

Implementation of Dynamic HSV Adjusting Method for Lane Detection

Yong Hee Park, Won Seok Choi, Ji Yong Oh, Cheol Jin Park, Seong Gon Choi

Information & communication Engineering, Chungbuk National University, Chungcheongbuk-do, Korea

yh0360@chungbuk.ac.kr, wschoi@chungbuk.ac.kr, jysyoh@chungbuk.ac.kr, p016037013@chungbuk.ac.kr, choisg@chungbuk.ac.kr

Abstract— We propose design and implementation of system that dynamically adjusts value range of HSV using a photo resistor. In autonomous driving, lane detection is operated by fixing the color range of the lane. However, the color range of the lane changes with environment (time variations, Illumination, etc.), so it is necessary to adjust the range. To do this, we create matrix that make correspond to measured illumination and HSV value. And we designed lane detection Including this matrix. Experiment was conducted in two ways: using headlight and not using it. Experimental results showed that lane was detected despite changing illumination levels.

Keywords— autonomous driving, lane detection, image process, sensor, auto-control

I. INTRODUCTION

Autonomous-driving is technique that use advanced IT technologies to reduce human decision. Lane detection is a technique for recognition when autonomous-driving vehicles drive on roads. typical technique for lane detection is a visual-based approach using cameras. Lane detection can be divided into two method: classic computer vision and learning-based. Recognition-based lane detection includes Cleaning, Feature Detection, Model Application, Tracking Integration, and Coordinates Translation. Learning-based lane detection extracts features using constructed learners [1][2]. Visibility-based lane detection is popular because of its cost-effectiveness, but can be easily affected by Illumination changes. Lane detection is can used in Advanced Driver Assistance System (ADAS) [3].

The HSV model is a channel that can intuitively process colors with hue, saturation, and value configurations [4]. HSV can be used where the robot is controlled or shadowed [5]. Concerning the illumination issue, Lane detection systems shall be adaptable to Illumination circumstances [1]. Illumination scenario includes shading by trees and buildings, rapid illumination changes, and tunnel entry. This situation leads to problems such as recognition errors, noise, etc [6].

Existing studies specify color of lane and they convert it into a binary image [7]-[9]. It also detects lanes in image frames with image processing techniques such as canny edge, Hough transformation, and Sobel filter. After this step, it draws a virtual line in the middle of the line considering the ROI between the lines. An angle of movement is calculated by

this line, and the vehicle moves in a straight, right, left direction according to the specified angle. In the previous papers, only lane detection in a single environment is considered, and actual lane detection needs to consider changing environment (weather, time, etc).

This paper develops lane detection of the Classic Computer Vision method by considering Illumination scenario by illumination. We use photo resistor for that. The system first compares the photo resistor with the value of HSV. and it creates a matrix. It then dynamically adjusts range of values using the generated table.

This paper is composed as follows: In Section 2, we review the paper that developed existing lane detection and we compare it with what was developed in this paper. Section 3 describes the development. Section 4 shows the result. Section 5 describes the conclusions and further study.

II. RELATED WORKS

There is study that implemented lane detection using Python. They detected lanes using techniques such as canny edge, hot line, etc. Their results showed that lane detection accuracy was more than 90%. According to their other conclusions, lane detection was performed normally at the set time zone, but the algorithm showed that it was not able to detect lanes as it became dark at night. This is because constant parameters can only be used under the same lighting conditions. Therefore, they should add methods to adaptively change parameters with changes in day and night [7].

There are some studies that have implemented lane detection. One study implemented lane detection through raspberry pi. They used OpenCV to extract the color of the road and detect lanes. Their results created edges by comparing not only lanes but also other terrain (pools, unpaved roads, etc.) [8]. The other study implemented lane detection using canny edge, Sobel filter. They used lane detection in real vehicles and actually showed that the vehicle was autonomous-driving. However, their studies still did not address the adaptation of illumination to environmental changes [9].

