© 2015 IJSRSET | Volume 1 | Issue 4 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Implementation and Comparision of Various Edge Detection Methods

Rekha Shukla, Rajesh Kumar Rai
Department of Electronics and Communication, RGPV/NRI Institute of Information Science & Technology, Bhopal, Madhya Pradesh, Indian

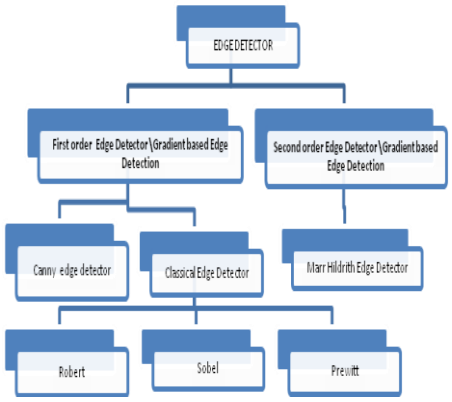
ABSTRACT

Edge is a basic feature of an image. Edges can be defined as boundary between two different regions in an image. Edge detection refers to the process of identifying and locating sharp discontinuities in an image. Edge detection process significantly reduces the amount of data and filters out useless information, while preserving the essential structural properties in an image. .In this paper we are implementing various edge detection techniques as Prewitt, Robert, Sobel, Marr Hildrith and Canny operators through Matlab tool and then comparing through each other. We can see that canny edge detector performs better than all other edge detectors on various aspects.
Keywords: Edge Detection, Digital Image Processing, Image segmentation

I. INTRODUCTION

Edge detection

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, within a neighbourhood 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. For a noisy image it is difficult to detect edges as both edge and noise contains high frequency contents which results in blurred and distorted result. Operators used on noisy images are typically larger in scope, so they can average enough data to discount localized noisy pixels. This Effect such as refraction or poor focus can result in objects with boundaries defined by a gradual change in intensity. The operator needs to be chosen to be responsive to such a gradual change in those cases. So, there are problems of false edge detection, missing true edges, edge localization, high computational time and problems due to noise etc. Therefore, the objective is to do the comparison of various edge detection techniques and analyse the performance of the various techniques in different conditions. There are many ways to perform edge detection. However, the majority of different methods may be grouped into two categories:



II. METHODS AND MATERIAL

2.1 Gradient based Edge Detection:

The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. 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.

It is based on the use of a first order derivative, or can say gradient based. If I (i , j) be the input image, then image gradient is given by following formula

$$\nabla I(i,j) = \hat{\imath}\frac{\partial I(i,j)}{\partial i} + \hat{\jmath}\frac{(\partial I(i,j))}{\partial j}$$ where,

$\frac{\partial I(i,j)}{\partial i}$ is the gradient in the i direction.

$\frac{\partial I(i,j)}{\partial j}$ is the gradient in the j direction.

The gradient magnitude is given by the formula:

$$|G| = \sqrt{\left(\frac{\partial I}{\partial i}\right)^2 + \left(\frac{\partial I}{\partial j}\right)^2}$$

$$|G| = \sqrt{(Gi)^2 + (Gj)^2}$$

The angle of orientation of the edge giving rise to the spatial gradient (relative to the pixel grid orientation) is given by:

$$\theta = \arctan(Gj/Gi)$$

The magnitude of gradient through above gives edge strength and the gradient direction is always perpendicular to the direction of edge.

2.2 Classical operators

Robert, Sobel and Prewitt are classified as classical operators which are easy to operate but highly sensitive to noise.

2.2.1 Robert operator

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 input image is convolved with the default kernels of operator and gradient magnitude and directions are computed. It uses following 2 x2 two kernels:

1	0
0	-1

Gi

0	1
-1	0

Gj

Figure 2.1 : Robert Mask

The plus factor of this operator is its simplicity but having small kernel it is highly sensitive to noise.

2.2.2 Sobel operator

Sobel operator is a discrete differentiation operator used to calculate 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 convolves the input image with kernel and computes the gradient magnitude and direction. It uses following 3x3 two kernels:

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

Gi

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

Gj

Figure 2.2: Sobel Mask

As compared to Robert operator have slow computation ability but as it has large kernel so it is less sensitive to noise as compared to Robert operator. As having larger mask, errors due to effects of noise are reduced by local averaging within the neighbourhood of the mask.

