SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, Dharwad-580002

(An autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi – 590018)

Department of Electronics and Communication Engineering

A Report on the Major-project entitled

ADAPTIVE CRUISE CONTROL

Proposed by

Mr. Ayush Kumar	**2SD16EC020**
Mr. Ayush Raj	**2SD16EC021**
Mr. Darshan Kini	**2SD16EC027**
Mr. Sudhanshu Suryavanshi	**2SD16EC106**

Students of 8th semester

Under the guidance of

Prof Megha G Shidenur,

Assistant Professor, Department of ECE

SDM College of Engineering and Technology, Dharwad

During the academic year 2019-2020 & submitted in May 2020.

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CERTIFICATE

This is to certify that **Mr. Ayush Kumar(2SD16EC020), Mr. Ayush Raj (2SD16EC021), Mr. Darshan Kini (2SD16EC027), Mr. Sudhanshu Suryavanshi (2SD16EC106), Students of 8th Semester** have satisfactorily completed the **Major Project** entitled **"Adaptive Cruise Control"** submitted to **Department of Electronics and Communication Engineering, SDM College of Engineering and Technology, Dharwad–580002**.

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ABSTRACT

The project is designed to develop an adaptive cruise control system to help the driver in safer and efficient driving of the vehicle. Safety on the road is one of the major issues we deal with nowadays and our project aims at resolving that issue for our user. Increase in number of cars on the road has caused great congestion on roads and has also led to increase in number of accidents on roads especially on highways. So, if there was a way to reduce the amount of accidents on the road it would help the drivers on the road in avoiding these fatal accidents.

Adaptive Cruise Control system can be divide in three major blocks High Level Control Unit, Low level control unit and Sensing unit. This prototype uses a Arduino Uno board and other components such as a L298N H-Bridge, a DC motor and various other sensors for successful implementation of this project.

Further the project can be enhanced by integrating all the blocks to construct the Adaptive Cruise Control model. Shifting from one state to another depending on the sensor inputs will help in moving one more step forward towards automatic driving.

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CHAPTER 1

INTRODUCTION

1.1 Overview:

Adaptive cruise control (ACC) is an available cruise control system for road vehicles that automatically adjusts the vehicle speed to maintain a safe distance from vehicles ahead. As of 2019, it is also called by 20 unique names that describe that basic functionality.This isalso known as Dynamic cruise control.

Control is based on sensor information from on-board sensors. Such systems may use a radar or laser sensor or a camera setup allowing the vehicle to brake when it detects the car is approaching another vehicle ahead, then accelerate when traffic allows it to. ACC technology is widely regarded as a key component of future generations of intelligentcars.They impact driver safety and convenience as well as increasing road capacity by maintaining optimal separation between vehicles and reducing driver errors.

1.2 Background:

Ever since the first automobiles rolled onto the road, manufacturers have been introducing technology to ensure they avoid crashing into each other. But it wasn't until the mid-1990s that innovation really moved up a gear and cars could intelligently assist drivers to keep their distance from those in front. Adaptive cruise control was one of the first functions to appear on production cars that could truly be considered a first step toward 'autonomous' driving. However, it did take time and some trial and error to settle on a technology that worked.

1.3 Objectives:

- To analyse the problem statement undertaken and list out the components required to build the system.
- To understand the working of all the required components and their role in accomplishing the results.
- To assemble all the components i.e., interface the various sensors onto the Arduino.

- Reading the real time data of the Vehicles obtained from the sensors (done using Arduino) and sending signal to actuator to manipulate motor speed.

1.4 Motivation:

The motivation for these systems is that they aim at increasing the driving comfort, reducing traffic accidents and increasing the traffic flow throughput. The ACC systems autonomously adjust the vehicle's speed according to current driving conditions. In order to accomplish driver comfort the system must resemble driver behavior in traffic. The system must avoid irritation of the driver and of the surrounding traffic. Therefore, to design a system that resembles the natural longitudinal behavior of a driver a good model is needed. There exist several attempts to model the drivers' longitudinal behavior, which all aim at describing various parts of the drivers' behavior. The model structures are different, some are based on cognitive models.

1.5 Problem statement:

Adaptive cruise control system

To design a system that assists the driver to move the vehicle at a particular speed, also maintaining a safe distance with the leading vehicle.

1.6 Area of utility:

This new technology, called adaptive cruise control, uses forward-looking radar, installed behind the grill of a vehicle, to detect the speed and distance of the vehicle ahead of it.Adaptive cruise control is similar to conventional cruise control in that it maintains the vehicle's pre-set speed. However, unlike conventional cruise control, this new system can automatically adjust speed in order to maintain a proper distance between vehicles in the same lane. This is achieved through a radar headway sensor, digital signal processor and longitudinal controller. If the lead vehicle slows down, or if another object is detected, the system sends a signal to the engine or braking system to decelerate. Then, when the road is clear, the system will re-accelerate the vehicle back to the set speed.

