Comparative Study of Boundary Detection Algorithm Techniques with Positive and Negative Details

Dr. Ganga Shirisha M S.
Asst Prof, Dept of Computer Science,
SSA Govt. First Grade College(Auto), Ballari,
Karnataka. (India)

Abstract: there are many popular features of image edge but as per the records image edge is most popular amongst it. For connecting two different types of regions image edge is used. Edge detection helps in reducing the data consumption; it also distinguishes between image or data which is important and needed and the one which is a waste during the process of handling the important structural properties in an image. With the help of MATLAB software it is developed. As per research and studies we come to know that Canny's edge detection algorithm performs better than all operators. The images under noisy situations like Canny, LoG(Laplacian of Gaussian), Robert, Prewitt, Sobel doing well respectively. With the help of comparison it can be found that Canny's edge detection algorithm is more expensive compared to LoG(Laplacian of Gaussian), Sobel, Prewitt and Robert's operator.

Keywords*: Edge Detection, Matlab, Digital Image Processing.*

*****

I. INTRODUCTION:

Edge detection is a set of mathematical methods through which the points in an image can be found out where the image intensity such as brightness can be differentiated or could be held more sharply.

Any shape of object can be created with the help of edges. As per the technical point, edge is basically a set of connected or joint pixels that create a sort of bridge between two different regions. Edge detection can be called as a method of dividing an image into regions of conclusion. Corner detection or shape detection are other names of edge detection. If edge is to be detected than shape is also required to be known**.** Line segments are made where the image changes its brightness sharply and later they come to be known as edges. 1D signal may have many breaks and problems the process of finding breaks in is edge detection. Problems of edge detection can be related as identifying the signal that are discontinued in nature over time and are specially they are categorized as change detection in image processing.[1]

A characteristic direction of the operator geometry gets determined in its most sensitive part to edges. Operators can be transformed to look for horizontal, vertical, or diagonal edges. Difficulty arises when the noisy images has to be sedge detected, reason for it is that both of them have high edge frequency. Efforts are made to reduce the noise which ultimately gave blurred and distorted edges. Operators that are being used on noisy images are mainly larger in scope, so they could have enough average data to discount localized noisy pixels. It sums up with being less accurate localization of the detected edges. By all the edges step change in intensity is not done by those which are involved. Effects such as refraction or poor focus can turn in objects with boundaries defined by a gradual change in intensity [1]. After some gradual unforeseen changes the operator needs to be selected with intense care and considering all the matters. Resultantly, there are blunders like false edge detection, missing true edges, edge localization, high computational time and problems due to noise etc. Many ways could be found out to follow edge detection. However, the main different methods may be grouped into two categories[3]

1. Gradient Based Edge Detection
2. Laplacian based Edge Detection

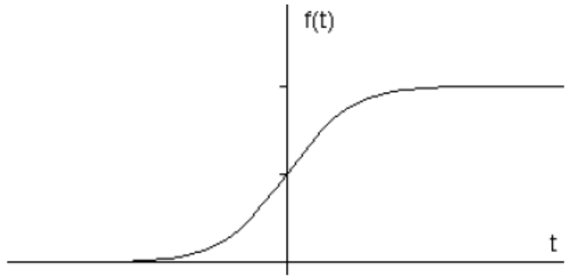
1. Gradient Based Edge Detection

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

2. Laplacian based Edge Detection

Laplacian based Edge Detection: in this method it searches for zero crossings in the second derivative of the image to find edges. An edge has the one-dimensional shape of a ramp and calculating the derivative of the image can highlight its location. Suppose we have the following signal, with an edge shown by the jump in intensity below:

 ISSN: 2321-8169
306 – 310



If we take the gradient of this signal for examining it (which, in one dimension, is just the first derivative with respect to t) we get the following:[1]

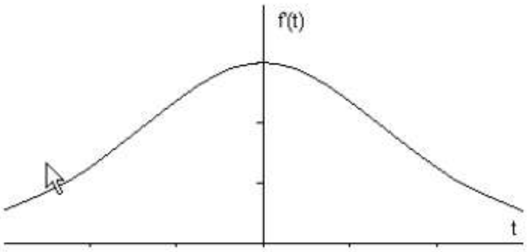


Fig: Gaussian Graph [1]
00

II. METHODOLOGIES

2.1 Robert operator

On the image the Roberts operator performs a simple quick to the compute 2-D spatial gradient measurement. Regions of high gradient will be highlighted which often correspond to edges. In most of its usage the input operator is a grey scale image and is also the output. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point. [2]

How It Works

In theory, the operator is of a pair of 2×2 convolution masks as stated in Figure 4.2. One mask is simple and the other is rotated by 90°. This is very similar to the Sobel operator.

