Computational Methods and Modeling for Engineering Applications

GENG 8030

ADAPTIVE CRUISE CONTROL USING MATLAB

Submitted by

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ABSTRACT

Any feature which can offer a comfortable driving environment ends to be an attractive selling point of a vehicle. That feature must be driver-friendly at the same time must increase the economic viability of the vehicle. These requirements of satisfied by two systems called cruise control and adaptive cruise control modes. These mechanisms effectively reduce the driving stress by enabling the vehicle to achieve partially automated motion. It also offers to increase the fuel economy by maintaining the set speed of the vehicle.

This project concentrates on constructing a mini set up to represent the functioning of cruise control and adaptive cruise control modes by using MATLAB software. The Arduino Uno microcontroller board is used to create the interface between code generated using the software and the sensory input. Ultrasonic sensors are used to detect the obstacle and revert with signals to the Arduino board. Mode shifting can be achieved by using buttons and the display unit is used to display the current speed of the vehicle. The interconnections are made on a breadboard using jumper wires.

This setup enables to accomplish the systems of cruise control and adaptive cruise control mode. The cruise control mode allows the user to set the speed of the vehicle. This set speed is maintained throughout the journey until manual acceleration or deceleration. The adaptive cruise control mode is the modernized version of the cruise control mode. This mode along with facilitating the user to set a constant speed value can also detect a hindrance in the path of motion and thereby reduces the speed of the vehicle. Once the obstacle is out of the lane, the speed of the vehicle gradually increases until the set speed value is achieved.

Keywords: Arduino Uno, ultrasonic sensors, MATLAB, adaptive cruise control

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CHAPTER 1

INTRODUCTION

The significant growth of stress related to driving includes worst road conditions, unprecedented weather conditions, and severe traffic, which demands driver-friendly technology to overcome the above-stated issues. A self-sufficient vehicle that could evaluate its surrounding conditions and navigate to the destination with minimal human effort is already prevalent in the automotive industry. This can be achieved by a technology called the cruise control system. It is an Advanced Driver Assistance System (ADAS) that controls the speed of the vehicle by maintaining the constant speed specified by the driver [1]. The Adaptive Cruise Control (ACC) system is an advanced version of the cruise control system wherein along with maintaining a constant speed, it also maintains a safe distance from the vehicle in the front using proximity sensors.[2]

The objective of this project is to develop an ACC model using MATLAB software. This can be achieved by establishing an interface between Arduino UNO and the sensors. In simple terms, the code generated in the software will be fed into the Arduino microcontroller with specific conditions. The Arduino board and the sensors will be interconnected using a breadboard and jumper wires. The sensors will be actuated according to the signals received and display the readings through an anode display unit concerning the code conditions.

CHAPTER 2

PROJECT OBJECTIVE

The following objectives are to be achieved to obtain the result of the project:

- Purchasing the components such as Arduino Uno board, breadboard, buttons, resistors, sensors, jumper wires, and display unit.
- Building a suitable model in MATLAB software while considering the test cases to achieve the final conditions of the project.
- Developing a program code to feed into the Arduino microcontroller.
- Establishing an interface between the sensory input, Arduino Uno, and the display unit employing the breadboard and wires.
- Enabling the Arduino Uno to process the sensor signal by interfacing with the code running laptop.

The primary objective of the project is to build a successful ACC model using MATLAB software such that the following conditions are achieved:

- Maintaining a constant speed of the vehicle without manual intervention.
- Decelerating the speed of the vehicle when there is a hindrance (such as another vehicle) in the path of motion.

CHAPTER 3

ACCESSORIES AND COMPONENTS

3.1 Arduino Uno:

It is a microcontroller board that comprises 14 digital input/output pins out of which 6 pins can be used for Pulse Width Modulation (PWM) output and another 6 pins can be used for analog inputs. It also consists of a microcontroller chip, ATmega328P which has 32KB programmable flash memory with an 8-bit processing speed. This can be easily connected to a computer using a USB cable and get it started [3]. The program code developed using the software will be fed into this board.

Figure 1: Arduino Uno Microcontroller [3]

3.2 Liquid Crystal Display (LCD) unit:

This is an electronic display unit for displaying numerals along with alphabetical messages. The pin configuration of the display unit includes Read/Write (R/W) pin, a register select (RS) pin, an enable pin, and 8 data pins [4]. In this project, it will be employed to project the current mode and speed of the vehicle.

