School

of

Electronics and Communication Engineering

Minor Project Report

on

LANE DETECTION WITH STEER ASSIST

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SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that project entitled " **LANE DETECTION WITH STEER ASSIST** " is a bonafide work carried out by the student team of " **Rajendra G Kanbargi - 01FE19BEC246, Prajwal Vakkund - 01FE19BEC250, Tejaswini N - 01FE19BEC256 and Vishwas Raju Banagar - 01FE19BEC258** ". The project report has been approved as it satisfies the requirements with respect to the minor project work prescribed by the university curriculum for BE (VI Semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2021-2022.

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ABSTRACT

Self-driving vehicles require a high level of precision and consistency to operate. It is based on a wide range of factors, many of which are impossible to forecast and control. The efficiency of control algorithms is commonly impaired as a result of bad parameter selection.

A self-driving car is one that operates without the assistance of a human driver. Two systems are being monitored in this study. The first employs image processing to determine a lane and sends data to a steering system that uses a servo motor as an actuator to control the self-driving car's speed and movement. Detecting lane and providing input for steer assist is how an autonomous vehicle steering control system is characterised.

Lane detection is the first sprint in our project, and it is performed using histograms, warping, the sliding window approach, and curve optimization. The steering controller directs the steering actuator to maintain the proper steering angle. A servo motor is used to operate the steering handle. This project will demonstrate the operation of a car's lane detection system. This technology is becoming more widespread in autos, and it is a key component of advanced driver assistance systems (ADAS) in autonomous and semi-autonomous vehicles. This code recognizes lanes, calculates curve radius, and monitors the offset from the center. The system uses this information to improve safety by ensuring that the car stays centered between the lane lines, as well as comfort if it is intended to operate the steering wheel to navigate mild highway curves without driver input. Raspberry pi 3+ board has been used to simulate our project , servo motor S3003 is used to control the steering angle and the Dc motor and motor driver module LN298 are used to control the speed and lateral motion of the vehicle.

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Chapter 1

Introduction

1.1 ADAS:

A combination of electronic technologies known as advanced driver assistance systems (ADAS) assists drivers with driving and parking. By offering a secure human-machine interface, ADAS increases car and road safety. ADAS uses automated technologies such as vehicle sensors and cameras to detect and respond to surrounding barriers and driver errors. Advanced Driver Assistance Devices (ADAS) are technologies that assist drivers with day-to-day driving responsibilities. Some technological solutions include adaptive cruise control (ACC), intelligent speed adaptation (ISA), and collision warning systems (CWS). ADAS functions are divided into two categories: comfort and safety. The comfort functions are intended to notify the driver by triggering a warning such as a flashing light, sound, vibration, or even a gentle steering suggestion..

The advanced driving assistance system (ADAS) monitors the lane departure warning system, Lane Keeping Assistance System (LKAS), Forward Collision Warning System, and Smart Parking Assistant System through a human–machine interaction (SPAS). When LKAS senses the vehicle drifting from its lane, it assists it in staying on track by supplying a constant amount of counter-steering force. SPAS assists the driver in backing into a parking space by providing automatic steering assistance along a specified path. A self-driving car is one that can go to a destination without the need for the driver to be present.
5.3

Figure 1.1: ADAS

1.2 Levels of Driving Automation:

The Society of Automotive Engineers classified the stages of development up to the self-driving vehicle (SAE). There are five degrees of development from concept to autonomous vehicle. It specifies the extent to which the vehicle can and will take over the driver's responsibilities.

Level 0 - No Automation:
The driver is entirely responsible for driving the vehicle, including steering,braking,accelerating, and slowing down. Backup cameras,blind spot warnings, and collision warnings are all available on Level 0 vehicles. Because it does not act over a continuous period, even automatic emergency braking, which provides severe braking in the case of an impending collision, is classed as Level 0.

