

Iris Recognition System using Gabor Filter & Edge Detection

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Abstract: Biometric identification is the recognition of an individual by means of their physical or behavioral characteristics. Iris recognition in past decade has become one of reliable & unique biometric identification. In this research the various iris recognition method such as segmentation & normalization are applied on the eye image of 320x280 dimensions is obtained from CASIA database. 1-D Gabor Filter is used for feature extraction for eyelid detection & enhancing the segmented iris image. Edge detection techniques such as canny, sobel & prewitt are used for obtaining the fine edges. Performance is calculated on various evaluation parameters such as PSNR & MSE value for these edge detection techniques. Result shows sobel has less PSNR & showing more accurate & better result as compare to canny & prewitt. Matching is done using hamming distance by calculating the bit difference of processed or original image.

Keywords: Segmentation, normalization, Feature extraction, 1-D Gabor Filter, Edge detection, PSNR, MSE.

I. INTRODUCTION

Biometric is a life measurement system associated with a unique identification of an individual by their physical & behavioral characteristics. A biometric system is a pattern recognition system that operates by acquiring biometric data from an individual [13] such as finger print, facial recognition, voice recognition, signature etc. Iris recognition is a unique physical identification system which remains stable throughout its adult life for an individual due to its epigenetic factor [3]. Iris is the internal organ which is well protected by cornea & lens. Iris uses the dilator & sphincter muscles for controlling the amount of light that enter the eye. Eyes of two twins either they are phenotype or genotype have different iris structure of their eyes. Iris is a colored portion of eye among pupil & sclera. Iris color is determined primarily by the density of melanin in the interior layer and stroma. The algorithm for iris recognition were determined by Jaun Daugman at Cambridge University. The steps involved in iris recognition are:

Segmentation: Detection of inner and outer boundary of iris from sclera & pupil. Normalization: Conversion of iris from Cartesian form to polar form. Feature Extraction: Extract the unique feature vector from iris image. Matching: Comparison of iris processed template with the other template stored in database. Various technique such as hamming distance, weighted Euclidean distance & normalized correlation etc.

The main purpose of this study is to use edge detection operator such as Canny, Sobel & Prewitt for finding the most accurate iris key feature during extraction and matching. 1-D Gabor filter is used for feature extraction for extract the unique set of feature vector such as in noise removal & eyelid detection from original segmented iris image Another objective is to calculate the MSE & PSNR

values of edge detection operators for recognition of the biometric of an individual.

II. RELATED WORK

Mohd.Tariq Khan [1] proposed an fast & effective algorithm for the extraction of feature by 1-D Gabor filter by using different iris dataset. Result of his research shows good performance & computation speed. The Daugman [17] proposed the most well known iris recognition algorithm. Zaheera Zainal Abidin [5] study the edge detection technique & calculate the PSNR value for estimating the noise between original iris image & new iris template image. Study shows that Canny edge detection among Prewitt & sobel edge detection shows more accurate result. Edge detection operator such as Sobel, Log, Prewitt & Canny are applied for the noisy IR images & quality is compared by calculating PSNR & RMSE value before filtering & after filtering. Median, Lee & Kaun filter are used for filter IR noisy image. Experimental result shows that Sobel edge detector perform well with median filter study given by G.PadamVathi [2]. V.Saravanam [12] presented an iris verification algorithm based on Gabor filter. Performance matrices such as False Acceptance Rate (FAR), False Rejection Rate(FRR) & Equal Error Rate(EER) are calculated. Iris verification algorithm is implemented by using a DSP blackfin processor consists of decoding part, encoding part & DSP processing part.

III. METHODOLOGY

Iris recognition involves pattern recognition technique on iris codes of an human's eye. Iris recognition consists of various preprocessing steps for recognition of an individual. The information inside iris pattern is processed from the eye image, converted into rectangular shape & stored into database using the information processing techniques. The stored iris features is a unique identification of a human &

useful for future matching process. The step involves in Iris recognition system are:

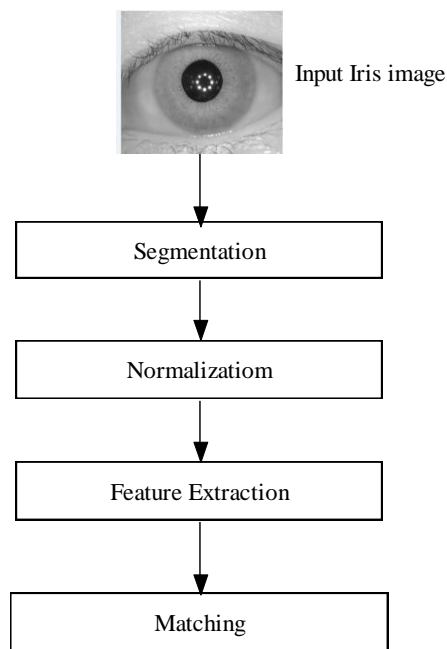


Figure 1: Block Diagram of Iris Recognition

A. Segmentation

The first step is to assume an input eye image of dimensions(320x280) from CASIA-InternalIrisV3 database. Segmentation or localization is to simplify or change the representation of an image into something that is more meaningful & easier to analyze. Segmentation is the process of partitioning an image into multiple region i.e. set of pixels [18]. Iris can be approximated by two circles, one for iris/sclera and another for iris/pupil boundary. The output of segmentation is iris signature. The circular Hough Transform is used to deduce the radius & center coordinate of pupil & iris region [11]. Hysteresis thresholding for marking edges in iris image by checking the threshold value

of image pixel between upper threshold & lower threshold of an image. Inner & outer boundary of iris is localized by finding the edges of iris by using canny edge detection. Iris image gamma values in the range 0-1 enhance contrast of bright region and values greater than 1 enhance contrast in dark region.

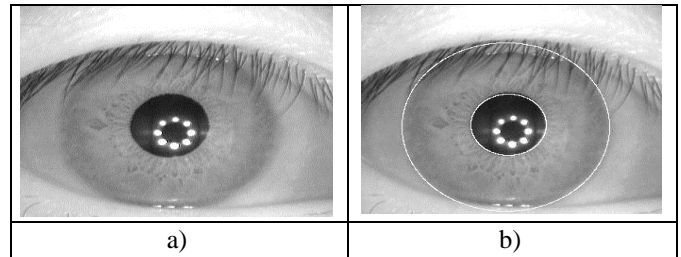


Figure 2: Segmentation of iris inner & outer area. a) Input iris image , b) Segmented iris image

B. Normalization

After successful segmentation of iris boundary the next phase is to unwrapping of segmented iris to fixed resolution. Iris texture is converted into a rectangular shape of dimension 280x20 pixels. In normalization process the segmented iris image is converted from coordinate form (x, y) to polar form(r, θ). Daugman’s Rubber sheet model is used for iris texture transformation to polar form [4].

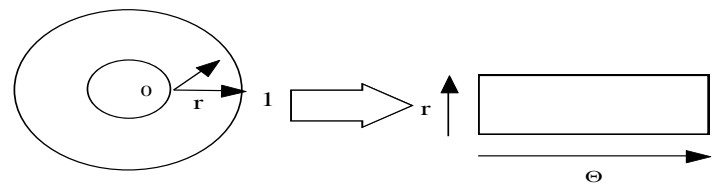


Figure 3: Daugman’s Rubber Sheet Model

The process is in fewer dimensions in angular direction & in radial direction, the texture is assumed to change linearly which is known as rubber sheet model.

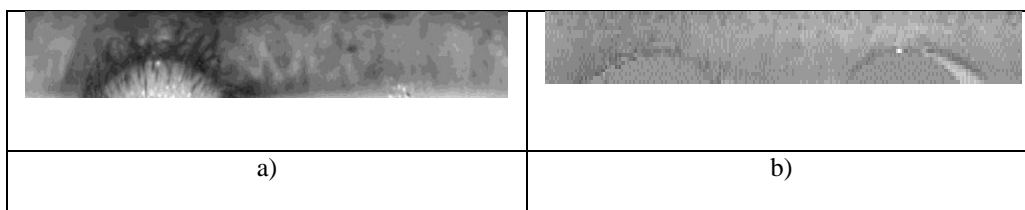


Figure 4: Normalized iris image of two different eyes a), b)

C. Feature Extraction

Feature extraction is used for transformation of data into a set of feature or feature vector. A feature vector is formed which consists of the ordered sequence of feature extracted from the various representation of the iris images. Method used for feature extraction uses the wavelet transform [7] & Gabor filter. Wavelet transform represent the function having discontinuous & sharp peaks where as Gabor filter [19] is a linear filter project one image intensity to other and

are directly related to Gabor wavelet for various dilation & rotation. In this work 1-D Gabor filter is used as band pass filter which gives Gabor wavelet & Gabor envelop. 1-D Gabor filter is used for the eyelashes detection & removing the noise among the iris preprocessed image. The steps involved in 1-D Gabor filter are:

Step 2-1: Gabor wavelet is determine as

$$G(x,y) = S(x,y)W(x,y) \tag{1}$$

Complex carrier in the form:

$$S(x, y) = e^{j(2\pi(ux+vy)+P)} \quad (2)$$

Step 2-2: Extraction of real & imaginary part.