1.7 DESIGN METHODOLOGY:

- Design of states and state table.
- Deriving the formulas for respective states.
- Programming for individual blocks.
- Testing of individual blocks.
- Integration of all the blocks.
- Testing of the ACC system.

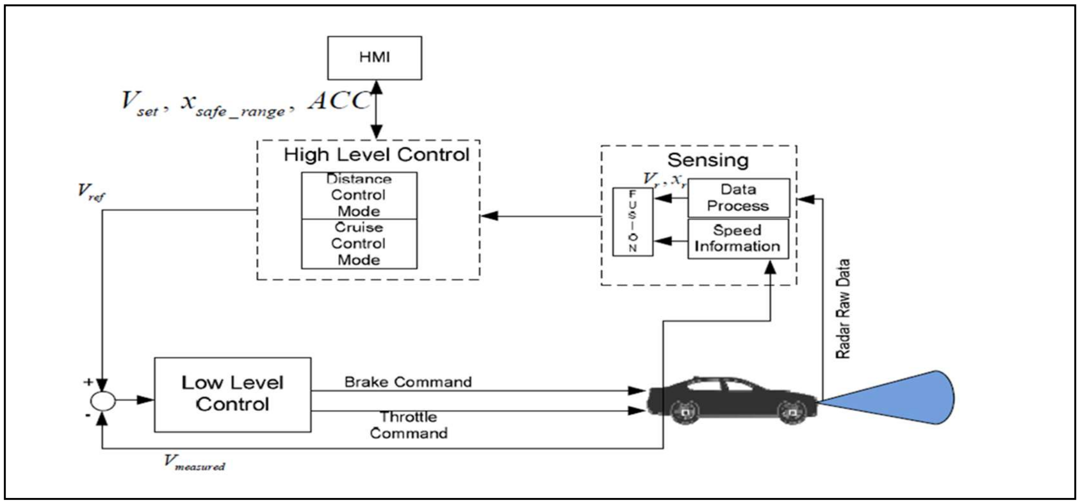

Fig 1.1 ACC Block Diagram

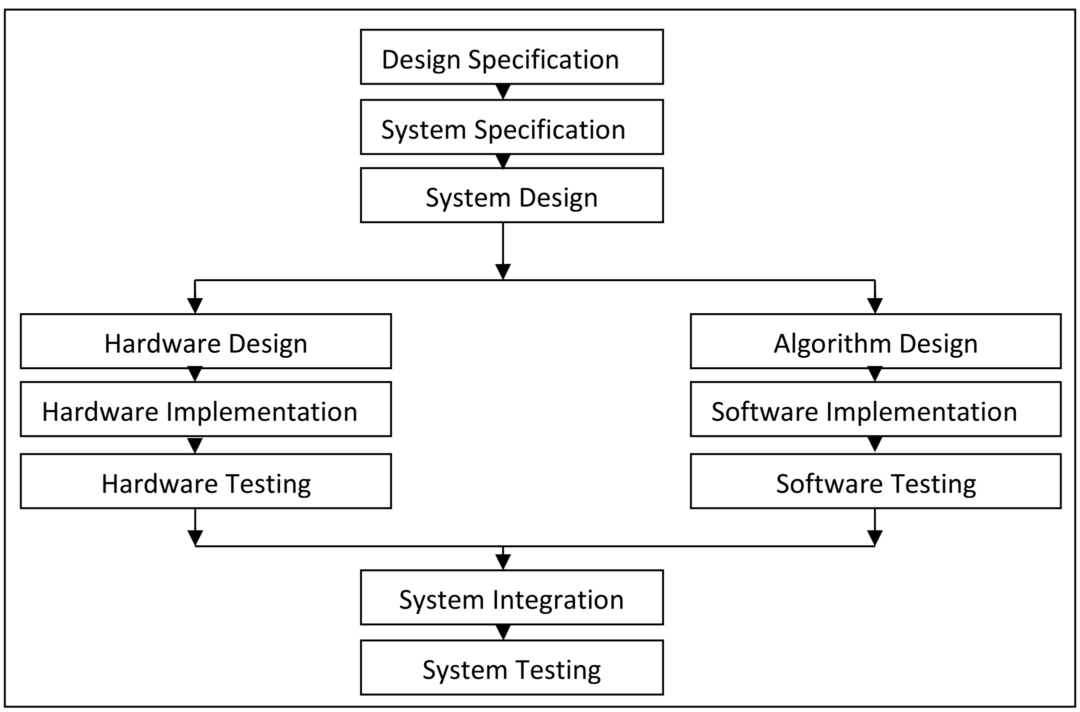

Fig 1.2 Design Flow

CHAPTER 2

LITERATURE SURVEY

[1] Adaptive Cruise Control for an Intelligent Vehicle

In this research, an adaptive cruise control system is developed and implemented on an AIT intelligent vehicle. To develop the adaptive cruise control system, the original throttle system and braking system of the vehicle have to be modified. The original throttle valve which is controlled by a cable from the accelerator pedal is modified to the drive-by-wire system by using a dc motor with a position control algorithm. The braking system is modified by using a dc servo motor to directly control the brake pedal. A proportional and derivative control with error compensation algorithm is proposed to perform the velocity control mode. In the distance control mode, a fuzzy logic algorithm is applied. Inputs of the fuzzy controller are distance error and relative velocity read from a laser range finder. The experiments on a racing circuit show that the vehicle can perform adaptive cruise control efficiently.

