VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANA SANGAMA, BELGAUM-590018, KARNATAKA, INDIA.

A Project report on

"V-ASSIST: VEHICLE ASSISTANCE AND SAFETY SYSTEM"

in

ELECTRONICS AND COMMUNICATION ENGINEERING

by

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Under the Guidance of

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COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI– 590008

(2021-22)

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CERTIFICATE

Certified that the Project work (18ECP83) entitled **"V-ASSIST: Vehicle Assistance And Safety System"**, is carried out by **Vaibhav Alur** **(2KL18EC118)**, **Yash B. Joshi** **(2KL18EC116)**, **Prashant Bhajantri** **(2KL18EC122)** **and** **Varsha Mattur** **(2KL18EC109)** are bonafied students of **Department of Electronics and Communication Engineering, KLE Dr. M. S. Sheshgiri College of Engineering and Technology, Belagavi,** in partial fulfillment for the award of **Bachelor of Engineering** in **Electronics and Communication** of the **Visvesvaraya Technological University, Belagavi,** during the year **2021-22.** It is certified that all correction/suggestions indicated have been incorporated in the report and has been approved as it satisfies the academic requirements in respect to project prescribed for the said degree.

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(Project Coordinator)	(Guide)
Dr. Dattaprasad A. Torse	**Dr. Basavaraj G. Katageri**
(HOD)	(Principal)

Name of Examiners	Signature with Date
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2. ______________________	______________

KLE Dr. M. S. SHESHGIRI
COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI.

Department of Electronics & Communication Engineering

Vision and Mission of the Department of Electronics and Communication Engineering are:

VISION

To be the center of excellence for education and research in Electronics and Communication Engineering

MISSION

1. To achieve academic excellence by encouraging active student-teacher relation.
2. To groom students with high moral and ethical standards.
3. To promote socially-relevant research and development activities.
4. To collaborate with institutions and industries for knowledge sharing, employability and entrepreneurship.
5. To encourage life-long learning in developing innovative products and services.

PROGRAM EDUCTIONAL OBJECTIVES (PEOs)

The educational objectives of the undergraduate program in Electronics and Communication Engineering are:

1. To impact the knowledge and skills to meet the needs of current and emerging technologies in Electronics and Communication Engineering.
2. To enable active pursuance of life-long study in Electronics and Communication Engineering in order to develop innovative technologies for quality products and services.
3. To cultivate the ethical and socially relevant research and development activities.
4. To impact effective communication skills for success in interdisciplinary and multicultural teams.

Program Outcomes: (POs)

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem Analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes :(PSOs)

1. Demonstrate theoretical and practical knowledge of Electronic and Communication Engineering.
2. Exhibit the technical and soft skills leading to employability.
3. Actively pursue lifelong learning to develop innovative products and services.

KLE Dr. M. S. SHESHGIRI

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Project Work (18ECP83)

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Mapping of Program Outcomes (POs):

Project Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
-ASSIST: VEHICLE ASSISTANCE AND SAFETY SYSTEM	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓

Mapping of Program Specific Outcomes (PSOs):

Project Title	PSO1	PSO2	PSO3
V-ASSIST: VEHICLE ASSISTANCE AND SAFETY SYSTEM	✓	✓	✓

DECLARATION

We hereby declare that the project work and report entitled “**VASSIST: VEHICLE ASSISTANCE AND SAFETY SYSTEM**” has been prepared based on the project work undertaken by us in KLE Dr M.S. Sheshgiri college of Engineering and Technology, Belagavi, during the 7th and 8th semester of academic year 2021-22 under the guidance of Dr. Arun S. Tigadi for the partial fulfilment of the requirement for award of degree of Bachelor of Engineering in Electronics & Communication Engineering of Visvesvaraya Technological University, Belagavi.

We also declare that the report has been prepared with our efforts; That is, it has not been submitted for the award of any academic degree, diploma, or certificate in any other university. All sources of material that are used for this report have been duly acknowledged.

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Every successful work is backed by sincerity and hard work. However, it would not have been possible without various individuals during the course of the project work. We would like to acknowledge the help and encouragement given.

We are deeply indebted and very grateful to the invaluable guidance given by guide **Dr. Arun S. Tigadi**, Associate Professor, Department of Electronics & Communication Engineering.

We would like to thank project coordinator **Mr. Kunjan D. Shinde**, Assistant Professor, Department of Electronics & Communication Engineering, for his kind support.

We would like to express my sincere gratitude to **Dr. Dattaprasad A. Torse**, Professor and Head, Department of Electronics & Communication Engineering, KLE Dr. MSSCET, Belagavi, for his kind support, guidance and encouragement.

We are thankful to our beloved Deans & Principal **Dr. Basavaraj G. Katageri** for providing excellent academic climate.

We would like to thank all the teaching and non-teaching staff of Dept. of E&CE for their kind cooperation during the course of the work. The support provided by the college and departmental library is greatly acknowledged.

We are extremely thankful to our parents and friends, who helped me in one way or the other throughout our project work.

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ABSTRACT

Traffic accidents are becoming more common and serious as civilization has progressed and car sales have increased dramatically. Simultaneously, with both the rapid progress of science and technology, automobile industry has evolved as well, with vehicle safety technology gradually becoming integrated into all areas of the vehicle.

It has been pointed that most of the accidents on the roads are caused by driver faults, inattention and low performance. Increasing stress levels in drivers, along with their ability to multi task with infotainment systems cause the drivers to deviate their attention from the primary task of driving. Hence much emphasis is being given to occupant safety.

Although there are several different implementations of safety systems with different operation conditions, the development of an active safety system inventory becomes a useful tool for experts to have a feel for the generic system, project the functionality of such a system onto available data collected, and, most relevantly, assess if somehow the system completely meets the needs of drivers.

It is critical to comprehend the complete functioning of the system, taking into the consideration, as many design aspects as possible, and incorporate past assessment research when analyzing how safety systems serve drivers' expectations, resulting in an appraisal of total benefit.

There is a trend by automakers to gradually add technologies that collaborate with drivers both in driving and maintaining the car itself, such as: Adaptive Cruise Control (ACC), Anti-Lock Braking System (ABS), Electronic Stability Control (ESC), Lane Departure Warning (LDW),
Left Turn Crash Warning (LTCW), Collision Warning System (CWS), Automatic Emergency Braking (AEB), High Speed Warning (HSW), Curve Speed Warning (CSW), Blind Spot Detection (BSD) and Road Sign Recognition (RSR).

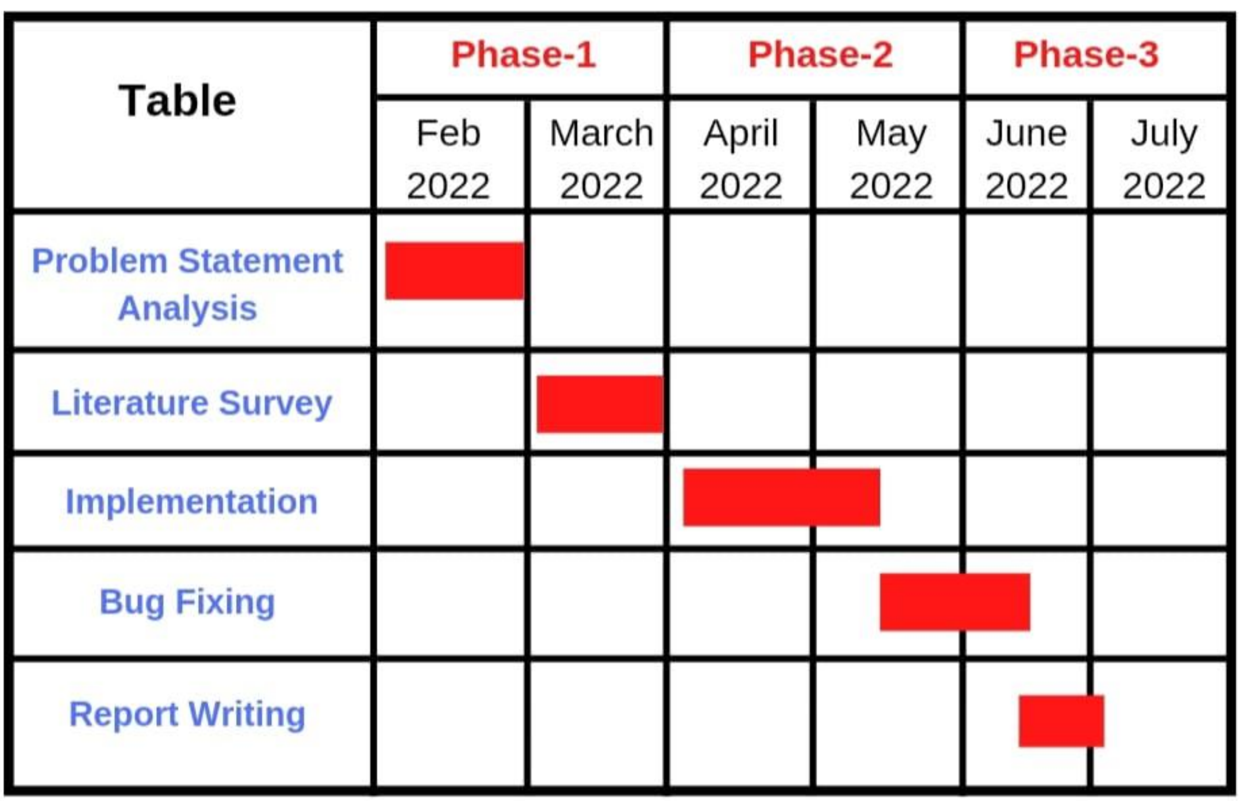
In this report, we aim to implement an ADAS based system on a small remote device and test the algorithm on different scenarios. There are four primary features of active safety system – Adaptive Cruise Control, Emergency Braking System, Blind Spot Detection and Lane Assistance System.

PROBLEM SCENARIO AND STATEMENT

Problem Scenario: "KPIT research and development team observed that more that 50% of total accidents occur at highway. Highway road network which comprises of only 5% of total road network, need extra layer of safety measures to reduce accident rates. In this regard, KPIT wants to overcome this problem by introducing Advanced Driving Assistance System (ADAS) to modern automobiles."

Problem Statement: "To overcome the issue raised by KPIT over the highway safety aspect, we propose an ADAS based system titled "V-ASSIST" comprising of four features – Adaptive Cruise Control (ACC), Lane Assistance System (LAS), Emergency Braking System (EBS) and Blind Spot Detection (BSD). The objective is to solve the major cause of accidents on highway which are generally human errors, lack of quick response in the time of emergency."

Schedule Of The Project



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LIST OF ABBREVIATIONS

V-ASSIST	VEHICLE ASSISTANCE AND SAFETY SYSTEM
ACC	Adaptive Cruise Control
LAS	Lane Assistance System
EBS	Emergency Braking System
BSD	Blind Spot Detection
ADAS	Advanced Driving and Assistance System

CHAPTER 1:

INTRODUCTION

Bearing in mind that car accidents are the 8th leading cause of death globally, and 95% of the accidents are caused by human error, the expectation is that transport automation will represent a significant reduction in the number of occurrences and, mainly, of victims. Although it is still in its infancy, autonomous driving technology is becoming increasingly common and could radically transform our transport system [1].

Different cars are capable of varying levels of autonomy:

- **Level 0:** humans control all significant systems.
- **Level 1:** specific systems, such as cruise control or automatic braking, can be controlled by the vehicle, one at a time.
- **Level 2:** the vehicle offers at least two simultaneous automatic functions, such as acceleration and steering, but requires human beings for safe operation.
- **Level 3:** the vehicle can manage all critical safety functions under certain conditions, but the driver must take over when alerted.
- **Level 4:** the vehicle is fully autonomous in some driving scenarios, although not all.
- **Level 5:** the vehicle is fully capable of autonomy in all situations.

