DETECTION OF VEHICLE NUMBER PLATE USING PROBABILISTIC HOUGH TRANSFORM

Purnama Sari Nur Mellinda[1], Febryanti Sthevanie, S.T., M.T.[2], Kurniawan Nur Ramadhani, S.T., M.T.[3]

[1,2,3]Faculty of Informatics, Telkom University, Bandung
[1]lindapurnama@students.telkomuniversity.ac.id, [2]sthevanie@telkomuniversity.ac.id,
[3]kurniawannr@telkomuniversity.ac.id

Abstract

Detection of the position of a vehicle number plate is an effort to take advantage of technological developments. Many benefits can be obtained when detecting the position of a vehicle license plate. There are various kinds of algorithms that can be used for plate detection, namely based on texture, edge detection, histogram, morphological processing, and transformation. This thesis will detect vehicle number plate using the Probabilistic Hough Transform method for finding the lines of the plate, and bounding rectangle to extract the plate boundary lines. This research used 42 samples, with 32 data successfully detected, and 10 undetected images so that an accuracy of 76.2% was obtained.

Keywords: Vehicle number, Probabilistic Hough Transform (PHT), bounding rectangle

1. Introduction

1.1 Background

According to bps.go.id, every year the growth of motor vehicle users in Indonesia increases exponentially. Due to population growth and their needs, position detection of vehicle plate number plays an important role in the transportation system, such as speed control, stolen car identification, toll gate transactions [2].

Vehicle number plate in Indonesia there are 8 types of colors that have different meanings [3], but generally used, there are 4 types of plates, such as private vehicle number plate (black), public transport vehicle number plate (yellow), government-owned vehicle number plate (red), and Transportation Dealer vehicle number plate (white) [4].

Because each country has different shapes, colors, and characteristics on the plates. Thus, there are various algorithms that have been applied for plate detection, namely based on texture, edge detection, histogram, morphological processing, and transformation [5]. In paper [6] for plate position detection process was performed using edge detection and there were 25 images detected so as to obtain 72% accuracy. in 2015, there are same paper using morphological processing and get 80% [7]. Another paper still was conducted in 2015 by using Hough Transform for license plate location number on the digital image of the vehicle have an accuracy 90% [8].

Based on paper [9] written one of the major obstacles is that the complexity of the method is largely dependent on the size of the input data, thus consuming computation time. So the paper suggests an alternative approach to fast Hough Transform computation using Probabilistic Hough Transform. Probabilistic Hough Transform works, takes small subset of the edge points in the image, selected at random [10]. Another paper [11] said that Probabilistic Hough Transform for line detection method gives higher line detection rate, at the expense of moderate execution time acceptable.

And, an extraction method is needed to identify the boundaries of an object. In order to obtain more accurate results, the boundaries of the number plate area in an image are highlighted, identify of the rectangles in the image that is attempted [12]. Based on paper [13] there is a simple method to the closed the region by using a bounding rectangle, and the result shows that the approach is accurate and fast.

So, based on the problem above the author suggest using Probabilistic Hough Transform (PHT) which is used for finding the lines of the plate, and Bounding Rectangle is used to extract the plate boundary lines.

1.2 Scope of Problem

To avoid misunderstanding and broad thinking in terms of opinions regarding this thesis then the authors provide the following restrictions:

1. The dataset used was retrieved manually by the author.
2. This thesis only detects the position.
3. The dataset used is an image of a private car (black plate) used in Indonesia, in accordance with the rules that have valid in Indonesia.

4. The Resolution of the image with width = 4000px.
5. The dataset used the .JPG format.

1.3 Purpose

How to do Detection of Vehicle Number Plate Using Probabilistic Hough Transform ?

1.4 Goal

The goal of this thesis is to implement the Probabilistic Probabilistic Hough Transform methods for detection of vehicle number plate.