[2] Safety Problems In Vehicles With Adaptive Cruise Control System

In today's world automotive industries are still putting efforts towards more autonomous vehicles (AVs). The main concern of introducing the autonomous technology is safety of driver. According to a survey 90% of accidents happen due to mistake of driver. The adaptive cruise control system (ACC) is a system which combines cruise control with a collision avoidance system. The ACC system is based on laser and radar technologies. This system is capable of controlling the velocity of vehicle automatically to match the velocity of car, bus or truck in front of vehicle. If the lead vehicle gets slow down or accelerate, than ACC system automatically matches that velocity. The proposed paper is focusing on more accurate methods of detecting the preceding vehicle by using a radar and lidar sensors by considering the vehicle side slip and by controlling the distance between two vehicles. By using this approach i.e. logic for calculation of former vehicle distance and controlling the throttle valve of ACC equipped vehicle, an improvement in driving stability was achieved.

[3] Two Approaches to the Adaptive Cruise Control (ACC) Design

The cruise control system is usually implemented as a PI or PID controllers. In this paper we will show the modification of the structure and parameters of the controller depending on the requirements of the cruise control system. Different controller structure is required for a step changes of speed and another one for a linearly varying speed. The structure of the controller is more complicated for the adaptive system responding to the velocity changes of the target vehicle in the front of the host vehicle. Then the control system has to measure also the distance as a disturbance value to calculate the speed of the target vehicle.

[4] Cooperative Adaptive Cruise Control in Real Traffic Situations

Intelligent vehicle cooperation based on reliable communication systems contributes not only to reducing traffic accidents but also to improving traffic flow. Adaptive cruise control (ACC) systems can gain enhanced performance by adding vehicle–vehicle wireless communication to provide additional information to augment range sensor data, leading to cooperative ACC (CACC). This paper presents the design, development, implementation, and testing of a CACC system. It consists of two controllers, one to manage the approaching maneuver to the leading vehicle and the other to regulate car-following once the vehicle joins the platoon. The system has been implemented on four production Infiniti M56s vehicles, and this paper details the results of experiments to validate the performance of the controller and its improvements with respect to the commercially available ACC system.

CHAPTER 3

ADAPTIVE CRUISE CONTROL SYSTEM

Adaptive cruise control (ACC) is a driver assistance technology that sets a maximum speed for vehicles and automatically slows the speed of the car when traffic is sensed in front of the vehicle. The technology is also known as autonomous cruise control.

Standard cruise control allows the driver set a steady speed and takes a foot off the throttle, but requires driver intervention to turn off cruise control when that set speed is no longer possible. Adaptive cruise control allows for smart, reactive management of a vehicle's speed without driver intervention. ACC automates responses in situations that would have otherwise required action on the part of the driver. Without required driver intervention, the technology can reduce driver discomfort and fatigue more than standard cruise control while safely maintaining distance from vehicles ahead on the road.

The system adjusts the vehicle’s driving speed to the flow of traffic by automatically accelerating and braking. Even in the heaviest traffic, ACC can maintain the pre-set safe distance to the vehicle in front, enabling the driver to better concentrate on the driving situation at hand.

