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Application of Canny Method to Detect Vehicle License Plate in Tanjung Balai City Government Mess Area

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ABSTRACT

Vehicles have a license plate that serves to be the identity of a vehicle. The shape of the plate is in the form of a piece of metal mounted on the vehicle as an official identity. Making a license plate or Motor Vehicle Number Sign in Indonesia is regulated in Government Regulation No. 60 of 2016 with a validity period of 5 years. The regulation is about the type and tariff of Non-Tax State Revenue (BNBP), and has been officially enacted on January 6, 2017, by replacing Government Regulation No.50 of 2010, quoted from the Kompas newspaper website. Image is one of the components of multimedia that plays an important role because it contains information in visual form. Images have more information that can be conveyed than in the form of text. An image is a collection of image elements (pixels) that as a whole record a scene through a visual sensory (camera). Canny edge detection can detect edges with a minimum error rate, canny edge detection has a difference with other operators because it uses a Gaussian Derivative Kernel that can refine the appearance of the image. Good location can minimize the distance of edge detection produced by processing, so that the location of the edge can be detected similar to the real edge. The accuracy value of applying this method reaches 99.88%-100%. And lastly, one response to single edge that can produce a single edge, not giving false edges.

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1. INTRODUCTION

A monitoring system is a system used to perform a periodic monitoring function to obtain the desired information. The results of the monitoring system play an important role in improving various aspects, namely information, security, productivity levels, and performance[1]. One form of monitoring system is an object detection application. Object detection applications are object detectors that can define or extract information from objects in an image.Mess Tanjung Balai City Government is a service of providing lodging / Pesanggrahan / Villa owned and / or managed by the Tanjung Balai City Government.

A vehicle is a means of transportation used to move from one place to another. Be it man-made vehicles such as cars, motorcycles, trains, boats and planes. Or vehicles that are not man-made but in the form of animals that are used as vehicles by humans such as horses, camels and others. In general, vehicles have a license plate that serves to be the identity of a vehicle[2]. The shape of the plate is in the form of a piece of metal mounted on the vehicle as an official identity[3]. Making a license plate or Motor Vehicle Number Sign (TNKB) in Indonesia is regulated in Government Regulation No. 60 of 2016 with a validity period of 5 years. The regulation is about the type and tariff of Non-Tax State Revenue (BNBP), and has

been officially enacted on January 6, 2017, by replacing Government Regulation No.50 of 2010, quoted from the Kompas newspaper website[4].

Image is one of the components of multimedia that plays an important role because it contains information in visual form. Images have more information that can be conveyed than in the form of text. Meanwhile, according to [5]an image is a collection of image elements (pixels) that as a whole record a scene through a visual sensory (camera). For processing needs with the help of a computer, the image is presented in a discrete form called a digital image[6].

An image is a representation (picture), resemblance, or imitation of an object. The image as the output of a data recording system can be optical in the form of photographs, analog in the form of video signals such as images on a television monitor, or digital in nature that can be directly stored on a storage medium [7]. Image data recording can be divided into two, namely: (a) Analog images consist of electromagnetic signals that cannot be distinguished so that in general their size cannot be determined. 3 Analog images have a continuous function. Recording results can be optical in the form of photographs (conventional photographic film) and video signals such as images on television monitors[8]. (b) Digital Image Digital images consist of signals that can be distinguished and have a function that is not continuous in the form of image-forming color points. The results of digital image recording can be stored on a storage medium.

The representation of images from malar (continuous) functions into discrete values is called digitization. The resulting image is called a digital image. In general, digital images are rectangular, and their dimensions are expressed as Height x Width (Width x Length). A digital image whose height is N, width is M, has L degrees of gray can be considered as a function [9].

