SOBEL EDGE DETECTION METHOD FOR MATLAB

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ABSTRACT

Sobel which is a popular edge detection method is considered in this work. There exists a function, edge.m which is in the image toolbox. In the edge function, the Sobel method uses the derivative approximation to find edges. Therefore, it returns edges at those points where the gradient of the considered image is maximum. The horizontal and vertical gradient matrices whose dimensions are 3×3 for the Sobel method has been generally used in the edge detection operations. In this work, a function is developed to find edges using the matrices whose dimensions are 5×5 in matlab.

Key words: Sobel, Edge Operator, Edge Detection, Image Processing, Gradient Matrices

ÖZET

Bu çalışmada, popüler bir kenar işleci olan Sobel kenar işleci ele alınmaktadır. Image (görüntü) toolbox içinde edge.m adlı bir matlab fonksiyonu bulunmaktadır. Edge.m fonksiyonunda, Sobel kenar işleci, kenarları bulmak için türevsel yaklaşımı kullanmaktadır. Dolayısıyla bu fonksiyon, ele alınan görüntünün en büyük gradyana sahip olduğu noktaları, kenar olarak bulmaktadır. Sobel kenar işlecinde, genel olarak yatay ve düşey 3×3 boyutlu gradyan matrisleri kullanılmaktadır. 5×5 boyutlu gradyan matrislerinin türetilmesi ve kullanılması bu çalışmada verilmektedir. Bu çalışmada, boyutları 5×5 olan matrisleri kullanarak kenarları bulan bir fonksiyon geliştirilmiştir.

Anahtar kelimeler: Sobel, Kenar Ýþleci, Kenar Bulma, Görüntü Isleme, Gradyan Matrisleri

INTRODUCTION

Edge detection is the process of localizing pixel intensity transitions. The edge detection have been used by object recognition, target tracking, segmentation, and etc. Therefore, the edge detection is one of the most important parts of image processing.

There mainly exists several edge detection methods (Sobel [1,2], Prewitt [3], Roberts [4], Canny [5]). These methods have been proposed for detecting transitions in images. Early methods determined the best gradient operator to detect sharp intensity variations [6]. Commonly used method for detecting edges is to apply derivative operators on images. Derivative based approaches can be categorized into two groups, namely first and second order derivative methods. First order derivative based techniques depend on computing the gradient several directions and combining the result of each gradient. The value of the gradient magnitude and orientation is estimated using two differentiation masks [7].

In this work, Sobel which is an edge detection method is considered. Because of the simplicity and common uses, this method is prefered by the others methods in this work. The Sobel edge detector uses two masks, one vertical and one horizontal. These masks are generally used 3×3 matrices. Especially, the matrices which have 3×3 dimensions are used in matlab (see, edge.m). The masks of the Sobel edge detection are extended to 5×5 dimensions [8], are constructed in this work. A matlab function, called as Sobel5×5, is developed by using these new matrices.

Matlab, which is a product of The Mathworks Company, contains has a lot of

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toolboxes. One of these toolboxes is image toolbox which has many functions and algorithms [9]. Edge function which contains several detection methods (Sobel, Prewitt, Roberts, Canny, etc) is used by the user.

The image set, which consist of 8 images (256×256), is used to test Sobel3×3 and Sobel5×5 edge detectors in matlab.

SOBEL EDGE DETECTION

Standard Sobel operators, for a 3×3 neighborhood, each simple central gradient estimate is vector sum of a pair of orthogonal vectors [1]. Each orthogonal vector is a directional derivative estimate multiplied by a unit vector specifying the derivative's direction. The vector sum of these simple gradient estimates amounts to a vector sum of the 8 directional derivative vectors. Thus for a point on Cartesian grid and its eight neighbors having density values as shown:

a	b	c
d	e	f
g	h	i

In [1], the directional derivative estimate vector *G* was defined such as density difference / distance to neighbor. This vector is determined such that the direction of *G* will be given by the unit vector to the approximate neighbor. Note that, the neighbors group into antipodal pairs: (a,i), (b,h), (c,g), (f,d). The vector sum for this gradient estimate:

$$G = \frac{(c-g)}{R}\cdot\frac{[1,1]}{R} + \frac{(a-i)}{R}\cdot\frac{[-1,1]}{R} + (b-h)\cdot[0,1] + (f-d)\cdot[1,0]$$

where, $R = \sqrt{2}$. This vector is obtained as

$$G = [(c-g-a+i)/2 + f - d,\ (c-g+a-i)/2 + b - h]$$

Here, this vector is multiplied by 2 because of replacing the divide by 2. The resultant formula is given as follows (see, for detail [1]):

$$G' = 2.G = [(c-g-a+i) + 2.(f-d),\ (c-g+a-i) + 2.(b-h)]$$

The following weighting functions for x and y components were obtained by using the above vector.

