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Research on Sobel Edge Detection Algorithm of Grayscale Images to Analyse Car Number Plate

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Abstract: Image processing is a very important subject to be discussed in computer science. Many applications of image processing are already in the field. Image processing techniques are applied in color and grayscale images. The application of image processing are ranging for military, medical and many other applications. One most important thing to analyse image and enhance its quality is doing edge detection. Edge detection in image is a well known approach to be used to detect discontinuity in grayscale image. Edge detection functions to identify edge line in images. Sobel algorithm is one of most known algorithm, others are prewitt, canny, homogeneity algorithms. Image can be made sharper and will enhance its quality. To detect number plate of cars, an edge detection algorithm needs to be applied. In number plate, to recognize the cars number plate, the image should be clear and clean from dirt. Sometimes we can not recognize the plate number if it is too blur or has many dirt. So in its application we need a strong edge detection algorithm to recognize car number plate easily. In this journal, five car's images are presented. Each with the original image, grayscale image and the image after edge detected by sobel algorithm. It is concluded that this algorithm is quiet good in the implementation. But in the result, there are poor quality image also. For PSNR of images after edge detected, their values are between 19 and 20 dB, which are not good.

Keywords: car number plate, edge detection, image processing, PSNR, sobel algorithm

INTRODUCTION

Image processing is a very important subject to be discussed in computer science. Many applications of image processing are already in the field. Image processing technique are applied in color and grayscale images. The application of image processing are ranging for military, medical and many more applications (Baareh et al., 2018). Thus, the use of image processing is very important (Perangin-angin & Gunawati Harianja, 2019).

Digital image processing is a process with the purpose to analyse and manipulate images with the help of computer, since the image is in the form of bits. There are two activities in the digital image processing. First, to improve the quality of images. Thus, human eye can see it and interpret it with ease. Second, to process information contained in an image, so that objects can be automatically recognized (Asmaidi et al., 2019) (Wicaksono Yuli Sulistyo et al., 2020) (Pamungkas et al., 2020).

To analyse image, image can be manipulated to get better and more sharp images. There comes the idea of edge detection in image. Edge detection in image is a well known approach to be used to detect discontinuity in grayscale image. Edge detection functions to identify edge line in images (Ayyed, 2020) (Sobel & Prewitt, 2020). Edge detection functions to identify edge line from one object to the background of it. With edge detection algorithm, edge lines on images can be identified accurately, All objects can be found its character like shape, the size of objects can be measured. The edge of image is a position where intensity of pixel changed from low value into high value, or from high value to low value (Hasibuan et al., 2020) (Zhang & Han, 2021). The main purpose of edge detection is to enhance the appearance of the boundary of an area of object in the image (Tian et al., 2021).

In the field of computer science, there are several known algorithms of edge detection, which are sobel, prewitt, canny and homogeneity algorithms. Each with its positive and negative characters. In this research, the point of discussion is about sobel algorithm. This research is an experimental research. In this jurnal, matlab software and programming is used to display image before edge detected and after edge detected with sobel algorithm. Matlab is a powerfull programming language. Many researches have been applied with matlab. Matlab programming also

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provides many functions in terms of digital image processing. That is why the reason in this journal, matlab were used.

Grayscale in image is image where in every its pixel only contain color intensity with white and black. Image on grayscale also called monochromatic. Because it does not have other color except the variants intensity of black and white. Thus, the display of image in grayscale will be different if it is in colorful image.

Number's plate in cars usually are in black and white. With background white and the number or letter is white, or the background black and the number or letter is white. But other the color of car number plate might be different from country to country. To recognize the plate numbers of cars, the image should be clear and clean from dirt. Sometimes, we can not recognize the number plate if it is too blur or has many dirt. So, in its application we need a strong edge detection algorithm to recognize car number plate easily.

This journal is arranged in the following sections. The first section is introduction. Here the discussion about edge detection techniques are discussed. The second section is method. Here, discussion about several method of edge detection algorithms are given. The more specific is sobel edge detection algorithm. Then the next section is analysis and result. Here the analysis and result of sobel edge detection algorithm to analyse plate number of cars are discussed. Five images of cars and its plate number are given and analysed. Then the next step is discussion. Here the peak to noise ratio of the images and the discussion about the result comparison of images of this algorithm are given. And, the last section is conclusion. The programming were done with matlab.

METHOD

Sobel operator

Sobel edge detection algorithm or usually called sobel operator is a discrete differentiation gradient-based operator. Sobel algorithm computes the gradient approximation of image intensity function for image edge detection (Muhammad Rizky Alditra Utama et al., 2022). There are two kernels with 3x3 size matrixes and gradient magnitude G. At the pixels of an image, the Sobel operator produces either the normal to a vector or the corresponding gradient vector. The two 3 x 3 mask or kernels are convolved with the input image to calculate the horizontal and vertical derivative approximations respectively. It is known that the sobel operator has the capability to reduce noises before calculating the edge detection (Kasthuri, 2022)(Aulia Annisa Br Bangun et al., 2022)(Shylashree et al., 2022)(Kumar & D, 2022)(Younis et al., 2022).

$$Gx=\begin{bmatrix}-1 & 0 & 1\\ -2 & 0 & 2\\ -1 & 0 & 1\end{bmatrix} \qquad Gy=\begin{bmatrix}-1 & -2 & -1\\ 0 & 0 & 0\\ 1 & 2 & 1\end{bmatrix} \tag{1}$$

$$G=\sqrt{((I*(Gx))^2)+(I*(Gy))^2)} \tag{2}$$

Convolution Process and Grayscale Conversion

Convolution processing is based on the theory of matrix. With matrix size 3x3, we have Gx And Gy. Its coefficient from convolution by shifting the matrix to the neighboring pixel from the convolution result. The result of this 3x3 matrix convolution is in the middle of the matrix's target. By doing convolution, a new image is comes up.

