# Edge Detecting and Partitioning by Comparative Gradient

Hamid Akramifard, Reza Askari Moghadam, and Mohammad Firouzmand

***Abstract*— In this article, we present an efficient and highly accuracy method for edges and parts of a colorful picture extracting. In this method besides the use of common methods for edging, a new process has been added to this stage and noticing to the differences of color parts' amounts, we extracted the edges. In continuance, we introduce three solutions for extracting the parts of an image, noticing to the gotten edges. The first is finding a spot inside each part and then extracting the girth of each part with the place where the lines that are omitted of that spot and the edges cross each other. The second is based on using the line chasing system and joining the ends of the two line chaser, which start their opposite departure and at last join together. And the third, attempt to extract parts noticing to the juncture of bright spots in the shape and by observing the color.**

***Index Terms*—Derivative, gradient, edge, parts, spatial domain and frequency domain filter.**

## I. Introduction

Up until now, so many methods for extracting edges and parts of an image have been generated; each one has usage in some cases. But the method, which extracts the edges completely, has not been presented yet. Here, we have two total extent for extracting edges, spatial domain methods and frequency domain methods [1]. In spatial domain methods, we usually use the filters, which are padding the whole image as mask. Among spatial domain methods, we can point to basic filters, high reinforcing filters and derivative ones. Derivative filters have more applications and many samples of them have been implemented. From derivative operators we can name Roberts' operator, prewitt, and sobel. Here we use canny method (of course with some changes in selected image) because of its high performing speed.

The canny method for edging could be abstracted in following algorithm:

1) Reducing the noise and smoothing the image
2) Selecting the size of optimum mask (which is usually 3×3)
3) Calculating the gradient's measure by convolution and sobel operator in vertical and horizontal straight
4) Determining the edge's straight in these angles (135,90,45,0)
5) Narrowing (the bigger pixel will be choose)
6) Thresholding (we use two thresholds, which upper than the maximum threshold will be edge and in the middle of two thresholds maybe is edge, and less than the minimum threshold will not be edge.)

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In addition, the frequency domain methods have so many applications at extracting the edges of image. In this kind of filters which are known as the high-pass filters, after Fourier transform and carrying the picture to frequency domain and noticing to the point that edges information are in high frequencies of image, by weaken or omitting the low frequencies and reinforcing the high frequencies, we extract the image's edges. From frequency high-pass filters we can point to the ideal filters [2] (1) and butterworth (2).

$$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \quad \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$$

a) Roberts

$$\begin{bmatrix} 1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

b) Prewitt

$$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \quad \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

c) Sobel

Fig.1. some types of spatial domain filters for calculating derivation and edge extracting [3], [4]

$$\mathrm{H}(u,v) = \begin{cases} 0, & \mathrm{D}(u,v) \le \mathrm{D}_0 \\ 1, & \mathrm{D}(u,v) > \mathrm{D}_0 \end{cases} \tag{1}$$

$$\mathrm{H}(u,v) = \frac{1}{1+[\mathrm{D}_0/D(u,v)]^{2n}} \tag{2}$$

In above equations H (u, v) is the image of the edge, $D_0$ is the distance between cutoff frequency and the coordinate center, and D (u, v) is the distance between the spot (u, v) and coordinate center after Fourier transform.

Of course, with changes that we mentioned in previous part, we can use each one of the above methods.

In continuance in part 2 we explain related works, in section 3 we present our method for edge detecting, and in section 4 we present our method for image segmentation.

## II. Related Works

In this section of this paper we introduce some related works to edge detecting and image segmentation.

### A. Edge Detecting

In recent years there many works about edge detecting, and here we can't cover all of them. Then we mention only some recent works.

For edge detection, different approaches [5] have been followed, such as mathematical morphology, markov random fields, surface models, or pde [6], [7]. The most common method is still the derivative approach with linear filtering.