2. Literature Review

Supporting theories used in the thesis of position detection of vehicle number plate system are as follows:

2.1 Vehicle Number Plate Spesification

A vehicle number plate is a form of vehicle identity, and every country has a different specification. In Indonesia, itself has a physical form in the form of an aluminum plate sheet and has an arrangement of letters and numbers. Two-wheeled and three-wheeled vehicles have a plate size with 275 millimeters of height and 110 millimeters of width, while four or more wheeled vehicles are 430 millimeters of height and 135 millimeters of width. There is a white line around the plate to define the plate area. Official vehicle number plates are issued by the Samsat office [9]. The dataset that is going to be used is a private car (black plate). The main advantages are the vehicle number plates are having very high contrast white areas in their edges with black background.

Figure 2.1 Vehicle Number Plate for 4 or More Wheeled

Figure 2.2 Vehicle Number Plate for 2 and 3 wheeled

Explanation:

a = Private Car (Black Plate)

b = White Trim/line around the plate

2.2 Canny Edge Detector

Edge detection aims to improve the appearance of edges on the image. An object can be easily detected in an image if the object is sufficiently contrasted from its background [15]. The method used for edge detection is the Canny method. The result of this edge detection process is a binary image (black and white), where the white color shows the border. Canny has an optimal algorithm for edge detection, such as a low error rate, the points on the edges are allocated correctly, and only one response (1-pixel width) for each edge [15].

2.3 Probabilistic Hough Transform Method

Hough Transform is a well known as method to detecting linear structure [10] or find in images shapes. This is how Hough Transform line works:

generally, every point (x0, y0), the type of line passing through this point can be defined as equation (1), as follows:

$$r_\theta = x_0 . \cos\theta + y_0 \sin\theta \quad (1)$$

that means every pair (r θ, θ) shows every line that is get through (x0, y0). The Probabilistic Hough Transform is an optimization of Hough Transform. Probabilistic Hough Transform gives the extreme output of the detected line (x0, y0, x1, y1), It doesn't take all the points into consideration, instead, take only a random subset of points in Hough Transform calculation [11]. The algorithms of Probabilistic Hough Transform (PHT) is independent of the size, shape [12]. The Hough Probabilistic Transform (PHT) provides more flexibility and takes time in determining parameters to obtain the desired results to get accurate accuracy.

2.4 Bounding Rectangle

Bounding rectangle is one of the contour features. Contours can be explained simply as a curve joining all the continuous points (along the boundary) [13]. In OpenCV, finding contours is like finding white object from black background, so object to be found should be white and background should be back [13]. Bounding rectangle is the smallest enclosing rectangle of an object aligned to a set of axis. It is represented by 4 parameters corresponding to the (x,y) coordinates in space that defined the lower left and upper right vertices of its parameter, [16], and the computation begins with the finding the boundary points for each region, by define the minimum every point in the region [17]. Whereas the object the minimum bounding box represents may be many orders of magnitude more complex [16].

3. Built Systems

3.1. System Overview

This section explains how the main system works, is shown in Figure 3.1 illustrates the block diagram of the proposed system.