One of the modern edge detection operators is edge detection with the Canny operator. Canny edge detection was invented by Marr and Hildreth who researched modeling human visual perception [10].Canny edge detection can detect edges with a minimum error rate, canny edge detection has a difference with other operators because it uses a Gaussian Derivative Kernel that can refine the appearance of the image. Some of the advantages of canny edge detection include, good detection can maximize the Signal to Noise Ration (SNR) which is useful for all edges to be detected properly. Good location can minimize the distance of edge detection produced by processing, so that the location of the edge can be detected similar to the real edge. And lastly, one response to single edge that can produce a single edge, not giving false edges[11].

Hough Transformation was first introduced by Paul Hough in 1962 to detect straight lines. Hough Transform is an image transformation technique that can be used to isolate or otherwise obtain features from an image[12]. Since the goal of a transformation is to obtain a more specific feature, the Classical Hough Transform is the most commonly used technique for detecting curve-shaped objects such as lines, circles, ellipses and parabolas. The main advantage of the Hough transform is that it can detect an edge with a gap at the feature boundary and is relatively unaffected by noise[13].

The results of research conducted by Ardian E. Rumetra, et al (2023), on Segmentation on Vehicle Plates Using Canny Edge Detection and Thresholding Methods, Vehicle plate segmentation is carried out to compare two different methods that have advantages and disadvantages in each method. From the test results that have been carried out using the canny edge detection method and thresholding with the amount of data tested as many as 100 images. The result is that the canny edge detection method is slightly superior in the accuracy rate which is exactly 90 for the canny edge detection method and 85 for the thresholding method [14].

The results of research conducted by Damar Wicaksono (2024), on "Comparative Analysis of Image Pre-Processing Methods for Canny Edge Detection on Images of Various Road Conditions using the Python Programming Language", it is known that from the test results that the application of the Canny Edge Detection method with pre-processing using median blur is an effective approach in road marking detection on highway images. This method is able to produce accurate and optimal edge detection, which can be the basis for the development of automatic road marking detection systems on highways. The findings can contribute to the improvement of motorist safety and navigation as well as the development of more accurate and effective edge detection technologies on road markings [9].

The results of research conducted by Riki Winanjaya, et al (2022), on "Application of the Sobel and Canny (SoCan) Algorithm Combination in Identifying Albatross Laysan Inversion Image", it is known that based on the analysis of 10 experiments that have been carried out, the combination of the Sobel and Canny (SoCan) algorithms is not good at doing edge detection, because it only has an average accuracy of 47.79% with an error rate of 52.21%. Thus it can be concluded that for this case, the combination of the Sobel and Canny (SoCan) algorithms is not able to identify the Inversion Image [8].

By utilizing the Canny method, it will be possible to detect vehicle plates in the Tanjungbalai City Government Mess. And with the various descriptions that have been conveyed above, researchers will

conduct research as well as fulfill the final project with the title "Application of the Canny Method to Detect Vehicle Plates in the Tanjung Balai City Government Mess Area".

2. MATERIAL AND METHOD

2.1. Image Processing

Image processing is the processing of images, especially using computers, into better quality images. The main purpose of image processing is to make disturbed images easy to interpret by people and machines (computers). Digital image processing techniques are transforming two-dimensional images into other images using computers [4]. Image segmentation refers to the technique of fracturing a digital image as multiple segments meaning that pixels are positioned, pixels in an identical portion and dependent on some homogeneous state color, intensity or texture, to monitor and distinguish image artifacts [15].

This process is characterized by input data and output information in the form of images. So the input is an image and the output is also an image, with better quality than the input image. Some examples of image processing operations are changing image contrast, removing noise with filtering, sharpening, pseudocoloring, and so on [16]. These operations will be applied to image processing when:

1. Used to improve the quality of appearance or highlight some aspects of the information contained in the image by image enhancement or modification.
2. Need to group, match or measure elements in the image.
3. Need to merge part of the image with other parts of the image.