The images then converted into grayscale, after first inputting the color images, which is in RGB. By using command function in MATLAB, rgb2gray, the grayscale images are calculated by the system.

Calculation of Sobel Algorithm

let's say we have a 4x4 matrix of image. This image will be calculated based on sobel algorithm.

178	175	174	253
200	**176**	186	201
168	176	200	193
170	140	253	193

We will calculate the pixel of second row and second column of the image matrix, which has value of 176, print in bold above.

$$Gx=\begin{bmatrix}-1 & 0 & 1\\ -2 & 0 & 2\\ -1 & 0 & 1\end{bmatrix} \qquad image=\begin{bmatrix}178 & 175 & 174\\ 200 & 176 & 186\\ 168 & 176 & 200\end{bmatrix}$$

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Calculation of convolution of Gx:
I*Gx = ((-1)*178+0*175+1*174+(-2)*200+0*176+2*186+(-1)*168+0*176+1*200=0

Calculation of convolution of Gy:

Gy=

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

image=

178	175	174
200	176	186
168	176	200

I*Gy=(-1)*178+(-2)*175+(-1)*174+0*200+0*176+0*186+1*168+2*176+1*200=18

After that we calculate G:
$G=\sqrt{((I*(Gx))^2)+(I*(Gy))^2)}= \sqrt{(0^2+18^2)} = 18$

So it is concluded that the pixel on the second row and the second column, which before was 176 then it becomes 18. The calculation must be done to all of the pixel in the image matrix.

Peak Signal to Noise Ratio (PSNR)

To analyse image with objectivity we must use a calculation. Then, we use PSNR. PSNR analysis is usually a standard used in image processing. This formula measures the ratio between the highest power possible of a signal and the power of distortion or noise that affects the quality of an image. Its formula is (Muhammad Rizky Alditra Utama et al., 2022) :

$$PSNR= 10 \text{ Log}_{10}(R^2/\sqrt{MSE}) \quad (3)$$

Where "R" is the maximum possible pixel value of the image, and "MSE" is the mean squared error between the original image and the distorted (noisy) version. The higher the value of PSNR, the better the quality of an image.

Subjective Performance Evaluation

The subjective performance evaluation is given by expert in image quality. Each of these factors, the level of edge discontinuity, amount of detail, will be given some numbers, from one to five to determine its quality. Please take a look at Tabel 1 below. With 1 being the lowest performance and 5 is the highest performance (Baareh et al., 2018). Also the quality of images are given in five criterias or factors, excellent, very good, acceptable, poor quality and non-acceptable. In this research, five images of car's plate number are used. Analysis will be given to each of this image.

Tabel 1 Subjective Quality of Images

Quality of image	Level of edge discontinuity	Amount of detail
Excellent	5	5
Very good	4	4
Acceptable	3	3
Poor Quality	2	2
Non-acceptable	1	1

RESULTS

Several cars, actually five cars with number plates are proposed to be processed with sobel algorithm. Several with sharp edge of number plate images, but there are blur ones. These images will be the subject of analysis and run with matlab programming. The result can be found below, the original images with colours, and afterwards change into grayscale, then these images are edge detected. In line with the pseudo code, below:

Algorithm of matlab

Below is the the pseudo code of matlab to analyse five car number plates, all of which has number's plate, with results from clear to blur. To analyse car number plate, the original colourful images will be converted into grayscale, then they are edge detected with sobel algorithm. Then afterwards, the car number plate will be screen shot. All is done in matlab programming. Below please find the pseudo code of matlab:

Pseudo code:

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Inputting an image
Converting RGB color image to be grayscale image
Displaying grayscale image
Converting the image to double
Pre-allocating the filtered image matrix with zeros
Defining and arranging the Sobel Operator Kernels or Masks
Processing the Edge Detection (Calculation of Sobel Algorithm)
Displaying the image that already edge-detected

Please take a look at figure 1, below.

