Application of a Nobel Approach for Edge Detection of Images

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Abstract
In this paper, a unique edge detection technique which computes edges of different images using the concept of Center of Mass with Canny Edge Detector is presented. The proposed method can be used as framework for running multi-scale edge detectors for different images in image processing. Here the edge detection by COM with Canny edge detector is compared with COM technique.

Keywords:*Edge detection, Center Of Mass, Canny Edge Detector, multi-scale edge detector, Image Processing.*

INTRODUCTION

Edges are a representation of changes in intensity functions of an image. Image intensity variations include steps, lines and junctions [4]. Edge detection is 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 [6].

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 respond robustly to noise but can filter out fine details [3].Multi-scale edge detection face a runtime issue: when scale increases there is a linear or quadratic increase of time consumption [9].

There are different traditional operators such as Sobel Operator, Prewitt Operator, LOG Operator, Canny Operator and Robert Operator used for edge detection of images [10]. The general idea of edge detection is to first convolve the input image with a filter to obtain gradient. The complexity of this

Operation per pixel is usually $O(n)$ or $O(n2)$, where n is the filter width.

COM METHODOLOGY

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. We can compute a local COM of non-edge locations within a region of certain size, wherein the center of mass will be very close to the center of that region. The location of COM is given by the equation:

$XCOM = \Sigma mixi/\Sigma mi$

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.

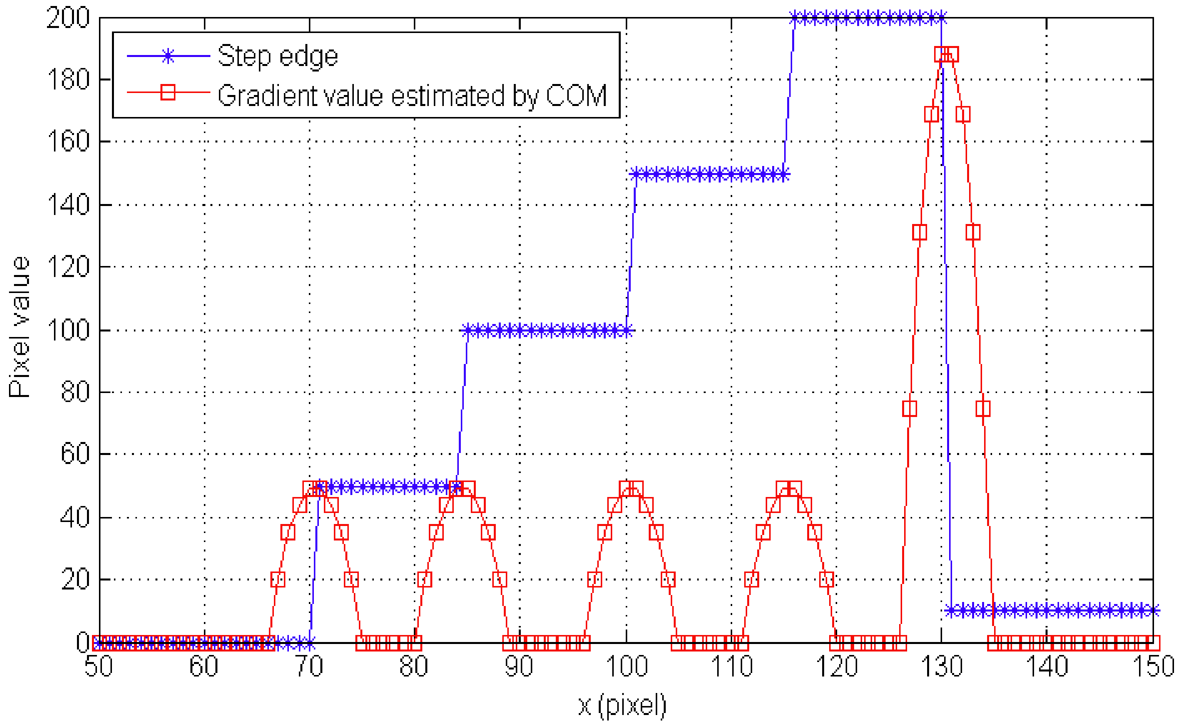

***Fig. 1:** Gradient estimation of 1D case*

Directional gradient of an image is calculated as:

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

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

where(x,y) is image intensity, (xc, yc) is the center of the region (called kernel in conventional edge detection method), Σf all denotes $\Sigma f x<x\leq x$, $y<y\leq y$, $x1$, $x2$, $y1$,

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$y2$ 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, which simply means they are heavier. Therefore, COM is closer to brighter area. COM based method can be applied to a 2D image. Digital image is a discrete object where each pixel, as a particle, has its own mass. In image processing, such mass is referred to as intensity.

CANNY EDGE DETECTOR

The Canny operator was designed to be an optimal edge detector according to particular criteria. The operator works in a multi-stage process.

First of all the image is smoothed by Gaussian convolution. Then a simple 2-D first derivative operator is applied to the smoothed image to highlight regions of the image with high first spatial derivatives. Edges give rise to ridges in the gradient magnitude image.

Step 1

- Noise is filtered out – usually a Gaussian filter is used
- Width is chosen carefully

Step 2

- Edge strength is found out by taking the gradient of the image
- A Roberts mask or a Sobel mask can be used

Step 3

- Edge direction is found using this formula -

$$\theta = \tan^{-1}\left(\frac{Gy}{Gx}\right)$$

Step 4

- Edge direction is resolved

Step 5

- Non-maxima suppression – Trace along the edge direction and suppress any pixel value not considered to be an edge. Gives a thin line of edge

Step 6

- Use double / hysteresis thresholding to eliminate streaking

EXPERIMENTAL RESULTS

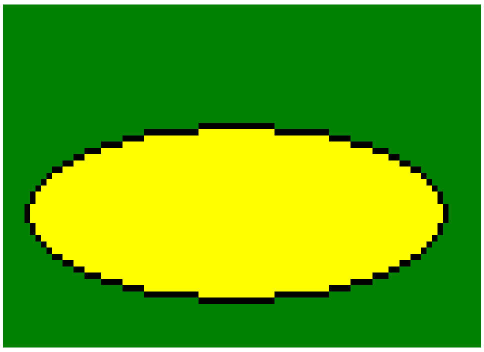

Fig. 2: *Original Image*

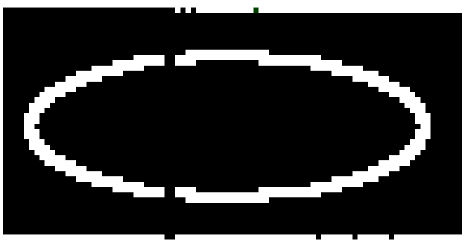

Fig. 3: *Result Using COM Methodology*

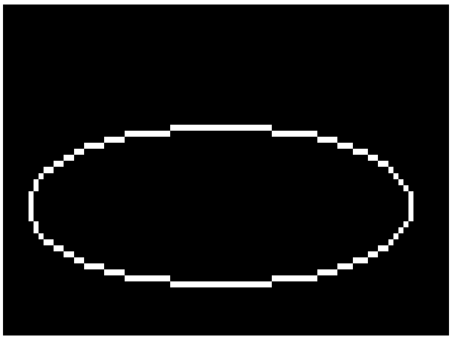

Fig.4: *Result Using COM with Canny Edge Detector*

From the experimental analysis, Fig. 2 represents the original image on which different methods are applied, Fig. 3 represents the resultant image after applying COM technique and Fig. 4 represents the resultant image after applying the COM with Canny Edge Detector.

CONCLUSION

In this paper, the COM methodology and COM with Canny edge detector was implemented to find the edges associated with an image. From the experimental result, it is concluded that the COM with Canny edge detector gives a better result.

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