2.2.3 Prewitt operator

The function of Prewitt edge detector is almost same as of sobel detector but have different kernels:

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

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

Figure 2.3 : Prewitt Mask

2.2.4 Laplacian of Gaussian or Marr Hildrith operator

The Marr-Hildreth edge detector was a very popular edge operator before Canny proposed his algorithm. It is a gradient based operator which uses the Laplacian to take the second derivative of an image. It works on zero crossing method. It uses both Gaussian and laplacian operator so that Gaussian operator reduces the noise and laplacian operator detects the sharp edges.
The Gaussian function is defined by the formula:

$$G(i,j) = \frac{1}{(2\pi\sigma^2)^{1\backslash 2}} \exp - \frac{(i2\text{-}j2)}{2\sigma^2}$$

Where, σ is standard deviation And the LoG operator is calculated from the formula:

$$\text{LoG} = \frac{\partial^2(i,j)}{\partial i^2} G(i,j) + \frac{\partial^2(i,j)}{\partial j^2} G(i,j)$$

2.2.5 Canny Operator

The Canny edge detection technique is one of the standard edge detection techniques.
To find edges by separating noise from the image before find edges of image the Canny is a very important method. Canny method is a better method without disturbing the features of the edges in the image afterwards it applying the tendency to find the edges and the serious value for threshold.

III. RESULTS AND DISCUSSION

Figure 3.1 (a) shows the original Image in gray code Figure 3.1 (b),(c) and (d) shown the Edge Detection Techniques (b) Sobel (c) Prewitt (d) Robert.Unlike Roberts and Sobel, the Canny operation is not very susceptible to noise. If the Canny Detector worked well it would be superior.

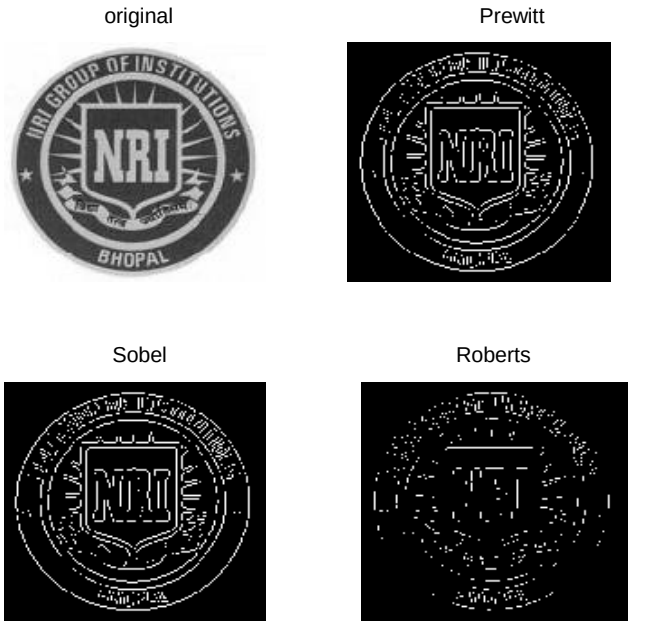


Figure 3.1 : Comparison of Edge Detection Techniques (a) Original Image (b) Sobel (c) Prewitt (d) Robert