Image 1

Original image

Grayscale image

Sobel edge detection

Car's number plate

Image 2

Original image

Grayscale image

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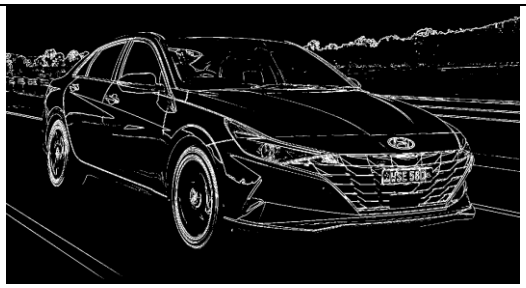
	
Sobel edge detection	Car's number plate

Image 3

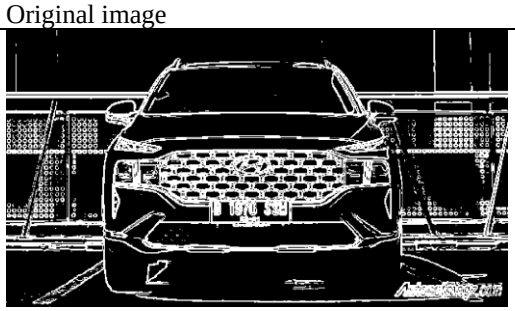
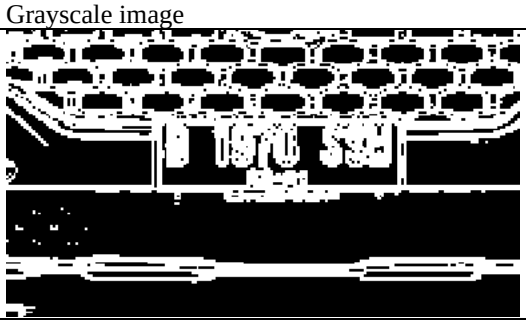
	
Original image	Grayscale image
	
Sobel detection image	Car's number plate

Image 4

	
Original image	Grayscale image

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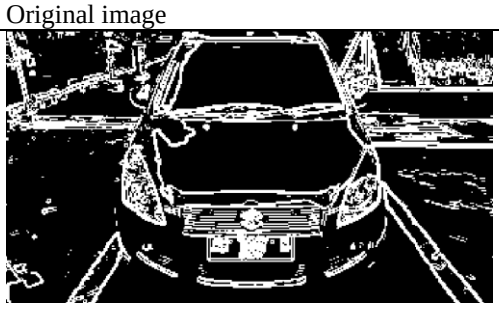
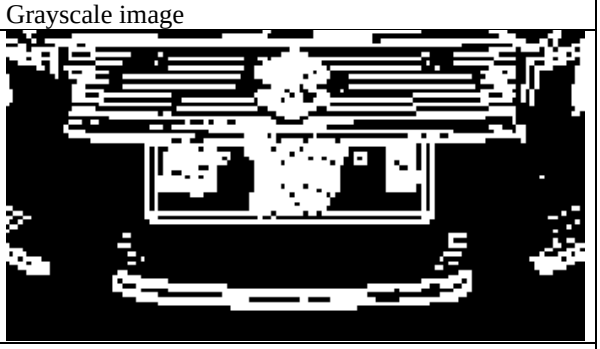
Sobel edge detection | Car's number plate

Image 5

Original image | Grayscale image





Sobel edge detection | Car's number plate

Figure 1. Images Data, from color into grayscale images

DISCUSSION

Here is the details of subjective analysis: We have five images. The first original image is considered excellent. And the level of edge discontinuity is acceptable, which is 3, the amount of detail is also acceptable, which is 3. The second image has quality excellent in the original image. The level of edge discontinuity of image 2 is also acceptable, so does its amount of detail. The third image has excellent original image, but its level of edge discontinuity is just acceptable, so does its amount of detail. The fourth image is excellent in original image, but the same as image 3, the level of edge discontinuity and its amount of detail is just 3, which is acceptable. The last image, has excellent original image, but its level of edge discontinuity and its amount of detail is poor quality, which is and the amount of detail is non-acceptable which is 1. Since the car number plate for image 5, could not be read. Please take a look at Tabel 2. Below:

Tabel 2. Subjective Analysis of The 5 Images

Image	Quality of original image before edge detection	Level of edge discontinuity (after edge detected)	Amount of detail (after edge detected)	PSNR of the edge detected image
1	Excellent (5)	Acceptable (3)	Acceptable (3)	19.9962
2	Excellent (5)	Acceptable (3)	Acceptable (3)	19.9748
3	Excellent (5)	Acceptable (3)	Acceptable (3)	20.0491
4	Excellent (5)	Acceptable (3)	Acceptable (3)	19.9891

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5	Excellent (5)	Poor quality (2)	Non-acceptable (1)	20.1254

For PSNR, it is usually the values of the PSNR in lossy image and video compression are between 30 and 50 dB. The higher the value is better. The value of more than 40 dB are normally considered very good and those below 20 dB are normally unacceptable. Here we have all the value between 19 and 20 dB, which is meant that after sobel detection algorithm, the values of PSNR are not good.

CONCLUSION

It is concluded that using sobel algorithm on car number plate edge detection is the right step, because by edge detection, the car number plate can be clearer, even though one image, the image 5 it is blurred. In image 5, the car number plate could not be read. The implementation of matlab programming produced different subjective analysis of the level of edge discontinuity and the amount of details. For PSNR value of all images are not good which are between 19 and 20 dB. For future works, it is suggested to compare sobel algorithm with other edge detection algorithms like prewitt, laplace, roberts, and canny, and other known algorithms for edge detections.

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