CANNY OPERATOR'S IMPLEMENTATION OF IMAGE SEGMENTATION

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Abstract

The process of segmentation in digital images that separates an object from the background or background can be obtained from the RGB value of each pixel in the digital image so that the object can be processed for other purposes. As technology develops in applications that process digital images, segmentation is becoming increasingly necessary. The results of segmentation must also be more accurate because if the results of segmentation are inaccurate it will affect the results of the next process. In general, the segmentation process is divided into three parts based on classification, by edge, and by region. the process starts with inputting a digital image and then the grayscale process is carried out. Next, choose the method then do the edge detection process with the Canny or Laplacian operator and finally the dilation procccess
Keywords: segmentation, image, canny

1. Introduction

The utilization of image processing in this almost digital era is urgently needed. Analysis of the composition of an image can have an impact on life change. Image processing is a method or technique that can be used to process images or images by manipulating them into desired image data to obtain certain information.Segmentation is an important process in image processing that aims to split an image into several segments with certain criteria. Image segmentation is the separation of one object with other objects in an image or between objects with a background contained in an image. With this segmentation process, each object in the image can be taken individually so that it can be used as input. This type of operation is closely related to pattern recognition.

The segmentation process in digital images is done with edge detection to provide a target path along the edge (edge) of the image object. The edge in the image is the area on the edge of the image object with strong contrast intensity, so the intensity jumps from one pixel to another. Edge detects images by significantly reducing the amount of data and filtering out information that is not useful filtering, and also maintaining important properties needed in the image in this case that supports the appearance of the edges of the image. Edge Detection in an image of a process that results in the edges of image objects, the purpose is to mark the details of the image and to improve the details of the blurred image, which occurs due to errors or the effects of the acquisition process image. A point (x, y) is said to be the edge (edge) of an image if the point has a high difference with its neighbors. [1], [2]

2. Literature Rivew
2.1 Image Definition

Image is a representation of similarity, or imitation of an object. Image as the output of a data recording system can be optical in the form of photos, analogous in the form of video signals such as images on television monitors, or digital that can be directly stored on a storage medium. The concept of an image

is a function is an important concept in the process of developing and implementing image processing techniques. [3]–[5]

2.2 Image Representation

Digital images are formed by a collection of dots called pixels (pixels or picture elements). Each pixel is described as a small square. Each pixel has position coordinates. The coordinate system used to express digital images is shown in the image below
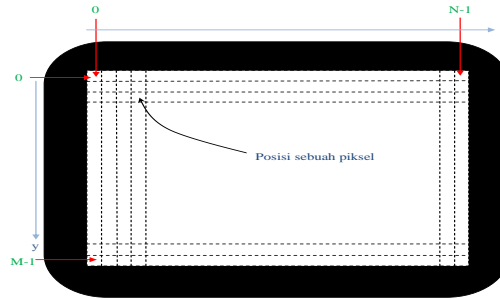

Figure 1. Image Coordinate System with MxN Size

With the coordinate system following the scanning principle on the standard TV screen, a pixel has coordinates in the form of (x, y). In this case x represents the column position and y represents the row position, the upper-left corner pixel has coordinates (0, 0) and the pixels in the lower-right corner have coordinates (N-1, M-1). [6]

2.3 Image Resolution

In addition to counting the brightness intensity, the number of pixels used to compile an image affects the quality of the image. The term ordinary image resolution is stated by the number of pixels in the width and height direction. The usual pixel resolution is expressed by the notation m x n, with m expressing height and n expressing width in the number of pixels. The example in Figure 2.7 shows that if an apple image is only expressed in 8 x 8 pixels, the image formed is very different from the original. If the number of pixels used is more, of course, it will be closer to the original image

2.4 Canny Operator

The canny operator proposed by Jhon Canny in 1986, is known as the optimal edge detection operator. One of the modern edge detection algorithms is edge detection using the Canny method. There are some of the most optimal edge detection criteria that the Canny algorithm can meet: [7]–[10]

1. Detect well (detection criteria)

   The ability to place and mark all edges following the selection of convolution parameters made. While also providing a very high flexibility in terms of determining the level of detection of the desired edge thickness.

1. Localize properly (criterialocalisasi)

   With Canny it is possible to produce a minimum distance between the edge detected and the original edge.

2. Clear response (response criteria)

   There is only one response for each edge. So it is easily detected and does not confuse subsequent image processing.