Figure 2: Liquid Crystal Display unit [5]

3.3 Ultrasonic sensors:

These types of sensors work by the principle of emission of ultrasonic sound waves. These sound waves are reflected by a hindrance in the pathway thereby converting the sound into an electrical signal. They are mainly used as proximity sensors in the ACC model for vehicle deceleration when it finds a hindrance in the path of motion. It consists of two components namely transmitters and receivers to send and receive the sound waves [6].

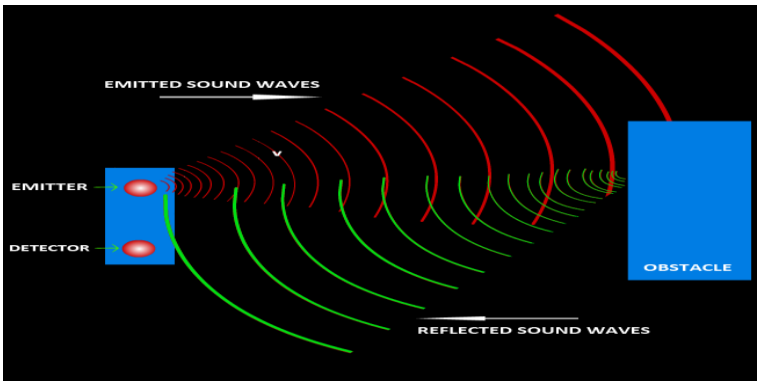


Figure 3: Working of Ultrasonic sensor [6]

3.4 Buttons:

Buttons are used to control the entire circuit setup. In this project, 5 buttons are used for different purposes namely: set speed button (sets the constant speed to be maintained), adaptive speed button (maintains the constant speed until faced by a hindrance), increase speed button (accelerates the speed for every press), decrease speed button (decelerates the speed for every press) and cancel button (cancels the current circuit operation mode).

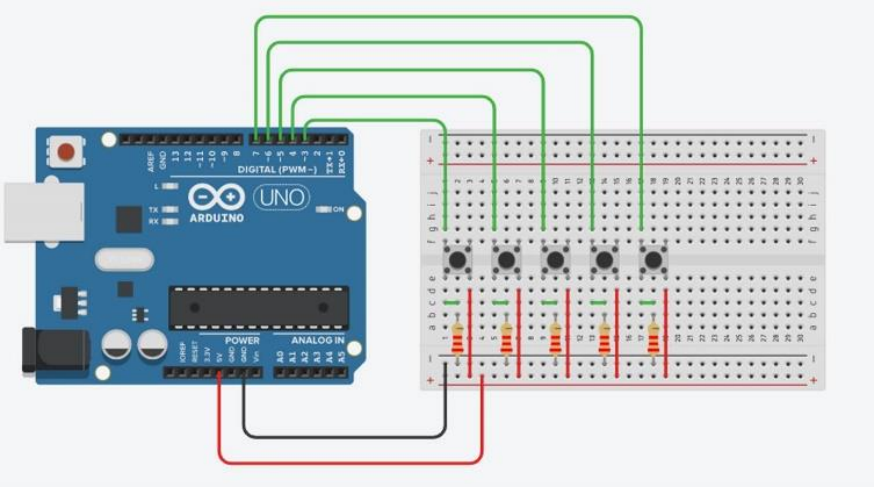


Figure 4: Buttons [7]

3.5 Breadboard, jumper wires, and resistors:

These are accessories that create the interface between the above-mentioned devices. The breadboard is the platform board with several plug-in holes through which the Arduino board, buttons, ultrasonic sensors, and anode display are interconnected by using jumper wires. The resistors (220 Ω) are used to regulate the current flow through certain circuitry connections.

