Comparison of Edge Detection Techniques for Iris Recognition

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ABSTRACT
Nowadays security and authentication are the foremost parts of our daily life. Iris is the one of the most reliable organ or part of the human body which can be used for identification and authentication purpose. This paper examines for edge detection techniques use for iris recognition system .Between the prewitt,sobel,LoG,Min.contructor of laplacian edge detector techniques the experimental results show that minimum constructor of laplacian edge detector(Hybrid) has better ability to detect edges in digital image.

General Terms
Your general terms must be any term which can be used for general classification of the submitted material such as Pattern Recognition, Security, Algorithms et. al.

Keywords
Sobel, Prewitt, LoG, Min.constructor of laplacian edge detector(Hybrid), SSIM

1. INTRODUCTION
The term "biometric" is formed by joining two words "bio" which means life and "metric" which means measure. By the term "biometric" means measurement and statiscal analysis of characteristics of people which are either physical or behavioural. Biometric is the study of distinguishable biological characteristics that are unique and measureable like iris, face, colour of eye, etc. They can be used for the purpose of verification and now a days it is very popular and safe .A person can be more secure using biometric as it ascertain whether a person is who he claimed to be or not. The main aim of "iris recognizaton" is used to verify and authenticate a person from his or her unique pattern of iris. The patterns of iris are different and unique for each individual. The unique pattern of iris is shown in the following figure:

Fig 1.1: Distinctiveness of human iris

Iris Recognization system has mainly eye capturing , image pre-processing ,edge detection,feature extraction and pattern matching.From alll of the above edge detection plays an impertant role in iris recognization system. . Edge detection techniques transform images into edge images benefiting from the changes of grey tones in the images [27]. Detection of edges for an image may help for image segmentation, data compression, and also help for well matching, such as image reconstruction and so on [28]. Various types of edge detection techniques are used and available for image extraction etc. Each technique is constructed to be sensible for assertive types of edges. Among them Prewitt,Sobel,Robert ,Canny,Laplacian and Laplacian of Gaussian are foremost techniques.

2. METHODOLOGY
Edge detection is a type of image segmentation techniques which determines the presence of an edge or line in an image and outlines them in an appropriate way [9]. The aim of edge detection is to reduce the image data so that lesser amount of data is being refined.Generally, an edge is defined as the boundary pixels that connect two seprate regions with changing image amplitude characteristics.The methodology used in this paper as follows:

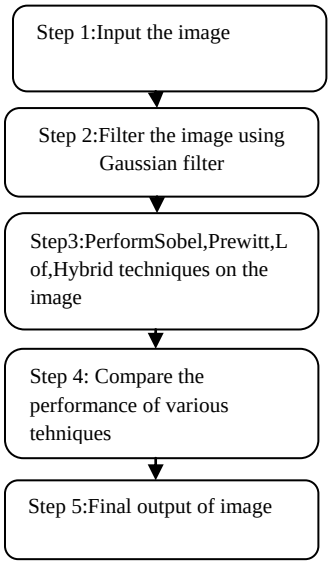

Fig 2.1: Methology used in the paper

2.1 Gaussian Filtering
Gaussian filtering has been intensively studied in image processing and computer vision. Using Gaussian filter for noise suppression, the noise is smoothed out, at the same time the signal is also distorted. The use of Gaussian filter as preprocessing for edge detection will also give rise to edge position displacement, edges vanishing, and phantom edges.

2.2 Sobel Operator
It is 3x3 convolution kernels. One kernel is simply the other rotated by 90°. It is a row edge detector.

-1	0	+1
-2	0	+2
-1	0	+1

Gx

-1	0	+1
-2	0	+2
-1	0	+1

Gy

Fig 2.2: Sobel mask filter in X direction and Y direction

GX and GY are the common masks used in Sobel Operator. This figure shows the masks used by Sobel operator. The kernel can be applied separately to input image for obtaining gradient component in each orientation i.e. GX and GY. The magnitude is:

$|G|=\sqrt{GX2+GY2}$ ….2.1

And its approximation is:

$|G|=|GX| + |GY|$ 2.2

The orientation of angle is:

$\theta=\arctan(GX/GY)$ ….2.3

2.3 Prewitt Operator:

It is similar [11] to the Sobel Operator and is used to detect vertical and horizontal edges in an image. The prewitt mask operator used is as follows:

-1	0	1
-1	0	1
-1	0	1

Px

1	1	1
0	0	0
-1	-1	-1

Py

Fig 2.3: Prewitt mask filter in X direction and Y direction

2.4 Laplacian of Gaussian (LoG):

It was proposed by Marr (1982). The LoG of an image f(x,y) is a second derivative defined as

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} \quad \ldots 2.4$$

It first smoothes the image and then computes the Laplacian. This yields in double edge image; hence for finding the edge the zero crossing between the double edges is taken.