Level 1 - Driver Assistance:
Automated systems begin to take control of the car in some instances at the point, but not entirely, Level 1 automation includes adaptive cruise control, which regulates acceleration and braking in highway driving. Depending on the functionality, drivers can take their feet off the pedals.

Level 2 - Partial Automation:
Due to a greater knowledge of its surroundings, the vehicle can execute more complex functions that combine steering(lateral control) with accelerating and braking(longitudinal control).

Level 3 - Conditional Automation:
Drivers at Level 3 can detach from the act of driving, but only in certain circumstances. Certain vehicle speeds, road types, and weather circumstances may be restricted. However, because drivers can divert their attention to something else, such as reading a phone or paper, this is often seen as the first step toward autonomous driving. Nonetheless, when the system asks it, the driver is expected to take control over it.

Level 4 - High Automation:
At this level, the vehicle's autonomous driving system is fully capable of monitoring the driving environment and carrying out all driving operations for regular routes and conditions described within its operational design area (ODD). The vehicle may inform the driver if it is approaching its operational limits owing to an environmental condition that demands human control, such as deep snow. If the driver does not answer, the vehicle will be automatically locked.

Level 5 - Full Automation:
Level 5-capable vehicles are completely self-contained. The presence of a driver is not required. A steering wheel, as well as gas and brake pedals, may be absent from Level 5 vehicles. Passengers in Level 5 vehicles may be able to manage cabin factors such as temperature and media choices via voice commands. 1.2

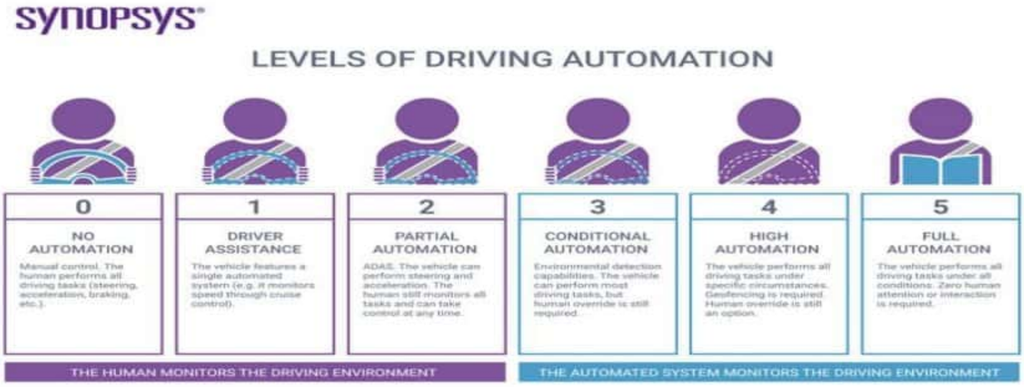

Figure 1.2: Levels of Driving Automation

1.3 Motivation

Autonomous vehicles and advanced driver assistance technologies are projected to improve safety while lowering fuel and energy consumption and reducing pollution on the road. Lane detection and tracking are the advanced basic features of the advanced driving assistance system. Lane detection is the process of recognising white lines on the road. Lane tracking is a technique for assisting the vehicle in keeping on track by regulating the motion model with previously found lane markers.

The Purpose of Self-Driving Vehicles:
We're still a long way from having a self-driving car. A real self-driving car is one that can be driven in essentially the same way that a human driver can. This is an extremely difficult feat to accomplish.

Major automakers have been attempting to develop fully autonomous vehicles. The following are the key reasons for the concept:

1.Safer Roads.
2.Increase in productivity.
3.More economical.
4.The movement will be more efficient.
5.More environment friendly.

1.4 Objectives

Our objective is to:
1. It provides better safety by ensuring that the car keeps within the lane lines.
2. Modify the steering wheel to create small changes on roads without any human drivers.
3. Lane detection is the process of identifying lane limits in a single image without having any direct knowledge of lane position.
4. To indicate the path for self-driving cars and potentially prevent into the adjacent lane.

