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COMPARISON OF CANNY AND SOBEL EDGE IN DETECTION TECHNIQUES

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ABSTRACT

The edges for an image are always the important characteristics for a higher frequency and better results. Iris recognition system mainly includes eye image capturing, image pre-processing and edge detection through iris region segmentation, features extraction and pattern matching. Among them edge detection is one of the major part in iris recognition system. Edge detection technique makes pupil boundary detection accurately and easier. Detection of edges may help the image for image segmentation, normalization, data compression, and also for image reconstruction. Edge detection technique plays an important role in digital image processing and in different aspects of human life. Here we are seeing various edge detection techniques as Prewitt, Robert, Sobel, and Canny operators. An edge may be defined as a set of connected pixels that forms a boundary between two disjoints regions. Edge detection is a method of segmenting an image into regions of discontinuity On comparing them we can see that canny edge detector performs better than all other edge detectors on various aspects such as give better results for noisy image, remove streaking problem & adaptive in nature etc.

KEYWORDS: Edges, Edge detection, Canny and Sobel operators

INTRODUCTION

Edge detection is divided into three main steps: image pre-processing, feature extraction of iris image and template matching**.** Digital image processing is meant for processing digital computer. It is the use of computer algorithm to perform image processing on digital images. It is a technology widely used for digital image operations like feature extraction, pattern recognition, segmentation, image morphology etc. Edge detection is a well developed field on its own within image processing.

Edge detection is basically image segmentation technique, divides spatial domain, on which the image is defined, into meaningful parts or regions. Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edges typically occur on the boundary between two different regions in an image.

Edge detection allows user to observe those features of an image where there is a more or less abrupt change in gray level or texture indicating the end of one region in the image and the beginning of another. It finds practical applications in medical imaging, computer guided surgery diagnosis, locate object in satellite images, face recognition, and finger print recognition ,automatic traffic controlling systems, study of anatomical structure etc.

Many edge detection techniques have been developed for extracting edges from digital images .Gradient based classical operators like Robert, Prewitt, Sobel were initially used for edge detection but they did not give sharp edges and were highly sensitive to noise image.

Edge Detection is a basic tool used in image processing, basically for feature detection and extraction, which aim to identify points in a digital image where brightness of image changes sharply and find discontinuities. The purpose of edge detection is significantly reducing the amount of data in an image and preserves the structural properties for further image processing. In a grey level image the edge is a local feature that, with in a neighborhood separates regions in each of which the gray level is more or less uniform with in different values on the two sides of the edge**.**

Edge detection makes use of differential operators to detect changes in the gradients of the grey levels. It is divided into two main categories:

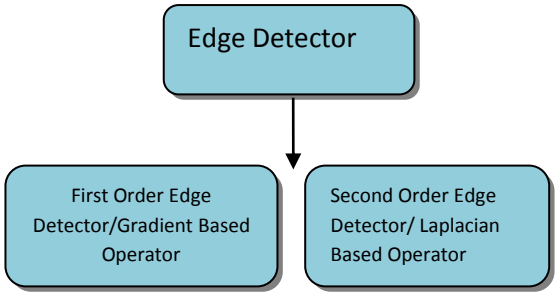

Fig. 1 Types Of Edge Detector

CLASSICAL OPERATORS IN EDGE DETECTION

Robert, Sobel , Prewitt are classified as classical operators which are easy to operate but highly sensitive to noise.The Roberts operators: It is gradient based operator. It firstly computes the sum of the squares of the difference between diagonally adjacent pixels through discrete differentiation and then calculate approximate gradient of the image.

The plus factor of this operator is its simplicity but having small kernel it is highly sensitive to noise not and not much compatible with today's technology. The input image is convolved with the default kernels of operator and gradient magnitude and directions are computed.

0	0	0
0	−1	0
0	0	1

0	0	0
0	0	−1
0	1	0

Fig. 2 The Roberts operators.

Prewitt edge operator: It gives better performance than that of sobel operator. The function of Prewitt edge detector is almost same as of sobel detector but have different kernels:

−1	−1	−1
0	0	0
1	1	1

−1	0	1
−1	0	1
−1	0	1

Fig. 3 The Prewitt operators.

Sobel operator: It is a discrete differentiation operator used to compute an approximation of the gradient of image intensity function for edge detection. At each pixel of an image, sobel operator gives either the corresponding gradient vector or normal to the vector. It uses following 3x3 two kernels.

–1	–2	–1
0	0	0
1	2	1

–1	0	1
–2	0	2
–1	0	1

Fig. 4 ***The Sobel operators***

Fig. 5 Edge Detection:
(a) Original image. (b) Roberts operator.

c) Prewitt operator. (d) Sobel operator.

CANNY EDGE DETECTION

Canny edge detector have advanced algorithm derived from the previous work of Marr and Hildreth. It is an optimal edge detection technique as provide good detection, clear response and good localization. It is widely used in current image processing techniques with further improvements. In order to simplify the computation, we adapt another equation equal to the equation; this equation is first-order derivative function of Guassian function. Because computation of 2-dimension convolution is complex and large.

Canny edge detection technique is then applied to the obtained smoothed image. As a result we get the major boundaries/edges of the image. The biggest connected component in the obtained image is the outer boundary of the IRIS. Hence it is termed as the outer segmentation.