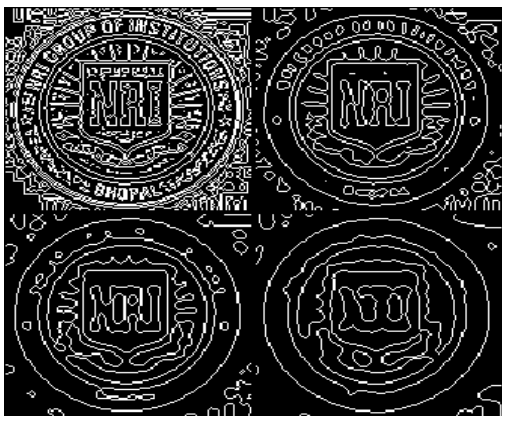


Figure 3.2 : Marr Hildrith Edge Detection Techniques

Marr/Hildreth edge detection is based on the zero-crossings of the Laplacian of the Gaussian operator applied to the image for various values of standard deviation (sigma), the standard deviation of the Gaussian is shown in figure 3.2. The top left is sigma=1, the top right is sigma=2, the bottom left is sigma=3 and the bottom right is sigma=4. (Matlab Laplacian of Gaussian edge detection normally selects a threshold so that only zero-crossings of sufficient strength are shown. Here, the threshold is forced to be zero so that all zero-crossings are reported, as is required by the Marr/Hildreth edge detection.)

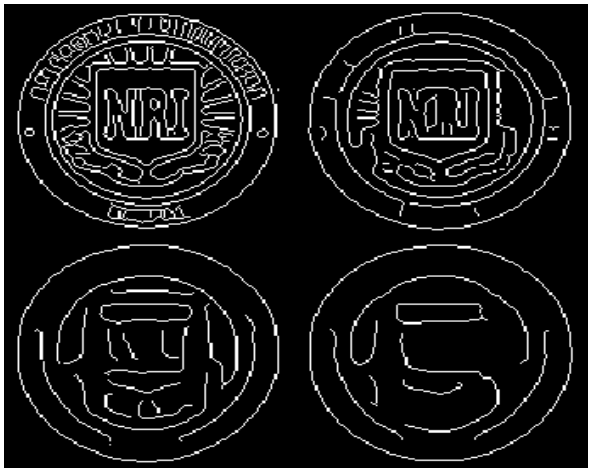


Figure 3.3 : Canny Edge Detection Techniques

Canny edge detection is based on first derivative of the Gaussian operator applied to the image for various values of sigma, the standard deviation of the Gaussian. The top left is sigma=1, the top right is sigma=2, the bottom left is sigma=3 and the bottom right is sigma=4. The Canny method uses two thresholds to link edge points. The Matlab implementation can estimate both thresholds automatically.

It is observed that zero-crossings in Marr/Hildreth edge detection always form connected closed contours (or leave the edge of the image). This comes, however, at the expense of localization, especially for larger values of sigma.Canny edge detection does a better job of localization.

IV. CONCLUSION

The objective of this paper is theoretical study of various edge detection methods and then implementing these method with the help of Matlab simulation . The original image and the image obtained by using different edge detection techniques are given in figure 3.3. Marr Hildrith and canny are two smoothening based edge detectors. Normally edge detector uses only one

threshold but canny edge uses two threshold for whole image. The Marr–Hildreth operator, however, suffers from two main limitations. It generates responses that do not correspond to edges, so-called "false edges", and the localization error may be severe at curved edges. Canny result is superior one when compared to all for a selected image since different edge detections work better under different conditions.

V. REFERENCES

[1]. James Clerk Maxwell, 868 DIGITAL IMAGE PROCESSING Mathematical and Computational Methods.

[2]. R .Gonzalez and R. Woods, Digital Image Processing, ,Addison Wesley, 1992, pp 414 - 428.

[3]. S. Sridhar, Oxford university publication. , Digital Image Processing.

[4]. Shamik Tiwari , Danpat Rai & co.(P) LTD. "Digital Image processing"

[5]. J. F. Canny. "A computational approach to edge detection". IEEE Trans. Pattern Anal. Machine Intell., vol.PAMI-8, no. 6, pp. 679-697, 1986 Journal of Image Processing (IJIP), Volume (3) : Issue (1)

[6]. Geng Xing, Chen ken , Hu Xiaoguang "An improved Canny edge detection algorithm for color image" IEEE TRANSATION ,2012 978-1-4673-0311-8/12/$31.00 ©2012 IEEE.

[7]. Yuesong Mei, Jianqiao Yu "An Algorithm for Automatic Extraction of Moving Object in the Image Guidance", IEEE, International Conference on Intelligent System Design and Engineering Application,2010.978-0-7695-4212-6/10 $26.00 © 2010 IEEE DOI 10.1109/ISDEA.2010.253