1.5 Literature survey

1." On the Image Sensor Processing for Lane Detection and Control in Vehicle Lane Keeping Systems ",C.Y. Kuo, Y.R. Lu and S.M. Yang *
Advanced driving assistance systems in autonomous vehicles rely on lane keeping systems to keep a vehicle in the desired lane. This study provides a low-cost image sensor with an efficient processing technique for autonomous delivery systems' lane recognition and lane management applications. The algorithm comprises lane recognition using inverse perspective mapping and random sample consensus parabola fitting, as well as lane control using a nonholonomic kinematic model and pure pursuit steering controller and classical proportional integral speed controller.

2." Steering Wheel Control in Lane Departure Warning System ",Maximiliano Hernández García Rojas1 , Humberto Velasco Arellano1 , David Ubach González2 , Martín Montes Rivera1 , Marving Omar Aguilar Justo3, ISSN 1870-4069
Lane incursions are one of the types of accidents that advanced driver assistance systems (ADAS) can help prevent. Modern automobiles now include visual and control systems to keep them centred in a lane, while older vehicles do not have access to these new helper systems. We offer a position steering wheel control (SWC) in a lane detecting prototype in this work, which is intended for use in cars that do not have this system installed. For SWC, the proposed solution employs a self-tuning PID controller attached to a DC motor that takes advantage of the road's line orientation. Lines are spotted using image processing techniques such as the Sobel filter convolution and the Hough transform, which allow for orientation determination.

3." Real Time Lane Detection for Autonomous Vehicles "Abdulhakam.AM.Assidiq, Othman O. Khalifa, Md. Rafiqul Islam, Sheroz Khan
In the framework of Advanced Driver Assistance Systems, boosting safety and reducing road accidents, hence saving lives, is of major concern. Road lane detection or road boundary detection appears to be one of the more complex and difficult tasks that future road vehicles will face. It is based on the detection of lanes (which includes the localization of the road, the determination of the relative position between vehicle and road, and the analysis of the vehiclepsilas heading direction). One of the most common methods for detecting road limits and lanes is to use a vehicle's visual system. The technology uses a camera installed on the car to capture the front view, then applies a few procedures to determine the lanes.

4." Lane Detection Techniques using Image Processing " Vighnesh Devane, Ganesh Sahane, Hritish Khairmode, Gaurav Datkhile Department of Electronics Engineering, Ramrao Adik Institute of Technology, Mumbai University, India

Lane detection is a new technology that is being used in cars to enable self-driving navigation. The majority of lane detecting systems are built for roads that have a suitable structure and rely on the presence of markings. The fundamental flaw in these approaches is that they may produce erroneous results or fail to perform at all in instances when markers are unclear or absent. A method for detecting lanes on an unmarked road is reviewed in this article, followed by an improved method. Both methods rely on digital image processing techniques and work solely with vision or camera data. The primary goal is to obtain a real-time curve value that will assist the driver/autonomous vehicle in making essential turns while avoiding going off the road.

1.6 Problem statement

To design and implement lane detection with steer assist for an autonomous vehicle.

1.7 Application in social context

1.Lane detection determines the path for self driving car.
2.It prevents the vehicle from entering into another lane.
3.It supports road safety as well as it provides steerability to a vehicle.
4.To improve efficiency and driving safety of a autonomous vehicle .

1.8 Project Planning

The goal of our project is to develop and test a lane detection model for steering control of the vehicle. We conducted a literature survey based on the purpose to attain our goal, which benefited us by providing a clear idea and a clear path to follow. We found several models that were relevant to our project, did a comparison study, and constructed a model based on image processing techniques, which we prototyped and tested before successfully implementing our project..

