International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 06 | June-2016 www.irjet.net p-ISSN: 2395-0072

Image Edge Detection Algorithms Study

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Abstract: *Edge is the basic quality of image, edge detection plays an important role in image analysis. The valuable and identical information contained in edge of sub-image facilitate edge detection to be the main approach to image analysis and recognition. This paper compares and analyses three kinds of classical algorithms of image edge detection ,including Roberts,Sobel, and Prewitt with MATLAB tool.*

Keywords: Prewitt, Roberts, Sobel.vertical, horizontal,threshold

1.Introduction

Unexpected changes of discontinuities in an image are called as edges..Most of the shape information of an image is with this in edges.so first detect these edges in an image and by using these filters that is sobel,Roberts and prewitt then by enhancing those areas of image which contain edges,sharpness of the image will increase and image will become clearer.

There are two goals for image processing one is to find the image that more suitable for human observing and understanding, the other one is to identify the image automatically by computer. The key step is to decompose a large image into small image with independent feature.

The edge commonly exists between objects and background objects and primitives. It contains rich information, step property, shape,size etc, which is able to describe the target object. There are two types of edge detection: one is step modify edge whose pixels grayscale of two sides have significantly difference, the other one is covering edge that is the turning position from increase to decrease of gray value.Edge is symbolizes the end of one area and the opening of the other area. The detected edge may become wide or separate with the existence of noisy and ambiguity. The edge obtaining is to detect the discreteness of partial image and then remove breaking points of edges. Complete edge is combined by these edge pixels.

II. PRINCIPLE OF EDGE DETECTION

Edge detection operator is a alteration in the nature of the image edge to test the edge. There are two main types[2]. First one is the first derivative-based edge detection operator to detect image edges by computing the image gradient values, such as Sobel operator, Prewitt operator; Roberts operator, the other one is the second derivative-based edge detection operator, by looking for the second derivative zero-crossing to edge detection,such as LOG operator, Canny operator.

III. ALGORITHMS OF EDGE DETECTION

Sobel edge detection

Sobel operator is used to extract the edge. Each point in the image are the two nuclear convolutions. One checks maximum response of the vertical edge, and the last one checks maximum response of the horizontal edge. The maximum value of two convolutions will be referred as output value of the changing point. Sobel operator is easy to do in space, has a smoothing effect on the noise, is almost affected by noise, can provide more precise edge direction information but it will also detect many false edges with coarse edge width.

$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \text{ and } \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix},$$

which yield horizontal and vertical edges respectively.

Agreement with true physical area occurs at no TBAC ratio for either the small or the large cylinder. For the small cylinder, all calculated areas exceed their true size, and for the large cylinder, the opposite case holds. At TBAC ratios of 2.02 and 3.02, the Sobel method fails entirely to identify the small target cylinder, delineating the exterior surroundings cylinder instead. The area of the background

cylinder is greater than 28,000 mm2, and as a result, the data points for these two TBAC ratios are well off the plot.

Only a little better results are obtained with the medium cylinder, with two TBAC ratios (10.0 and 14.1) yielding concurrence between measurement and reality within experimental error. For the medium cylinder, measurements at TBAC ratios of 3.02 and 5.11 lie under the physical values, and at the lowest TBAC ratio (1.96), the outside background cylinder is once again erroneously identified.