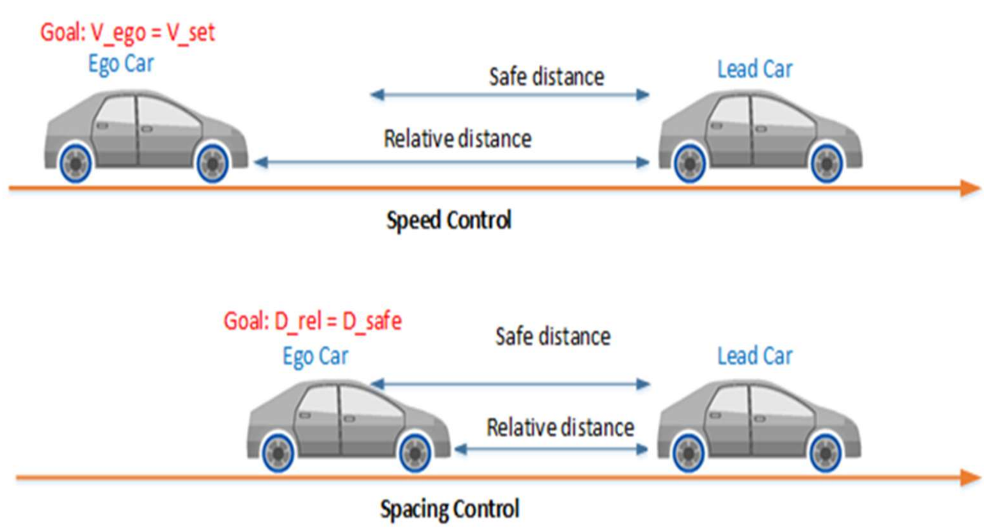

Fig: 3.1 Adaptive Cruise Control System

3.1 Adaptive Cruise Control Design

Adaptive Cruise Control system can be divide in three major blocks High Level Control Unit, Low level control unit and Sensing unit. The sensors gives the data to the low level block which consists of controller. The controller sends a signal to the actuators which are the components of High level block which results in the manipulation of speed of the vehicle.

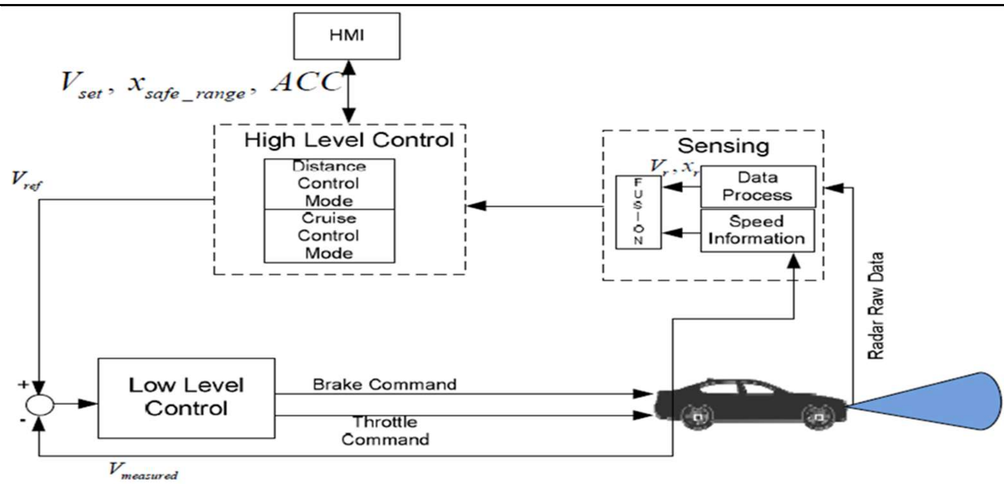

Fig 3.2 ACC Block Diagram

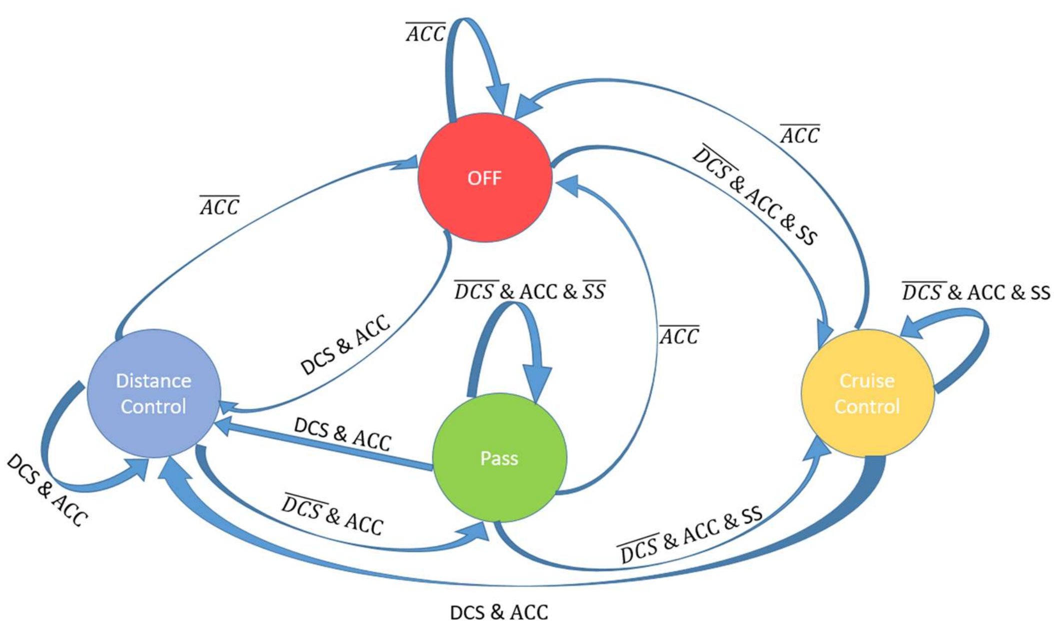

Fig 3.3 State Diagram

3.2 High Level Control Unit

The HLC is responsible for the conscious level decisions such as adjust the speed to keep a minimal distance or keep the desired velocity. The decision parameters such as desired safety distance range and desired speed is set by the user through the HMI unit. The decision mechanism is realized using the state machine, depending on the measured target speed, host vehicle speed and the user parameters.