1.9 Bill of materials

Sl.No	Components	Specification	Cost	Quantity
1	Raspberry pi kit	Raspberry pi 3 B+	6000/-	01
2	Servo Motor	S3003	270/-	01
3	Motor Driver	LN298 Motor Driver Module	250/-	01
4	DC Motor	60 rpm	200/-	01
4	Wires	-	-	-

Table 1.1: Bill of materials

1.10 Organization of the report

- Chapter 1 Covers the introduction.
- Chapter 2 Briefs about functional block diagrams , design alternatives and final design.
- Chapter 3 Gives implementation details.
- Chapter 4 Discusses the results and discussions.
- Chapter 5 Gives the conclusion.

Chapter 2

System design

2.0.1 Functional block diagram

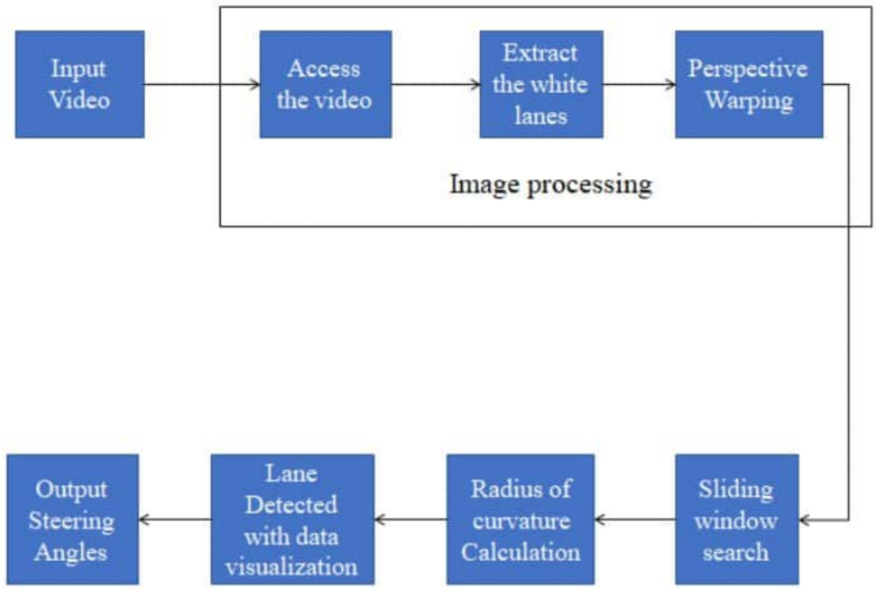

Figure 2.1: Block diagram

2.0.2 Design specification:

1. Taking input as a video file showing a traffic camera clip from a vehicle travelling just next to the highway.
2. The Python software uses a modular way to do lane detection and includes various functionalities like perspective warping, histogram and measuring the curvature of the lane .
3. By giving this input to the raspberry pi , we will control the steering angle using servo motor and controlling the speed using DC motor and LN298 module.
4. The vehicle's speed changes in response to changes in steering angle.

2.1 Design alternatives

2.1.1 Neural Networks

Neural networks are the computing system which is used to evaluate patterns. Neural networks resembles simple human brain structures which is made up of 3 layers. those are input layer, hidden layer and output layer. Convolutional neural networks are the class of neural networks used to analyze image processing.