The Laplacian of an image with the pixel intensity value L(x,y) is given by:

$$L(x,y) = \frac{\partial^2 I}{\partial x^2} + \frac{\partial^2 I}{\partial y^2} \quad \ldots 2.5$$

The commonly used discrete approximations to Laplacian filter are:

0	1	0
1	-4	1
0	1	0

Lx

0	-1	0
-1	4	-1
0	-1	0

Ly

Fig 2.4: Laplacian filter in X direction and Y direction

2.5 Min Constructor With Laplacian Edge Detector

Min Construction Method :

The lower constructor is a generalization of the tn-processing A t-norm T: $[0, 1]2 \rightarrow [0, 1]$ is an associative, commutative, increasing function, such that, $T(1, x) = x$ for all $x \in [0, 1]$. At-norm T is called idempotent if $T(x, x) = x$ for all $x \in [0, 1]$. The four basic t-norms are as follows

1. The minimum $TM (x,y)=\min(x,y)$.
2. The product $TP(x, y) = x \cdot y$.
3. The Łukasiewicz t-norm
4. $TL(x, y) = \max(x + y - 1, 0)$.
5. The nilpotent minimum t-norm
6. $TnM(x, y) = \min(x, y)$, if $x + y > 1$

0, otherwise.

- Let $R \in F(X \times Y)$ be an FR. Consider two t-norms T1 and T2 and two values $n,m \in N$ so that $n \leq P - 1/2$, and $m \leq Q - 1/2$ .We define the lower constructor associated with T1 , T2 , n, and m in the following way:
- $L_{n,m}{}^{T1,T2} : F(X \times Y) \rightarrow$ given by

$$L_{n,m}{}^{T1,T2}[R](x, y) = T_{1m,n}(T2 (R(x - i, y - j), R(x, y$$

$$i=-n$$

$$J=-m \text{ for all } (x,y) \in (X,Y)$$

The Algorithm begins with reading an M x N image. The first set of nine pixels of a 3x3 window are chosen with central pixel having values (2,2) i.e for each pixel(i,j) we are taking the 8 neighbourhood of (i,j).After the initialization, the pixel values are initially marked as edge pixel after an observation to the 8 neighbourhood. After the subjection of the pixel values the algorithm generates an intermediate image using a construction method stated below. It is checked whether all pixels have been checked or now, if not then first the horizontal coordinate pixels are checked. If all horizontal pixels have been checked the vertical pixels are checked else the horizontal pixel is incremented to retrieve the next set of pixels of a window. In this manner the window shifts and checks all the pixels in one horizontal line then increments to check the next vertical location.

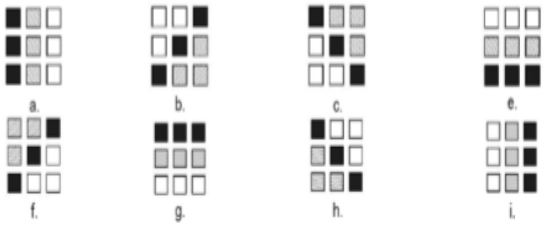

Fig 2.5:Initial conditions to check 8 neighbourhood

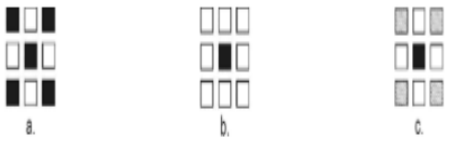

Fig2.6: (a,b)Type of unwanted edge pixels (c)condition for removal of unwanted edge pixels

After edge highlighting image is subjected to another set of condition with the help of which the unwanted parts of the output image of type shown in Fig.(a-b) are removed to generate an image which contains only the edges associated with the input image

Phase 1:

- Input: An image P of M x N pixels
- Output: An image Q of M x N pixels

Initial Edge Detection (A, B) using Min Construction

For I←2 to M-1

For J←2to N-1

If P (I-1, J)>P (I-1, J+1)

Then If P (I-1, J-1)>P (I, J)

Then If P(I, J-1)>P (I+1, J-1)

Then

Q (I-1, J+1) ←0

Q (I, J) ←0

Q (I+1, J-1) ←0

End For

End For

For I←2 to M-1

For J←2to N-1

If Q(I-1,J)=255& Q(I,J)=0& Q(I+1,J)=255& Q(I,J-1)=255

Then Q(I, J) is minimum and highlighted as edge initially.