Artificial Intelligence today, using computer vision and other methods, allows the vehicles to differentiate the types of obstacles and situations on the roads so as not only to react according to pre-established parameters but also to learn eventualities.

V-ASSIST is implemented as a part of active safety systems with the aim to provide four key features – Adaptive Cruise Control, Lane Assistance System, Emergency Braking System and Blind Spot Detection. These features are sufficient to provide enhanced safety on highways where majority of accidents occur. The project is designed on Highway Model. There is a trend by automakers to gradually add technologies that collaborate with drivers both in driving and maintaining the car itself, such as: Adaptive Cruise Control (ACC), Anti-Lock Braking System (ABS), Electronic Stability Control (ESC), Lane Departure Warning (LDW), Left Turn Crash

Warning (LTCW), Collision Warning System (CWS), Automatic Emergency Braking (AEB), High Speed Warning (HSW), Curve Speed Warning (CSW), Blind Spot Detection (BSD) and Road Sign Recognition (RSR).

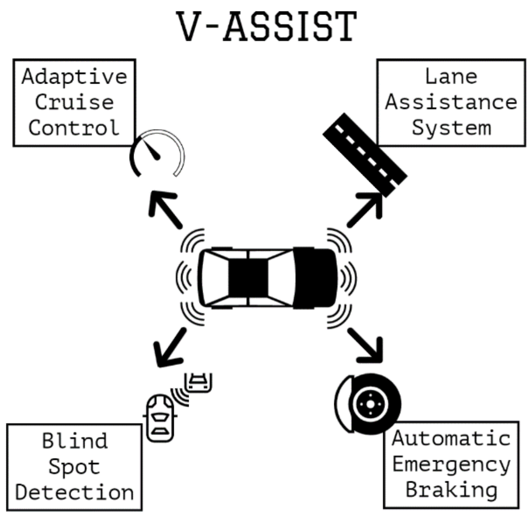

Fig 1.1: V-ASSIST Features

Autonomous vehicles can be further distinguished as connected or not, indicating whether they can communicate with other vehicles and with the city's infrastructure, such as the next generation of traffic lights and traffic management in cities [11].

CHAPTER 2:

LITERATURE SURVEY

Paper No.	Research Paper	Year Published	Author	Remarks
[14]	"An Advanced Lane-Keeping Assistance System with Switchable Assistance Modes"	2020	Y. Bian, J. Ding, M.Hu, Q. Hu, J. Wang & K. Li	To broaden the applicability of LKAS by use of two modes namely, LDP and LK Co-pilot and allowing quick detection of lane. Making the system efficient and reliable by preventing false lane detection
[3]	Mode Switching Strategies for ACC	2020	Y. Liu, C. Fu, X. Tang, M. Hu, C. Guo	Mode-switching strategy is very useful for quick response of the system in various scenarios.
[5]	A Model Reference ACC Approach	2020	A. Abdullahi and S. Akkaya	The Nonlinear equation plays a very crucial role for increasing the stability and smooth operation of a vehicle.
[6]	Longitudinal Control for Stop and Go Operation	2020	T. Kang, W. Y. Choi, C. C. Chung, J. Yang, and S. H. Lee	The time calculation method for three phases helps in smooth deceleration of a vehicle in Stop and Go Operation.
[15]	Under Emergency Braking Conditions, Dynamic Coordinated	2020	YANG YANG 1,2 (Member, IEEE), QINGSONG TANG LI BOLIN, AND CHUNYUN FU are	This paper examines the relationship between the slip rate and braking torque during ABS braking using an electrified vehicle as the research object, and derives the composition rule for the

Paper No.	Research Paper	Year Published	Author	Remarks
	Control for Regenerative Braking System and Anti-Lock Braking System for Electrified Vehicles		members of the IEEE.	braking torque required for ABS braking, which is made up of the ABS steady-state braking torque and the ABS dynamic-adjustment braking torque.
[12]	"On the Image Sensor Processing for Lane Detection and Control in Vehicle Lane Keeping Systems"	2019	C. Y. Kuo, Y. R. Lu, & S. M. Yang	Using Inverse Perspective mapping to determine the exact position of the vehicle in the lane. Enhancing the system for complex road scenarios with low-light conditions
[13]	"Robust multi-lane detection and tracking using adaptive threshold and lane classification"	2019	Son, Y., Lee, E.S. & Kum, D.	Developed a tracking algorithm for multi lane detection which determines the best route for roads with poor markings, guardrails and other obstacles. Enhancing the algorithm to work on Highways with lanes having different speed limits
[16]	Emergency Brake Vehicle Stability Control System on Split-mu Road	2017	Enguo Dong, Lei Zhang	The fuzzy PID approach makes controlling a sophisticated nonlinear ABS system easier. PID's fuzzy membership function performs well in terms of control. The fuzzy PID ABS controller's control results outperform the original ABS controller in terms of brake stability.

Paper No.	Research Paper	Year Published	Author	Remarks
[17]	The vehicle's movement direction is determined by the Pose Transition of a Vehicle in a Blind Spot Area.	2015	Kyeong-Hoon Jung and Kang Yi	Recently, a vision-based blind spot monitoring algorithm that makes use of the rear-view dashboard camera was proposed.
[18]	A Vision System Method for Detecting and Tracking Rear-Side Vehicles	2014	Seung-hwan Baek, Kwang-suck- Boo and Heung-seob - Kim	Detects shadows and edge features in the daytime to identify automobiles. In addition, at night, by the use of locating headlights.
[2]	Cruise Control for IV	2013	Sathiyan, S Paul, A. Selvakumar and Srinivas Kumar	Classification Of Adaptive cruise control gives better understanding of different Cruise modes available in the market.
[20]	Night-Time Blind Spot Vehicle Detection Using Visual Property of Head-Lamp	2011	Jung-Eun Joung, Hyun-Koo Kim, Ju-Hyun Park and Ho-Youl Jung	With a single camera, detects vehicles and motorbikes in neighboring lanes and warns the driver of potentially dangerous circumstances during lane changes.
[19]	On-Road Vehicle Detection during Dusk and at Night	2010	Thomas Schamm, Christoph von Carlowitz, and J. Marius Z¨ollner	After nightfall, color perception and peripheral vision are impaired.
[9]	Lateral control for	2008	Seong Yoon, Man	The obstacle-avoidance algorithm

Paper No.	Research Paper	Year Published	Author	Remarks
	obstacle avoidance		Hyung Lee, Hyung Park, and Jae Heon Ryu	covers the gaps in paper [7]. The angle calculation method is efficient and can be used for quick response.
[7]	String Stability for ACC	2007	Sang Jin Ko and Ju Lee	The Fuzzy-logic algorithm provides better stability for a vehicle moving in distance-control mode.
[8]	Lateral control for ACC	2006	B. A. Guvenc and E. Kural	The various scenarios mentioned in the paper helps to cover different test cases to test ACC. However, the paper does not cover the test cases related to different obstacle appearance.
[10]	Cooperative Cruise Control for ACC	2001	A. Girard, J. Hedrick, J. de Sousa and J. Misener	The architecture for establishing communication with other vehicles can be efficiently used. However, the architecture does not cover the weak signal situation, where the vehicle may connect or disconnect multiple times resulting in inefficient data transfer.

Table 2.1: Literature Survey

CHAPTER 3:

METHODOLOGY, BLOCK DIAGRAM AND FLOW DIAGRAM

Active Safety System is an intelligent real-time system capable of monitoring vehicle environment and actively help the driver to reduce the impact of an emergency situation.

The system has main features as listed below:

1. Adaptive Cruise Control (ACC)
2. Emergency Braking System (EBS)
3. Lane Assistance System (LAS)
4. Blind Spot Detection (BSD)

Project is split into 3 phases,

3.1 Phase 1 - Model Preparation

3.1.1 HARDWARE MODEL

Vehicle model is prepared from scratch. The model blueprint is given below,

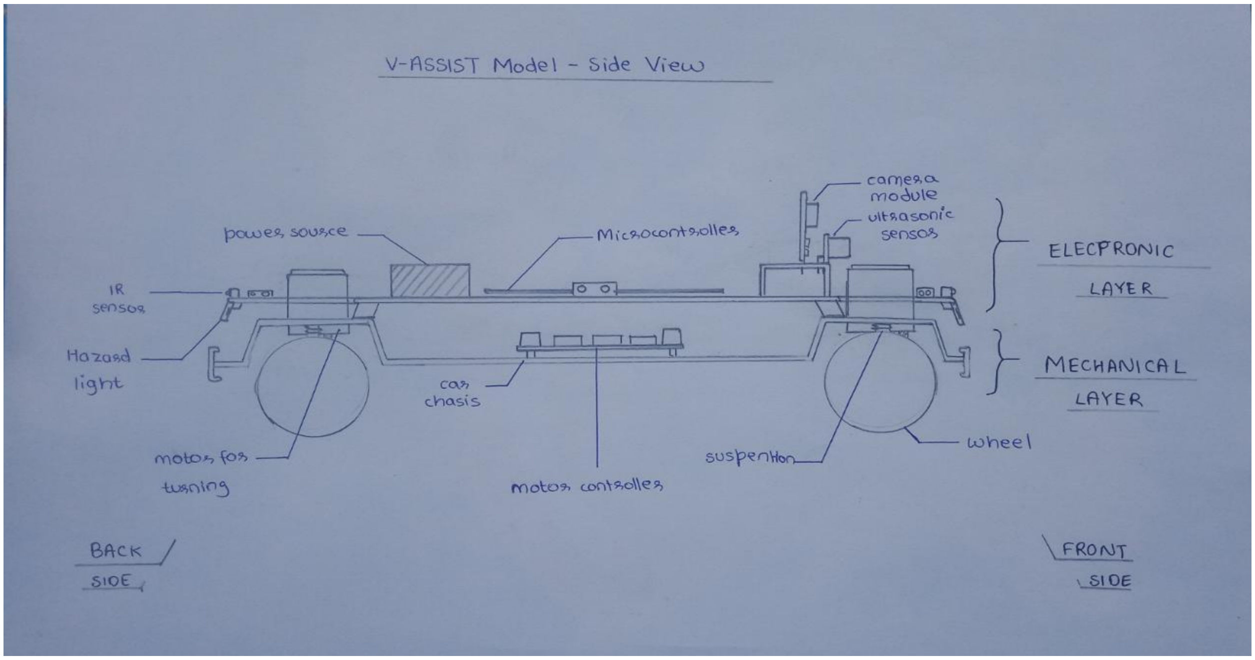

Fig 3.1 Blueprint Model for V-ASSIST

The model has three layers,

3.1.1.1 Bottom Layer:

It consists of motor controller, motors and IR sensors. As shown in the figure, the motor controller is used to control the speed using PWM pins ENA and ENB and directions IN1, IN2, IN3, IN4 of all four motors.