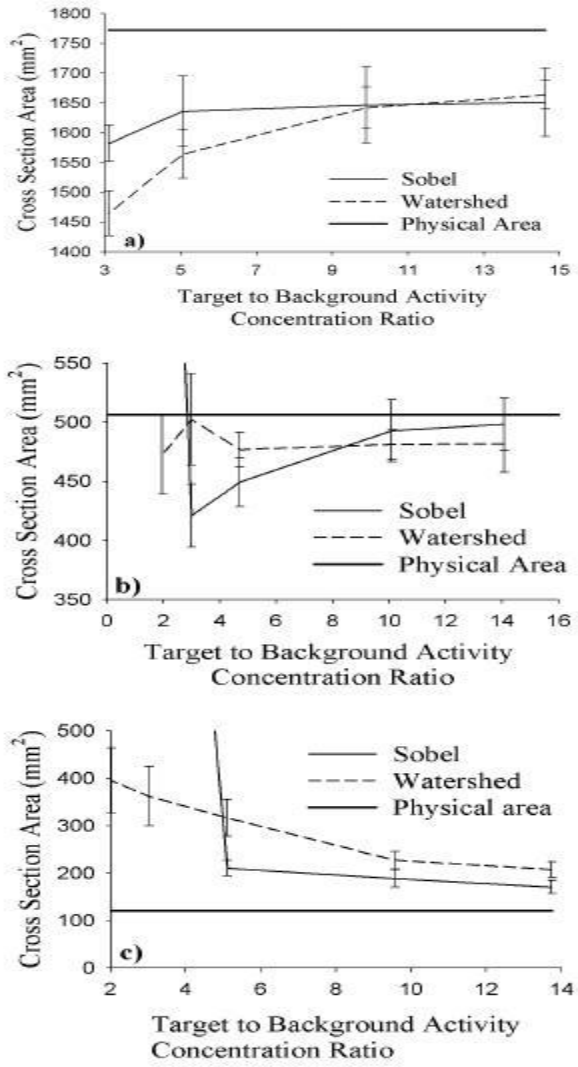

Chart1 : comparison of TBAC ratio

Roberts Edge Detector

The Roberts edge detector operator performs a simple, quick to compute, 2-D spatial gradient measurement on an image. It hence highlights regions of high spatial gradient which often correspond to edges. In its most common usage, the input image to the operator is a grayscale image, as is the output. Pixel values at each point in the output correspond to the expected absolute magnitude of the spatial gradient of the input image at that point.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

These masks are considered to respond maximally to edges running at 45° to the pixel grid, one mask for both of the two vertical orientations. The masks can be applied separately to the input image, to produce separate measurements of the gradient element in each orientation (call these *Gx* and *Gy*). These can then be combined together to find the complete magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

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

although typically, an approximate magnitude is computed using:

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

which is much faster to compute.

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

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

In this orientation 0 is taken to mean that the direction of maximum contrast from black to white runs from left to right on the image, and other angles are calculated anticlockwise from this. Often, the absolute magnitude is the only output the user sees the two components of the gradient are suitably computed and added in a single pass

over the input image using the pseudo-convolution operator.

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

Prewitt Edge Detection

Prewitt edge detection operator is used for edge detection in an image. It detects two types of edges

- Horizontal edges
- Vertical Edges

Edges are calculated by using distinction between corresponding pixel intensities of an image. All the masks that are used for edge detection are also identified as derivative masks..
All the derivative masks should have the following properties:

- Opposite sign should be present in the mask.
- Sum of mask should be equal to zero.
- More weight means more edge detection.

Prewitt operator has two masks one for detecting edges in horizontal direction and another for detecting edges in an vertical direction.

Vertical direction

This mask will find the edges in vertical direction and it is because the zeros column in the vertical direction. When apply this mask on the image it prominent vertical edges. It simply works like as first order derivate and calculates the differentiation of pixel intensities in a edge region. As the center column is of zero so it does not take in the original values of an image but rather it calculates the difference of right and left pixel values around that edge. This increase the edge strength and it become enhanced comparatively to the original image.

Horizontal Direction

This mask will find edges in horizontal direction and it is because that zeros column is in horizontal direction. it will convolve this mask onto an image it would prominent horizontal edges in the image.

This mask will important the horizontal edges in an image. It also works on the principle of above mask and calculates differentiation among the pixel intensities of a particular edge. As the center row of mask is consist of zeros so it does not consist of the original values of edge in the image but rather it calculate the difference of above and below pixel intensities of the exacting edge. Thus increasing the sudden change of intensities and making the edge more visible. Both these two masks following the principle of derivate mask. these masks have opposite sign in them and sum equals to zero. The third condition not be applicable in this operator as both the above masks are standardize and can't change the value in them.

IV. COMPARISON OF EDGE DETECTION

This paper use MATLAB[7] to calculate these algorithms by setting different thresholds.

4.1 The result of Roberts operator:

(a) original image

(b)

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

threshold = 0.00

(c) threshold = 0.05

(d) threshold = 0.3

Fig. 4 :Robert 's threshold images

4.2 The result of Sobel operator:


(a) threshold =0.00


(b) threshold = 0.05


(c) threshold = 0.3

Fig. 5 : Sobel 's threshold images

4.3 The result of Prewitt operator:


(a) threshold = 0.00


(b) threshold = 0.05


(c) threshold = 0.3

Fig. 6 : Prewitt's threshold images

Result analysis: figure 4, 5, 6, are the result of first order derivative of edge detection, The greater the threshold is, the clearer image edge processing effect is and the more rational the edge points are significant. However, when the threshold is over 0.3, the useful information of the image edge will be lost.

V. CONCLUSION

One-dimensional edge detect operator Roberts, Sobel and Prewitt are able to handle treatment effect of images of added gray-scale gradient and noise. The Sobel edge detector operator is more responsive to the diagonal edge is than to the horizontal and vertical edges. On the opposing, Prewitt operator is more sensitive to horizontal and vertical edges.

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