Sobel Edge Detector

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Abstract. There are several methods to detect edges, Sobel filter is a case in point. The same as Laplacian Filter, mathematical foundation of the Sobel edge detector is based on the derivation operation. Detecting of edges is utilized in enhancing blurred images such as deblurring remote objects in an optical image.

Keywords: Edge detection, Sobel edge detector

1 Introduction and Preliminaries

Edge detection is the process of identifying the position of high luminance changes between objects. The edge detection algorithms are of vital importance in machine vision applications such as object recognition, color constancy and segmentation. Therefore, we can see the importance of edge detection in the image processing. Several algorithms are proposed in this regard among them are well-known methods such as Sobel and Canny edge detectors. A commonly used method in finding edges of an image is taking the gradient of the image both vertically and horizontally and then combining them into one image. This is what the Sobel filter do to find the edges in an image. This report is dedicated to implement and evaluate the Sobel filter. We will see that the superiority of the Sobel filter over other edge detection methods is its simplicity and ease of use. This report is organized as follows. The first section is dedicated to the introduction. In the next section, we will briefly introduce the Sobel operator. The result of the implementation is shown in the third section. Finally, the codes are attached to this report.

2 Sobel operator

Mathematically, the Sobel operator uses two 3×3 kernels which are convolved with the original image to calculate approximations of the derivatives - one for horizontal changes, and one for vertical. If we define **A** as the source image, and $\mathbf{G}_x$ and $\mathbf{G}_y$ are two images which at each point contain the horizontal and vertical derivative approximations, the computations are as follows [1] :

$$\mathbf{G}_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} * \mathbf{A} \quad \text{and} \quad \mathbf{G}_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ +1 & +2 & +1 \end{bmatrix} * \mathbf{A} \tag{1}$$

G_x and G_y illustrate vertical and horizontal edge, respectively (as shown in Figure 1). Then by use of Equation (2) we combine them into one matrix G.

$$\mathbf{G} = \sqrt{\mathbf{G}_x^{\,2} + \mathbf{G}_y^{\,2}} \tag{2}$$

1	0	1
-2	0	2
-1	0	1

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

Figure 1 Vertical and horizontal Sobel mask respectively (from left to right)

After computing the magnitude of each pixel (i.e. the matrix G), we should find an appropriate threshold to assign each pixel to the edge or not edge classes. It can be done using the following function:

$$\mathrm{T(x)} = \begin{cases} 0 & -\varepsilon \le x \le \varepsilon \\ 1 & else \end{cases}$$

Where ε is the threshold. Thresholding is of great importance especially in the image segmentation. Wide variety of thresholding techniques have been proposed in the literature for image segmentation purposes such as iterative algorithm, entropy based and histogram based tech-

niques. Explaining more about the thresholding lies beyond the scope of this report.

We have implemented the Sobel filter. The results of our implementation are as follows.

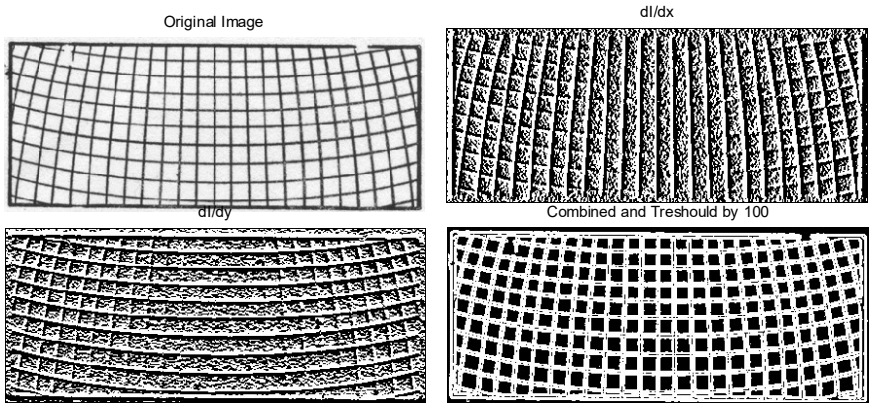
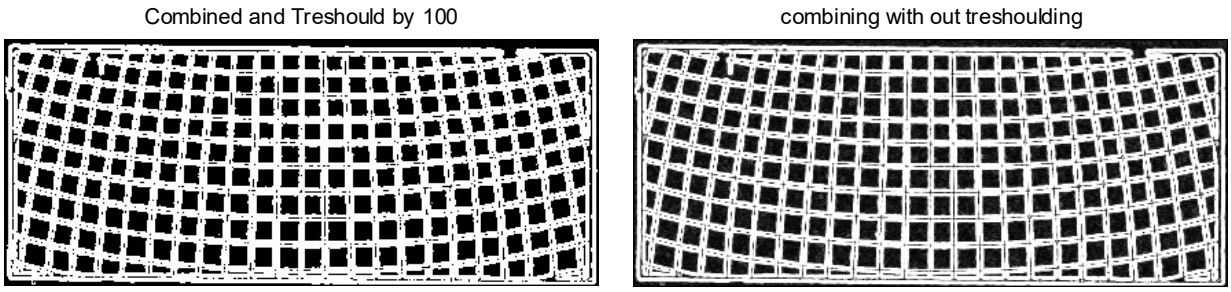


Figure 1 (a) Original image. (b) vertical edges finding – G_y .(c) horizontal edges finding - G_x .(d) combination of found vertical and horizontal edge .



a b

Figure 2 (a) theresholded image above 100, (b) thresholding is not applied to the image.

3 Result

4 Conclusion

In this work, we implemented the Sobel edge detector. A matlab function called *sobel* code (code 1 and 2) is developed and assessed using a set of images. The results of experiments showed us that Sobel algorithm is a very simple and efficient method for edge detection; however, there is no rule for setting the threshold. Hence, selecting the best threshold for the algorithm is still an open problem. In the future works, we can focus on this aspect of the project.

References

[1] Wikipedia encyclopedia ,sobel operation