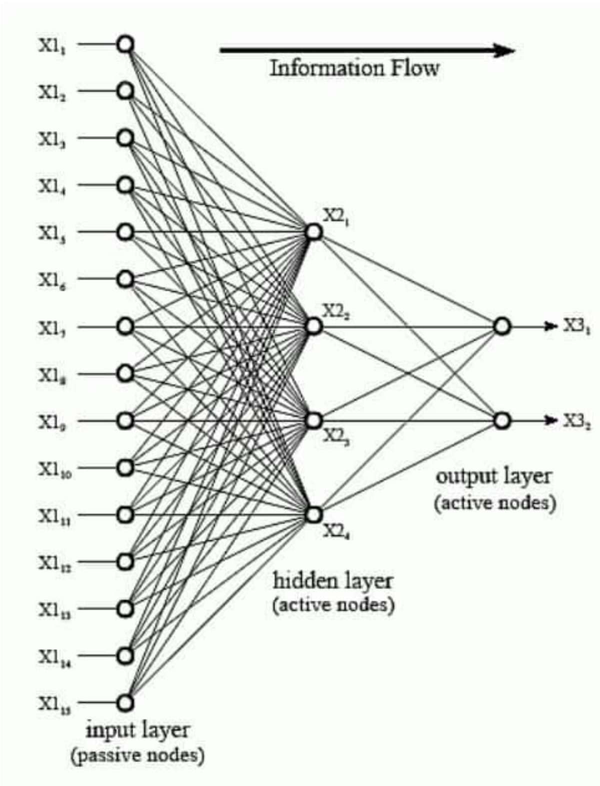

Figure 2.2: Neural Networks

2.2 Final Design

Following extensive investigation into several lane detection techniques: As we implemented our output with steer assist in prototype, we considered image processing as an optimum technique for our project. We choose the LN298, DC motor, servo motor, and raspberry pi3 b+ model after researching and checking component availability. The Raspberry Pi 3 replaced the Arduino. The Raspberry Pi 3 B+ model is quicker than the Arduino (1.2 GHz vs. 16 MHz), allowing it to perform common computer functions such as watching videos, accessing the web, and listening to music. If you want to use the Raspberry Pi 3 for media-related applications, this makes it an easy choice. Optimization of software: Using math and numpy library functions in Python. Various code optimization techniques

Figure 2.3: Servo Connection

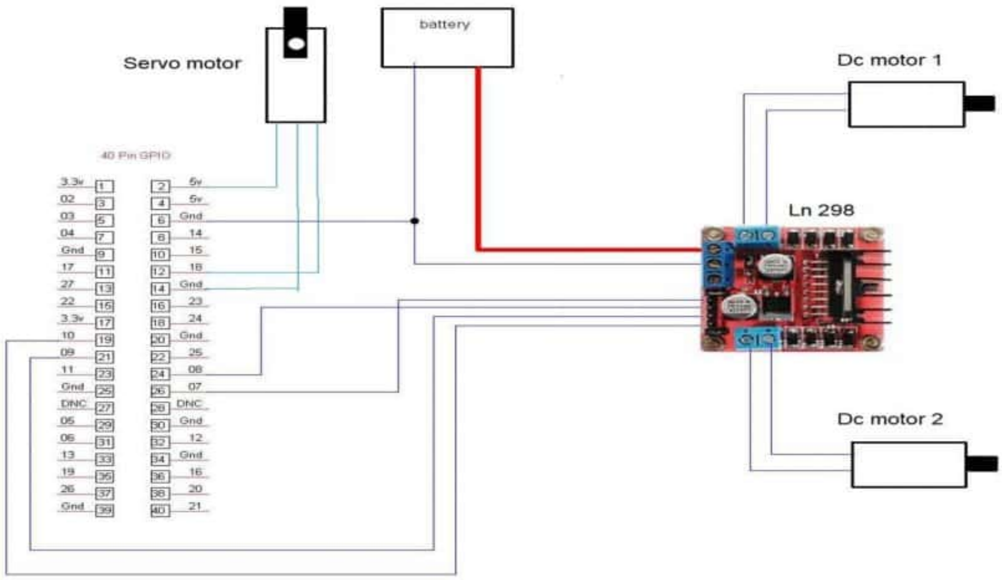

Figure 2.4: Circuit diagram

Chapter 3

Methods and Components

1.Using python library functions like math, numpy and opencv.

2.Using various code optimization like using loops, conditional statements.

3.By exploring and checking availability of components we selected LN298, DC motor, servo motor, raspberry pi3.

4.We went from Arduino to a Raspberry Pi 3 for this project. The Raspberry Pi 3 is also much quicker than the Arduino (1.2 GHz vs. 16 MHz), allowing it to perform common computer functions such as watching videos, accessing the web, and listening to music. If you want to use the Raspberry Pi 3 for media-related applications, this makes it an easy choice.

