



Edge Detection of Images: A Novel Approach

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Abstract---*In this paper, an improved edge detection method which computes image edges using the concept of Sobel Operator with Center of Mass method is presented. The proposed method can be used as framework for multi-scale edge detectors in image processing. Here the edge detection by Sobel Operator with Center Of Mass method is compared with simply COM method.*

Keywords--- *Edge detection, Sobel operator, Center of Mass, multi-scale edge detector, Image Processing.*

I. INTRODUCTION

Edge detection of an image reduces significantly the amount of data and filters out information that may be regarded as less relevant, preserving the important structural properties of an image. The state-of-the-art gradient-based edge detectors lack scalability in the filter size. Small-scaled filters are sensitive to edge signals but also prone to noise, whereas large-scaled filters are robust to noise but can filter out fine details [1].

Edges are representation of changes in intensity functions of an image. Image intensity variations such as steps, lines and junctions [3]. Edge detection as a fundamental image processing method. The edge detection methods detect edges by finding local maxima of first-order derivative function or zero-crossing of second-order derivative function of the intensity profile of given image. There are different traditional operators such as Sobel Operator, Prewitt Operator, Gaussian Operator, Canny Operator and Robert Operator which are used for edge detection of images [18].

The characterization of signals from multi-scale edges has been studied extensively in the literature [4]. Multi-scale edge detection face a runtime issue that when scale increases there will be a linear or quadratic increase of time consumption [6]. The general idea of edge detection is to first convolve the input image with a filter to obtain gradient. COM edge detector uses integral image to compute center of mass in constant time $O(1)$.

II. SOBEL OPERATOR

This operator performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial frequency that correspond to edges. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grayscale image.

In theory at least, the operator consists of a pair of 3x3 convolution kernels. One kernel is simply the other rotated by 90°.

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

G_x

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

G_y

Fig.1. Sobel Operator Matrix

The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these G_x and G_y). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

$$G = \sqrt{G_x^2 + G_y^2}$$

Typically, an approximate magnitude is computed using:

$$G = |G_x| + |G_y|$$

III. CENTER OF MASS METHOD

We calculate a local COM of non-edge locations within a region of certain size, the center of mass will be very close to the center of that region. The distance between COM and center of region can indicate the change of intensity function. This allows the possibility of using COM to design a new edge detector. The location of COM is given by the equation:

$$XCOM = \frac{\sum m_i x_i}{\sum m_i}$$

This is a vector equation that represents each of the three object dimensions in the physical world. We first try to estimate the gradient of image intensity by the distance between COM and the region center:

$$Gx' = c(XCOM - xc)$$

where c is a constant parameter and xc is region center.

The gradient estimated by COM reflects step changes of image intensity. However, the local maxima of gradient are not accurately located on the step edge.

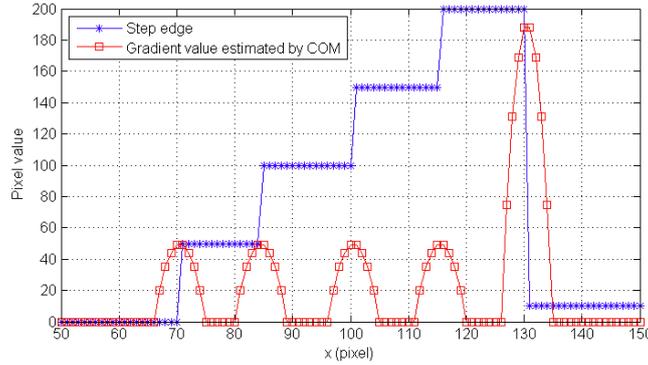


Fig 2. Gradient estimation of 1D type

COM based method can be applied to a 2D image. Digital image is discrete object where each pixel as a particle has its own mass. In image processing, such mass is referred as intensity. Directional gradient of an image is calculated as:

$$Gx = a(\sum I(x,y)x \sum I(x,y) - xc \sum I(x,y))$$

$$Gy = a(\sum I(x,y)y \sum I(x,y) - yc \sum I(x,y))$$

where $I(x,y)$ is image intensity, (xc, yc) is the center of the region (called kernel in conventional edge detection method), $\sum f$ all denotes $\sum_{x_1 < x \leq x_2, y_1 < y \leq y_2} f$, x_1, x_2, y_1, y_2 are the boundary of calculated region. Pixel intensity of a gray scale image can obtain a range of values from 0 to 255. Brighter pixels have heavier mass, i.e. they are heavier. Therefore, COM is closer to brighter area [7].

IV. EXPERIMENTAL RESULT



Fig 3. Original Image



Fig 4. Resultant Image Using COM Method



Fig 5. Resultant Image Using Sobel Operator with Center of Mass Method

V. CONCLUSION

In this paper, Sobel Operator with Center of Mass and COM method had been implemented to find the edges of an image. From the experimental result, it is concluded that the SOBEL operator with Center of Mass method provides better result.

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