As with the conclusion of Aziz, et al., fixed constant parameters used in lane detection need to be adaptable for reasons such as environmental changes. Therefore, we

implement a method to dynamically change the value range of HSV channels, which means a change in illumination. To do this, we use a photo register and create a matrix that matches the value of HSV and illumination. And we propose and implement an algorithm that uses the created matrix for lane detection.

III. DESIGN OF DYNAMIC ADJUSTING HSV

This section describes the development methods, which are divided into two categories: creation illumination / value matrix, lane detection considering illumination.

A. Creating Illumination / Value Matrix

Fixed range of value for lane detection causes lane to be missed if illumination changes in real environment. In this paper, our goal is to dynamically control the range of values. For this purpose, we get value of the photo resistor and we compare how it affects the real lane value. The two compared data are stored with time stamps and managed in matrix.

Figure 1 is a flow chart that creates a matrix that compares the values of illumination and value.

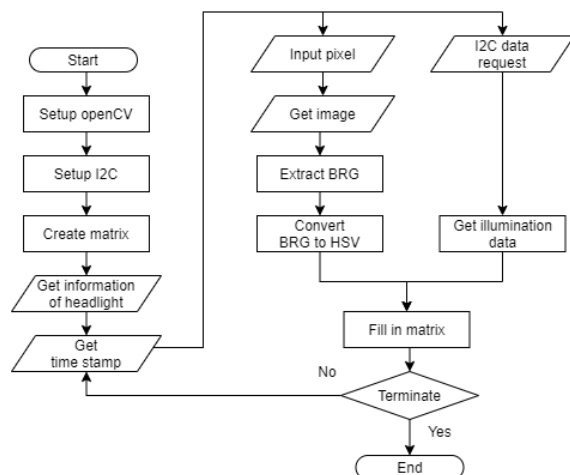


Figure 1. Flow Chart of Creating Illumination / Value Matrix

Image processing utilizes OpenCV, and photo resistor uses I2C protocols, so it is set up at the beginning of the initial program. It selects the pixel corresponding to the lane from image data and it extracts the value. It stores this value in matrix with a photo resistor.

B. Lane Detection Considering Illumination

In this paper, lane detection adopts the method of classic computer vision. The techniques include:

1) Application of Gaussian Filter: A Gaussian filter is a filter that removes noise from an image [10]. The principle of the Gaussian filter is to convolve each point of the input array with a Gaussian kernel, and then add them all together to create an output array while performing the filter operation.

2) ROI extraction technique: A region of interest (ROI) extraction technique is applied for lane detection. When ROI extraction technique is applied, lane line recognition accuracy increases because unnecessary backgrounds (sky, buildings, etc..) other than the lane lines are not recognized [6]. In addition, since the number of pixels of the image extracted only form the region of interest of the image is smaller than the number of image pixels of the previous image, the amount of calculation is reduced [11].

3) Edge Detection Techniques: One of the most basic methods of detecting a lane in an image extracted through an image is to perform edge detection. In the case of white lanes, black can be clearly distinguished from roads, and lanes of the road are bounded. In our experiment, we use the Canny edge algorithm for lane detection.

4) Hough Transformation: Canny edge Hough transformation is used to detect straight lines from edges extracted from the Canny edge algorithm. In the Hough transformation, orthogonal coordinate is converted a polar coordinate. The polar coordinate system can be straightened with an angle set with the length p and the x-axis vertically from origin.

5) Extraction techniques of representative line: Considering the slope of the straight line, it extracts only straight lines needed for lane. This allows the slope of each straight line to be calculated because the it able to know coordinate values for start and end points of all straight lines using Hough transformation. In addition, the horizontal slope was limited to 160 degrees in this paper, and the vertical slope was limited to 90 degrees. Then we remove the filtered straight lines and obtain each representative lines on left and right sides. Additionally, we draw a representative line in the direction that the vehicle is located and viewed.

In Edge detection, we specify HSV color ranges to distinguish boundaries. Here, created illumination / value matrix can be used to specify range of value. The flow chart of lane detection considering Illumination is shown in Figure 2.