As recent edge detecting methods we can introduce color morphological gradient (CMG). The CMG edge detector identifies the maximum and minimum pixels in one operation, although it does not distinguish between them. This is in contrast to the vector order statistics (VOS) edge detectors that sort the pixels in ascending order from the vector median to the vector extremum. However, the CMG edge detector suffers from the same sensitivity to noise as the classic morphological gradient and this has motivated the development of the robust CMG (RCMG) operator that employs a novel pairwise pixel rejection scheme to provide a better estimate of the true gradient in the presence of noise [8].

### B. Image Segmentation

Here, because of number of recently presented methods, we can't cover all of related works in image segmentation. Then we mention only some recently significant works.

Gray-level thresholding is one of the oldest techniques for image segmentation. Threshold may be chosen based on *histogram* or on gray-level co-occurrence matrix, or by analyzing intra-region and inter-region homogeneity. Canny has suggested a contour based technique employing hysteresis thresholding. Anisotropic diffusion and PDE-based regularization for segmentation has been developed by Romeny [9], Weickert [10]. Segmentation algorithms based on nonlinear diffusion have been devised by Niessen *et al.* [11], Jackway [12]. A different approach based on local monotonicity has been suggested by Acton *et al.* [13]. Another segmentation method proposed by Frank *et al.* [14], uses combination of optimal and adaptive thresholding. An overview of border detection and edge linking methods in connection to segmentation can be found in [15]. Region-based segmentation techniques, by and large, detect homogeneity in terms of parameters like gray-level, color, texture etc. A number of region growing techniques for color image segmentation may be found in [16], [17], [18]. A hierarchical merging method has been suggested by Goldberg *et al.* [19]. The watershed algorithm and its variants [20], [21], [22], are found to produce reasonably good segmentation results. In a different approach Malik *et al.* [23] have suggested a graph partitioning method for segmenting gray-level images. Manjunath *et al.* [24] in another approach have devised a technique for image segmentation based on edge flow. An unsupervised multiresolution scheme for segmenting images with low depth is proposed by Wang and *et al.* [25]. Image segmentation using neuro-fuzzy techniques, genetic algorithms, wavelets, fractals etc. may be found in [26], [27], [28], [29]. Acharya *et al.* [30] have made a very good review of biomedical image segmentation techniques.

## III. Edge Extracting

In this part we use the method which is done in human's eye, means using the contrast of light and color simultaneously for extracting edges and parts of the image and sending it to the brain's nerves for studying, adjusting, and recognizing.

In retina of human's eye, there are two kinds of light sensors, which are named cylindrical sensors and cone sensors [31], [32]. Cylindrical sensors are made for getting light and the cones for colors. In the eyes, as we know the retina and its nerves automatically recognize the edges, both navigates of sensors means color and light are used [33]. In the way that eyes' nerves analyze a combination of color and light, which is arrived to retina, and finally some edges are extracted which seems that in the brain line chasing system at acquired edges are used for extracting the parts of entrancing images.

We use the gradient's equation (by canny method) and some other formulas, which we bring an abstract of them below, for detecting the edges. In grayscale images, the edges are extracted just from an image and gradient's equation (3) gives us the image [1]:

$$\nabla f = \partial f/\partial x + \partial f/\partial y \tag{3}$$

In the above formula x is the length of image, y is the width of image, and $\nabla f$ is gradient's symbol.

If R, G, and B were symbols for red matrix, green matrix, and blue matrix, respectively, we would use the equation 4 - 6 for extracting the edge, and equation 9 for extracting the final edge. We show these calculation's results in Fig. 3.

$$\mathrm{H_{rg}} = \nabla(\mathrm{R/G})^7 \tag{4}$$

$$\mathrm{H_{rb}} = \nabla(\mathrm{R/B})^7 \tag{5}$$

$$\mathrm{H_{gb}} = \nabla(\mathrm{G/B})^7 \tag{6}$$

$$\mathrm{H_{GRAY}} = \nabla(\mathrm{gray(f)}) \tag{7}$$

$$\mathrm{D} = \mathrm{H_{rg}} + \mathrm{H_{rb}} + \mathrm{H_{gb}} + \mathrm{H_{GRAY}} \tag{8}$$

$$\mathrm{H}_{EDGE} = \begin{cases} 1\ ,\ D > 0 \\ 0\ ,\ D \le 0 \end{cases} \tag{9}$$

Fig.2. Processing image

In above equations, ∇ is gradient's symbol, $H_i$ is edge's symbol and D is the total edge's symbol. Moreover, the meaning of the word *gray* is carrying the picture to grayscale.