1	0
0	-1

GX

0	1
-1	0

GY

It is gradient based operator. First of all it calculates the sum of the squares of the difference between diagonally adjacent pixels through discrete differentiation and then later it calculate approximate gradient of the image.

The input image is made of the default kernels of operator and gradient magnitude and directions calculated. It utilizes following given 2 x2 two kernels:

$$D_x = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \quad \text{And} \quad D_y = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$$

For responding maximally to edges at 45° to the pixel grid one mask for each of the two perpendicular orientations these masks are designed. To the input image the masks is separately applied and to produce the separate measurements of the gradient component in each orientation (call *Gx* and *Gy*). These can later be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is defined by:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

Basically, an approximate magnitude is computed using:

$$|G| = |Gx| + |Gy|$$

It is much quicker to compute. The angle of orientation of edge gives rise to the dimensional gradient (relative to the pixel grid orientation) and it is given by:

$$\theta = \arctan(Gy/Gx) - 3\pi/4$$

In such case, orientation 0 is taken to mean such that the direction of maximum contrast from black to white runs from left to right on the image, and other remaining angles are measured anticlockwise. Mostly, the absolute magnitude is the only output the user sees and the two components of the gradient are later computed and added in a single pass over the input image with the help of pseudo-convolution operator.[2]

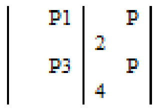


Fig: 5 Pseudo-Convolution masks used to quickly compute approximate gradient magnitude

Using this mask magnitude is given by:[2]

$$|G| = |P_1 - P_4| + |P_2 - P_3|$$

2.2 Sobel Operator Edge Detector

Common Names: Sobel, also related is Prewitt Gradient Edge Detector

Brief Description

A 2-D spatial gradient measurement is performed by the Sobel operator on an image and so it emphasizes regions of high spatial gradient that are related to edges. Basically it is used to find the average absolute gradient magnitude at each point in an input grey scale image. [2]

How It Works

In theory at least, here the operator consists of a pair of 3×3 convolution masks as stated in Figure 4.4 One mask is simply the other being rotated by 90°. This is highly similar to the Roberts Cross operator. [2]

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

Gx

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

Gy

Fig 4.4 Sobel Convolution Mask

To respond maximally to edges running vertically and horizontally these masks are designed and these are relative to pixel grid one mask for each of the two perpendicular orientations. The masks could be applied separately to the input image to the manufactured separate measurements of the gradient component in each orientation and these are called as *Gx* and *Gy*. At each point these can be combined together to find the absolute magnitude of the gradient and the orientation of that gradient. The gradient magnitude is defined by:[2]

$$|G| = \sqrt{Gx^2 + Gy^2}$$

Although typically, an approximate magnitude is calculated using:

$$\theta = \arctan(Gy/Gx) - 3\pi/4$$

It is much quick to compute.

The angle of the edge (relative to the pixel grid) gives rise to the spatial gradient and it is given by: [2]

$$|G| = |Gx| + |Gy|$$

Black to white runs from left to right on the image and remaining angles are calculated anticlockwise from this. Later, this absolute magnitude is the only output the user sees --- the two components of the gradient are easily computed and added in a single pass over the input image using the pseudo-convolution operator shown in Figure 4.5

P_1	P_2	P_3
P_4	P_5	P_6
P_7	P_8	P_9

Figure6 Pseudo-convolution masks used to quickly compute approximate gradient magnitude

Using this mask the approximate

$$|G| = |(P_1 + 2\times P_2 + P_3) - (P_7 + 2\times P_8 + P_9)| + |(P_3 + 2\times P_6 + P_9) - (P_1 + 2\times P_4 + P_7)|$$

2.3 Canny Edge Detector

For being an optimal edge detector the Canny operator was designed (as per respective criteria --- there are various detectors around that also claim to be optimal with respect to slightly different criteria). As an input it takes grey scale image and as an output produces an image showing the positions of captured intensity discontinuities.

How It Works

In a multi stage process the Canny operator works great. At first the image is smoothed by Gaussian convolution. Later by using a simple 2D first derivative operator (like the Roberts Cross) is applied to the smoothed image so that regions of the image with high first spatial derivatives are highlighted. In the gradient magnitude image Edges gives rise to all ridges. Along the top of these ridges the algorithm tracks and sets it to zero pixel that are not actually on the ridge top so that a thin line in the output is created all process is known as *nonmaximal suppression*. The tracking process shows hysteresis controlled by two thresholds: *T1* and *T2* with *T1* > *T2*. On a Chasing can only begin at a point on a ridge greater than *T1*. Chasing later gets continued in both directions out from the point until the height of the ridge falls under *T2*. This hysteresis helps alot to make sure that noisy edges are not broken up into multiple edge fragments.[2]

Fig: 7 Canny Edge Detector

- Canny Edge detector is advanced algorithm derived by Marr and Hildreth.
- It is an optimal edge detection technique as provide good detection clearly response and good localization.
- It is mainly and highly used in current image processing technique improvements.