   The choice of Canny edge detection parameters greatly affects the results of the resulting edges. Some of these parameters include: [11]

a. Gaussian Deviation Standard Value

b. Threshold Value

The canny algorithm approach is carried out by the convolution of the image function with the Gaussian operator and its derivatives. The first derivative of the image function that is convoluted with the gaussian function,

g (x, y) = D [gauss (x, y) * f (x, y)] 2.6

Equivalent to the image function that is convoluted with the first derivative of the gaussian function,

g (x, y) = D [gauss (x, y)] * f (x, y) 2.7

This algorithm is known as a good algorithm for detecting limits. This edge detection first smoothes the image by removing noise. Then found the gradient of the image to highlight areas that have high falsification space. This algorithm then takes a path along that space and suppresses pixels that are not maximum (non-maximum emphasis).

By using the Canny edge method that is produced more clearly, the difference between the edge of the image background is noticeable. But in Canny itself, noise in certain parts can not just disappear. Another test for edge detection is to use its resistance to noise. Disturbances in the input image (input) can be used as one of the parameters that determine the level of display of several methods for tracking the edges of an object. The grayscale level value on an object's edge will change so that it will be more difficult for the detection operator to determine the edge of an object.

The following will also be included steps on how to detect edges of edges/edges using canny, namely:

1. The first step that must be done is to filter and remove noise by changing the object to a grayscale image on the original image before trying to set and detect edges. To eliminate noise we can use a Gaussian filter, but this is also used exclusively in the Canny algorithm.

$$f_o(X,Y) = \frac{f_i^R(X,Y) + f_i^G(X,Y) + f_i^B(X,Y)}{3}$$

2. After smoothing the image and getting rid of the noise, the next step is to find the edge using the gradient of the image. The Sobel operator creates a gradient size of the space in the image. Then, the magnitude of the gradient at each point can be searched. The Sobel operator uses a pair of 3×3 convolution matrices, one matrix to calculate gradients in x (columns) and one to calculate gradients in y (rows).

3. Analysis and Discussion

The color image can be converted into a grayscale image by calculating the average of the elements of the color Red, Green, Blue. Mathematically the calculation formula is as follows.

$$f_o(X,Y) = \frac{f_i^R(X,Y) + f_i^G(X,Y) + f_i^B(X,Y)}{3}$$

With the following calculation

2. $f_o = \frac{246+251+254}{3} = 250$ 15. $f_o = \frac{246+255+255}{3} = 252$

3. $f_o = \frac{249+255+255}{3} = 253$ 16. $f_o = \frac{247+255+255}{3} = 252$

4. $f_o = \frac{245+250+255}{3} = 250$ 17. $f_o = \frac{244+254+255}{3} = 251$

5. $f_o = \frac{246+254+255}{3} = 252$ 18. $f_o = \frac{243+253+255}{3} = 250$

6. $f_o = \frac{242+251+250}{3} = 248$ 19. $f_o = \frac{243+252+255}{3} = 250$

7. $f_o = \frac{247+255+255}{3} = 253$ 20. $f_o = \frac{247+255+255}{3} = 252$

8. $f_o = \frac{248+255+255}{3} = 253$ 21. $f_o = \frac{248+255+255}{3} = 253$

9. $f_o = \frac{232+239+245}{3} = 239$ 22. $f_o = \frac{247+255+255}{3} = 252$

10. $f_o = \frac{242+251+255}{3} = 249$ 23. $f_o = \frac{242+252+254}{3} = 249$

11. $f_o = \frac{242+252+251}{3} = 248$ 24. $f_o = \frac{240+249+254}{3} = 248$

12. $f_o = \frac{243+253+254}{3} = 250$ 25. $f_o = \frac{242+251+255}{3} = 249$

13. $f_o = \frac{244+244+255}{3} = 251$

Then the results obtained from the color pixel to grayscale as in the table below.

Table 1. Grayscale Image Results

249	250	253	250	252
248	253	253	239	249
248	250	251	246	252
252	251	250	250	252
253	252	249	248	249

The 5x5 weight matrix is an asymmetrical matrix which will be multiplied by matrix A, which is each pixel (center position) in the image along with 24 neighboring pixels that surround it. The matrix will be normalized by dividing each of the contents of the matrix by the total number of contents of the matrix that is 4090.