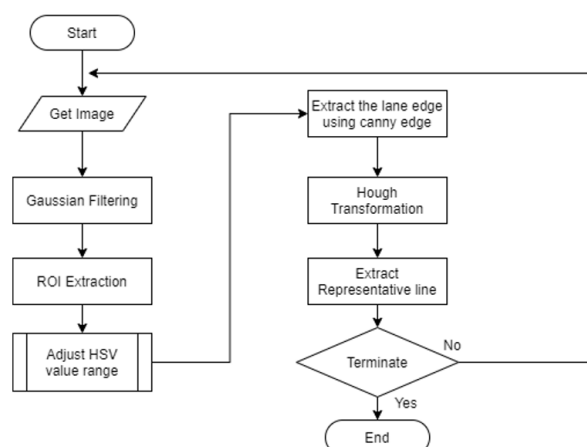


Figure 2. Flow Chart of Lane Detection

In this paper, the part for value range is 'Adjust HSV value range' as shown in Figure 3.

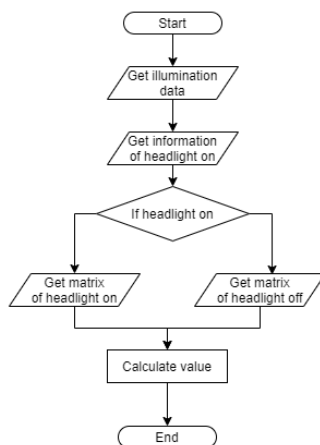


Figure 3. Flow Chart of Adjusting HSV Value Range

Illumination / value matrix is divided into two situations: headlight on and off. Therefore, it takes the information that turns on headlight, gets the correct matrix, and adjusts the value.

IV. IMPLEMENTATION

The experiment is divided into three categories: Specifications, making an illumination / value matrix and lane detection considering illumination.

A. Specification

Table 1 shows the specification of HW and SW used in the experiment.

TABLE 1. SPECIFICATION OF IMPLEMENTATION

Model	Specification
MCU	Raspberry Pi4 Model B+
Camera	Raspberry Pi HQ Camera, Logitech webcam HQ 1080
Photo Resistor	BH1750FVI
OS	Raspbian 32-bit released on 2021-05-07
OpenCV	4.5.1
Headlight	8000 Lumen

HW and SW configurations are as follows. MCU is a Raspberry Pi Model 4B. The camera is a Raspberry Pi HQ camera and a Logitech webcam. The photo resistor used BH1750FVI. The headlight is a flashlight of 8,000 Lumen. OS

is Raspbian 32-bit, released on 2021-05-07. Data collection for photo resistor and lane detection are written in python. In addition, image data collection is written in C++. API used is OpenCV. Figure 1 shows the devices used.

B. Creating Matrix

Experimental environment is the time when the sun sets from 17:30 to 19:00 on August 13, 2021. The images were taken every 10 minutes and it recorded with photo resistor. A picture including the experimental process is shown in Figure 4.

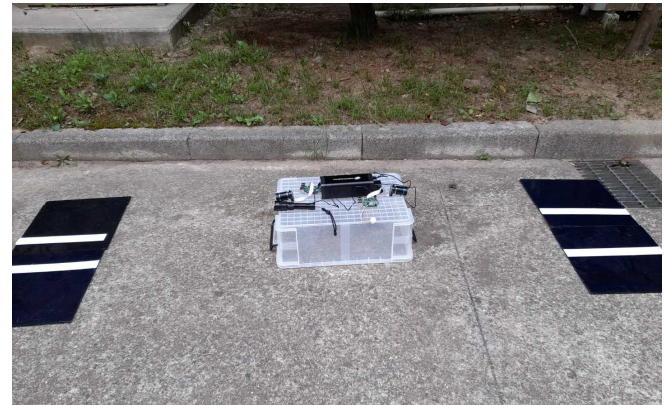


Figure 4. Environment of Creating Matrix

The left side of picture is headlight on, and right side is not.