3.2.1 Distance Control State:

In distance control state, the vehicle tracks the safety distance. If the inputs ACC=1, and DCS=1, state switches to distance control state.

Let us define safe distance as $X_{safe.}$ This distance is pre-set by the programmer or user:

Using the Ultrasonic sensor HC-SR04, This popular ultrasonic distance sensor provides stable and accurate distance measurements from 2cm to 450cm. It has a focus of less than 15 degrees and an accuracy of about 2mm.

This sensor uses ultrasonic sound to measure distance just like bats and dolphins do. Ultrasonic sound has such a high pitch that humans cannot hear it. This particular sensor sends out an ultrasonic sound that has a frequency of about 40 kHz. The sensor has two main parts: a transducer that creates an ultrasonic sound and another that listens for its echo. To use this sensor to measure distance, the robot's brain must measure the amount of time it takes for the ultrasonic sound to travel.

Sound travels at approximately 340 meters per second. This corresponds to about 29.412µs (microseconds) per centimeter. To measure the distance the sound has travelled we use the formula: Distance = (Time x SpeedOfSound) / 2. The "2" is in the formula because the sound has to travel back and forth. First the sound travels away from the sensor, and then it bounces off of a surface and returns back. The easy way to read the distance as centimeters is to use the formula: Centimeters = ((Microseconds / 2) / 29). For example, if it takes 100µs (microseconds) for the ultrasonic sound to bounce back, then the distance is ((100 / 2) / 29) centimeters or about 1.7 centimeters.

We will calculate the distance of the object or preceding vehicle from the user vehicle using this sensor and determine, whether the target vehicle is out of bound, at a safe distance or less than the safe distance from the user vehicle.

After we have determined the status of the preceding vehicle the distance control block comes into action, the speed of the user vehicle is varied in such a way that the distance between the two vehicle is bought back to the safe distance or distance greater than the safe distance. Once the distance has been maintained the sensor again checks for the status of the distance between the two cars, if the distance is found to be ‘out of bound’ or equal to ‘safe distance’ then ACC=1 and $\overline{\text{DCS}}$=1 and thus the control is transferred further to the pass state.

In this state the current speed of vehicle is compared to desired speed and if it is less than, the reference speed is increased considering the acceleration value. If target vehicle’s speed is increasing less than 2 m/s2 acceleration, reference speed value of host vehicle taken as target vehicle speed. They are feed to the low level controller.

3.2.2 Cruise Control Mode

Cruise control (sometimes known as speed control or autocruise, or tempomat in some countries) is a system that automatically controls the speed of a motor vehicle. The system is a servomechanism that takes over the throttle of the car to maintain a steady speed as set by the driver.

Operation

The driver must bring the vehicle up to speed manually and use a button to set the cruise control to the current speed.

The cruise control takes its speed signal from a rotating driveshaft, speedometer cable, wheel speed sensor from the engine's RPM, or from internal speed pulses produced electronically by the vehicle. Most systems do not allow the use of the cruise control below a certain speed - typically around 25 mph (40 km/h). The vehicle will maintain the desired speed by pulling the throttle cable with a solenoid, a vacuum driven servomechanism, or by using the electronic systems built into the vehicle (fully electronic) if it uses a 'drive-by-wire' system.

All cruise control systems must be capable of being turned off both explicitly and automatically when the driver depresses the brake, and often also the clutch. Cruise control often includes a memory feature to resume the set speed after braking, and a coast feature to reduce the set speed without braking. When the cruise control is engaged, the throttle can still be used to accelerate the car, but once the pedal is released the car will then slow down until it reaches the previously set speed.

On the latest vehicles fitted with electronic throttle control, cruise control can be easily integrated into the vehicle's engine management system. Modern "adaptive" systems (see below) include the ability to automatically reduce speed when the distance to a car in front, or the speed limit, decreases. This is an advantage for those driving in unfamiliar areas.

The cruise control systems of some vehicles incorporate a "speed limiter" function, which will not allow the vehicle to accelerate beyond a pre-set maximum; this can usually be overridden by fully depressing the accelerator pedal. (Most systems will prevent the vehicle accelerating beyond the chosen speed, but will not apply the brakes in the event of overspeeding downhill.)

On vehicles with a manual transmission, cruise control is less flexible because the act of depressing the clutch pedal and shifting gears usually disengages the cruise control. The "resume" feature has to be used each time after selecting the new gear and releasing the clutch. Therefore, cruise control is of most benefit at motorway/highway speeds when top gear is used virtually all the time.