Canny edge detection algorithm runs in several steps. First in smoothing step, the operators blur the image to remove noise. Then in finding gradients step when operator detects the large magnitude of gradient of image it marks the edges. In non-maximum suppression step the operator only look for local maxima and marked it as edges. Then the operator applies threshold to determine potential edge. In final step edges are determined by suppressing all edges that are not connected to strong edge. All the edge detection method applied by using MATLAB image processing tool.

SOBEL OPERATOR EDGE DETECTION

In Sobel technique, an operator is selected for each point of the image and it generates the corresponding gradient vector. The Sobel edge detection, the operator uses two 3×3 matrix kernels which are convolved with the original image to calculate the approximations of the derivatives.

The Sobel kernels can be decomposed as the products of an averaging and a differentiation kernel, they compute the gradient with smoothing. The *x*-coordinate is defined as increasing in the "right"-direction, and the *y*-coordinate is defined as increasing in the "down"-direction. Each point of the image, the resulting gradient approximations can be combined to give the gradient magnitude and gradient's direction. If the matrix is defined as a source image, and the

two images which contain the horizontal and vertical derivative of the approximations respectively then the relation can be represented as follows:

$$W_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} *A \text{ and } W_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} *A \quad (1)$$

Where * here denotes the 2-dimensional convolution operation. Since the Sobel kernels can be decomposed as the products of an averaging and a differentiation kernel, they compute the gradient with smoothing. The *x*-coordinate is defined as increasing in the "right"-direction, and the *y*-coordinate is defined as increasing in the "down"-direction. Each point of the image, the resulting gradient approximations can be combined to give the gradient magnitude and gradient's direction by using Equation (2) and Equation (3).

$$W = \sqrt{W_x^2 + W_y^2}$$

$$\theta = \tan^{-1}\left(W_y / W_x\right) \quad (2) \text{ and } (3)$$

RESULT AND DISCUSSION

Results obtained by applying the Sobel edge detection and the Canny edge detection techniques.

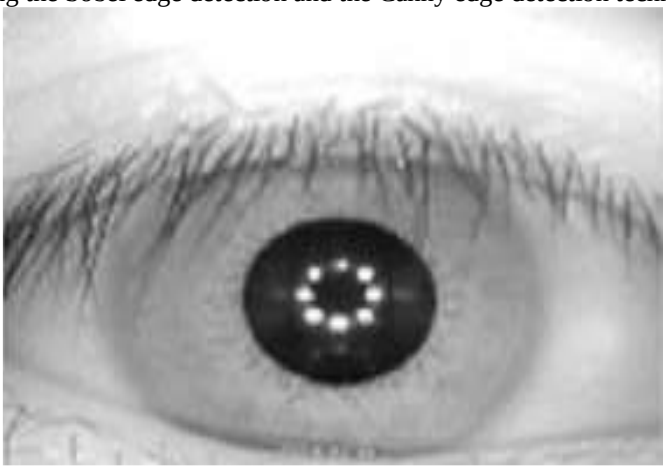

Fig. 7 Original Eye Image

Fig. 8 Sobel Horizontal Edge Detection

Fig. 9 Sobel Vertical Edge Detection

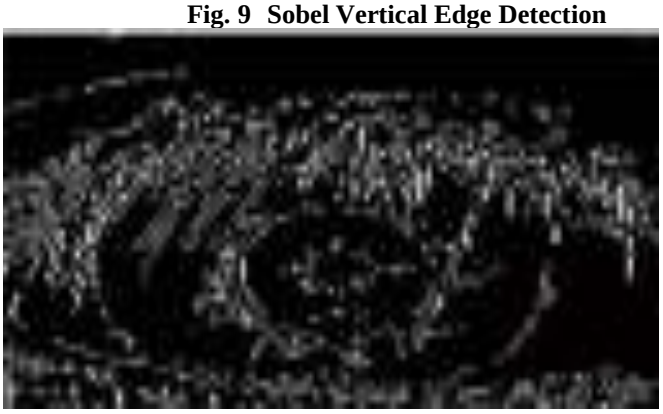

Fig. 10 Canny Edge Detection

The result shows how rapidly and smoothly the image changes. The Canny operator is optimum even for noisy images. This operator fills the gap between strong and weak edges of the image. Compared to other edge detection techniques, this operator is less fooled by specious noise.In Sobel edge detection method, it looks for both horizontal and vertical edges independently then represents them together. The Canny edge detection technique is more efficient to detect both the slow variation of gray level as well as strong variation of gray level of the image.

Table 1: The Statistical details of Iris Detection Using Canny & Sobel Operator

Parameters of Iris Detection	Statistical Parameter	Canny Operator	Sobel Operator
Success Ratio	Mean	0.80	0.53
False Acceptance ratio	Mean	0.08	0.24
False Rejection ratio	Mean	0.09	0.20

CONCLUSION

In this paper it is observed that the Canny edge detection technique has better performance compared to the Sobel edge detection technique.

Unless the preconditions are particularly suitable, it is difficult to find an edge detector that performs significantly better than the Canny edge detector. However Sobel edge detection technique has the ability to detect both horizontal and vertical edges individually that presented in combined form, thus computation is relatively cost-effective.

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