C. Lane Detection

An example of lane detection considering Illumination is shown in the following figures. First of all, if it is daytime in Only Camera situation, it is shown in Figure 5. Illumination value is 40 Lux and Value is approximately 180.

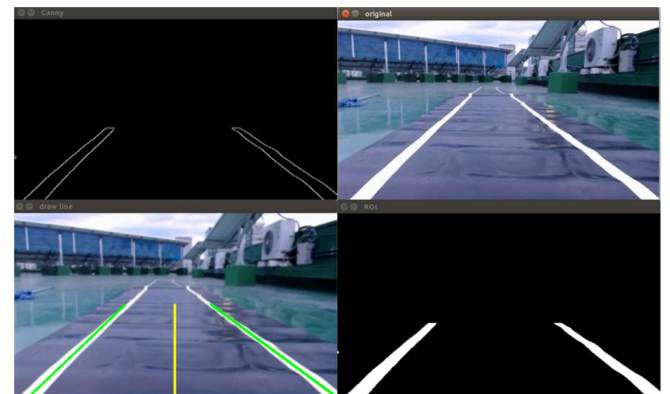


Figure 5. Lane Detection Not Using Headlight at Day

In the Only Camera situation, if it is night time, it is shown in Figure 6. In this case, illumination value is 0 lux and value is approximately 40.

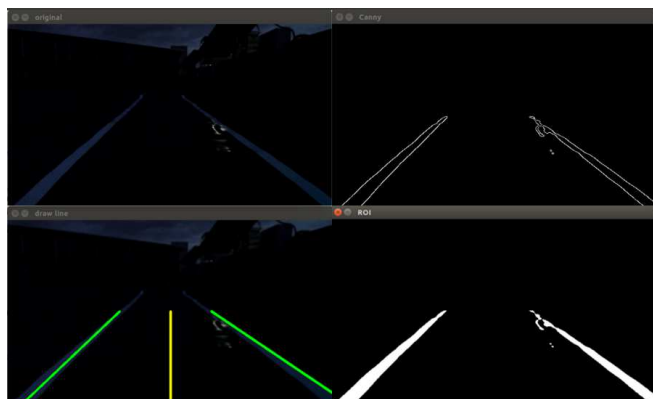


Figure 6. Lane Detection Not Using Headlight at Night

When using headlight at night, it is shown in Figure 7. In this case, illumination value is 0 lux and value is approximately 180.

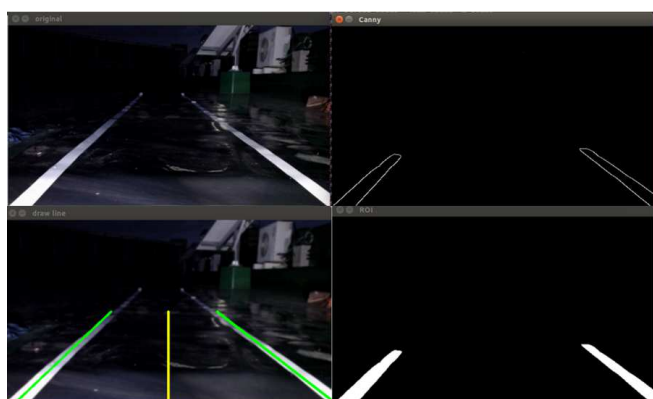


Figure 7. Lane Detection Using Headlight at Night

V. CONCLUSIONS AND FURTHER STUDY

This paper shows development of a method for dynamically regulating detection value range of HSV in edge detection through photo resistor. This shows that illumination / value matrix can be created and it able to automatically adjust value in lane detection

In this paper, values must be calibrated prior to completing the matrix. This is a tricky task to apply in practice. Future research needs to learn the range of value like reinforce learning by inputting values of images and photo resistor. It also requires means to consider other variables such as environment, streetlights, angles of headlight, etc.

ACKNOWLEDGMENT

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(2020R1A6A1A12047945)

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIT) (No. 2019R1A2C1006167).