5.A servo steering system is a simple approach for precisely controlling the steering position of remote control cars and small robots. Servo control, unlike traditional DC motor-based steering, is based on angular degree, allowing the motor to stop and maintain a position without the use of additional mechanical parts or stoppers.

6.Using opencv is better, because it allows you to quickly alter pixels, allowing you to create your own image and video processing algorithms.

7.The Raspberry Pi should not be used to train neural networks. There is just not enough RAM on the Raspberry Pi. The processor is inefficient. In general, it's not the proper hardware for computationally intensive tasks.

Chapter 4

Implementation details

4.1 Specifications and final system architecture

4.1.1 Image Processing

:

readVideo(): The readVideo() function is used to access the video file, which is in the same directory as the program.

processImage(): This function extracts white lane markings and presents them for analysis by following instructions using some processing techniques.

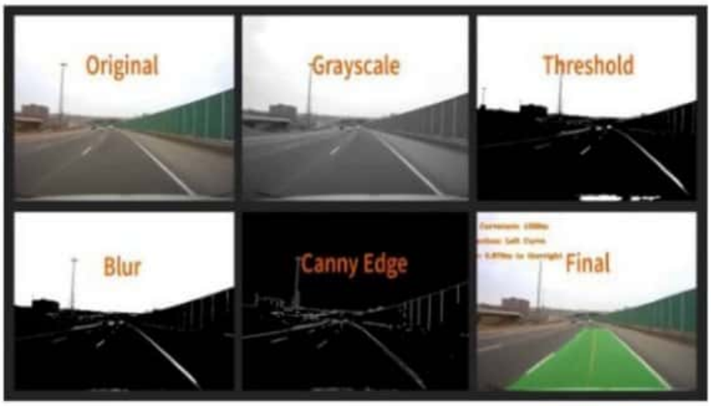

Figure 4.1: Processing Image

perspectiveWarp(): We apply a perspective warp after we have the image we need. Four points are arranged on the frame so that they only surround the lanes, and the data is then mapped into another matrix to provide such a birds eye overview of the lanes.

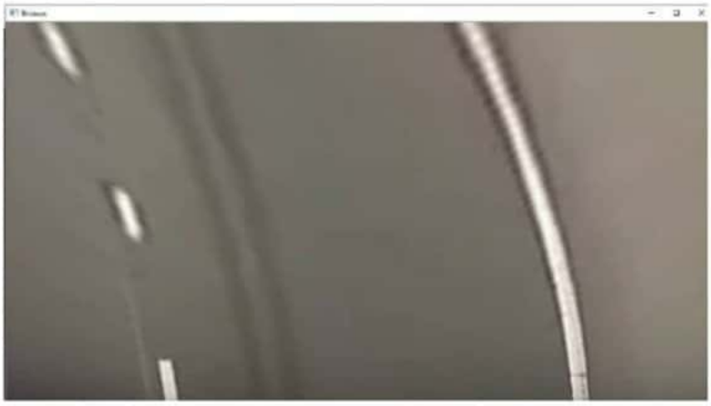

Figure 4.2: Perspective Warping

slidewindowsearch(): A sliding window method is used to determine lanes and their curvature. It generates a box with a lane in the middle and used the data from the past histogram function.

generalsearch() : A sliding window approach will be used to distinguish lanes and their curvature. It produces a box with a lane in the middle and used the data from the past histogram function.

measurelanecurvature() : The np.polyfit() procedure is used again with the information provided by the previous two functions, but the values are multiplied by the x and y variables to convert them from pixel space to meters space.