To detect edges using the Canny method, we will use a gradient of G (x, y) which is a vector consisting of two elements, Gx and Gy. Edge detection is done by reading each pixel in the image by reading from the top leftmost pixel (northeast) and moving to the bottom rightmost pixel (southwest). Therefore, to assist with edge tracing, the Gx and Gy gradients are calculated with the Sobel Mask 3x3 operator matrix. This operator takes the principle of laplacian and gaussian functions known as functions to generate HPF. With the following matrix

Table 2 Matrix 3x3 Sobel Operators

Sy=	1	2	1	Sx=	-1	0	1
	0	0	0		-2	0	2
	-1	-2	-1		-1	0	1

So the gradient size can be calculated using the equation:

Sx = (p1 + cp2 + p3) − (p7 + cp6 + p5)

Sy = (p1 + cp8 + p7) − (p3 + cp4 + p5)

$|S| = |S_x| + |S_y|$

Here are the results of matrix multiplication calculations using the sobel operator to determine the segmentation of an image with a 5x5 matrix. The first convolution is carried out on a pixel that has a value of 1 (the center of the mask).

Table 3 Grayscale Matrix 5x5 imagery

249	250	253	240	252
248	253	253	239	249
248	250	251	246	252
252	251	250	250	252
253	252	249	248	249

1. Value 16 in the first convolution image is obtained by calculation:

   Sx = (249)(-1) + (248)(-2) + (248)(-1) + (253)(1) +(253)(2) + (251)(1) = 17

   Sy = (249)(1) + (250)(2) + (253)(1) + (248)(-1) +(250)(-2) + (251)(-1) = 3

2. The second convolution is carried out on a pixel that has a value of 10 (the center of the mask)

   Sx = (250)(-1) + (253)(-2) + (250)(-1) + (240)(1) +(239)(2) + (246)(1) = 42

   Sy = (250)(1) + (253)(2) + (240)(1) + (250)(-1) +(251)(-2) + (246)(-1) = 2

3. The second convolution is carried out on a pixel that has a value of 10 (the center of the mask)

   Sx = (253)(-1) + (253)(-2) + (251)(-1) + (252)(1) +(249)(2) + (252)(1) = 8

   Sy = (253)(1) + (240)(2) + (252)(1) + (251)(-1) +(246)(-2) + (252)(-1) = 10

4. The second convolution is carried out on a pixel that has a value of 18 (the center of the mask)

   Sx = (248)(-1) + (248)(-2) + (252)(-1) + (253)(1) +(251)(2) + (250)(1) = 9

   Sy = (248)(1) + (253)(2) + (253)(1) + (252)(-1) +(251)(-2) + (250)(-1) = 3

5. The second convolution is carried out on a pixel that has a value of 12 (the center of the mask)

   Sx = (253)(-1) + (250)(-2) + (251)(-1) + (239)(1) +(246)(2) + (250)(1) = 23

   Sy = (253)(1) + (253)(2) + (239)(1) + (251)(-1) +(250)(-2) + (250)(-1) = 3

6. The second convolution is carried out on a pixel that has a value of 4 (the center of the mask)

   Sx = (253)(-1) + (251)(-2) + (250)(-1) + (249)(1) +(252)(2) + (252)(1) = 0

   Sy = (253)(1) + (239)(2) + (249)(1) + (250)(-1) +(250)(-2) + (252)(-1) = 22

7. The second convolution is carried out on a pixel that has a value of 24 (the center of the mask)

   Sx = (248)(-1) + (252)(-2) + (253)(-1) + (251)(1) +(250)(2) + (249)(1) = 5

   Sy = (248)(1) + (250)(2) + (251)(1) + (253)(-1) +(252)(-2) + (249)(-1) = 7

8. The second convolution is carried out on a pixel that has a value of 12 (the center of the mask)

   Sx = (250)(-1) + (251)(-2) + (252)(-1) + (246)(1) +(250)(2) + (248)(1) = 10

   Sy = (250)(1) + (251)(2) + (246)(1) + (252)(-1) +(249)(-2) + (248)(-1) = 0

9. The second convolution is carried out on a pixel that has a value of 4 (the center of the mask)

   Sx = (251)(-1) + (250)(-2) + (249)(-1) + (252)(1) +(252)(2) + (249)(1) = 5

   Sy = (251)(1) + (246)(2) + (252)(1) + (249)(-1) +(248)(-2) + (249)(-1) = 1

Table 4: 3x3 Matrix Image Convulation Results

*	*	*	*	*
*	20	44	18	*
*	12	26	22	*
*	12	10	6	*
*	*	*	*	*

Then the edge detection results obtained from the calculation of the matrix to determine the segmentation of the image using the canny method, the results obtained in the multiplication of matrix 3x3 with grayscale matrix image 5x5 in table 4

4. Conclusion

The process of segmenting digital images in detecting the edges of images in JPG format produces edges of image objects to mark the details of the image, correcting the details of blurred images, which occur due to errors or the effects of the image acquisition process on grayscale images

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