Data processing can be done by vb, either a microprocessor-based computer or a mainframe computer, depending on the amount of data and the type of processing [17]. The data display process is one of the important aspects because after all, the processed digital image must be able to be assessed by the eyes of people through a display. The viewer used is usually a graphic monitor or a graphic printer/plotter.The convolution of the image function with the gaussian operator and its derivatives can only be done by the canny detection algorithm [14].The first derivative of the image function convolved with the gaussian function:

$$g(x,y) = D[gauss(x,y) * f(x,y)] \quad (1)$$

Therefore, the level of smoothness and edge detection is possible to combine into a convolution in one dimension with two different directions (vertical and horizontal)

2.2. Canny Method

Canny method is one of the commonly used methods in image processing for edge detection [18] To perform a manual calculation of the Canny method on an image, we will follow more detailed steps with the following 3x3 example image with pixel intensity values:

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 255 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Edge detection is a vital part in image processing to detect the desired object. Edge detection is to extract the desired information and filter out unwanted information in object detection and further classification. Edge detection recognizesand finds sharp discontinuities and variations in an image [19].

The Canny operator is an optimal edge detector that uses a grayscale image as the input and produces an output image showing the positions of edges tracked by the discontinuousness of the intensity. The Canny detector is applied here because it satisfies three criteria: a low error rate, edge localization, and displaying one response to a single image. In this algorithm optimal defining edge is detected based on some criteria which include finding edges by minimizing error rate, making edges closely to the actual edges to maximize location and marking edges only once when a single edge exists for minimal response.

The initial stage carried out in this research is research planning. This research was conducted by applying the Canny method to detect vehicle plates in the Tanjung Balai City Government Mess Area. The process of collecting data samples in the form of 10 images.

2.3 Flowchart Methodology

The method was used in research activities as following:

1. Literature study
   The research begins with an understanding of the material against previous research methods and through several literature reviews, and collecting information from several journals related to the topic.

2. Sample collection
   The collection of samples as data to be used in the program is in the form of a signature image that is scanned using a scanner or printer. It can be seen in Figure 1 the stages of image processing process.

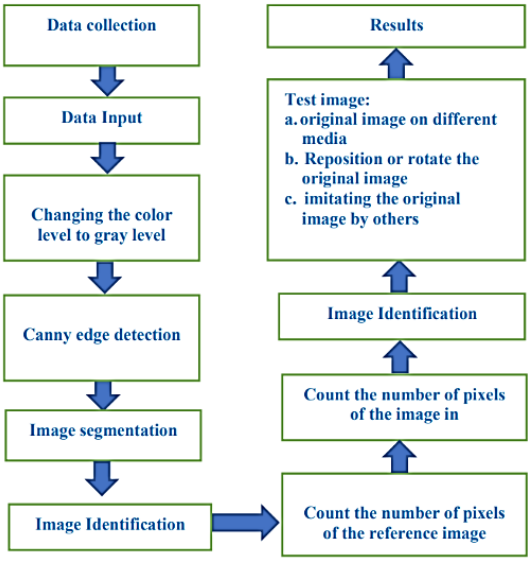


Figure 1. Stages of Image ProcessingProcess

3. Implementation after the image was available
   The canny edge detection algorithm was implemented using Matlab software. In Matlab, the syntax was made according to the algorithmic process. So, the signature can be identified. In the syntax, a database process was carried out, which would produce information on the similarity level of the signature image when the testing process was carried out.

3. RESULTS AND ANALYSIS

In this section, it is explained the results of research and at the same time is given the comprehensive discussion. Results can be presented in figures, graphs, tables and others that make the reader understand easily [2], [5]. The discussion can be made in several sub-chapters.The acquired data will go through a series of processing stages to detect edges using the Canny method. Each of these stages is important to ensure accurate and reliable results in edge detection.

The first step is to convert the original image into a grayscale image. This process simplifies the image data by reducing the color information, so that only the light intensity is considered. The grayscale image is the necessary basis for the next steps in the analysis.Once the image has been converted to grayscale, the next step is to apply a Gaussian filter. This process aims to smoothen the image and reduce any noise that may be present. By applying a Gaussian filter, small insignificant details can be removed, while the main structure of the image is preserved.The third stage is to calculate the gradient magnitude image. At this stage, the change in light intensity along the image is calculated to identify areas with significant changes. This gradient magnitude image highlights potential edges in the image that will be processed further [20].