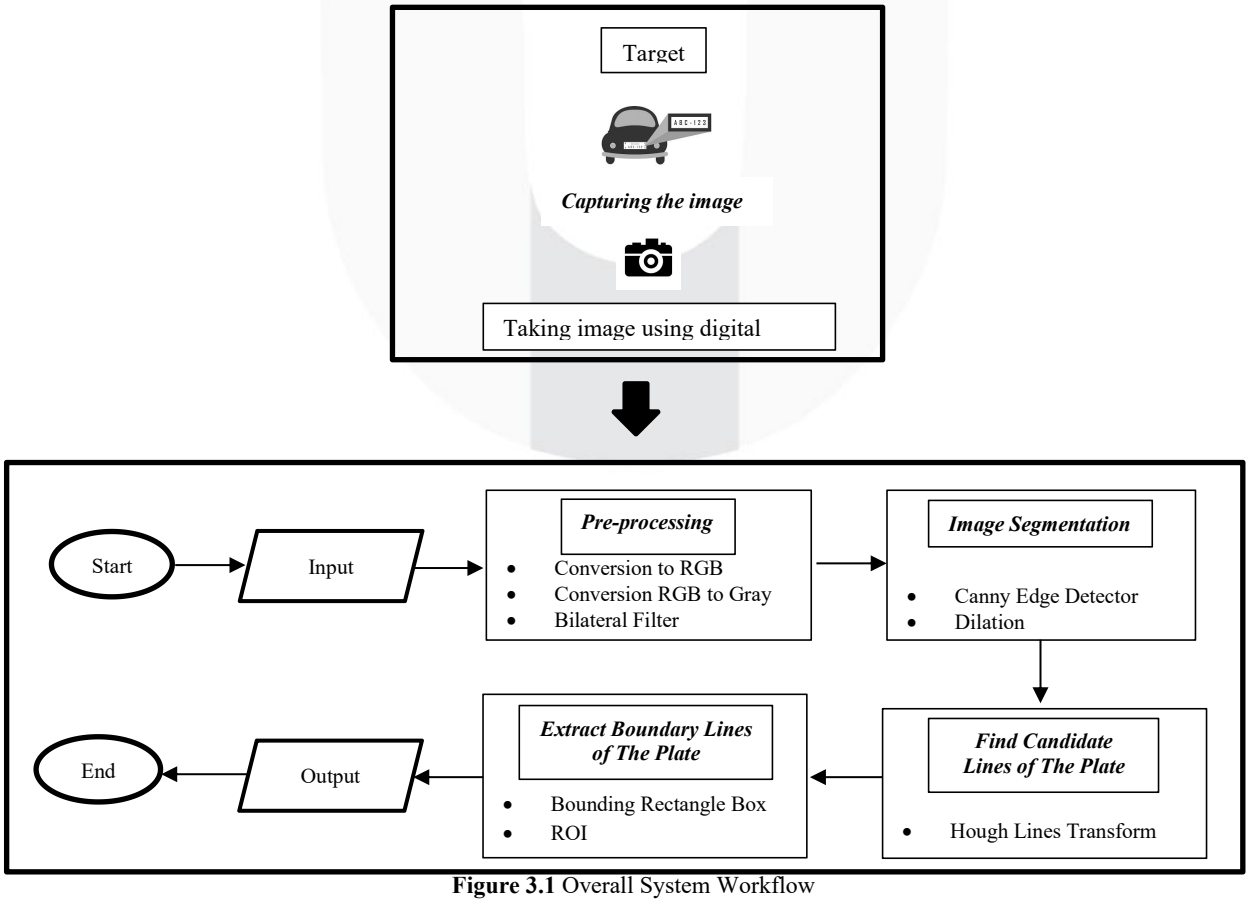


Figure 3.1 Overall System Workflow

These steps are further explained in the following subsections.

3.2. Data Collection

Data collection is done by taking pictures in the author's residential area, in daylight and cloudy conditions. The number of datasets used is 42 images with 21 for train data and 21 for test data, taken using a digital camera. each image has a size resolution width = 4000px. Python 3 and OpenCV are used to implement the system.