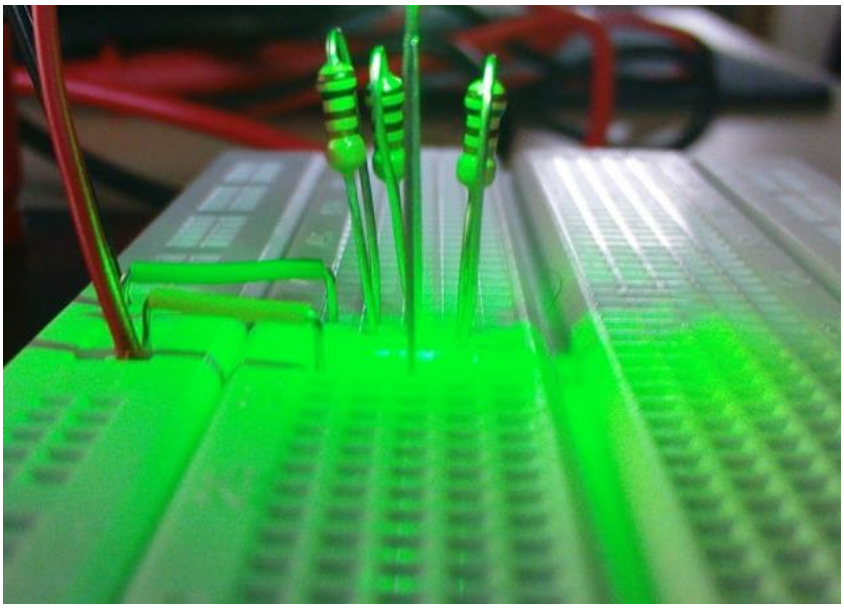
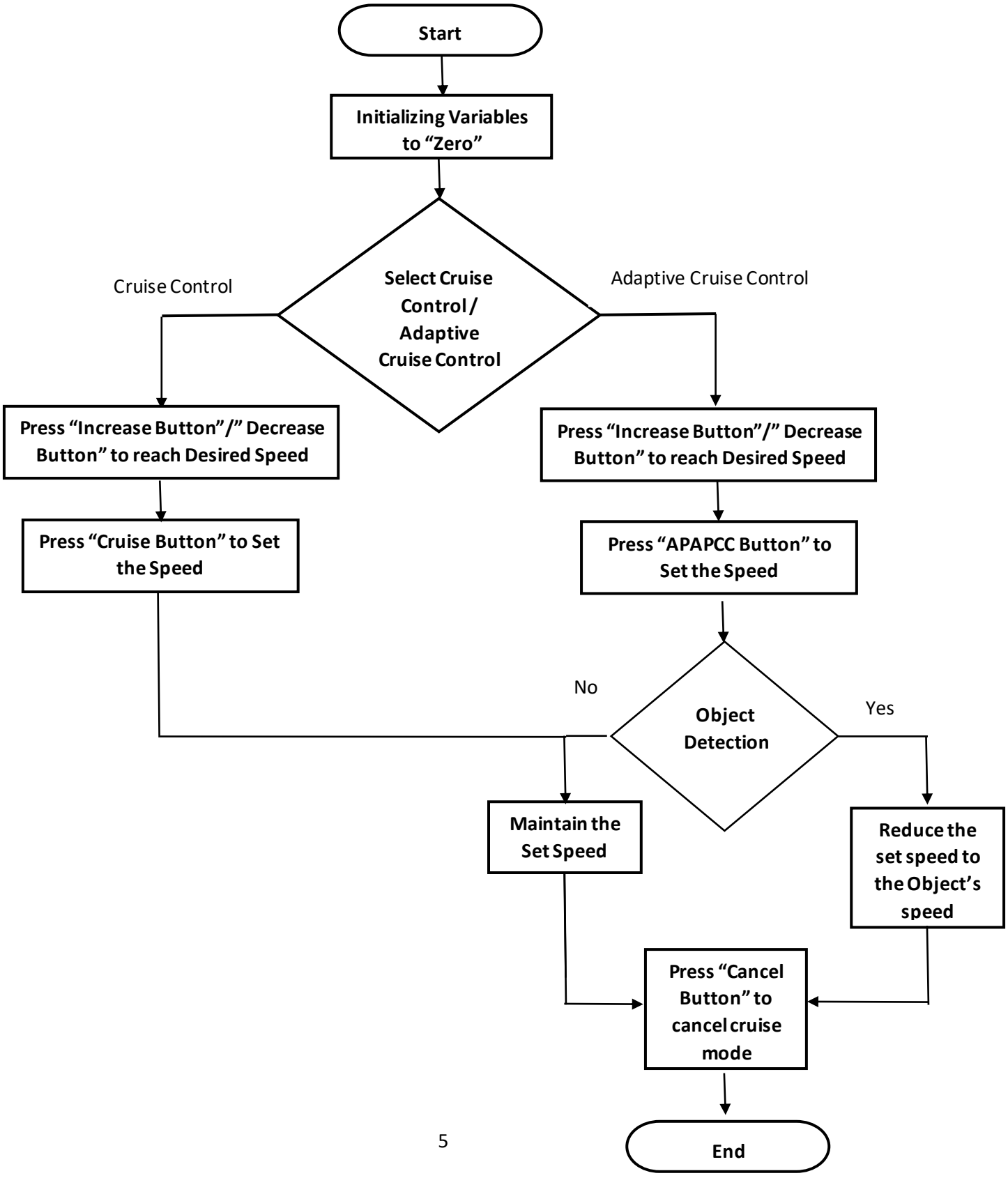