The next step is the application of non-maximum suppression. This process aims to thin out the edges by retaining only the pixels that have the largest gradient value along the gradient direction. The result is an image with clearer and well-defined edges.After that, a double thresholding technique is applied. In this stage, two threshold values are used to classify edges as strong, weak, or insignificant. Edges that have a value above the high threshold will be considered strong and retained, while edges below the low threshold will be ignored. Edges that fall between these two thresholds will only be retained if they are connected to a strong edge.The last stage is to generate an edge image using the Canny method. The end result of this process is an image with accurately detected edges, ready to be used for further analysis or specific

applications such as car plate detection. The Canny method ensures that significant edges are retained, providing reliable and accurate results in various image processing applications.

3.1. Representation of Data

In this research, the author uses 10 car license plate images as test data for the edge detection process using the Canny method. Each image undergoes a series of systematic processing stages to ensure accurate and consistent edge detection results.The samples used in this study consist of images of car vehicles taken in the Tanjung Balai mess area. These images were acquired using a mobile phone camera, ensuring that the data collected reflects real conditions and a wide variety of lighting and environmental variations. Each image will then go through an edge detection process using the Canny method to evaluate the effectiveness of the algorithm under realistic and diverse conditions.

The following is a set of car license plate images that will be tested for edge detection using the Canny method. Each image will go through a series of processing stages to detect edges with high accuracy.

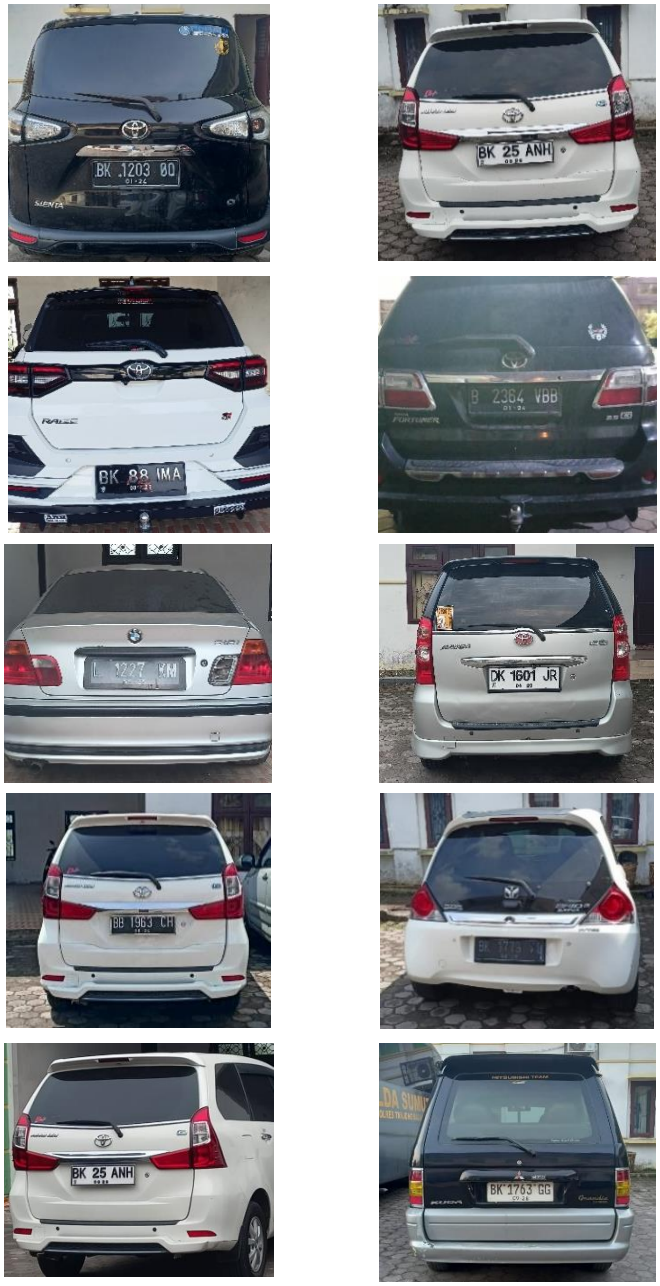


Figure 2. Data Sample

The first step is to crop the images obtained from the mess to a size of 500 x 900 pixels. Can be seen in Figure 3.