3.3. Pre-Processing

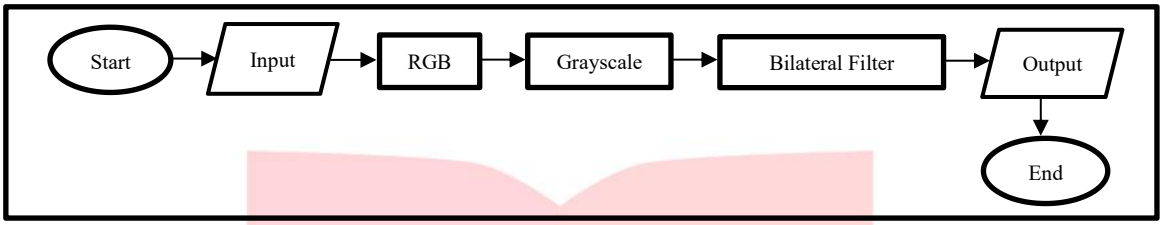


Figure 3.3 Pre-Processing

The purpose of the image pre-processing process is to eliminate features that are not needed by the system by manipulating the parameters of the image. In openCV uses BGR as its default colour order for images, matplotlib uses RGB. So, when the image showed it will loaded with OpenCv in matplotlib the channels will be back to front (BGR). So, the first step is convert it to RGB, after that convert the RGB image to the grayscale, last step is smoothed the area of the grayscale image to reduce noise using bilateral filters.

3.4. Image Segmentation

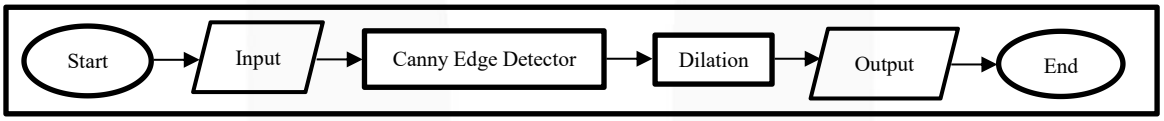


Figure 3.4 Image Segmentation

Canny Edge Detector is used to detect the lines that compose the object image. The purpose of this detection is so that objects in the image can be recognized and simplified from various forms. to clarify the required part, a dilation operation is needed. Dilation adding pixels to the boundaries between objects in a digital image to make the image look clear.