* Corresponding Author: S.G. Choi(choisg@cbnu.ac.kr)

REFERENCES

- [1] M Feniche, T Mazri, "Lane Detection and Tracking For Intelligent Vehicles: A Survey", 2019 International Conference of Computer Science and Renewable Energies (ICCSRE), 22-24 July 2019
- [2] H Zhou, H Wang, "Vision-based lane detection and tracking for driver assistance systems: A survey", 2017 IEEE International Conference on Cybernetics and Intelligent Systems (CIS) and IEEE Conference on Robotics, Automation and Mechatronics (RAM), 19-21 Nov. 2017
- [3] Y Ma, V Havyarimana, J Bai, Z Xiao, Vision-Based Lane Detection and Lane-Marking Model Inference: A Three-Step Deep Learning Approach, 2018 9th International Symposium on Parallel Architectures, Algorithms and Programming (PAAP), 26-28 Dec. 2018
- [4] A Aqthobillobbany, AN Handayani, D Lestari, Muladi, RA Asmara, O Fukuda, "HSV Based Robot Boat Navigation System", 2020 International Conference on Computer Engineering, Network, and Intelligent Multimedia (CENIM), 17-18 Nov. 2020
- [5] X Wang, K Jia, Z Sun, "An Efficient Method of Shadow Elimination Based on Image Region Information in HSV Color Space", 2015 International Conference on Computational Intelligence and Communication Networks (CICN), 12-14 Dec. 2015
- [6] K Manoharan, P Daniel, "A Robust Approach for Lane Detection in Challenging Illumination Scenarios", 2018 International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), 12-13 Oct. 2018
- [7] MVG Aziz, AS Prihatmanto, H Hindersah, "Implementation of lane detection algorithm for self-driving car on toll road cipularang using Python language", 2017 4th International Conference on Electric Vehicular Technology (ICEVT), 2-5 Oct. 2017
- [8] G Pannu, MD Ansari, "Design and Implementation of Autonomous Car using Raspberry Pi", International Journal of Computer Applications, 2015
- [9] S Kamçı, D Aksu, "Lane Detection For Prototype Autonomous Vehicle", Muhammed Ali Aydin, Computer Vision and Pattern Recognition, 11 Dec 2019
- [10] C. Jang, S. Lee, S. Choi, and Y. Kim, "Realtime robust curved lane detection algorithm using gaussian mixture model," J. Institute of Control, Robotics and Syst., vol. 22, no. 1, pp. 1-7, 2016J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.
- [11] U. Ozgunalp, R. Xiao, and A. Dahnoun, "Multiple lane detection algorithm based on novel dense vanishing point estimation," IEEE Trans. Intell. Transp. Syst., vol. 18, no. 3, pp. 621-632, 2017



Yong Hee Park received B.S. degree in the College of Information & Communication Engineering, Chungbuk National University, Korea in 2019. He is currently a M.S. candidate in School of Information & Communication Engineering, Chungbuk National University. His research interests include Autonomous Vehicle, AI, Smart Grid.



Won Seok Choi received B.S. and Ph.D. degree in the College of Electrical and Computer Engineering, Chungbuk National University, Korea in 2008 and 2015 respectively. He is currently researcher in Research Institute of Computer and Information Communication(RICIC), Chungbuk National University. His research interests include Vehicle network, AI, Energy saving network, SDN, NFV and NGN.



Ji Yong Oh currently B.S. candidate in the College of Information & Communication Engineering, Chungbuk National University, Korea. His research interests include Autonomous Vehicle, Embedded software.



Cheol Jin Park currently B.S. candidate in the College of Information & Communication Engineering, Chungbuk National University, Korea. His research interests include Autonomous Vehicle, Embedded software.



Seong Gon Choi received B.S. degree in Electronics Engineering from Kyeongbuk National University in 1990, and M.S. and Ph.D. degree from Information Communications University, Korea in 1999 and 2004, respectively. He is currently an associate professor in College of Electrical & Computer Engineering, Chungbuk National University. His research interests include Autonomous Vehicle, smart grid, IoT, mobile communication, high-speed network architecture and protocol.