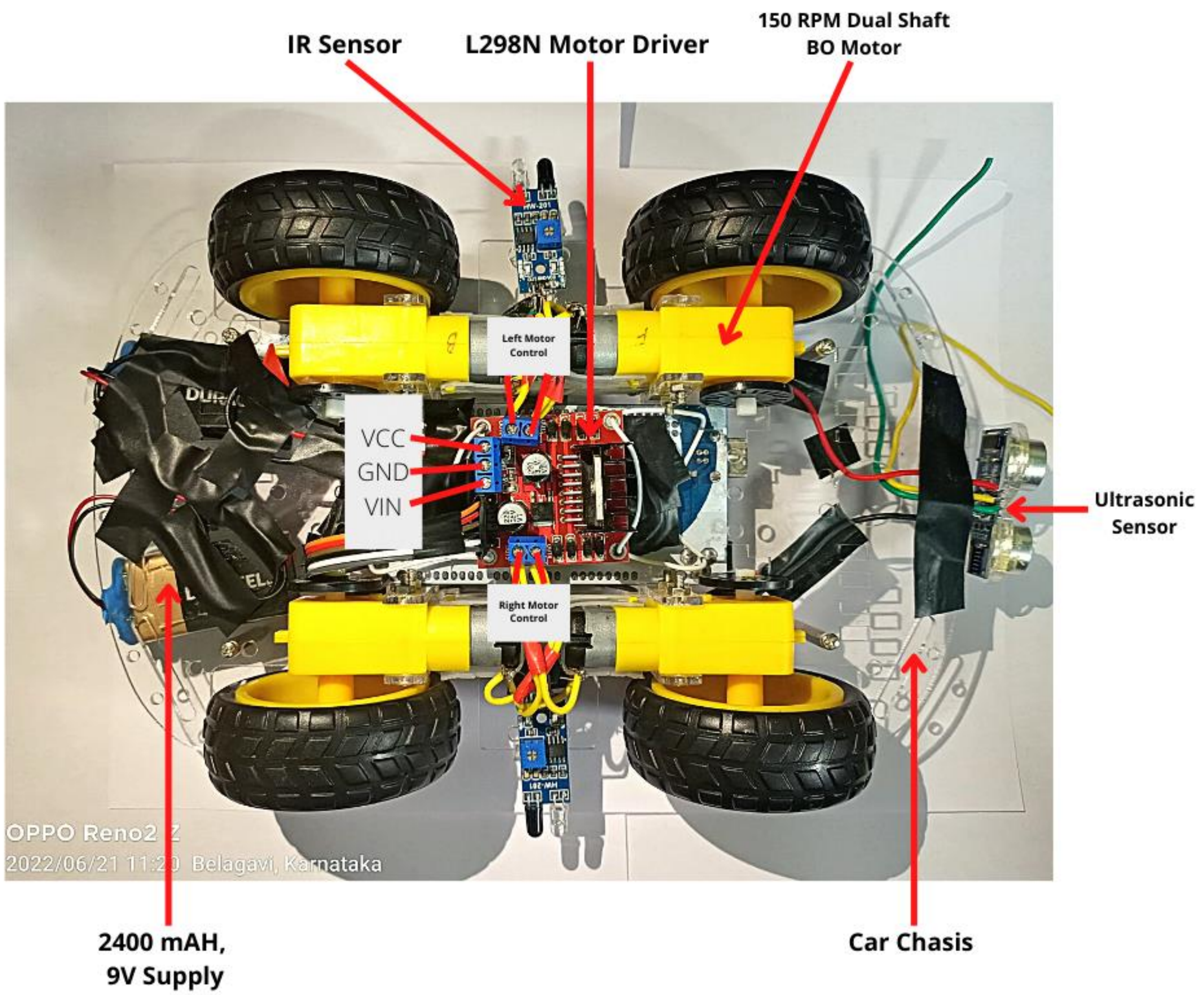

Fig 3.2 Bottom Layer of V-ASSIST Vehicle Model

3.1.1.2 Secondary Layer:

Secondary layer consists of microcontroller – Arduino Mega Board which controls the motor speed and direction, takes input from IR sensor and Ultrasonic sensor and takes command from Raspberry Pi. This layer also has two 9 V, 1200 mAH battery each connected in parallel, used to provide load power to motors. The switch is used to turn ON/OFF the motor system.

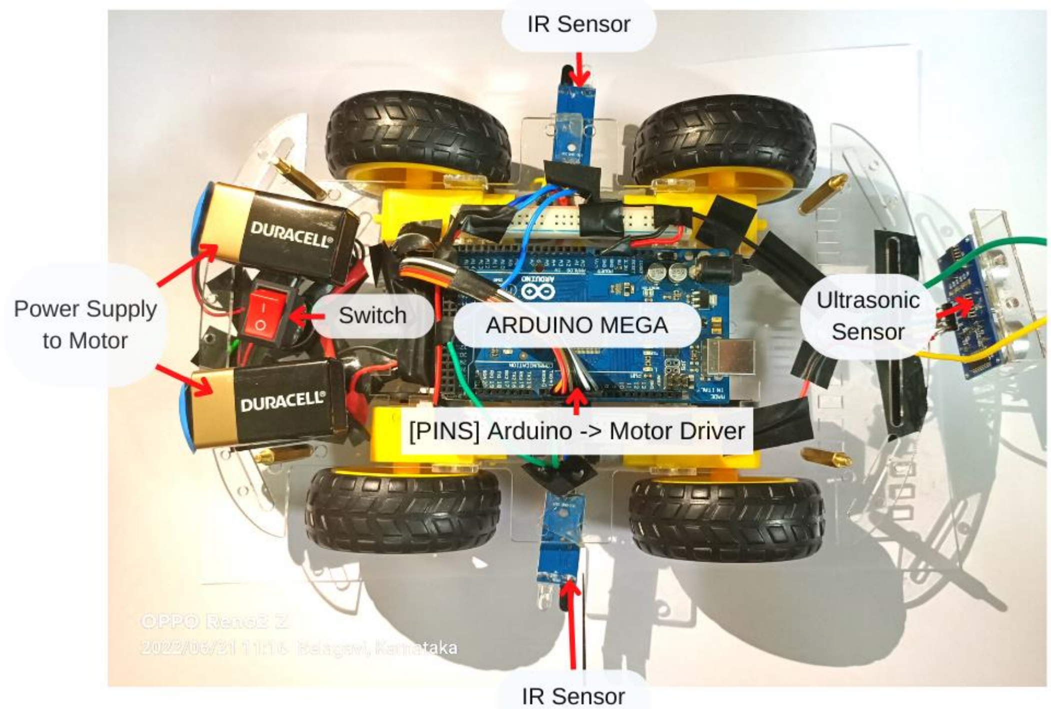

Fig 3.3 Middle Layer of V-ASSIST Vehicle Model

3.1.1.3 Top Layer:

In the top layer, Raspberry Pi model 4b is placed which is the referred as the brain of the safety system. Main function of system is to read the camera input – Pi Camera, process the image and send commands to Arduino for controlling motors. Top layer also has rechargeable battery which supplies 5V to the Arduino.

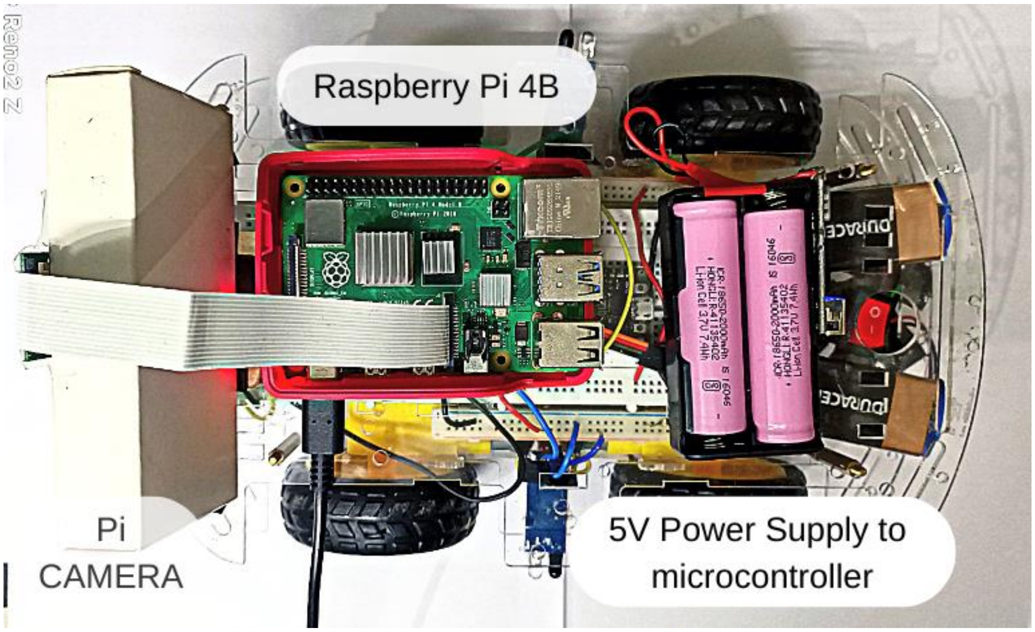

Fig 3.4 Top Layer of V-ASSIST Vehicle Model

The final images of the model are shown below,

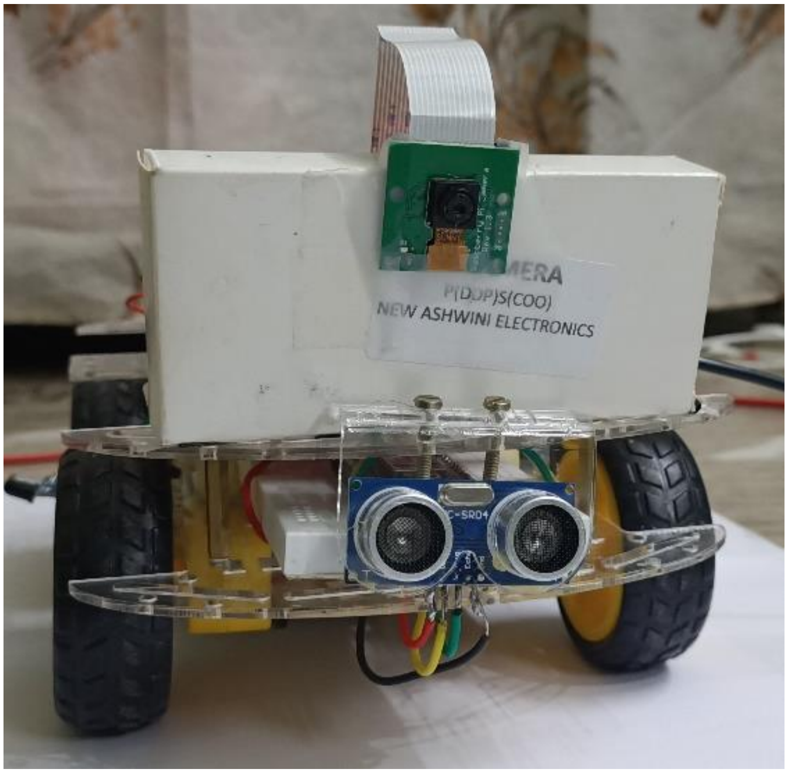

Fig 3.5 Front View Of the model

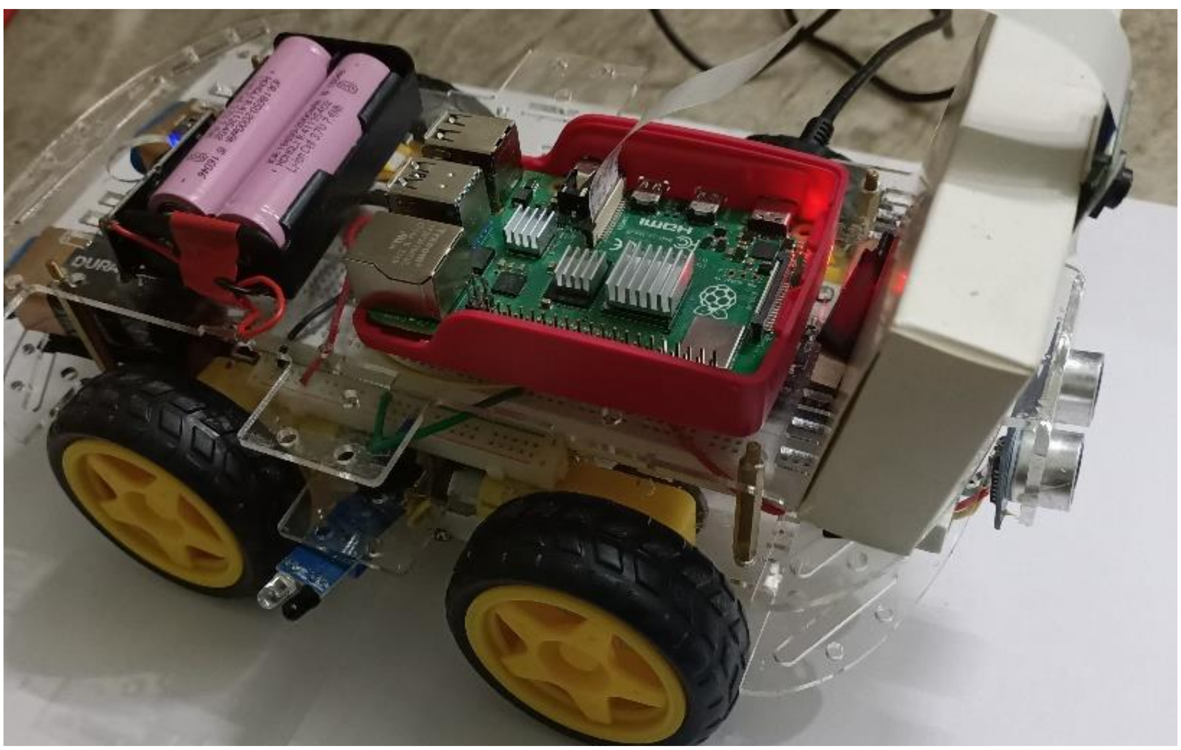

Fig 3.6 V-ASSIST Vehicle Model edge view

3.1.2 HIGHWAY MODEL

Highway model will be created to test the software working of vehicle with crafting of highway model, various scenarios will be created for testing of the algorithm. Below are the images of the test path.