3.5. Finding the Lines of the Plate (Probabilistic Hough Transform Method)

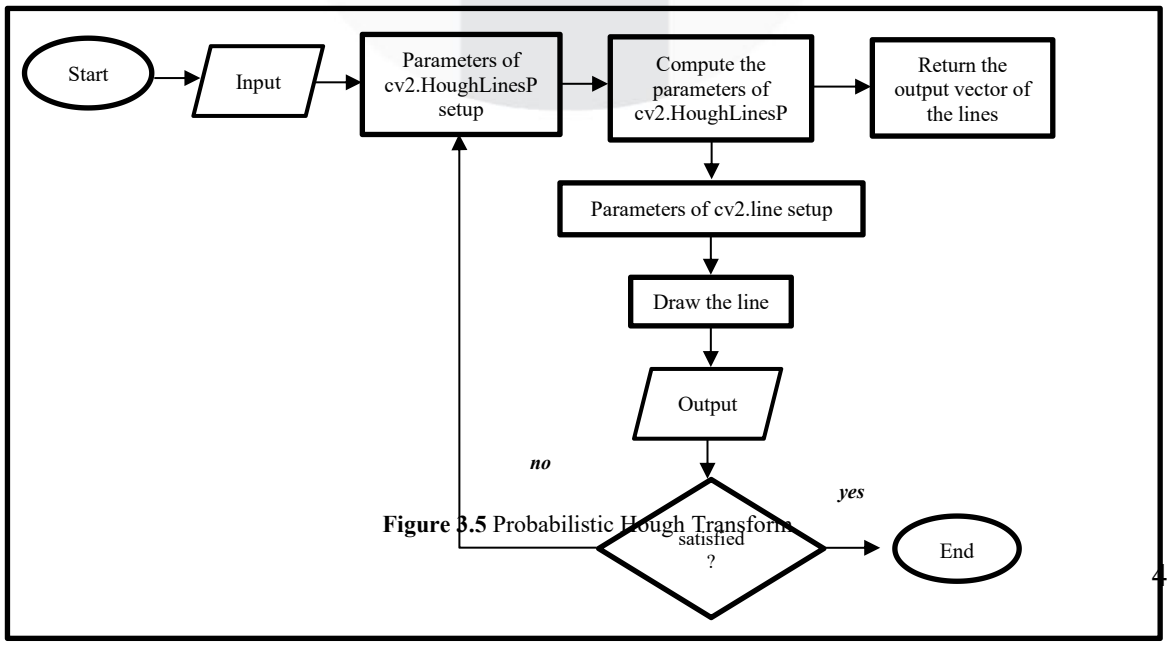


Figure 3.5 Probabilistic Hough Transform

A position search is performed to find the line that is the plate candidate in image segmentation.First, we need to set the parameters of cv2.HoughLinesP, and then the parameters will process and gives 4 values(leftx, boty, rightx, topy). Which are the two points will be able to draw the line using the cv2.line method. To draw the line we need to set the parameters for the cv2.line, Parameters contained in Hough Probabilistic Transform (PHT) consist of:

1. rho = Distance resolution parameter ρ in pixels.
2. theta = Angle resolution parameter θ in radians.
3. threshold = The minimum number of intersecting points to detect a line.
4. minimum line length = Minimum length of line. Line segments shorter than this are rejected.
5. maximum line gap = Maximum allowed gap between line segments to treat them as single line.

And then showing the image. If the result not satisfied go back to the set parameters of cv2.HoughLinesP, otherwise process is done.

3.6. Extract The Plate Boundary Lines (Bounding Rectangle)

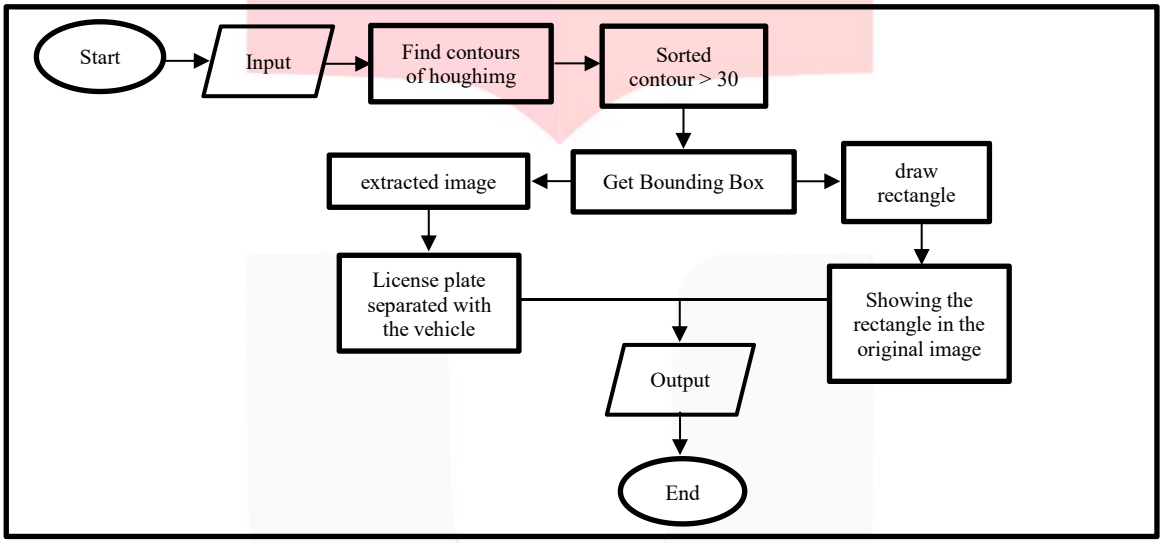


Figure 3.6 Bounding Rectangle

To extract vehicle number plates, a methodology based on bounding rectangle is presented. This method will works, to detect the number plate by detecting a rectangle-shaped contour to separate the license plate with the vehicle. So, for execute everything, we start off by using the bigger contour by using image from the output of Probabilistic Hough Transform. Second, we need to sorting them in the order of their area size, from largest to smallest, by calculating the area of the contour using cv2.contourArea ,and keeping the minimum required area as '30' (anything smaller than this will not be considered) third, finding bounding rectangle of the sorted contour. The original image will be saved in ROI containing the delimiting rectangles that have been detected. Fourth, extract the ROI. Otherwise, it displays a bounding rectangle using the cv2.rectangle method on the original image and process is done.