Fig.3. The edges, which are acquired from the suggested algorithm

Fig. 4. The red part of the main image

## IV. PARTS' EXTRACTING

In this part, we introduce three methods for extracting image's parts which all of them use the acquired edges from previous part. In this method noticing to the extracted pages, for each color (black, white, red, blue, green, purple, brown, pink, yellow and orange) we attain some pages that each one has separate parts. And each one has some groups of continuous spots. We will use these pages in following sections.

### *A. Finding Center of Each Section, Determining Their Outset and Their End, and Then Extracting the Object Container Rectangle*

In this method, we determine the center of each section by averaging each color's separate and continuous parts' coordinate, which are indicated in Fig. 4.

After determining each section's center (Fig. 5) which have continuous spots with each other, we draw four lines or more in horizontal, vertical and gauche state until they meet each section's edge in some spots (Fig. 6). We save the conflict coordinate in one matrix. And we use the maximum and minimum width and height which are acquired of that matrix as the extracted rectangle for determining each part's confine (Fig. 7).

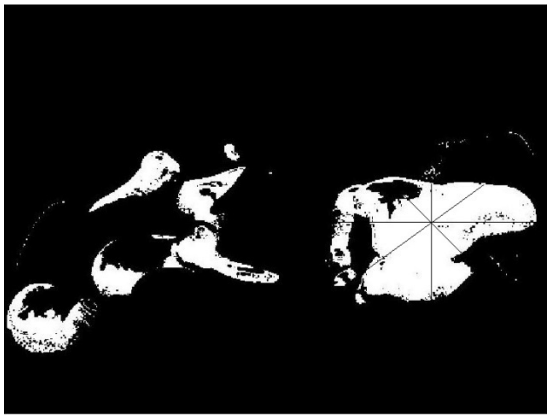

Fig.5. Determining each continuous part's center (for example red) for determining image's parts (in this figure, the lines are just for indicating the probable thing's center and they aren't signs for any action)

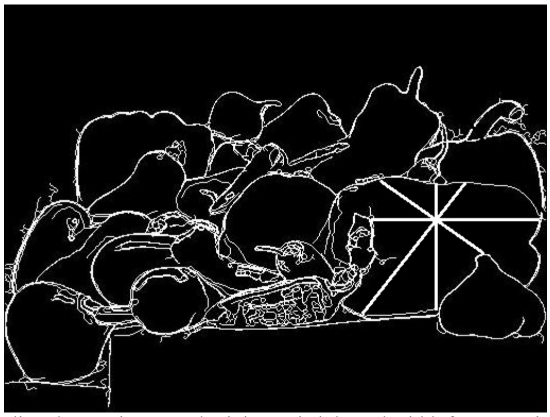

Fig. 6. Finding the maximum and minimum height and width for extracting each part

Fig.7. One extracted part of the selected image

### *B. Using the Line Chasing System for Determining Any Object's Confine*

In this method we use two 3×3 filters which start their act from the first spot of the found edge. These two filters start their moves from the selected spot in two paths and they somehow perform line chasing. The preference of each filters' move is in the way which one filter at first moves to the right and then down the image, and another one moves to the down and then to the right side of the image (Fig. 8). And they continue their moves after starting the first one's move, with right preference and then forward and the next is left side and finally behind of itself, And the second with the preference of left and then forward and next right side and finally behind of itself. Every where they arrive each other, we attain one part of the image. We save all the spots of the two filters' length of path's coordinate in a matrix, and the maximum and minimum acquired spots' width and height in another matrix, and we extract each part in a rectangle (Fig. 9).