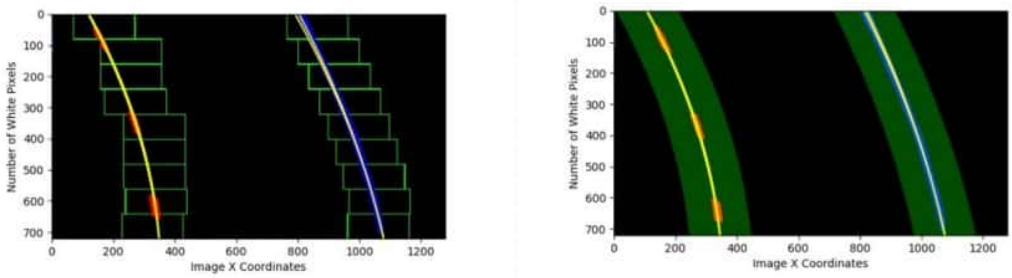

Figure 4.3: Sliding Window

4.2 Mathematical Modelling

Based on Brewnog's idea,

r = s / (sqrt(2 - 2 * cos(2*a/n))

For one complete turn of steering i.e., 360 degree wheel turn by 24 degree.

a=n/2*cos$^-$1$(1 - (s^2/2r^2)$

s = wheel base
a = steering wheel angle
n = steering ratio (e.g. for 16:1, n = 16)
r = radius of curvature, in the same units as the wheel base

Chapter 5

Results and Discussion

5.0.1 Discussion

In this project we have developed a prototype , Which detects the lanes for given real time video using image processing , predict the radius of curvature of lane, curve direction, off center and calculate the steering angle. The steering angle output is fed to the steering system to steer the wheels for given angle and in predicted curve direction.

5.0.2 Results

Sl.No	Output	Radius of curvature
1	Right curve	0477m
2	Left curve	0086m
3	Straight direction	zero

Table 5.1: Results

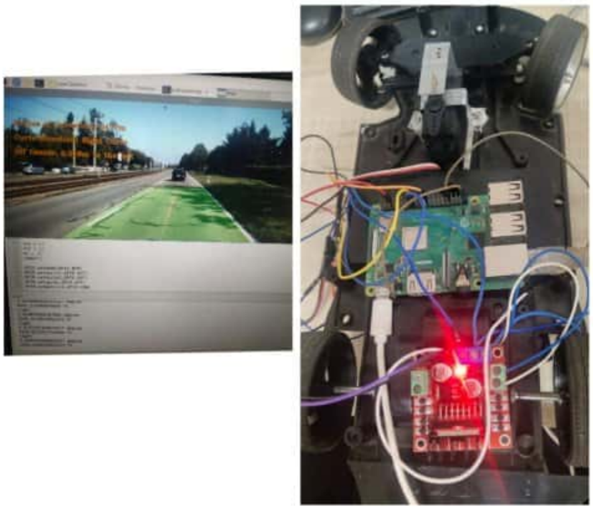

Figure 5.1: Right curve

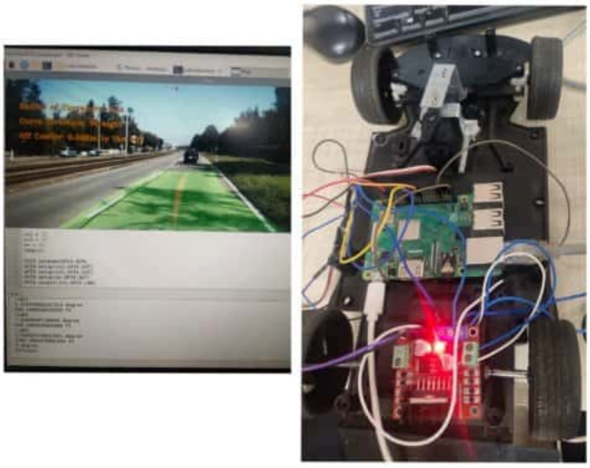

Figure 5.2: Straight direction

Figure 5.3: Left curve

Chapter 6

Conclusion

In Intelligent Transportation Systems, lane detection has proven to be an effective strategy for preventing accidents. It is possible to determine an optimal driving direction for the smart car based on the driving lane, as well as provide the precise position of the vehicle in the lane; these capabilities contribute greatly to enhancing the efficiency and driving safety of automatic driving. Some references [1–5],

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