in section IV

IV. EDGE DETECTION

Edge detection provide a number of derivative operators which significantly detect the local changes of intensity in an image. It occurs on the boundary between two different regions of iris features. The goal of edge detection is to produce drawings for instance corners, lines, curves and points in order to extract the key features of key information from the iris feature. The typical operator is sensitive to horizontal edges, vertical edges, or both. The purpose of edge detection is to significantly reduce the amount of data

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in an image, while preserving the structural properties to be used for further matching process. It returns a binary image containing 1's where edges are found and 0's elsewhere .In this study, Sobel, Prewitt and Canny edge detection operators are used. The most powerful edge-detection method is the Canny method. The Canny method differs from the other edge-detection methods because it uses two different thresholds in detecting between the strong and weak edges. [12] If the output at the weak edges is connected to weak point, it means weak edges. The sensitivity level of thresholds at the weak edges determines the number of information to be extracted.

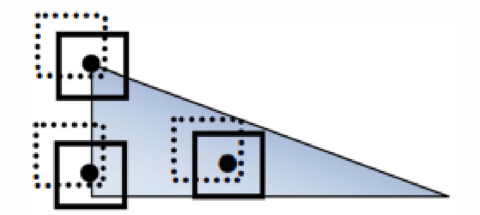

Figure 3. The diagram of strong and weak edges in thresholds.

Referring to figure 3 corners have been the most reliable feature used to find the correspondence between images.[13]Sobel operator is a discrete differentiation operator, which computes the gradient of image intensity. The result of Sobel operator is correspond to gradient vector and convolving the iris feature with small, separable, and filter in horizontal and vertical direction for high frequency variations in iris feature Mathematically, the operator uses 3x3 kernels convolved with original image. Let say A is the iris feature; Gx and Gy are reference and sample iris features which contain the horizontal and vertical approximations. Since the kernels can be decomposed as products of average and differentiation kernel, thus compute the gradient with smoothing. At each point in the iris feature, the gradient can be combined by gradient magnitude:

$$G = \sqrt{G_x^2 and G_y^2}$$

The characteristics of Prewitt operator is almost the same with Sobel operator, provided that the operator is not divided by 2. It is a discrete differentiation operator and computes the gradient of the image intensity at each point. The smooth edge gives the magnitude which is more reliable and easier to interpret than the direction of calculation. Mathematically, the operator uses 3x3 kernels convolved with original image. Let say B is the iris feature; Ix and Iy are reference and sample iris features which contain the horizontal and vertical approximations. Since the kernels can be decomposed as products of average and differentiation kernel, thus compute the gradient with smoothing. At each point in the iris feature, the gradient can be combined by gradient magnitude:

$$I = \sqrt{I_x^2 and I_y^2}$$

A comparison of output image between different edge detection operators is as in table 1.

TABLE 1 A COMPARISON OF OUTPUT BASED ON THE EDGE DETECTOR

Edge	S1001L04.jpg-polar.jpg - CASIA
Sobel	
Prewitt	
Canny	

V. RESULT

The experiments have been implemented using human eye images from CASIA database. Using the Matlab R2010, experiments have been conducted in measuring the PSNR before and after the edge detection implementations. Table II shows that the PSNR value before the employment of edge detection is 24.93. After the edge detection implementation, Canny operator shows that the value of PSNR is 9.123 which is less than the Prewitt and Sobel Operators. Both of Prewitt and Sobel give the same value of PSNR, which is 18.5. The experiments show that the Canny operator is more reliable and produce accurate performance compared to the other two operators.

TABLE 2. COMPARISION OF PSNR IN EDGE DETECTION TECHNIQUES

PSNR values for S1001L04.ipg-polar.jpg			
Before	After		
	Canny	Prewitt	Sobel
24.93	9.123	18.5	18.5

VI. CONCLUSION

This paper presented a study on the edge detection criteria and measures the PSNR values in estimating the noise between the original iris feature and new iris template. The evaluation is conducted using eye image with [320x280] dimension which is obtained from the CASIA database. The eye image has been pre-processed through the segmentation and normalization in obtaining the rubber sheet model with [20x240] in dimension. During the evaluation, Canny, Sobel and Prewitt operators is used as a benchmark for this work. Findings have shown that, the PSNR values of iris feature before and after the process of extraction, was 24.93 and 9.12.For Sobel and Prewitt, both give 18.5 after the process. This study suggests that the impact of edge detection techniques produces higher accuracy in iris recognition system.

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