Real part:

$$\text{Re}(s(x, y)) = \cos(2\pi(ux + vy) + P) \quad (3)$$

(3)

Imaginary part:

$$\text{Im}(s(x, y)) = \sin(2\pi(ux + vy) + P) \quad (4)$$

(4)

u & v are the frequency of horizontal & vertical sinusoidal, P is arbitrary phase shift. Filter each image by Gabor filter & calculate the Gabor radial filter component. Extract feature vector from iris image & for each row of image do the convolution & back transformation.

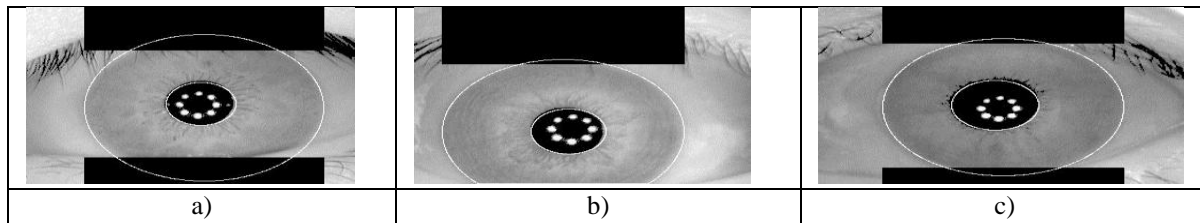


Figure 5: Eyelid Detection & Filter iris image of different eyes a), b), c)

D. Edge Detection

Edge detection is technique which provides a number of derivative operators which significantly detect the local change of intensity in an image. It occurs on the boundary between two different regions of iris texture [7]. The edge operators are sensitive to horizontal edges, vertical edges or both. It returns image containing binary 1's where edges are found and binary 0's elsewhere [5]. The goal of edge detection is to produce drawing instance corners, lines, curves and points in order to extract the key feature or key information from iris feature.

In this study edge operators canny, sobel & prewitt are used for detecting edges. Sobel shows the better & more accurate edges in comparison to other edge operator i.e. canny & prewitt. Sobel operator uses the image with a separable and integer valued filter in horizontal or vertical direction [2]. Mathematically, sobel operator uses 3x3 kernels convolved with original image. Let G_x and G_y are reference and sample iris features which contain the horizontal and vertical approximations. The gradient at each point in the iris feature can be combined by gradient magnitude:

$$G = \sqrt{G_x^2 + G_y^2} \quad (5)$$

Canny is designed as an optimal edge detector. Canny convolves the image with the derivate of Gaussian for smoothing the image. It takes input as grayscale image and produce an output an image showing the positions of tracked intensity discontinuities. Canny method uses two different thresholds in detecting strong & weak edges. The sensitivity level of threshold at weak edges gives the number of information to be extracted [5].

Prewitt edge operator is a discrete differential operator computing an approximation of the gradient of image intensity. The local edge orientation is estimated with the orientation of kernel which can be combined together to find the absolute magnitude of gradient at each point and

orientation of gradient. Prewitt operator characteristics are similar to sobel operator except it is not divided by 2. Gradient magnitude for horizontal approximation as given by I_x and vertical approximation as given by I_y are the iris feature can be calculated by taking their average at each point.

$$I = \sqrt{I_x^2 + I_y^2} \quad (6)$$

Edge Detection Technique	12.jpg CASIA
Sobel	
Canny	
Prewitt	

Figure 6 : Edge detection representation of various edge detection techniques

E. Matching

Matching is a process in which the iris template is compared with the iris image from the database for recognition. The various matching technique used are hamming distance, weighted Euclidean distance & normalized correlation. Weighted Euclidean distance [20] contain lots of calculation and this metrics also involve lots of integer value. Normalized correlation also involves a huge amount of computation [1]. Hamming distance is more fast and simple matching technique. In hamming distance calculation the new preprocessed iris image is compare with the already stored iris image in database. For matched images hamming distance is zero. Hamming distance is calculated as:

$$\text{Hamming Distance} = \frac{\text{Difference between bits of two iris template}}{\text{Length of vector}}$$

IV. RESULT & DISCUSSION

This work has been implemented using eye image of dimensions (320x280) having jpg extension from CASIA-InternalIrisV3 database. Using the MATLAB2007b, experiments has been conducted for measuring the MSE & PSNR for sobel, canny & prewitt edge detection operators.