3.3 Low Level Control Model

The LLC handles the control of throttle/brake tomaintain the required speed. Low Level control has a PID controller, with gains Kp=0.0253, Ki=2.527,Kd=0.159. The PID controller is designed for an electricalvehicle using Cohen-Coon method.

3.3.1 PID Controller

A proportional integral derivative (PID) controller can be used as a means of controlling temperature, pressure, flow and other process variables. As its name implies, a PID controller combines proportional control with additional integral and derivative adjustments which help the unit automatically compensate for changes in the system

The purpose of a PID controller is to force feedback to match a setpoint, such as a thermostat that forces the heating and cooling unit to turn on or off based on a set temperature. PID controllers are best used in systems which have a relatively small mass and those which react quickly to changes in the energy added to the process. It is recommended in systems where the load changes often and the controller is expected to compensate automatically due to frequent changes in setpoint, the amount of energy available, or the mass to be controlled.

The working principle behind a PID controller is that the proportional, integral and derivative terms must be individually adjusted or "tuned." Based on the difference between these values a correction factor is calculated and applied to the input. For example, if an oven is cooler than required, the heat will be increased.

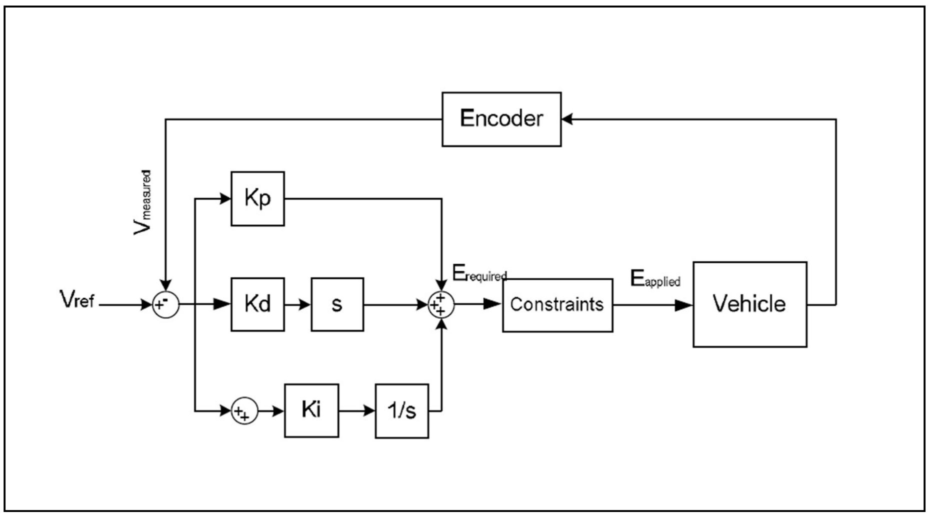

Fig: 3.4 PID Controller Block Diagram

3.3.2 Throttle Control

Throttle Control the dynamical equations (12) for the throttle subsystem are used to satisfy the control objectives. The leading vehicle is considered to be initially at rest and then accelerate to 10km\hr then to 20km\hr and then to 25km\hr at different acceleration. This is considered as the reference speed. The cruise vehicle is to move a speed such the relative speed between the vehicles is zero and the deviation between the relative distance and the desired spacing is zero.The control signal (13) keeps the vehicle at the desired speed. Fig 3 and Fig 4 gives the plot for vehicle speed, relative speed and deviation in spacing.

3.3.3 Brake Control

The dynamical equations (15) for the brake subsystem are used to satisfy the control objectives. The leading vehicle is initially at 20km/hr then decelerate to 15km/hr then suddenly made to stop so following cruise vehicle need to stop suddenly with the minimum required spacing in between. The stopping time should be very small to avoid rear-end collision. The control signal keeps the vehicle at the desired speed. The value of the gain parameters k5 and k6 are obtained by trial and error.

3.4 Sensing Unit

HC SR02 ultrasonic long range radar sensor is used as sensing unit. Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit.

ARS 308 LRR is used in most vehicles these days. ARS 308 LRR sensor can detect objects up to 0-200 m and with an accuracy of 0.25m, and an azimuth angle augmentation of -8.5o ...+ 8.5o. It has open can protocol, and baud rate is 500kbps. Object or target information send through CANBUS. The radar sensor is able to detect 64 objects in the line of sight. ACC also needs an encoder to measure the host vehicle speed. Industrial encoder is used to measure to host vehicle speed.

Systems with multiple sensors can practice sensor fusion to integrate the data from to improve safety and/or driving experience. This could allow a following car to interpret a turn signal by an exit as not requiring the following car to slow down, as the leading car will existing systems could also take note of traffic signs/signals and not, e.g., violate a red light while following a vehicle that crossed before the signal changed.

