



Design and Build a Prototype Unmanned Car Based on Road Markings with the Line Detection Method

Luqman Hardianto ^{a,1,*}, Miftachul Ulum ^{a,2}, Achmad Fiqhi Ibadillah ^{a,3}

^a Electrical Engineering, Universitas Trunojoyo Madura, Jl. Raya Telang, Bangkalan 69162, Indonesia

¹ 140431100001@student.trunojoyo.ac.id ^{*}; ² Miftachul.ulum@trunojoyo.ac.id; ³ Fiqhi.ibadillah@trunojoyo.ac.id

^{*} corresponding author

ABSTRACT

Keywords

Automatic self
driving car
computer vision
hough transform

Safety is a necessity in any case, as is driving. Many motorists today ignore safety in driving. Based on this innovation is needed in driving safety, automatic steering cars can be one of the driving safety solutions. This is because the automatic steering car uses a technological approach from various aspects ranging from deep learning, computer vision, sensor fusion, localization, control, unit path planning. In this discussion, the implementation of the line detection algorithm uses the hough transform and power steering methods. The results of the application of this method require a method to recognize the road markings with other things that are symmetrical in shape like a line, can be a shadow of a pole, a road divider, and so forth. Because the parameters of this method can only be used in ideal conditions. The overall application of this method successfully detects road markings with an accuracy of 75%.

1. Introduction

Safety is something that is needed in any case, as well as driving. many riders today ignore the safety of driving, this is supported by data from the Central Statistics Agency in 2016. Korps Lalu Lintas Kepolisian Republik Indonesia (Korlantas POLRI) recorded the number of accidents throughout 2016 as many as 106,129 incidents with 26,185 fatalities. This number is an increase of 7.23 percent compared to 2015 with 98,970 incidents[1]. Based on this, it is necessary to have innovation in the world of driving safety.

Automatic steering cars can be one of the driving safety solutions. This is because the automatic steering car uses a technological approach from various aspects ranging from deep learning, computer vision, sensor fusion, localization, control, unit path planning[2].

In this study, the input on an automatic steering car is in the form of real time video taken using a camera mounted on top of the vehicle. Image processing methods to detect road markings are a combination of canny edge detection and hough transform. The results of image processing are sent to the microcontroller to control the motor.

2. The Proposed Method/Algorithm

2.1. Camera

In the world of robotics, the camera has the role of a robot eye. with a camera, the robot is able to see like a human. To make the camera able to recognize objects, a digital image processing algorithm is needed.

2.2. Raspberry pi 3B

In this study, the Raspberry Pi 3B becomes a computer unit that can perform image processing. The image from the camera will be analyzed by Raspberry Pi with the Open CV library using the Python programming language[3].



2.3. Arduino

Arduino is an electric board that uses certain types of microcontroller. Arduino is a hardware output from Arduino Italy, one of which is Arduino Uno, which is one of Arduino which is very common or very widely used to design automatic devices that need to microcontroller[4].

2.4. Driver motor

The motor driver is a device that functions to control the speed and direction of rotation of the DC motor. The motor driver used consists of a 4 channel relay device and a pair of 250N IRF mosfets. relay functions to change the direction of rotation of the DC motor. mosfet functions to control the speed of a DC motor [5].

2.5. Motor

as a driving force for the robot to run a pair of DC motors is used. the advantage of a dc motor is that it is very easy to control the speed and direction of rotation of the motor[3].

3. Method

3.1. Hardware Design

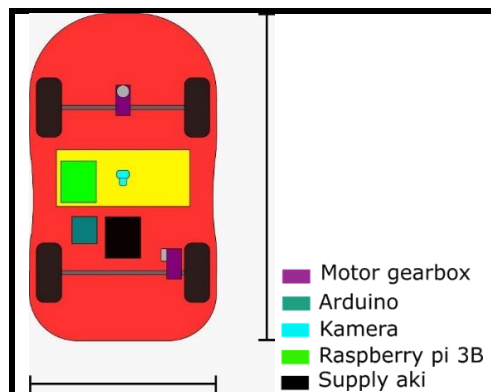


Fig. 1. Hardware design

Hardware design is very important in the construction of tools, because at this stage there is an electrical circuit in order to reduce errors on the device.