1	0	1
-2	0	2
-1	0	1

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

Now, we explain that the dimension of the matrices are extended by using [1]. The definition of the gradient can be used for 5×5 neighborhood [8]. In this case, twelve directional gradient must be determined instead of four gradient. The following figure 5×5 neigborhood.

a	b	c	d	e
f	g	h	i	j
k	l	m	n	o
p	r	s	t	u
v	w	x	y	z

The resultant vector *G'* (similar to the determination of Sobel 3×3 method) for 5×5 is given as follows:

$$G' = [20(n-l)+10(i-r-g+t+o-k)+5(e-v-a+z)+4(d-w-b+y)$$
$$+8(j-p-f+u),20(h-s)+10(i-r+g-t)+5\cdot(e-v+a-z)$$
$$+4(j-p+f-u)+8(d-w+b-y)]$$

The horizantal and vertical masks are obtained by using the coefficents in this equation such as (see, [8])

-5	-4	0	4	5
-8	-10	0	10	8
-10	-20	0	20	10
-8	-10	0	10	8
-5	-4	0	4	5

5	8	10	8	5
4	10	20	10	4
0	0	0	0	0
-4	-10	-20	-10	-4
-5	-8	-10	-8	-5

These masks are used by the edge detection functionfuction in the following section.

EDGE DETECTION FUNCTION

Each direction of Sobel masks is applied to an image, then two new images are created. One image shows the vertical response and the other shows the horizontal response. Two images combined into a single image. The purpose is to determine the existence and location of edges in a picture.

This two image combination is explained that the square of created masks pixel estimate coincidence each other as coordinate are summed. Thus new image on which edge pixels are located obtained the value which is the squared of the above summation. The value of threshold in this above process is used to detect edge pixels [10].

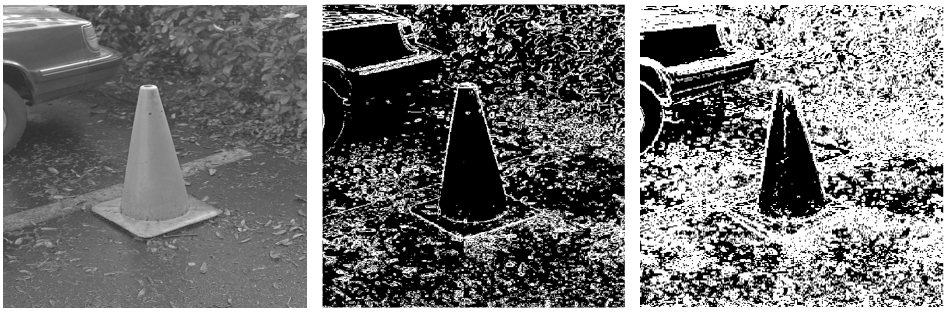
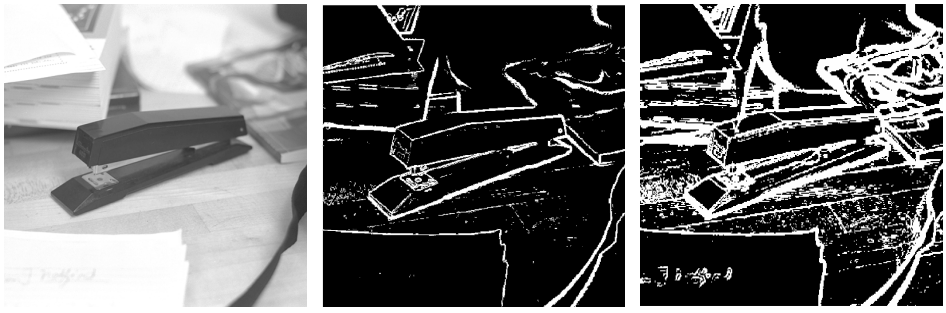
An algorithm is developed to find edges using the new matrices and then, a matlab function, which is called as Sobel5×5.m, is implemented in matlab. This matlab function requries a grayscale intensity image, two-dimensional array. The result which is returned by this function is the final image in which the egde pixels are denoted by white color (see, Appendix).