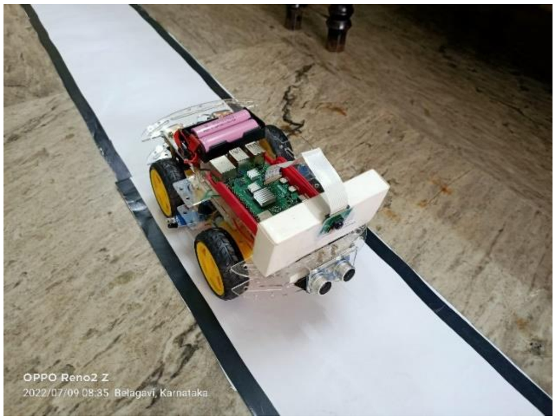

Fig 3.7 Vehicle moving on Highway Path

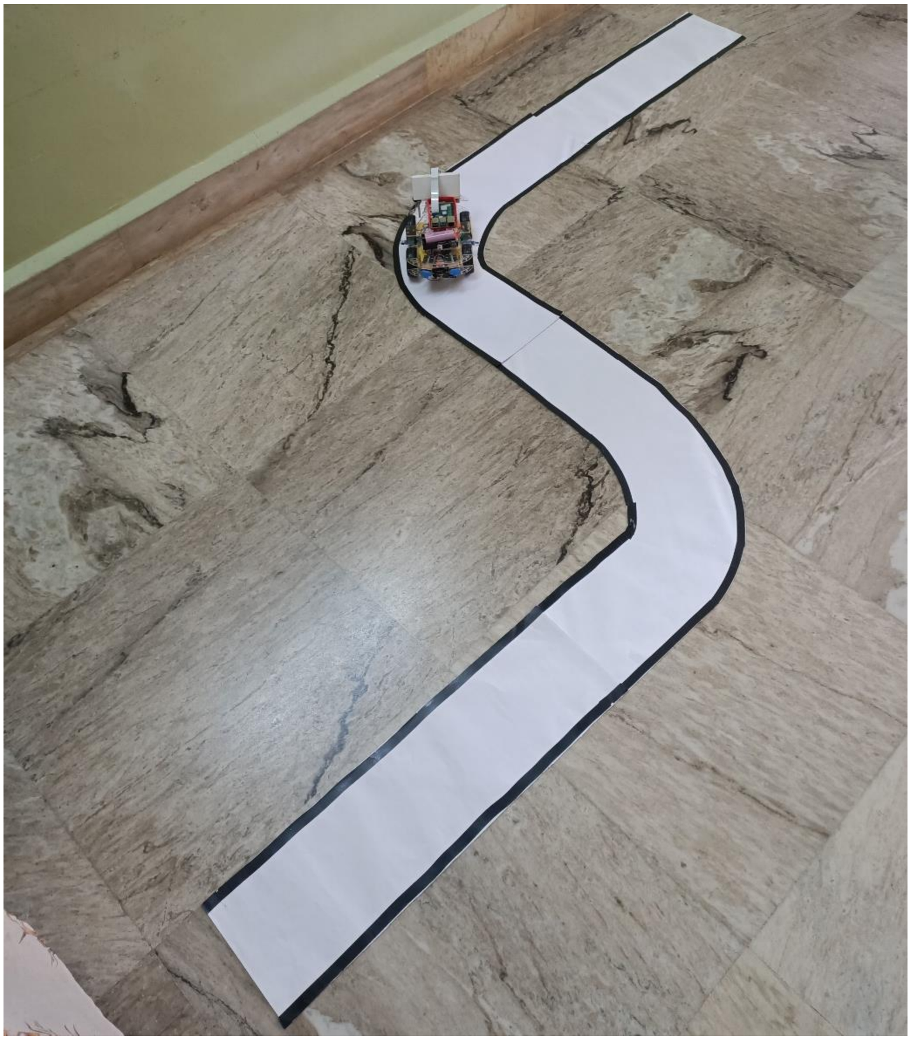

Fig 3.8 The Highway Model

3.1.3 Software Implementation

The core part of the project is to create a real time system by implementing algorithms of different features in a single system. The algorithm is initialised with two global parameters – “spd” and “turn”.

- spd: This variable is mapped between -1 to +1. This variable indicates speed of the vehicle.
- turn: This variable is mapped between -1 to +1. This variable indicates the steering angle of the vehicle.

These two global variables are used as input to function *“vassist.mov(spd, turn, delay)”* which is used to control the movement of the vehicle.

3.1.3.1 Adaptive Cruise Control (ACC)

Vehicles with Autonomous Cruise Control are considered Level 1 Autonomous Car. This feature can be enabled when vehicle is required to run on certain constant speed (> 40 kmph) on highway. Once enabled the vehicle starts monitoring the environment in a loop.

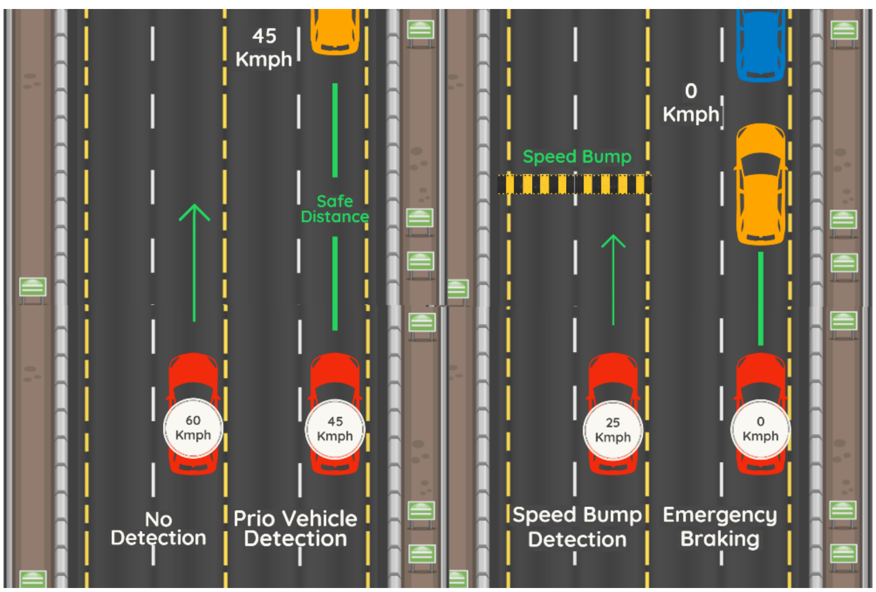

Fig 3.9 Working of Adaptive Cruise Control

Implementation method –

1. When driver activates the *cruise_mode*, current speed is saved in variable *currSpeed*.
2. Obstacle are detected and distance is measured using Ultrasonic sensor.
3. On a free lane, when no obstacle is detected, vehicle operates in velocity control mode. In this mode, the vehicle cruises in *currSpeed*.

4. When obstacle is detected at distance near THRESHOLD, vehicle operates in distance control mode, where the vehicle maintains a constant distance by controlling the *currSpeed*.
5. The global variable spd is updated by assigning it to *currSpeed*.

All such cases will be detected by sensors and camera and interrupt will be called to handle the situation.

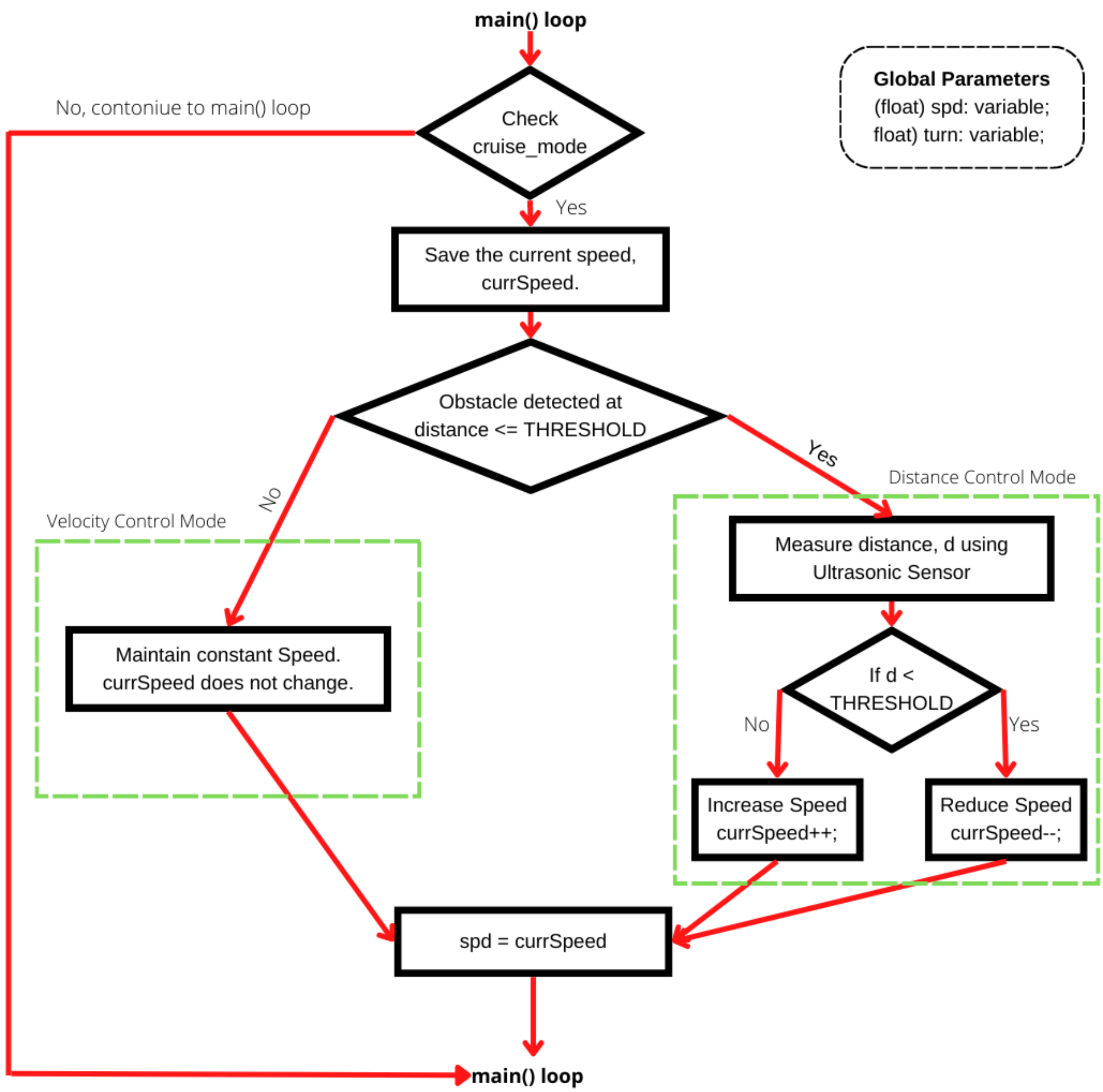

Fig 3.10 Flow Diagram of ACC algorithm

3.1.3.2 Emergency Braking System (EBS)

Majority of accidents occur due to unconsciousness of driver in emergency situation. The vehicle monitors the environment continuously and can avoid or reduce the impact of accident better than drivers. The working principle will be as follows:

1. Vehicle will be running in a loop in cruise mode or normal mode. Ultrasonic Sensor will be actively monitoring the environment.
2. If any obstacle is detected, distance is measured. EBS works two stage braking modes,
   - **ALERT MODE:** If the obstacle is present between *safeDistance* and *minDistance*, driver will be alerted and vehicle will be decelerated.
   - **ACTIVE-BRAKING MODE:** If the obstacle come very near to vehicle with distance less than *minDistance*, vehicle will apply emergency brakes to stop the vehicle. [15]
3. If no obstacle is detected, the control will move on *main()* loop.