4. Evaluation

In this research, the detection rate measurement method was based on a plate in good condition, with a white line on the edge. The number of errors can be caused by internal factors such as the condition of the plate itself, external factors such as firing position, if it is too high and the white line on the edge of the plate is not clear it can be damaged, and the system is also sensitive if there is a white area, even though the plate will not appear a bounding box, so that the pre-processing method affects the results.

4.1. Test Results

Figure 4.1 shows the qualitative results of pre-processing before plate number extraction. figure 4.1a shows the original RGB captured image. Figure 4.1b shows the RGB image converted to grayscale and figure 4.1c shows the detected edges in the image using Canny edge detector. Figure 4.1d shows structure element of Dilation enlarges the edges. Figure 4.1e shows the image that has transformed in the hough space, and figure 4.1f shows bounding rectangle box based on detected candidate vehicle number plate edges from hough transform. figure 4.1g shows the extracted vehicle number plate area of interest.

(a) Original RGB mage

(b) Grayscale image

(c) Canny edge detection image

(d) Dilate image

(e) Hough Transform image

(f) Bounding rectangle image

(g) Cropped vehicle number plate

Figure 4.1 Results of Overall System Workflow

No.	Name of Test Image	Original Image	Output	Status
1	data26.JPG			Success
2	data17.JPG		-	Failed. Because the plate doesn't have white trim on the plate area. there are no edges at an angle so it is difficult to form a rectangle.
3	data11.JPG			success
6	data36.JPG			failed. Because the vehicle number plate was bent. Failed to find the angle that formed the rectangle.

Table 4.1 Results of Each Image

4.2. Analysis of the test results

After testing all datasets, the next step is to find the accuracy of the results from the Probabilistic Hough Transform method. This will be calculated using the following formula:

$$\text{Accuracy} = \frac{\textit{total successful data}}{\textit{total overall data}} \times 100\ \%$$

The results of this study with a total sample of 42 images, found success in using this method, as many as:

Succeeded	Failed
32	10

Table 4.2 Test Results Data

Then the accuracy level can be calculated as follows:

$$\text{Accuracy} = \frac{32}{42} \times 100\ \% = \mathbf{76.2\ \%}$$

5. Conclusion

In summary, research that has been conducted on the image of a personal vehicle number plate using Probabilistic Hough Transform for finding lines of the plates, as follows:

1. There are still some images that fail. due to the condition of the plate itself, so it is sensitive to do the detect position.
2. it's difficult to do position detection with a plate with not clear or doesn't have white trim in their area.
3. This thesis obtains an accuracy of 76.2%, with a total of 32 successful and 10 failed data.

References

[1]. Badan Pusat Statistik. Perkembangan Jumlah Kendaraan Bermotor Menurut Jenis, 1949-2018. https://www.bps.go.id/linkTableDinamis/view/id/1133 (accessed June 7th, 2020)

[2]. Babu, K & Raghunadh, M. (2016). Vehicle number plate detection and recognition using bounding box method. 106-110. 10.1109/ICACCCT.2016.7831610.

[3]. Priandini, Dwi & Nangi, Jumadil & Muchtar, Mutmainnah & Sari, Jayanti Yusmah. (2018). DETEKSI AREA PLAT MOBIL MENGGUNAKAN OPERASI MORFOLOGI CITRA.

[4]. Bachtiar, Mochamad Mobed & Wasista, Sigit & Hidayatulloh, Mukhammad. (2018). Segmentation Plate and Number Vehicle using Integral Projection. Jurnal INFORM. 3. 10.25139/ojsinf.v3i1.633.