The result shows that the sobel edge detector has less PSNR and showing more accurate and effective result in comparison to canny & prewitt. The method has been implemented on five grayscale image from CASIA-InternalIrisV3 database given in figure:

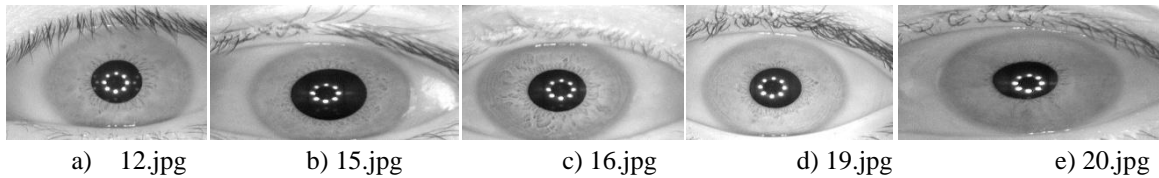


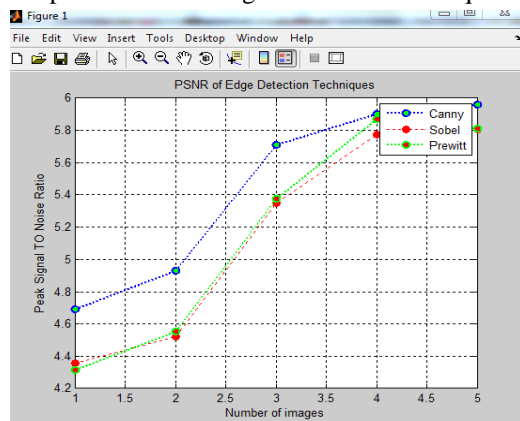
Figure 7 : CASIA database Iris image as input grayscale image

The PSNR & MSE of input iris image for three edge detection operators canny, sobel & prewitt is shown in table given below:

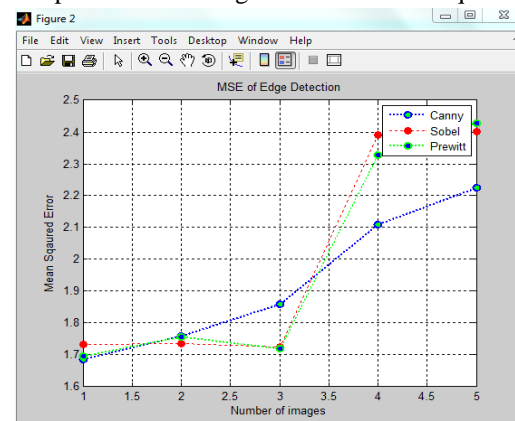
Table 1: PSNR & MSE of Edge detection technique

Serial Number	Image Name (320x280)	Peak Signal to Noise Ratio (PSNR)			Mean Squared Error (MSE)		
		Canny	Sobel	Prewitt	Canny	Sobel	Prewitt
1	12.jpg	4.6904	4.358	4.3126	2.2256	2.4026	2.4278
2	15.jpg	5.1927	5.7949	5.8072	1.858	1.7258	1.7209
3	16.jpg	4.9294	4.3781	4.5538	2.1083	2.3915	2.3273
4	19.jpg	5.7128	5.7726	5.3777	1.7587	1.7347	1.7568
5	20.jpg	5.9001	5.7752	5.8712	1.6845	1.7336	1.6959
Average		5.285	5.2157	5.3845	1.927	1.9976	1.9857

Graph 1: PSNR of Edge Detection Technique



Graph 2: MSE of Edge Detection Technique



The given table shows that among the five iris image sobel operator shows the less PSNR value and hence gives the more accurate and better performance as compare to canny & prewitt edge operator.

V. CONCLUSION

This paper presented a study on feature extraction using I-D Gabor filter for eyelash detection & removing noise from iris preprocessed image i.e. after segmentation & normalization. For estimating noise among these extracted images & preprocessed images matrices such as PSNR & MSE is calculated. Eye image of 320x280 dimension has been pre-processed through segmentation for iris inner or

outer boundary and normalization is obtained by Daugman's rubber sheet model of 20x240 dimension. Edge detection operator such as canny,sobel & prewitt are used for detecting the fine edges of iris image. Result shows that the PSNR value of sobel for five iris images taken from CASIA- InternalIrisV3 database shows less value as compare to canny & prewitt operator. This study suggest that Sobel edge detection shows more accurate & better

performance as compare to other edge detection technique in iris recognition system.

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