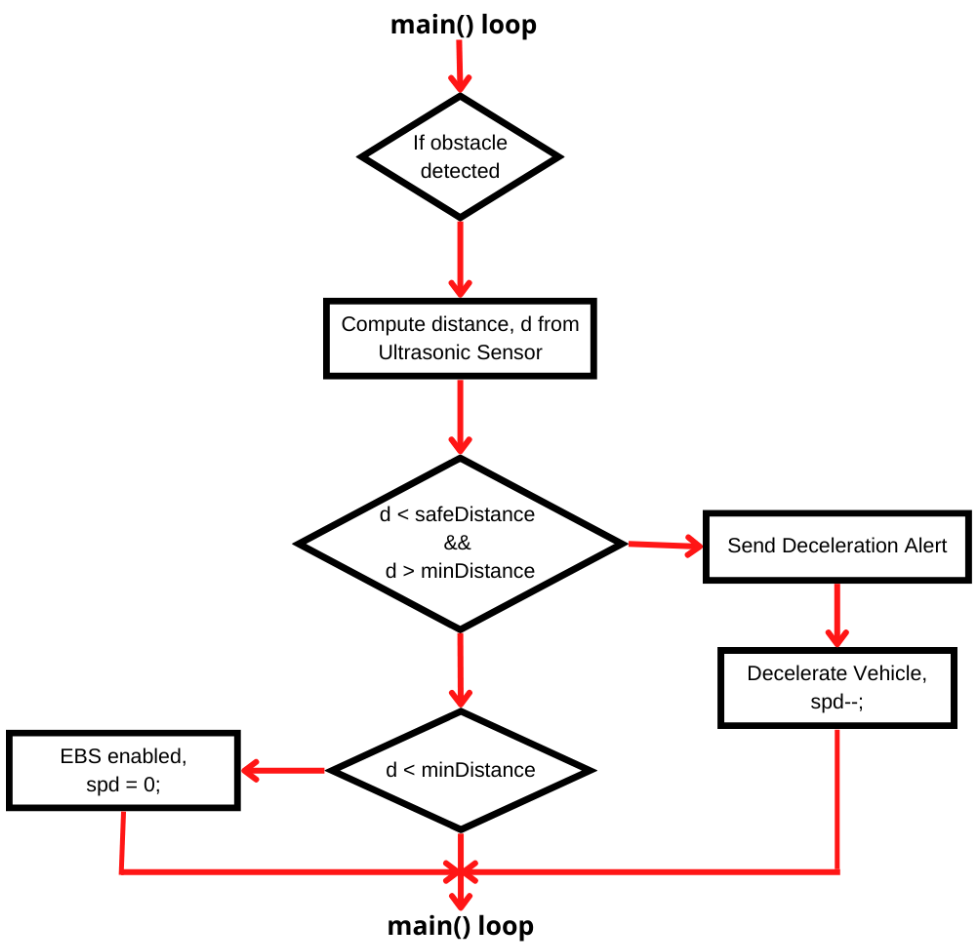

Fig 3.11 Flow Diagram of EBS algorithm

3.1.3.3 Lane Assistance System

Cruise control with lane assist comes under Level 2 Autonomous driving. The camera system detects the lane and assist the driver to smoothly control car on lanes. Implementation include:

1. When Cruise control is activated, LAS performs image processing using camera placed at front.
2. The camera captures real time frames, each frame is analysed by converting it into binary pixel.
3. The binary pixel consists of white lines indicating boundary of the lane.

   The algorithm then computes the curvature angle, using which the steering angle is computed.

   Entire image processing steps is shown below,

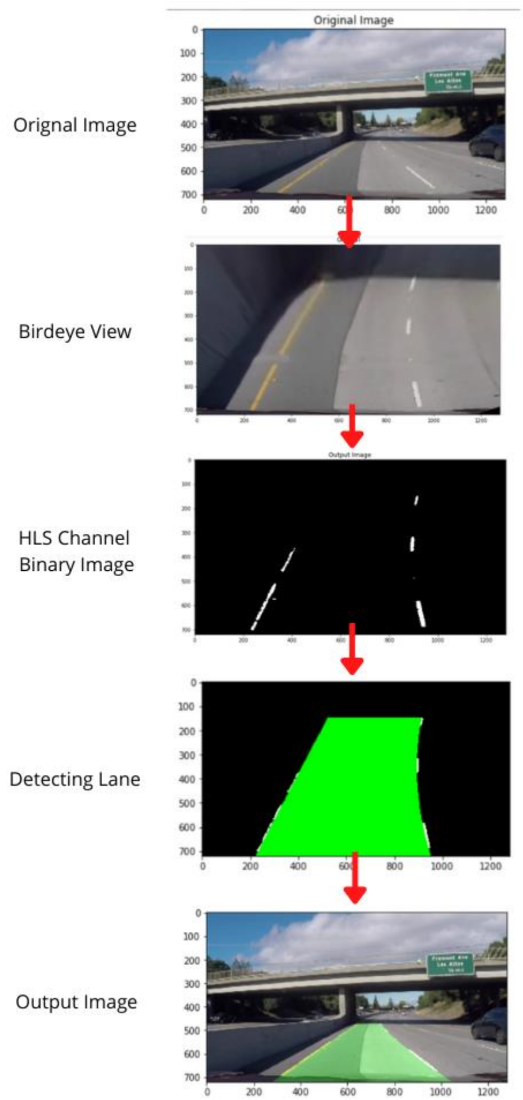

Fig 3.12 Lane Assistance System Algorithm output images after each step

4. Then, using the steering angle, global variable – "turn (-1, +1)" is updated.

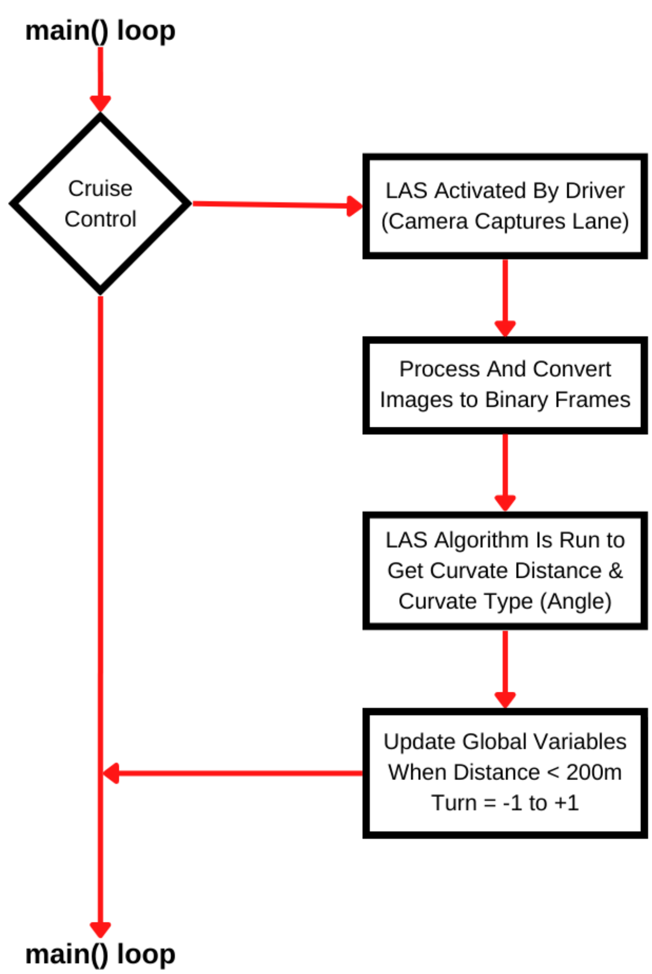

Fig 3.13 Flow diagram of LAS algorithm

Fig 3.14 Original image and output image after Lane Detection

3.1.3.4 Blind Spot Detection (BSD)

It’s a part of lane assistance system but when driver choses to turn the vehicle to another lane, one part of lane approaches vehicle rapidly. Such case will be used for blind spot detection.

Implementation method –

1. Vehicle uses IR sensor to alert the driver on display interface.
2. Blind spot detection also assists driver during parking, busy roads etc.

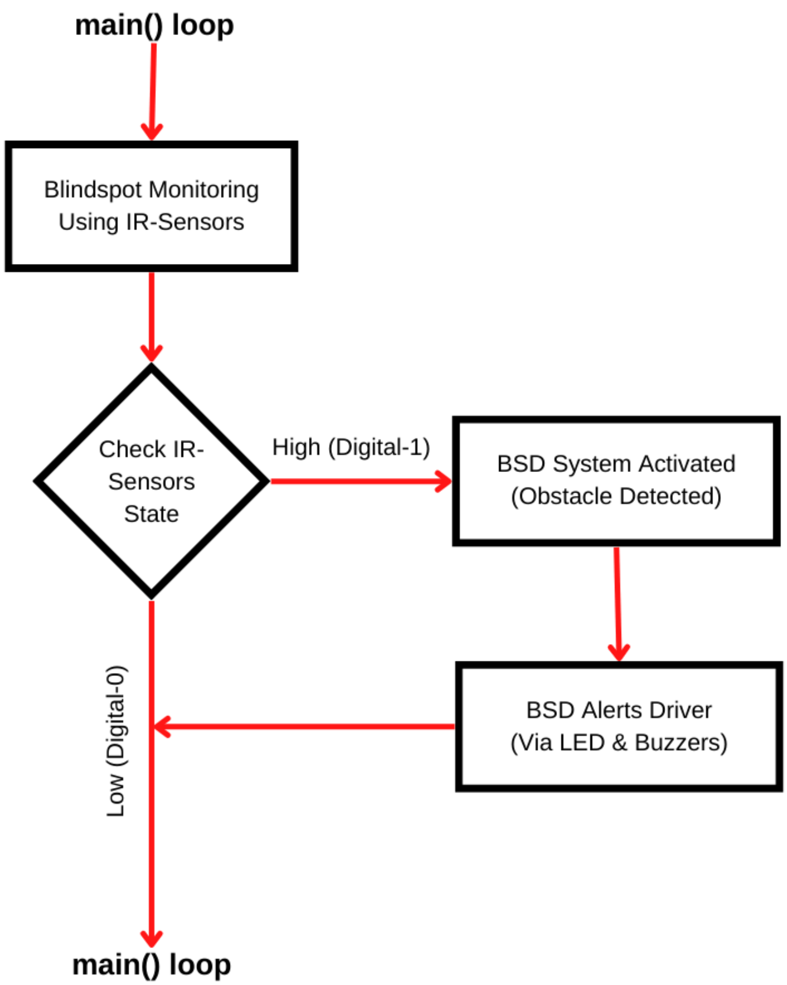

Fig 3.15 Flow Diagram of BSD algorithm

The entire software structure is divided into modules. Using modular programming has several advantages:

1. It helps in efficient program development with well-defined input and outputs.
2. Can be used multiple times. Adding key advantage in Object Oriented Programming.
3. Provides ease of debugging and modifying.