3.2. Electrical Device Design

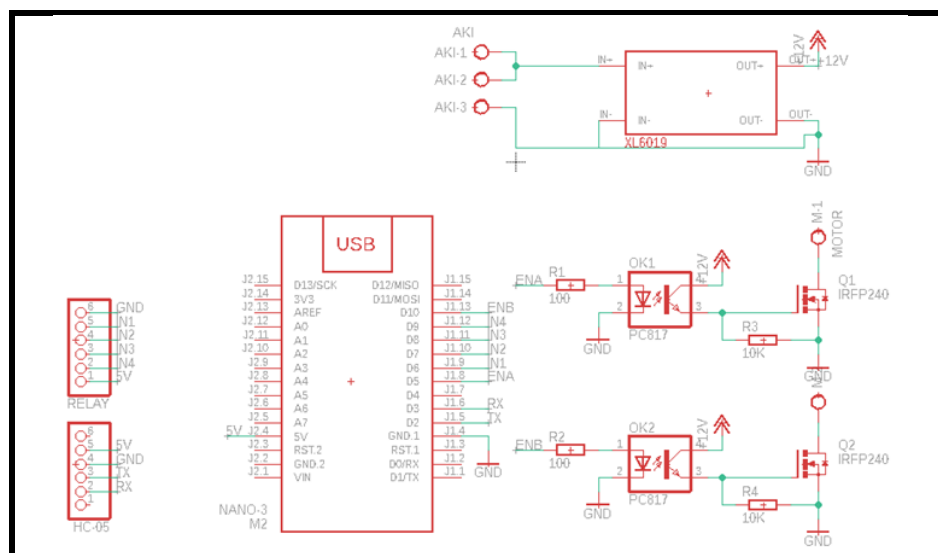


Fig. 2. Electrical Device design



Table 1. Electrical device design

Name	total
Raspberry pi 3b	1
Kamera Logitech C270	1
Arduino uno	1
MOSFET IRF 250N	2
Relay 4 channel	1
Motor DC dengan gearbox	2
AKI 6V	1
powerbank	1
Kipas 5V	1
Papan kayu 25cm	1

3.3. Block Diagram System

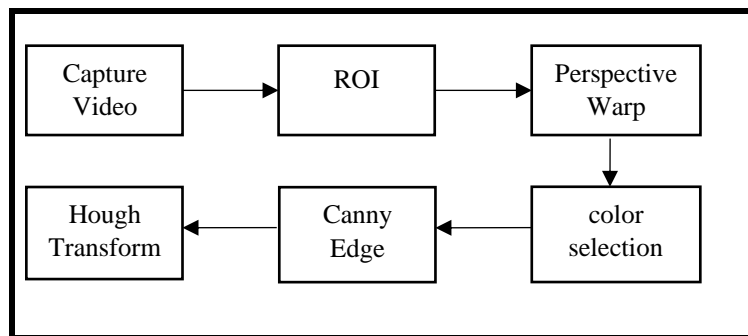


Fig. 3. Block Diagram System

The results of the camera capture are selected using ROI (region of interest) to determine the area to be detected. ROI result is changed from perspective view to new image. the result of perspective warp is used color selection to differentiate between road markings and non-road markings. edge detection is used to detect the edge used to detect lines. hough transform is used to detect the line from the edge.

3.4. Warp Perspective

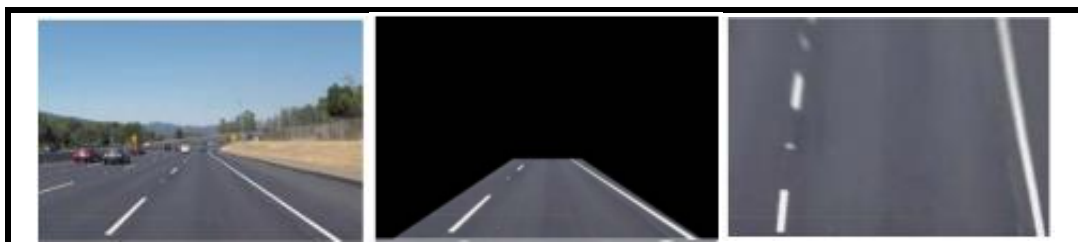


Fig. 4. Warp perspective

The process of bending the image is handled by changing the perspective of the input image where it tries to approach (M) the new image points (etc.) based on the ROI of the previous image (x, y) [6].

$$div(x,y) = (M_{31x} + M_{31y} + M_{13}) \tag{1}$$

$$dst(x,y) = \frac{(M_{11x}+M_{12y}+M_{13},M_{21x}+M_{22y}+M_{23})}{div(x,y)} \tag{2}$$

3.5. Color Selection

Color filtering is a method for displaying data with certain color criteria or the color we want. This method is used when we have determined the color intensity value between the upper and lower limits with the desired range to get the relevant color [3].