[5]. Sanap, P. & Narote, Sandipan. (2010). License Plate Recognition System-Survey. AIP Conference Proceedings. 1324. 255-260. 10.1063/1.3526208.

[6]. Wicaksana, Riza & Komputer, Teknik & Telematika, Dan & Teknik, Jurusan & Insitut, Elektro & Sepuluh, Teknologi & Suarabaya, Nopember. (2020). Pengenalan Plat Nomor Kendaraan Secara Otomatis Untuk Pelanggaran Lalu Lintas.

[7]. Guo, Si-Yu & Kong, Ya-Guang & Tang, Qiu & Zhang, Fan. (2008). Probabilistic Hough transform for line detection utilizing surround suppression. Proceedings of the 7th International Conference on Machine Learning and Cybernetics, ICMLC. 5. 2993 - 2998. 10.1109/ICMLC.2008.4620920.

[8]. Khin, Ohnmar & Phothisonothai, Montri & Choomchuay, Somsak. (2018). License Plate Identification from Myanmar Vehicle Images under Different Environmental Conditions. Sensors and Materials. 30. 2247. 10.18494/SAM.2018.1852.

[9]. Pemayun, I & Setiawan, Widyadi & Er, Ngurah. (2015). ANALISIS SISTEM PENDETEKSI POSISI PLAT KENDARAAN DARI CITRA KENDARAAN. Jurnal Ilmiah SPEKTRUM. 2. 61-67.

[10]. Jung, Claudio & Schramm, Rodrigo. (2004). Rectangle Detection based on a Windowed Hough Transform.. Brazilian Symposium of Computer Graphic and Image Processing. 113-120. 10.1109/SIBGRA.2004.1352951.

[11]. Kälviäinen, Heikki & Hirvonen, Petri & Xu, Lei & Oja, Erkki. (2006). Comparisons of probabilistic and non-probabilistic hough transforms. 10.1007/BFb0028367.

[12]. Shehata, Allam & Mohammad, Sherien & Abdallah, Mohamed & Ragab, Mohammad. (2015). A Survey on Hough Transform, Theory, Techniques and Applications.

[13]. Chaudhuri, D. & Samal, A.. (2007). A simple method for fitting of bounding rectangle to closed regions. Pattern Recognition. 40. 1981-1989. 10.1016/j.patcog.2006.08.003.

[14]. Hatekar, Prof & Manwani, Saurabh & Patil, Gaurav & Parekh, Akshat. (2017). Fire Detection on a Surveillance System using Image Processing. International Journal of Engineering Research and. V6. 10.17577/IJERTV6IS050094.
[15]. George, M., & Lakshmi, C. (2013). Object Detection using the Canny Edge Detector.
[16]. Rye, Esten. (2020). MINIMUM BOUNDING BOX (MBB).
[17]. Chaudhuri, D. & Samal, A.. (2007). A simple method for fitting of bounding rectangle to closed regions. Pattern Recognition. 40. 1981-1989. 10.1016/j.patcog.2006.08.003.

Attachment

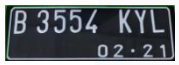
Attachment 1. Taking Datasets

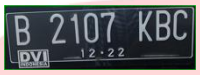
Attachment 2. Datasets

Attachment 3. Pre-processing

Attachment 4. Segmentation

Attachment 5. Probabilistic Hough Transform

Name of File(.JPG)	Cropped Data	Name of File (.JPG)	Cropped Data
data1		data22	
data2		data23	
data3		data24	
data4		data25	failed
data5		data26	
data6		data27	
data7		data28	
data8		data29	
data9	failed	data30	
data10	failed	data31	failed
data11		data32	
data12		data33	failed
data13		data34	failed
data14	failed	data35	
data15		data36	failed

data16		data37	
data17	failed	data38	
data18	failed	data39	
data19		data40	
data20	failed	data41	
data21		data42	

Attachment 5. Cropped