The Software program for V-ASSIST has four modules as shown in figure.

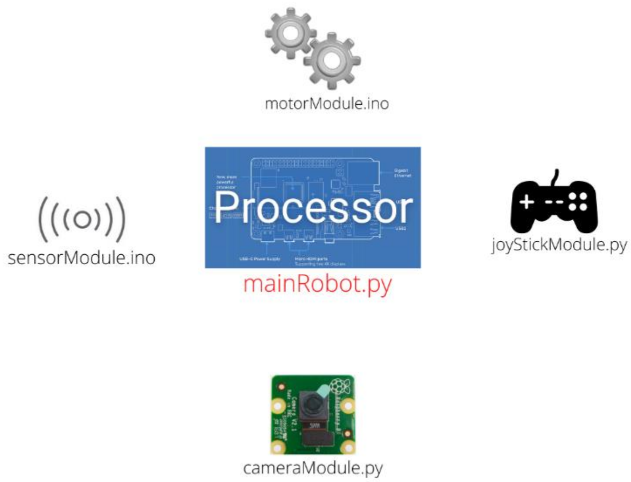

Fig 3.16 Modular programming in V-ASSIST

Each module performs independent processing and returns the result. The main module – mainRobot.py controls the flow of processing and contains main code.

Chapter 4:

CIRCUIT DIAGRAMS AND WORKING COMPONENTS DESCRIPTION

4.1 Circuit Diagram

V-ASSIST hardware models contains wide variety of components. Below figure shows the circuit diagram of the model,

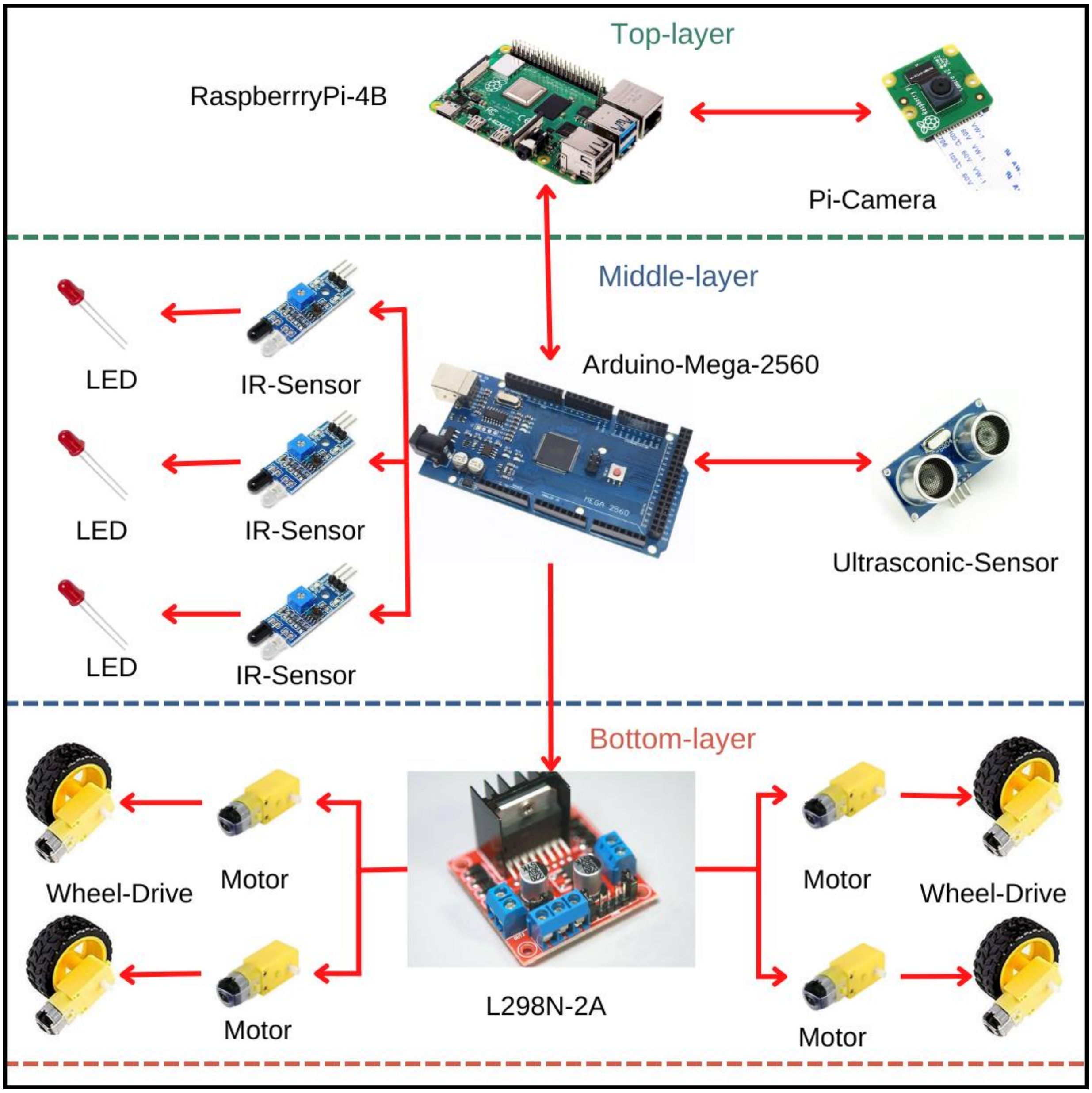

Fig 4.1 Circuit Diagram of V-ASSIST

The Hardware Model is Implemented as seen in the above circuit diagram, It is Divided into 3 Layers.

The Top, Middle and Bottom Layer:

- The Top Layer Consists of RaspberryPi-4B (Master Node) and Pi Camera
- The Middle Layer Consists of Arduino-Mega-2560 (Slave Node) and IR and Ultrasonic Sensors
- The Bottom Layer Consists of L298N-2A Motor Controller Which Controls four motors.

When the vehicle is moving on the lane, The Top Layer consisting of the Pi-Camera continuously monitors the lane ahead, gives this information in form of frames to RaspberryPi-4B in which The Image Processing Algorithm is used to determine and Move the Vehicle forward and maintain it in the lane.

The IR Sensors (Placed at the Middle Layer) detect any obstacle not visible to naked eyes of driver. The Ultrasonic Sensor placed ahead, is used to calculate the distance of the obstacles or moving objects at front.

Whenever IR Sensors detect any objects. They alert the driver using the LED's and Buzzer, i.e., Provide Visual and Audible Alerts. If Obstacle is detected towards left, left side LED and Buzzer are activated and vice versa.

Whenever The Ultrasonic Sensor Detects the distance less than the threshold. The Arduino Board Sends the Signal to Motor Driver to Slow / Decelerate Vehicle. If the Distance becomes too low, then emergency braking is applied and the Vehicle is stopped.

The bottom layer consists of the motor controller, which is controlling the four motors, connected to the 4-wheel drive. The motors are running on a pair of 9V, 1200 mAH Batteries.

4.2 Components Used

4.2.1 Raspberry Pi 4B

- This Raspberry Pi 4 is integrated with a 64-bit quad core cortex- A72 ARM v8, Broadcom BCM2711 and runs at a speed of 1.5GHz. Form Factor: Nano-ITX
- The new Raspberry Pi product is equipped with Bluetooth 5.0, BLE, gigabit ethernet and has 802.11ac wireless at 2.4GHz and 5GHz
- It provides faster data transfer with two USB 3.0 ports, two USB 2.0 ports, micro-SD slot for data storage and loading operating systems
- The Raspberry Pi 4 has 2 micro-HDMI ports (supports 4k@60p), 2 lane MIPI DSI display port, 2 lane MIPI CSI camera port and 4-pole stereo audio and composite video port

Fig 4.2 Raspberry Pi 4b

4.2.2 Arduino Mega

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Fig 4.3 Arduino Mega 2560

4.2.3 Motor Controller L298

This L298 Based Motor Driver Module is a high-power motor driver perfect for driving DC Motors and Stepper Motors. It uses the popular L298 motor driver IC and has the onboard 5V regulator which it can supply to an external circuit. It can control up to 4 DC motors, or 2 DC motors with directional and speed control. An H-Bridge is a circuit that can drive a current in either polarity and be controlled by Pulse Width Modulation (PWM). Pulse Width Modulation is a means of controlling the duration of an electronic pulse.

Features:

- Operates up to 35V DC.
- Drive part of the peak current Io: 2A / Bridge.
- Logical part of the terminal power supply range Vss :4.5V-5.5V.
- Logical part of the operating current range: 0 ~ 36mA.
- Maximum power consumption: 20W

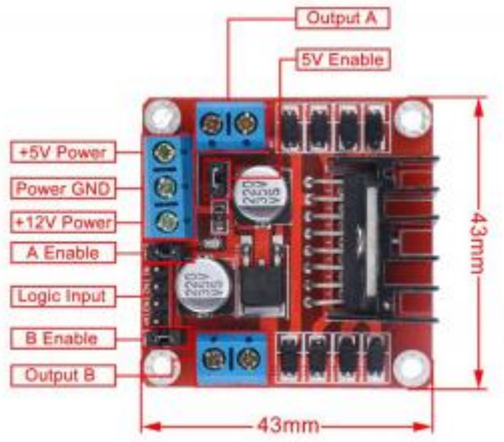

Fig 4.4 L298 Motor Controller

4.2.4 IR Sensor

Infrared Obstacle Avoidance IR Sensor Module (Active Low) has a pair of infrareds transmitting and receiving tubes. When the transmitted light waves are reflected back, the reflected IR waves will be received by the receiver tube. The onboard comparator circuitry does the processing and the green indicator LED comes to life. The module features a 3-wire interface with Vcc, GND, and an OUTPUT pin on its tail. It works fine with 3.3 to 5V levels.

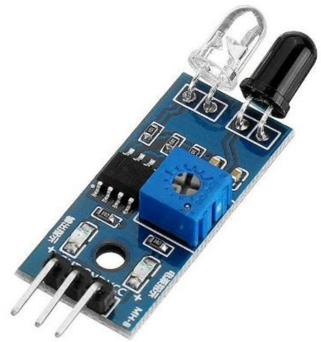

Fig 4.5 IR Sensor Module

4.2.5 Ultrasonic Sensor

It is an ultrasonic sensor module based on the CS100, an industrial-grade ultrasonic distance measurement chip. This chip integrates ultrasonic transmitter, ultrasonic receiver, and digital processing circuits. The distance measurement result output is in the form of pulse width. For an ultrasonic detector, there are two main parts: Emitter and Detector. The emitter transmits an ultrasonic sound wave, and the detector receives back the signal from the emitter reflected by an object. By calculating the travel time and the speed of sound, the distance of the object can be determined.

Fig 4.6 Ultrasonic Sensor

4.2.6 Pi Camera Module

The high-definition 5MP camera delivers outstanding photos but can also shoot video, ideal for drones or a CCTV project. The lightweight camera module allows for it to be used in more practical roles, such as a hidden camera or even a camera for a Pi-phone, for example. The camera connects to the BCM2835 processor on the Pi via the CSI bus, a higher bandwidth link which carries pixel data from the camera back to the processor. This bus travels along the ribbon cable that attaches the camera board to the Pi.

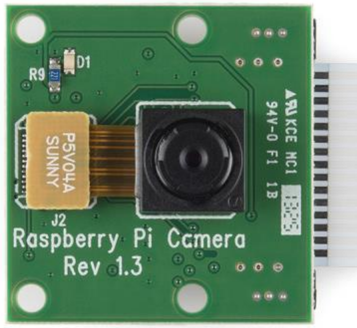

Fig 4.7 Pi Camera Module

4.2.7 60 RPM BO Motor

The 60 RPM Single Shaft BO Motor - Straight motor gives good torque and rpm at lower operating voltages, which is the biggest advantage of these motors.