Figure 3. Cropped Image

The next thing to do is to convert the color images into grayscale images. This process is important for simplifies image data by removing color information, so that only light intensity is considered.Next, the grayscale image is smoothed using a Gaussian filter. The application of this filter aims to reduce noise and small insignificant details in the image. The result of this stage is a smoother image, with reduced noise, making it easier to identify clear edges in the next step. As seen in the following Figure 4.

Figure 4. Gaussian Filtered Image

It involves computing the gradient magnitude for each image. At this stage, the change in light intensity along the image is calculated to identify areas with significant changes, which usually indicates the presence of edges. This gradient magnitude image highlights potential edges in each car plate image. As seen in the following Figure 5.

Figure 5. Gradient Magnitude Image

The process continues with the application of non-maximum suppression. This step aims to thin out the edges by retaining only the pixels that have the largest gradient value along the gradient direction. The result is an image with clearer and well-defined edges, which is important for further edge analysis.

After that, a double thresholding technique is performed. At this stage, two threshold values are used to classify edges as strong, weak, or insignificant. Edges that have a value above the high threshold are considered strong and retained, while edges below the low threshold are ignored. The edge between these two thresholds is only retained if it is connected to a strong edge. This can be seen in Figure 6 below.

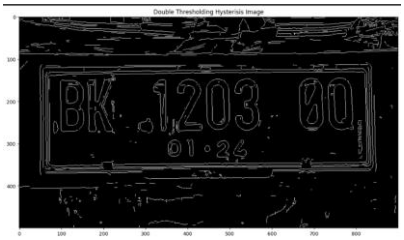


Figure 6. Double Thresholding Hysterisis Image

The final stage is to generate a Canny edge image. The end result of this process is an image with edges that have been accurately detected on each license plate image. The Canny method ensures that significant edges are retained, providing reliable and accurate results. It can be seen in the following Figure 7.

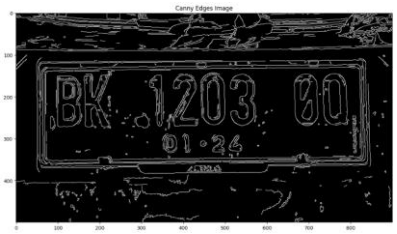


Figure 7. Canny Edges Image

Each step in the data processing process was documented visually and numerically. The result images of each stage are presented to provide a clear picture of how the Canny method works on each car license plate image. In addition, basic statistics such as the total number of detected edges, average edge length, and edge orientation distribution are presented to provide a more in-depth analysis. This comprehensive data representation ensures that the research results can be well understood and objectively evaluated.

3.2. Canny Edge

1. Gaussian Blur
   Reduces noise in the image, using kernel (5,5) and sigma 1,4.

2. Gradient calculation
   Suppose the result of the Sobel filter application gives the following gradient value:
   grad_x:

$$\begin{bmatrix} 10 & 20 & 10 \\ 30 & 40 & 30 \\ 10 & 20 & 10 \end{bmatrix}$$

   grad_y:

$$\begin{bmatrix} 10 & 30 & 10 \\ 20 & 40 & 20 \\ 10 & 30 & 10 \end{bmatrix}$$

3. Gradient Magnitude and Direction
   We calculate the gradient magnitude for each pixel. For example, for the center (2nd row, 2nd column):
   Grad_x = 40
   Grad_y = 40

$$magnitudo = \sqrt{(grad\_x)^2 + (grad\_y)^2}$$
$$magnitudo = \sqrt{40^2 + (40)^2}$$
$$magnitudo = \sqrt{1600 + 1600}$$
$$magnitudo = \sqrt{3200} = 56{,}57$$

   After calculating the magnitude for all pixels, we get the maximum value of the gradient magnitude. Suppose the maximum value we get is 56.57.

$$gradient\_magnitude\_normalized = \frac{56{,}57}{56{,}57} \times 255 = 255$$

   This shows that the maximum magnitude value before normalization has been normalized to 255.