3.6. Canny Edge

Edge detection method uses canny edge detection, where the edge detection has a minimum error rate in the process. so as to produce optimal edge image detection. The Canny method will detect the edge by finding the maximum local gradient value of an image[7].

$$G = \sqrt{G_x^2 + G_y^2} \tag{3}$$

$$\theta = \tan^{-1} \left(\frac{G_y}{G_x} \right) \tag{4}$$

Where G_x is the slope value of the horizontal image, G_y is the value of the vertical image.

3.7. Hough Transform

Hough transform is a transformation from a set of a pixel frame, points, in Cartesian space to another space known as hough space. Hough transform can be written with the following equation[8].

$$r_i = x \cos \theta_i + y \sin \theta_i \tag{5}$$

Where r is the distance from the origin to the nearest point on a straight line, and θ is the angle between the x -axis and the line connecting the origin to the nearest point.

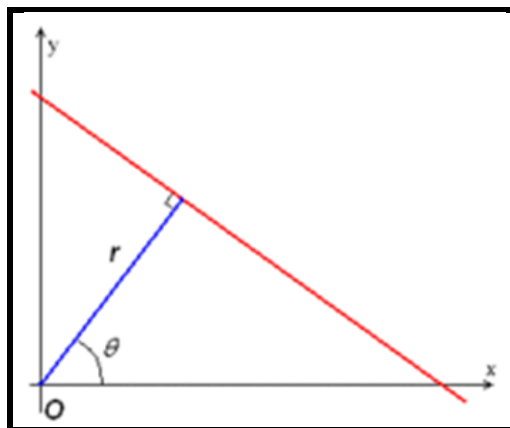


Fig. 5. Line Representation In Hough Space

The purpose of implementing this method is to detect each pixel, including the pixel comprising the line or not including the line[9].

3.8. Confusion Matrix

confusion matrix method is a tool used for evaluation of classification models to estimate whether objects are true or false[10].

Table. 2. Confusion matrix

Classification	Predicted Class	
	Class = Yes	Class = No
Class = Yes	A(True Positive-TP)	B(False Negative-FN)
Class = No	C(False Positive-FP)	D(True Negative-TN)

formula to calculate the level of accuracy.

$$accuracy = \frac{TP+TN}{TP+FP+TN+FN} = \frac{A+D}{A+B+C+D} \tag{6}$$

4. Results and Discussion

4.1. Light intensity Testing Result

Tested to determine the effect of light intensity on the results of the detection process of the vision system that has been made.





Table 3. Effect of light intensity on detection result

Light Intensity (Lux)	Result	
	Successful	Failed
93030-94800	10	0
23490-24430	10	0
320-356	5	5
180-230	5	5
100-117	4	6
Total	24	11
Total Number	35	

From the tests that have been done, the greater the value of light intensity, the better the success rate in detection.

4.2. Accuracy of The System Vision

The level of detection accuracy of the vision system is determined using the confusion matrix method. The sample data used are 10 images of road markings and 10 images of non-road markings.

Table 4. Confusion matrix detection result

Class	True	False
Positive	10	0
Negative	5	5

The level of accuracy of the vision system can be calculated using the equation (6).

$$accuracy = \frac{10 + 5}{10 + 5 + 5 + 0} = 0,75$$

4.3. Motor Response Testing Result

Motor testing was carried out 45 times in order to find the ideal motor speed.

Table 5. Motor Response

Motor speed (duty cycle (%))		Response	
Rear motor	Front motor	successful	failed
	25%	1	4
25%	50%	2	3
	75%	0	5
	25%	1	4
50%	50%	0	5
	75%	0	5
	25%	0	5
75%	50%	0	5
	75%	0	5
Total		4	41
Total Trial		45	

From the experiments that have been carried out, it has not been able to find the ideal motor speed combination, therefore the motor testing is carried out manually.