Small shaft with matching wheels gives an optimized design for your application or robot. Mounting holes on the body & light weight makes it suitable for in-circuit placement. This motor can be used with 69mm Diameter Wheel for Plastic Gear Motors.

Specifications of 60 RPM Single Shaft BO Motor - Straight: -

- Shaft length: 7 mm
- Shaft Diameter: 5.5 mm
- Size: 55 x 48 x 23 mm.
- Operating Voltage: 3 to 12V.
- Current (without loading): 40-180mA.
- RPM: 60 rpm.
- Output Torque: 1 kg cm.

Fig 4.8 60 RPM BO Motor

Chapter 5:

RESULTS AND DISCUSSIONS

The proposed model is carried out in the software and hardware platform. In the software component, the lane from the road is detected by means of using the image Processing Algorithms which can be captured in the use of the 1080p Pi camera and are processed the use of the RaspberryPi-Micro Controller. The proposed lane detection and departure caution system is carried out on a Raspberry-pi-4b Micro Controller with 8GB of RAM and 32GB of storage, with a 1.5GHz 64-bit quad-center ARM Cortex-A72 processor, with 1MB shared L2 Cache using Python and Open-CV virtual environment.

The vehicle is tested on a highway environment, where the vehicle is cruising at constant speed. Apart from cruise control, the vehicle equipped with lane detection is taking small turn on its own.

Fig 5.1 Highway Environment for testing Vehicle Model

The IR sensors used for blind spot detection are able to provide suitable warning to driver, if the driver wishes to change lane manually.

The ultrasonic sensor also responds to emergency conditions when obstacle is too near to vehicle, decelerating or applying emergency brakes to stop the vehicle.

5.1 Simulation Results

Simulation was performed on lane detection algorithm with test images and videos. The Simulation was performed on Jupiter Notebook with tools – python, OpenCV, MPimage, matplotlib and an open-source code was used to implement the algorithm.

The lane is detected by the following steps:

1. Import RGB frame using mpimg library,
2. Convert frame to hls format,
3. Transform frame to Birdseye view,
4. Use l channel image to find right lane,
5. Use h and s channel to find left lane,
6. Merge both images,
7. Detect lane in binary image using open-source function,
8. Calibrate image to normal form from Birdseye view.

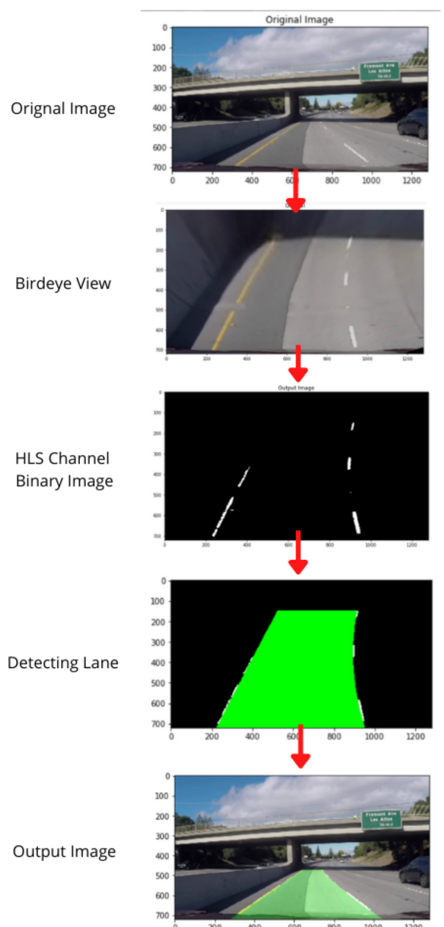

Fig 5.2 Lane Detection Simulation output taken after each step

This is how the resulting image looks like,

Fig 5.3 Input Image and Output Image after Lane Detection

After the processing, the global parameters that control the mobility of the vehicle is calibrated to take proper turns. The results of the algorithm are applicable in highway environment with vehicle running in cruise mode.

5.2 Implementation Details with model Photos

The hardware model is prepared as shown below,

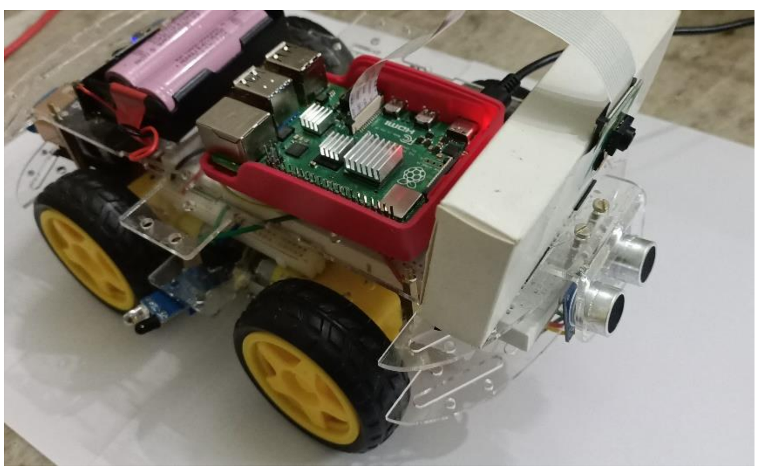

Fig 5.4 V-ASSIST Final Hardware Model

Three features – cruise control, emergency braking and blind spot detection are implemented using hardware by proper used of sensors. However, Lane detection is implemented using software. The algorithm used in simulation is now modified and implemented in Raspberry Pi Board. The camera connected to the board sends continuous streams of frames. The resulting image processing is shown below. At vehicle moves in forward direction when the curvature distance is greater the 2000.

Fig 5.5 Straight Road Lane Detection Output

As the vehicle approaches the curvature, the curvature distance decreases. The image shows the direction the vehicle to take turn. Based on the parameter, if curvature value goes less than 2000, the vehicle should start taking turn based on the type of turn mentioned. It should take soft turn as long as the vehicle distance is less than 1 m away from center. The vehicle takes left turn as shown below,

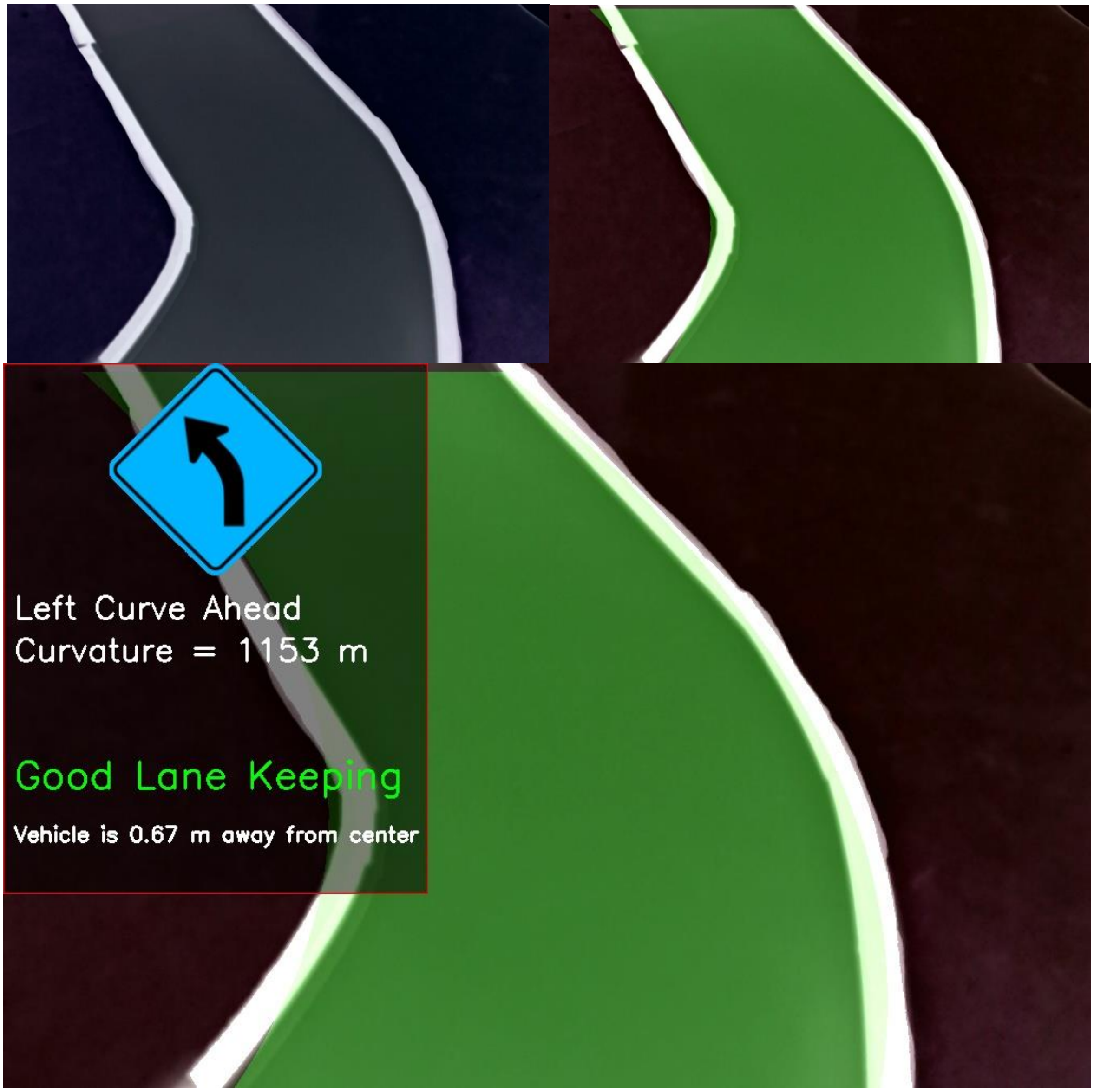

Fig 5.6 Vehicle taking right turn

The image is calibrated by adjusting the contrast, hue, highlight properties to get the best results. Below figure shows the right turn values.