End For

In the above algorithm Min construction[25] is used but not as after fuzzification the membership values would become fractions that can't be stored in unsigned char. Hence the same technique of min construction is used but on true picture and taking into consideration 8-nbd of a pixel (i,j). We can observe in the above algorithm written for a particular fuzzy condition that the nesting of statements is done in a manner that only the edge associated pixels are granted black pixel values and initially min valued edge pixels are given white value. These pixels are initially marked as edge.

Phase 2.

- Input: An image Q (256 color true bmp image) of size MxN
- Output: Edge image of size MxN

We now use Laplacian of Gaussian (log) operator[26] on the intermediate image to get the edge image. And In this way whatever image is being constructed is compared with edges found on same image by other existing techniques. The phase 1 actually performs a check like

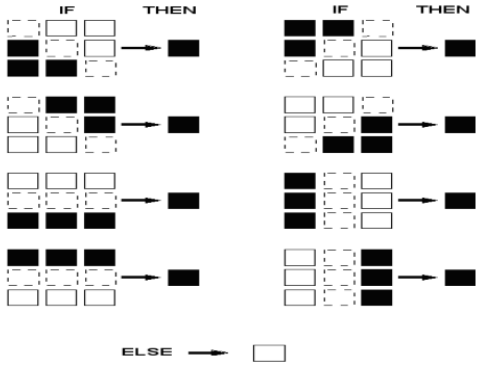

Fig2.7: Black pixels are having min values

3. EXPERIMENTAL RESULTS

The image of iris is considered as the input for applying the edge detection techniques. Here first iris image is filterd by using Gaussian filtering so that noise can be removed and then edge detection is used to extract the edge points in the characters in the iris images. Four Edge detection techniques have been analyzed and compared to detect the edgesin the iris image. Edges of an image are detected using Sobel, Prewitt, Laplacian of Gaussian (LoG) and minimum constructor with lalacian edge detectors(Hybrid). From the experimental results, the performance of Hybrid provides better result than other edge detection techniques for iris image .This work has been calculated by using SSIM (Structural Similarity Index for Measuring), which is used for measuring the similarity between two images. SSIM designed to improve on traditional methods such as peak signal-to-noise ratio (PSNR) and mean squared error (MSE). The improved SSIM measure can be used for edge detection (Parameterization), modulating of edge tracing outputs and comparison of edge tracing for real and fake images.