Figure 5: Breadboard, jumper wires, and resistors [8]

CHAPTER 4

FLOW CHART



CHAPTER 5

IMPLEMENTATION PROCEDURE

The mechanism and operation of Cruise Control (CC) and Adaptive Cruise Control (ACC) were investigated at the beginning of the project. The logic for creating a little prototype that depicts how CC and ACC work was devised. It was transformed into an algorithm that was used to create MATLAB code. The Arduino and the libraries required for the prototype are first set up in the code. The LCD and Ultrasonic sensor are then initialized by the model, with all variables mentioned in the code set to zero. According to the circuit diagram, the buttons and pins were defined. To accomplish the project's goal, five buttons were employed in all. The logic was written in MATLAB using a while loop and stacked if-else statements. The final output of vehicle speed was displayed in the LCD using the "printLCD" command.

The Arduino welcome kit was used to set up the hardware. One LCD, one Arduino UNO, two breadboards, and one ultrasonic sensor were among the key components used. There were also five buttons and five resisters employed. These components were connected using jumper wires to the breadboard according to the circuit design, with the positive end connected to the Arduino's 5V pin and the negative end to the ground pins. Because the power supply within the breadboard had broken, jumper wire was utilized to extend the supply. The USB wire was used to power the Arduino.

The "MATLAB Support Package for Arduino Hardware" was installed to set up MATLAB. The port to which Arduino was connected was also set up at the same time. The MATLAB code was then tested before being transferred to the Arduino UNO for programming. Several tests were carried out using the programmed Arduino in accordance with the test procedures.

CHAPTER 6

PROJECT WORKING MECHANISM

The project focuses on achieving the mechanism of two modes which include cruise control mode and adaptive cruise control mode. The set speed button is used to calibrate the constant speed of the vehicle thereby accomplishing the cruise control mode. The increase and decrease speed buttons are used to adjust the speed at which the vehicle has to move. When the cancel button is pressed the system abruptly exits the current mode and gradually decreases the speed of the vehicle.