CHAPTER 4

RESOURCE UTILIZATION

4.1 Arduino UNO

The Arduino Uno is an based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 Analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

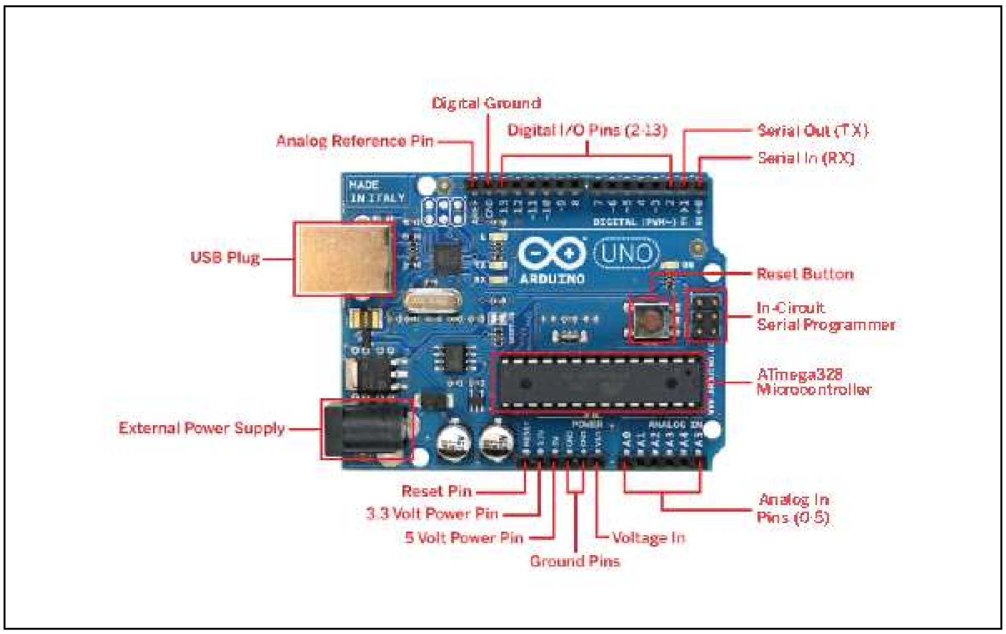

Fig 4.1 Arduino board

In our project, we have programmed this board in such a way that the rpm of the motor will decrease as some object will come in front of the ultrasonic sensor. The motor will stop if some object will come inside the safe zone i.e. very close and if the object will be out of the range of the sensor and a particular speed will be maintained i.e. cruise control.

4.2 L298N H-BRIDGE

L298N Dual H Bridge Motor Driver is a motor controller breakout board which is typically used for controlling speed and direction of motors. It can also be used to control the brightness of certain lighting projects such as high powered LED arrays. An H-bridge is a circuit that can drive a current in either polarity and be controlled by pulse width modulation.

The L298N is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. This depends on the voltage used at the motors VCC. The module have an onboard 5V regulator which is either enabled or disabled using a jumper.

An H-Bridge is a simple electronic circuit consisting of four switching elements like transistors (BJT or MOSFET) that can drive a motor in both the directions without switching the leads.

The name “H-Bridge” refers to the look of the connection consisting of four transistors and a motor in the center forming the letter “H”.

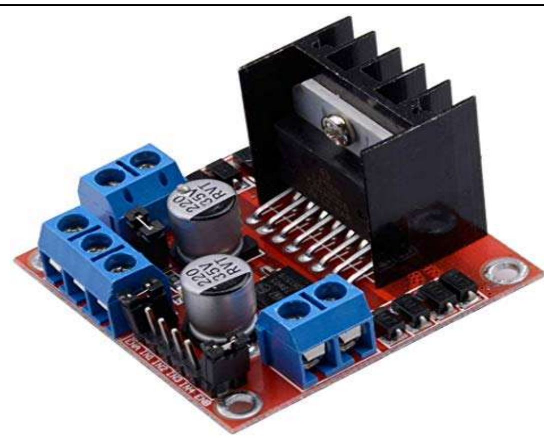

Fig 4.2 L298N H-Bridge

Applications:

- An **H-Bridge** is one way to easily control a motor with a low-power microcontroller.
- You can find **L298N**-based modules connected to low-power microcontrollers in many different projects.

- For example, robots, electronic tools, home automation **applications** (like automatic blinds) and in cheap, high-power LED drivers.

4.3 HC-SR04

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

(1) Using IO trigger for at least 10us high level signal.

(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.

(3) IF the signal back, through high level.

Time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time×velocity of sound (340M/S) / 2.

It **works** by sending out a burst of **ultrasound** and listening for the echo when it bounces off of an object. It pings the obstacles with **ultrasound**. The **Arduino** or Genuino board sends a short pulse to trigger the detection, then listens for a pulse on the same pin using the pulseIn() function

Fig 4.3 HC-SR04 ultrasonic sensor

Applications:

- The **HC-SR04 ultrasonic sensor** uses **sonar** to determine distance to an object like bats do.It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package.
- It comes complete with **ultrasonic** transmitter and receiver modules.