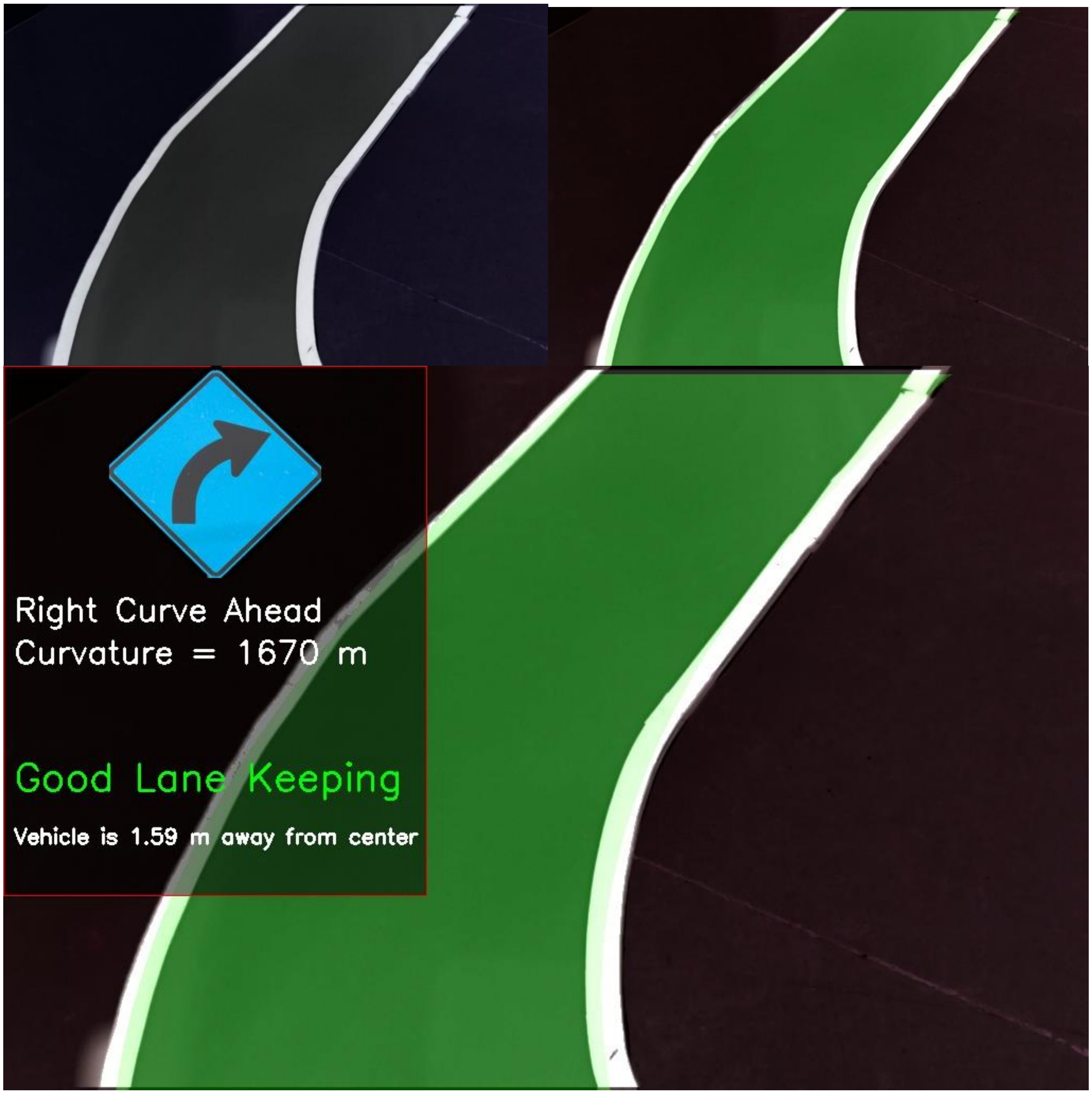

Fig 5.7 Vehicle taking left turn based on Lane Detection Algorithm

The vehicle takes the turn whenever the Curvature is less than 2000 and when vehicle is greater than 1 unit from the center.

The working model of the car cruising at constant speed and taking turns is shown below.

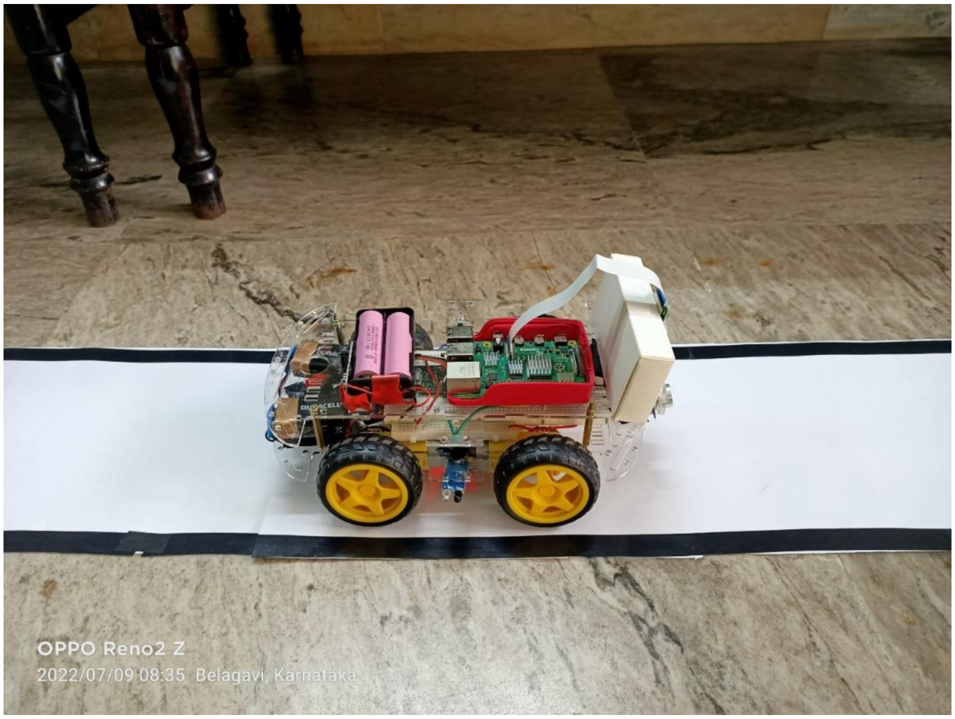

Fig 5.8 Model Pics

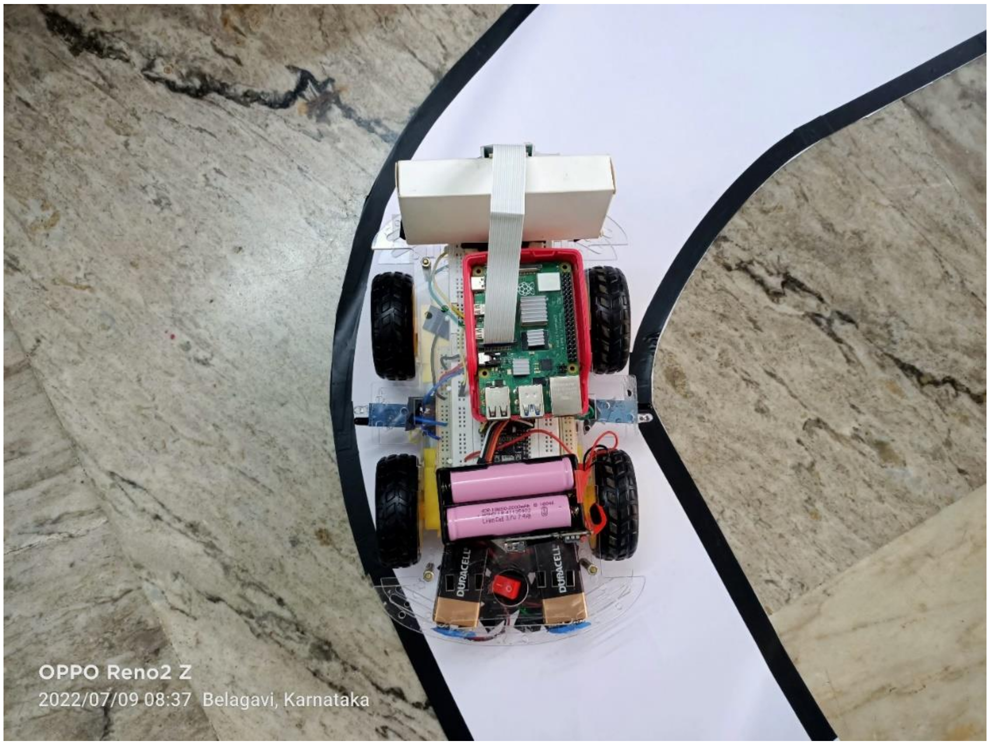

Fig 5.9 Model Taking Turn

ADVANTAGES AND LIMITATIONS, APPLICATIONS

ADVANTAGES:

- Reduction in reaction time for taking preventive actions during accident.
- Steady flow of traffic due to ADAS equipped vehicles on highway
- Self-driving automobiles will save wastage of fuel and reduce pollution by roughly 60%.
- Self-driving cars can easily reach areas where infrastructure is lacking.
- ADAS can make taxis more effective and affordable.
- Greater mobility options for elderly, young and specially abled users.

LIMITATIONS:

- Lack of standardization in the system makes it less user-friendly.
- Denial of insurance claim due to accidents caused by the associated risks with the ADAS.
- Failure or miscalculations of sensor can lead to fatal accidents.
- High cost and maintenance of automotive electronics.
- Replacement of human labor by machines.

APPLICATIONS:

The following are some of the most important safety-critical ADAS applications:

- Detection and avoidance of accidents with obstacles, pedestrians with the help of ACC.
- Warning or correction of lane deviation caused due to drowsiness during long journey.
- Blind Spot monitoring provides drivers with obstacle detection that are difficult or impossible to detect by naked eyes of the driver. They alert the driver by sound or visual medium.
- Automatic EBS provides quick response for prevention of accidents.

CONCLUSION

Given that automotive accidents are the eighth greatest cause of death worldwide, and that 95 percent of accidents are human caused mistakes, transportation automation is expected to result in a considerable decrease in the number of incidences and, more importantly, fatalities. Human error is to blame for almost all car accidents. Advanced Driver Assistance Systems (ADAS) can help you avoid this (ADAS).

The goal of ADAS is to reduce the incidence of car accidents and the severity of those that cannot be avoided, thus minimizing fatal accidents.

The following are some of the most important safety-critical ADAS applications:

- Detection and avoidance of obstacles, pedestrians etc.
- Warning/correction for lane deviation
- Recognizing traffic signals
- Emergency Braking System
- Blind Spot Detection

The ADAS has become even more important as a way in order to reduce car fatalities. EBS, pedestrian detection, surrounding view, parking assist, driver fatigue detection, and gaze detection are some of the ADAS applications that help drivers with stability functionality to reduce car accidents and save lives.

Accidents on the road can be decreased over time using these characteristics.

- The autonomous driving revolution will alter the automobile industry's traditional structure.
- Driving automation will alter infrastructure and older vehicles.
- Self-driving automobiles will save fuel waste and pollution by roughly 60%.
- Self-driving automobiles will allow consumers to avoid vehicle maintenance.
- Self-driving cars will make roads safer, with a 90 percent reduction in traffic deaths predicted.
- Autonomous vehicles could minimize traffic jams caused by stop-and-go driving (where humans, rather than road accidents, develop changes in speeds).

Autonomous vehicles will boost lane capacity by 100%, with a 20% increase in traffic speeds and a 40% reduction in trip times.

FUTURE SCOPE

Safety Systems are the latest trends in automobile industry. Many emerging cars are coming with Safety features that are actively preventing accidents. Our project aims at features for driver convenience and safety. With this features the accidents on road can be gradually reduced.

- Autonomous driving revolution will change the usual structure of the automotive industry
- Automation of driving will change infrastructure and legacy vehicles
- Driverless cars will cut fuel waste and reduce about 60% of fuel emissions
- Autonomous cars will help users to get rid of vehicle maintenance
- Driverless cars will make roads safer, with an estimation of 90% reduction in traffic deaths
- Autonomous cars could eliminate the waves of traffic created by stop-and-go behavior (where humans, rather than road accidents, develop changes in speeds).
- Autonomous Vehicles will increase the lane capacity by 100 % with 20 % increase in traffic speeds and reduce travel times by 40%.

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APPENDIX

Source Code or Related Details of Work:

Open-Source Code: https://github.com/Dt-Pham/Advanced-Lane-Lines

Software Code: https://github.com/YJ-928/V-ASSIST-VEHICLE-ASSISTANCE-AND-SAFETY-SYSTEM.

Datasheets:

Raspberry Pi 4B: https://datasheets.raspberrypi.com/rpi4/raspberry-pi-4-datasheet.pdf

Arduino Mega 2560: https://www.robotshop.com/media/files/PDF/ArduinoMega2560Datasheet.pdf

Motor Controller: https://www.sparkfun.com/datasheets/Robotics/L298_H_Bridge.pdf

IR Sensor: https://components101.com/sites/default/files/component_datasheet/Datasheet%20of%20IR%20%20Sensor.pdf

Ultrasonic Sensor: https://cdn.sparkfun.com/datasheets/Sensors/Proximity/HCSR04.pdf

Pi Camera: https://cdn.sparkfun.com/datasheets/Dev/RaspberryPi/RPiCamMod2.pdf

BO Motor: https://robu.in/product/bo-series-1-60rpm-dc-motor-straight/