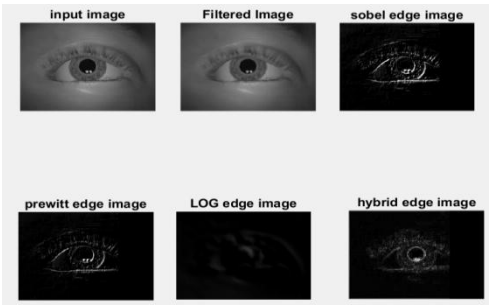

Fig3.1: output of various edge detection techniques applied in (a) image

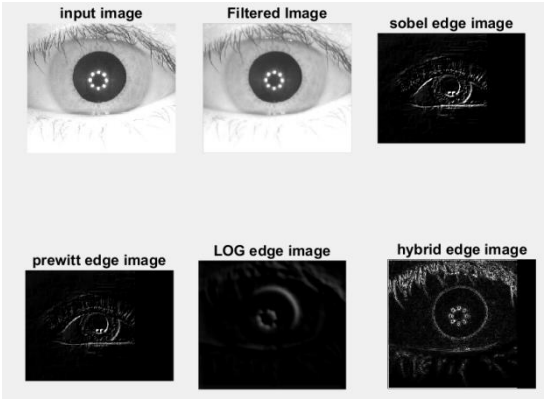

Fig3.2: output of various edge detection techniques applied in (b) image

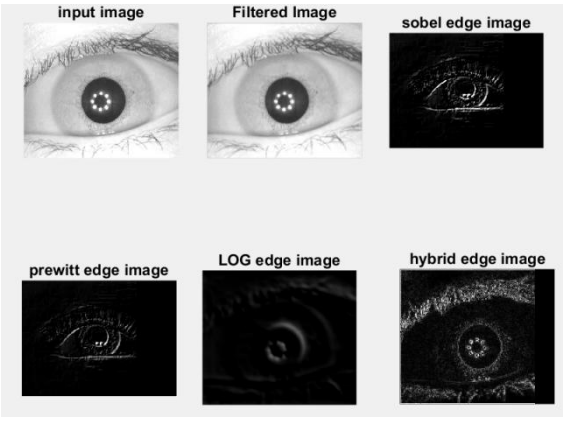

Fig3.3: output of various edge detection techniques applied in (c) image

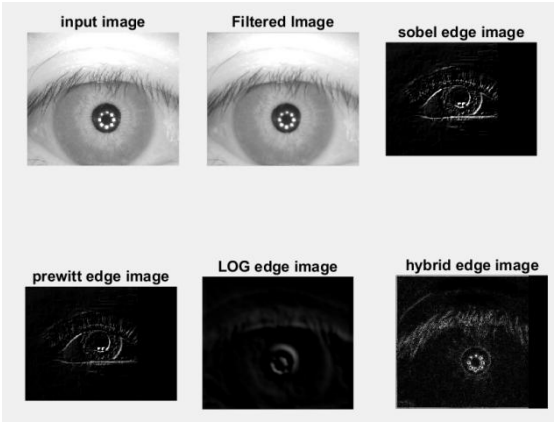

Fig3.4: output of various edge detection techniques applied in (d) image

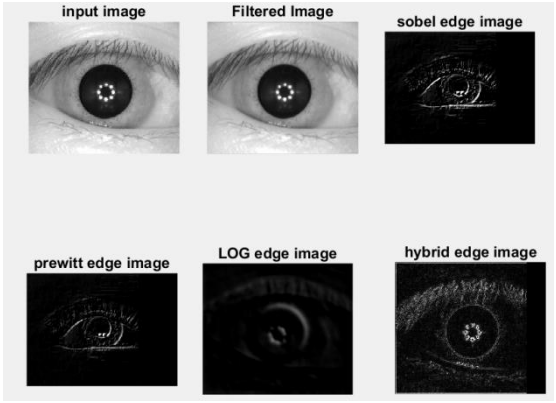

Fig3.5: output of various edge detection techniques applied in (e) image

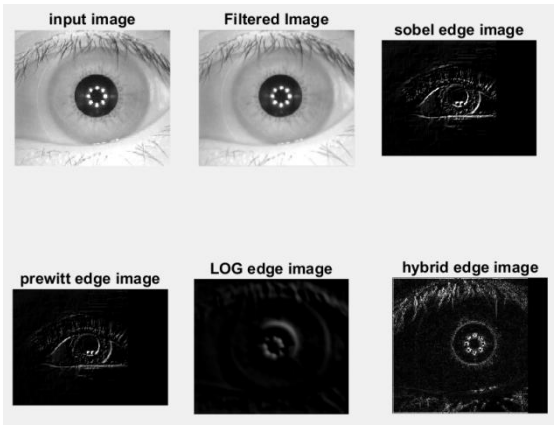

Fig3.6: output of various edge detection techniques applied in (f) image

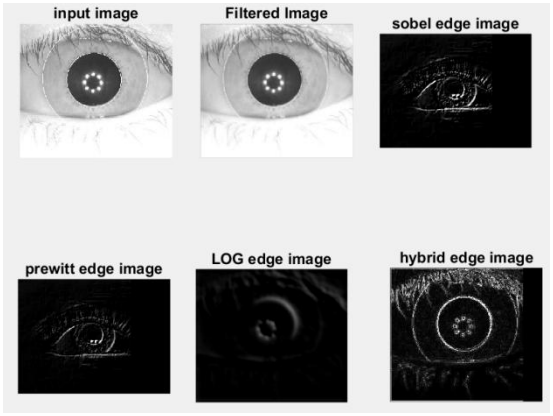

Fig3.7: output of various edge detection techniques applied in (g) image

4. RESULT

Table 1: SSIM values of various filters

Different Images of Iris	Sobel	Prewitt	LoG	Min.contructor of laplacian edge detector
a	3.49165e	3.94381e	0.0025941	0.0028153
b	-2.8772e	-1.87133e	0.0020141	0.0119238

c	-2.75792e	-1.47375e	0.0015134	0.0099203
d	7.15838e	4.39474e	-3.37233e	0.0049200
e	-5.67525e	-1.01076e	-0.0003138	0.0064094
f	-2.4396e	-9.77049e	0.0029285	0.0092613
g	-2.81019e	-1.83009e	0.0007359	0.0022296

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6. CONCLUSION & FUTURE SCOPE

An edge detector is basically a high pass filter that can be applied to extract the edge points in images. The edge detection is the primary step in identifying an image object. This work has compared various edge detecting techniques, Edges of an text image is detected using, Sobel, Prewitt, Laplacian, LOG, minimum constructor with laplacian edge detector and iris image is used for experimentation. The performance of these edge detection methods are analyzed and compared by using the parameter SSIM. It have been observed that that the minimum constructor with laplacian edge detections technique have produced higher accuracy in detection of edges compared with other edge detection algorithms.

7. FUTURE SCOPE

In the future scope the results can be compared by using different edge detection techniques like canny edge detection and different parameters can be used like PSNR and MSE.

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