4. Non-Maximum Suppression
   Suppresses values that are not local maxima along the gradient direction.

5. Double Threshold

$$\begin{bmatrix} 10 & 20 & 10 \\ 30 & 255 & 30 \\ 10 & 20 & 10 \end{bmatrix}$$

LowThreshold = 50
High Threshold = 100
Let's apply hysteresis thresholding manually to this matrix.

6. Hysteresis
Pixels that do not meet the above criteria are considered non-edge (zero_pixel).

$$\begin{bmatrix} 10 & 20 & 10 \\ 30 & 255 & 30 \\ 10 & 20 & 10 \end{bmatrix}$$

Pixels (2,2) = 255 (Strong edge)
Other pixels = Non-edge because < lowThreshold
After classification:

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 255 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

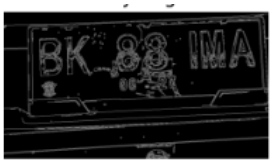
We only count pixels with a value of 255 (strong edges).
Number of edge pixels = 1

3.3. Result

In this section, the author will display the number of pixels detected as edges using the Canny edge detection method. With this method, each pixel in the image is evaluated to determine whether it is part of an edge based on its intensity gradient. These detection results provide important information about the edge features in the image, which is very useful in various applications such as object recognition and image analysis.

Table 1. Canny Edge Testing Results

Original Image	Crop the original image	Canny edge	Pixel
			32266
			23710

Original Image	Crop the original image	Canny edge	Pixel
			29859
			4765
			26730
			22016
			3131
			1945
			2581

Original Image	Crop the original image	Canny edge	Pixel
			2658

Table 1 presents data on the number of pixels that were successfully detected as edges using the Canny method. In this table, each value represents the number of pixels that have been identified as part of the image edge after the detection process is performed. This information is important to understand the extent to which the Canny method is effective in capturing the edge details of the various images tested. By looking at the number of pixels detected, we can evaluate the performance of the Canny algorithm in different contexts, as well as compare it with other edge detection methods. This table is a useful reference in analyzing the results and making decisions in further development. Edge detection using the Canny operator on digital images of license plates is successfully carried out with up to 100% conformity identification. For the identification of the test image with the original image that has been altered or rotated, it will be identified with a range of 99.88%-100%, meaning that the input license plate number matches the resulting output. With this method, the license plate becomes easier to read because relevant edge details are strengthened, while noise or other distractions that are not related to the license plate are removed or converted to black color. As a result, the resulting image focuses more on the important information of the license plate, reduces distraction from unnecessary elements, and improves accuracy in automatic license plate reading or recognition.

4. CONCLUSION

Edge detection using the Canny operator on digital images of license plates is successfully performed, resulting in images with clear and sharp edges. With this method, the license plate becomes easier to read as relevant edge details are strengthened, while noise or other distractions unrelated to the license plate are removed or converted to black color. As a result, the resulting image focuses more on the important information of the license plate, reduces distraction from unnecessary elements, and improves accuracy in automatic license plate reading or recognition. This technique is particularly effective for applications that require accurate visual identification of license plates under various lighting and image quality conditions.Research on edge detection in images is far from perfect, thus requiring further development to improve the quality of the information produced and its usability. Challenges such as poor lighting, noise, and low resolution need to be addressed through innovation and research that is more adaptive and robust so that edge detection results are more accurate and consistent.

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