Fig.8. The diagram of two filters at starting their moves for extracting image's parts

Fig.9. The extracted rectangle, which is acquired from the line chasing filters' moves

### A. *Using Spots Juncture for Determining Any Object's Confine*

In this method, after extracting the edges, we convert the edge's image (Fig. 10). Then, we put each continuous set from converted image's spots in a matrix. Also here, we put the maximum and minimum widths and heights of each set in another matrix and then, using them, we attain the object container rectangle (Fig. 11).

In this paper, we use the results, which we indicate them in Fig. 11, by the third method the spots' juncture of each attained color's image.

Fig.10. Converted edge's image

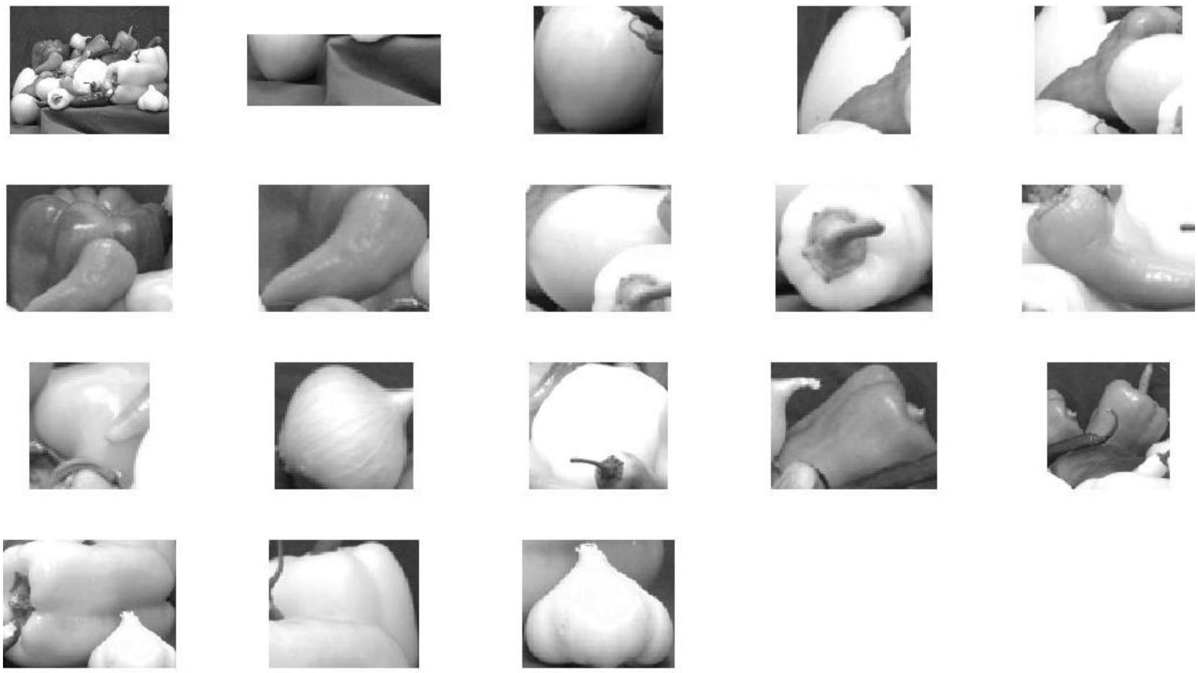

Fig. 11. The result of using continuous spots method

## V. Conclusion

In this article, we presented a novel method for extracting edge and parts of an image. We have compared other edge detecting methods (with best threshold value) with our method in Fig. 12. In each section using the others' experiences and with a little innovation for these instances, which are the ones of the most important topics in image processing and its semantic understanding, we reached to a partly desirable conclusion. Of course, without any doubt, there is no perfect solution for the real world's issues. In addition, the improvement and development of these methods is possible. Moreover, work offering for improving this technique is one of the possible acts for future.