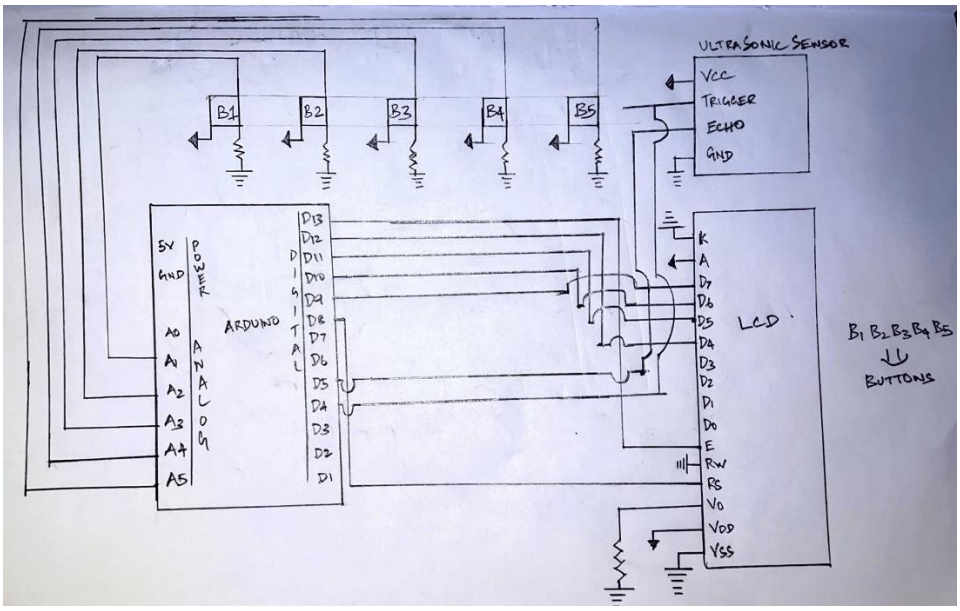


Figure 6: Circuit Diagram

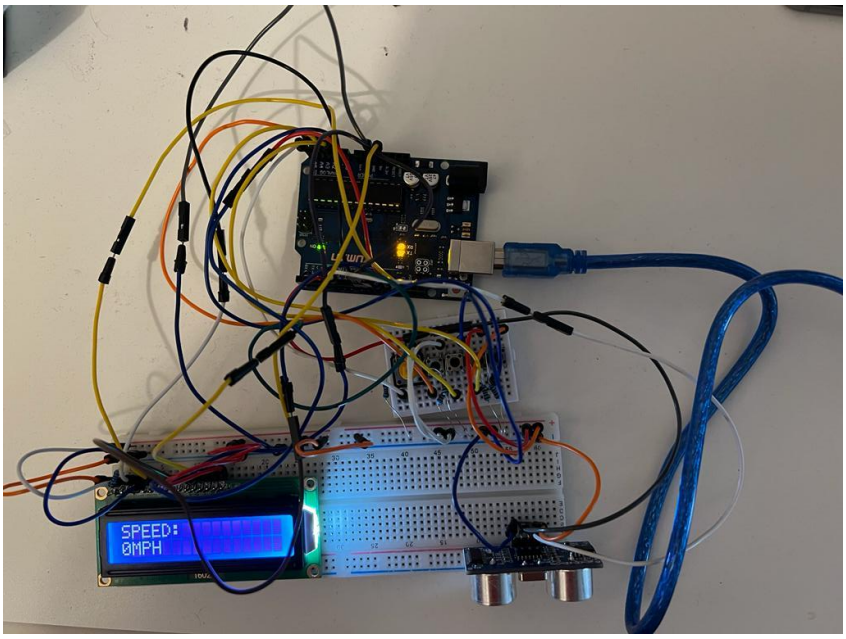


Figure 7: Hardware setup

There is one more button called the adaptive speed button which nullifies the functions of increasing and decreasing speed buttons. This happens because in the adaptive cruise control mode the speed of the vehicle is adjusted based on the sensor input. If the sensor senses an obstacle, the speed of the vehicle sharply decreases. When the obstacle is out of the path of motion then the speed of the vehicle increases until the set speed value is achieved. Again the cancel button is used to quit the current mode of function. The results obtained from the mechanism lead to the success of achieving road safety at the same time reducing driving stress by deducting the manual intervention.

CHAPTER 7

ANALYSIS OF THE RESULTS

Initially when the setup is switched on the LCD will display zero. As stated earlier, there are five push buttons namely accelerator, speed down, reset, adaptive_cc and set_speed. When the accelerator button is pressed, the current speed increases in one increment. When accelerator button is released, the speed decreases automatically. When the speed_down button is pressed, the speed reduces in the order of 2, which is lighly faster than the actual deceleration speed. In order to actuate cruise control mode, the accelerator button is used to reach the desired speed, followed by set_speed button to lock the speed. The cruise control set speed can be varied by pressing accelerator and speed down buttons thereby increasing or dcreasing the set speed according to test conditions. Further to this, to actuate ACC mode, the adaptive_cc button is pressed once the desired speed is set. In ACC mode, the accelerator and speed down button do not function. In order to differentiate CC and ACC mode, the LCD will display the message “ADAP-CC”. In this mode the ultrasonic sensor comes into action. When the sensor senses an obstacle in the path of motion, it sends feedback signal to the Arduino UNO. Owing to this signal the speed of the vehicle gradually decreases.Once the obstacle moves out of the way, the speed of the vehicle resumes to its set speed.When the reset button is pressed, it cancels the current mode of operation and the speed gradually dcreases to zero.Thus the test conditions are satisfied.

CHAPTER 8

MERITS AND DEMERITS

8.1 Merits of Adaptive Cruise Control mode:

- Fuel economy of the vehicle is increased.
- Vehicle overlapping is controlled.
- unwanted acceleration of the vehicle is controlled.
- Increased driving comfort.
- User-friendly system.

8.2 Demerits of Adaptive Cruise Control mode:

- Can be only used on highways with minimal traffic.
- May cause accidents since it reduces the reaction time of drivers.
- Sometimes doesn’t suit bad weather conditions.

CHAPTER 9

CONCLUSION

Every mechanism has its benefits and drawbacks. As far as this project is concerned, partial automation of vehicles can be achieved successfully that eventually reducing driving fatigue and at the same time improving fuel economy by maintaining a consistent speed. This setup can effectively contribute to two modes of operation which include cruise control mode and adaptive cruise control mode. Adaptive cruise control being an updated version of regular cruise control mode is a step forward toward completely automized cars without manual operation.

At the same time, the driving vigilance is impaired which in turn questions the safety while driving. Semi manual operation of the vehicles allows the drivers to self-repair the vehicles if there is a malfunctioning. If overrelaxation of the driver can be avoided and caution while driving can be maintained, this system has better scopes to offer in the future.

CHAPTER 10

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