 ISSN: 2321-8169
306 – 310

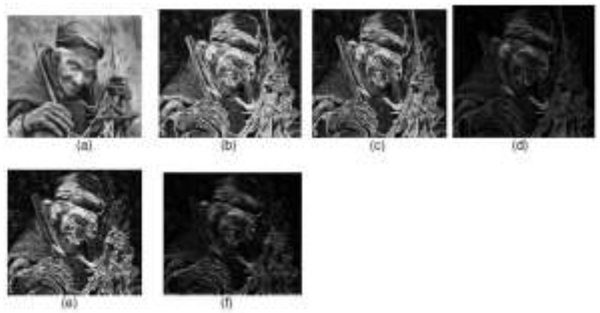


Fig: Comparison of Edge Detection Techniques Original Image (b) Sobel (c) Prewitt (d) Robert (e) Laplacian (f) Laplacian of Gaussian

Fig: Comparison of Edge Detection Techniques on Lena Image Original Image (b) Canny Method (c) Roberts Edges (d) LOG edges (e) Sobel

III. ADVANTAGE AND DISADVANTAGE :

Operator	Advantages	Disadvantages
Zero Crossing(Laplacian, Second directional derivative)	Detection of edges and their orientations. Having fixed characteristics in all directions	Responding to some of the existing edges, Sensitivity to noise
Gaussian(Canny, Shen-Castan)	Using probability for finding error rate, Localization and response. Improving signal to noise ratio, Better detection specially in noise conditions	Complex Computations, False zero crossing, Time consuming
Laplacian of Gaussian(LoG) (Marr-Hildreth)	Finding the correct places of edges, Testing wider area around the pixel	Malfunctioning at the corners, curves and where the gray level intensity function varies. Not finding the orientation of edge because of

		using the Laplacian filter.
Classical (Sobel, prewitt, Kirsch,…)	Simplicity, Detection of edges and their orientations	Sensitivity to noise, Inaccurate

IV. CONCLUSIONS

There are many reasons to know the difference between various edge detection techniques one of main reasons amongst them is that it is an initial step in object recognition. We got the knowledge of mostly used edge detection technique i.e. Gradient-based and Laplacian based Edge Detection. For using this in MATLAB this software is developed. Gradient-based algorithms for example the Prewitt filter have a high negative effect of being very sensitive to noise. The respective size of kernel filter and coefficients are non-flexible and cannot be used by a available image. There are various kinds of noise levels, an edge detection is used which proves to be an amazing solution to it. It must also help to differentiate between valid image contents from visual artifacts that are introduced by noise. Canny algorithm is highly depended on the adjustable parameters such as σ, and it is also a standard deviation for the Gaussian filter and threshold values like, 'T1' and 'T2'. Even σ controls the size of Gaussian filter. The value of σ determine the value of Gaussian filter more the value of σ greater the Gaussian filter tends to be. Later these get implemented to more blurring, which is demanded by noisy images, is good compared to detecting edges. As per common understanding if value of the Gaussian is big, lesser the chances of edge being localized are there. Smaller values of σ imply a smaller value.

Gaussian filter that tends to limit the blurring is taken care by the finer edges in the image. By adjusting these parameters the user uses this algorithm to make the adaptability to work in various environments in Canny's edge detection. If we compare this algorithm among all we will find this algorithm is computationally more expensive compared to Sobel, Prewitt and Robert's operator. We can compute that Canny's edge operators under almost all environments.

REFERENCE:

[1] Raman Maini & Dr. Himanshu Aggarwal International Journal of Image Processing (IJIP), Volume (3) : Issue (1) 1 Study and Comparison of Various Image Edge Detection Techniques.

[2] Divyang Goswami, "***Edge Detection Technology using Image processing in Matlab***", May 15 Volume 3 Issue 5 , International Journal on Recent and Innovation Trends in

ISSN: 2321-8169
306 – 310

Computing and Communication (IJRITCC), ISSN: 2321-8169, PP: 3466 - 3471, DOI:10.17762/ijritcc2321-8169.1505205.

[3] Sonam Saluja1 , Aradhana Kumari Singh2 , Sonu Agrawal3 A Study of Edge-Detection Methods International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 1, January 2013

[4] L. G. Roberts. "Machine perception of 3-D solids" ser. Optical and Electro-Optical Information Processing. MIT Press, 1965 .

[5] R. C. Gonzalez and R. E. Woods. "Digital Image Processing". 2nd ed. Prentice Hall, 2002.

[6] E. Argyle. "Techniques for edge detection," Proc. IEEE, vol. 59, pp. 285-286, 1971