Table 6. Motor Speed Combination

Motor speed (duty cycle (%))		Response	
Rear motor	Front motor	successful	failed
16,86%	33,33%	7	3
Total trial		10	



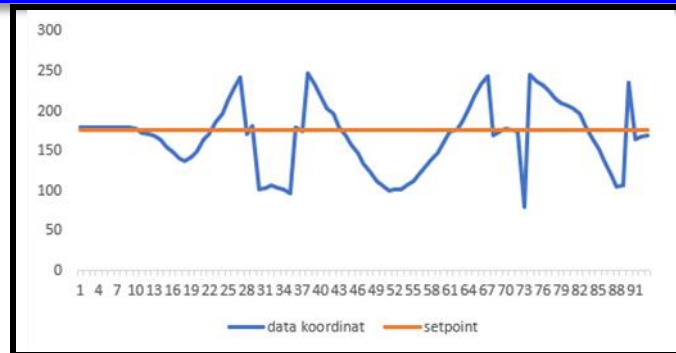


Fig. 6. Motor Response Graph

The x-axis represents time, the y-axis is the x-axis pixel value on the camera. the orange color chart represents the setpoint value. The blue graph represents the midpoint of the detected road markings. the average value of the deviation against the setpoint is 32 pixels.

5. Conclusion

With the hough transform method, road markings and their coordinates can be identified as a reference for tracking. obtained a road mark detection accuracy of 75%.

the robot movement system is very important for tracking road markings, at a constant speed. obtained a combination for the rear motor speed of 16.86% and the front motorbike 33.33% with an average deviation of the set point of 32 pixels.

References

- [1] BPS - Statistics Indonesia, "STATISTIK TRANSPORTASI DARAT," p. 72, 2016.
- [2] M. V. G. Aziz, H. Hindersah, and A. S. Prihatmanto, "Implementation of vehicle detection algorithm for self-driving car on toll road cipularang using Python language," *Proceeding - 4th International Conference on Electric Vehicular Technology, ICEVT 2017*, vol. 2018-Janua, pp. 149–153, 2018, doi: 10.1109/ICEVT.2017.8323551.
- [3] L. B. Prianggodo, "Perancangan Object Tracking Robot Berbasis Image Processing Menggunakan Raspberry Pi," 2016.
- [4] R. Pradana, D. Putra, and Y. Yenni, "The Design of Arduino Uno Based Automatic Concrete Maker," vol. 3, no. 2, pp. 171–178, 2020.
- [5] Y. Chen, C. D. Mershon, and Z. T. H. Tse, "A 10-mm MR-conditional unidirectional pneumatic stepper motor," *IEEE/ASME Transactions on Mechatronics*, vol. 20, no. 2, pp. 782–788, 2014.
- [6] B. T. Nugraha, S. F. Su, and Fahmizal, "Towards self-driving car using convolutional neural network and road lane detector," *Proceedings of the 2nd International Conference on Automation, Cognitive Science, Optics, Micro Electro-Mechanical System, and Information Technology, ICACOMIT 2017*, vol. 2018-Janua, pp. 65–69, 2017, doi: 10.1109/ICACOMIT.2017.8253388.
- [7] A. (Institut T. A. T. Suryowinoto, "Penggunaan Pengolahan Citra Digital Dengan Algoritma Edge Detection Dalam Mengidentifikasi Kerusakan Kontur Jalan," *Seminar Nasional Sains dan Teknologi Terapan V 2017 Institut Teknologi Adhi Tama Surabaya*, pp. 149–154, 2017.



- [8] J. Illingworth and J. Kittler, "A survey of the Hough transform," *Comput Vis Graph Image Process*, vol. 44, no. 1, pp. 87–116, 1988.
- [9] F. Indriani, F. Utamingrum, and Y. A. Sari, "Deteksi Zebra Cross Pada Citra Digital Dengan Menggunakan Metode Hough Transform," *Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer (J-PTIIK) Universitas Brawijaya*, vol. 2, no. 6, pp. 2374–2380, 2018.
- [10] D. Untari, "Data Mining untuk Menganalisa Prediksi Mahasiswa Berpotensi Non-Aktif Menggunakan Metode Decision Tree C4.5," *Fakultas Ilmu Komputer Universitas Dian Nuswantoro*, 2010.





This Page Intentionally Left Blank