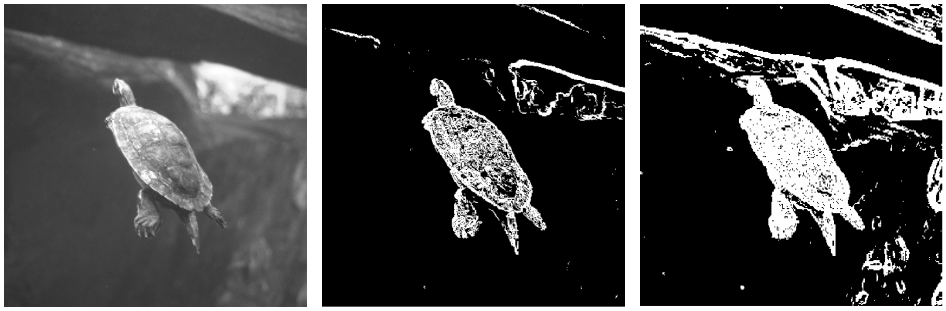
CONCLUSION

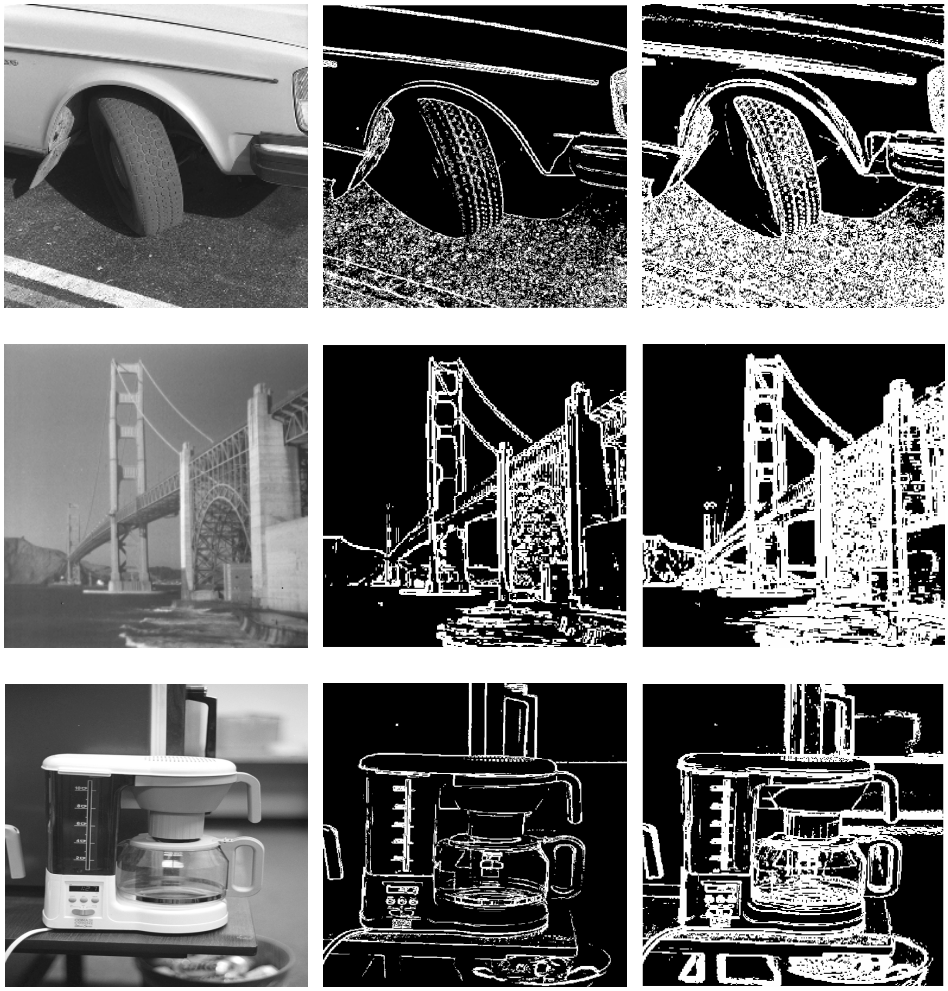
Sobel edge detection method is considered in this work. The common Sobel edge detector which have 3×3 horizontal and vertical masks is used in the edge function, in the image toolbox of matlab. These masks are extend to 5×5 dimension masks. A matlab function, called as Sobel5×5 is developed. This function and the edge function are analyse the image set. The results are given in Appendix section.

APPENDIX

In this section, the set of images which are gray scale and 256×256 is considered to use the developed matlab function and edge function. There exist 8 images and resultant image obtained from Sobel edge operators applied on original images. The original images are in the first column, the resultant images for the edge function (using Sobel's mask 3×3) and the the developed matlab function, Sobel5×5, are respectively in the second and third columns.





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