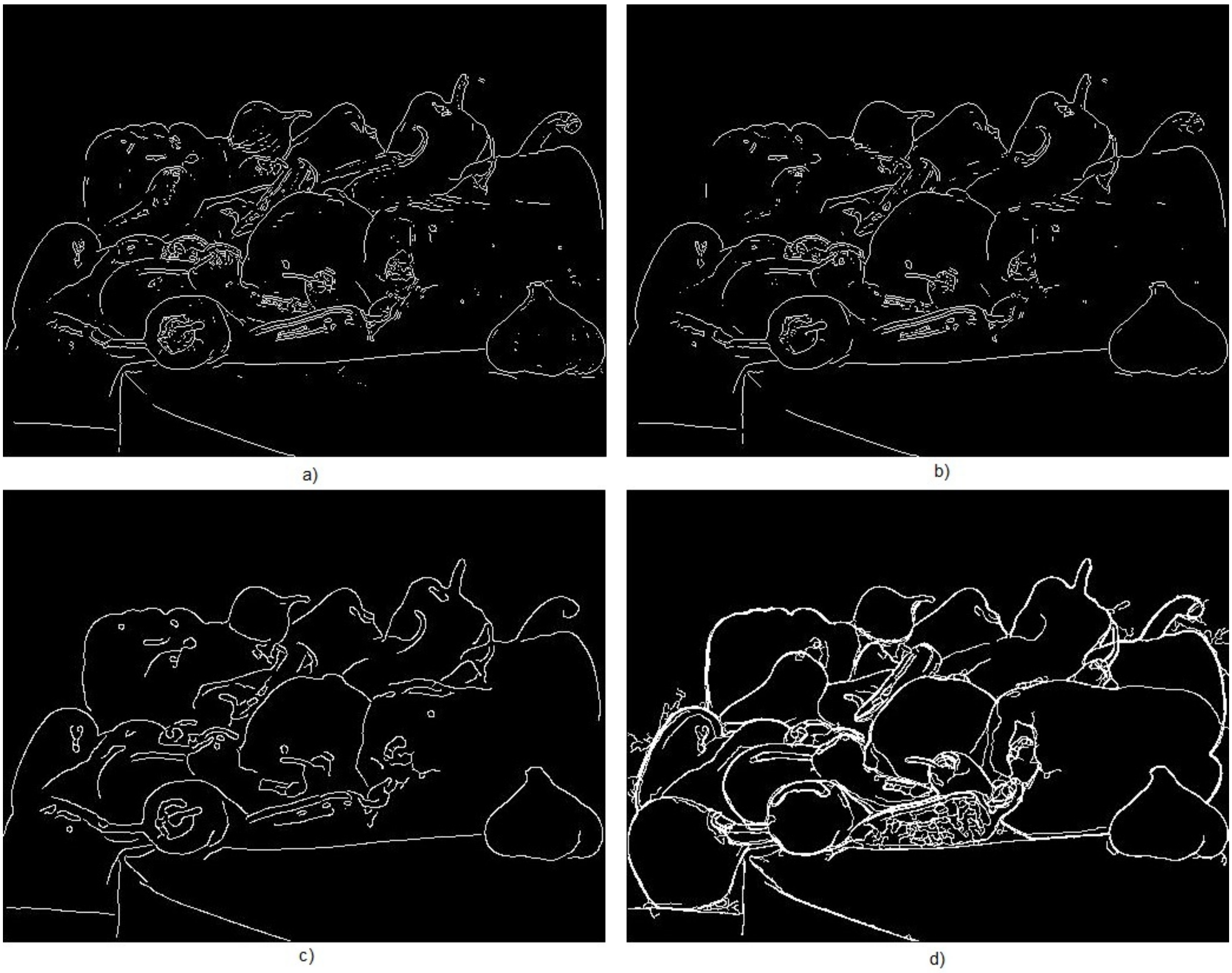


Fig.12 Comparison our edging method with other conventional method. a) edge acquired by sobel method with threshold equal to 0.05, b) edge acquired by prewitt method with threshold equal to 0.05, c) edge acquired by canny method with threshold equal to 0.3 and d) result of our method for edge extracting.

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