4.4 DC MOTOR

RPM, which stands for revolutions per minute, is the amount of times the shaft of a DC motor completes a full spin cycle per minute. A full spin cycle is when the shaft turns a full 360°. The amount of 360° turns, or revolutions, a motor does in a minute is its RPM value.

DC motor is used in automobile, such as Electric Positioning System (EPB), Automotive panoramic sliding skylight, Automotive Seat Headrest, Automobile Power Lift gate Cables, Throttle Actuator and so on.

Fig 4.4 DC motor

Applications:

- This form of power is most commonly produced by sources such as solar cells, batteries, and thermocouples.
- DC power is widely used in low voltage applications such as charging batteries, automotive applications, aircraft applications and other low voltage, low current applications.

CHAPTER 5

RELATIVE VELOCITY CALCULATION

5.1 Doppler Effect:

When sound waves are emitted by a moving source or when the observer of the sound is moving, the apparent frequency of the sound can change. This shift in frequency due to motion of the sound wave source or of the observer is called the Doppler Effect.
The Doppler Effect (or the Doppler shift) is the change in frequency or wavelength of a wave in relation to an observer who is moving relative to the wave source.

The formula for determining the frequency during the events are as follows:

$$f = \left(\frac{c}{c + V_s}\right) f_0$$

f = observed frequency
c = speed of sound
Vs = velocity of source (negative if it's moving toward the observer)
$f0$ = emitted frequency of source

Vs is negative since the source is moving towards the observer.

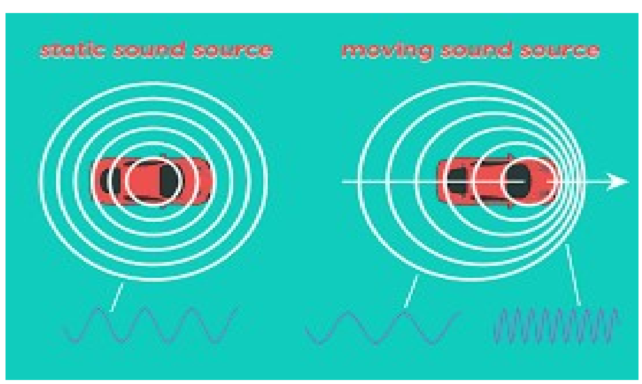

Fig 5.1 Doppler shift

CHAPTER 6

MAINTAINING THE VELOCITY

6.1 Pass Block:

If the target vehicle has a relative distance greater than reaction distance (the minimum distance up to which the actions taken by the controller wouldn't be late enough to cause an accident) and the ACC mode is on, the pass state becomes active. In this state the current speed of vehicle is compared to desired speed and if it is less than, the reference speed is increased considering the acceleration value (see Figure 6.1). If target vehicle's speed is increasing less than 2 m/s2 acceleration, reference speed value of host vehicle taken as target vehicle speed. They are feed to the low level controller.

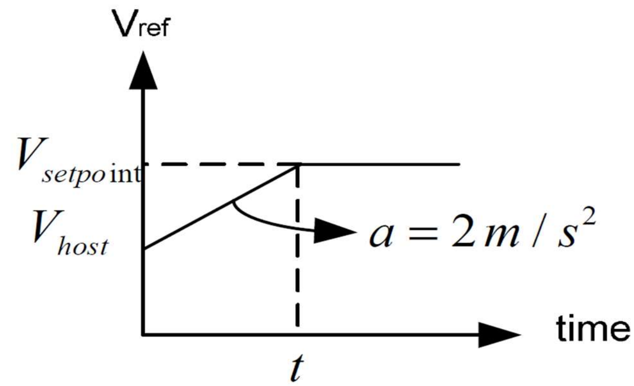

Fig 6.1Reference speed profile

In this state the speed status is checked. The speed status set to SS=1, if current speed of the host vehicle is in the vicinity of set point speed. Then the state machine switches to the cruise control state if $\overline{DCS}$ & ACC&SS is on. The main function of this state is to monitor the change in the relative speed of the preceding vehicle. As the vehicle is above the set point of reaction distance our goal is to try to maintain that distance and avoid any possibility of an accident. To do so we constantly monitor the relative velocity between the two vehicles and increase the speed of the user vehicle if demand arises. This block plays an important part of a bridge between Distance Block and Cruise Control Block.

CHAPTER 7

CRUISE CONTROL BLOCK

7.1 Introduction to Cruise Control:

Speed control was used in automobiles as early as 1900 in the Wilson-Pilcher and also in the 1910s by Peerless. Peerless advertised that their system would "maintain speed whether up hill or down". Modern cruise control (also known as a speedostat or tempomat) was invented in 1948 by the inventor and mechanical engineer Ralph Teetor. This system calculated ground speed based on driveshaft rotations off the rotating speedometer-cable, and used a bi-directional screw-drive electric motor to vary throttle position as needed. It was Cadillac Division that re-named the "Speedostat" and marketed the device as "Cruise Control."

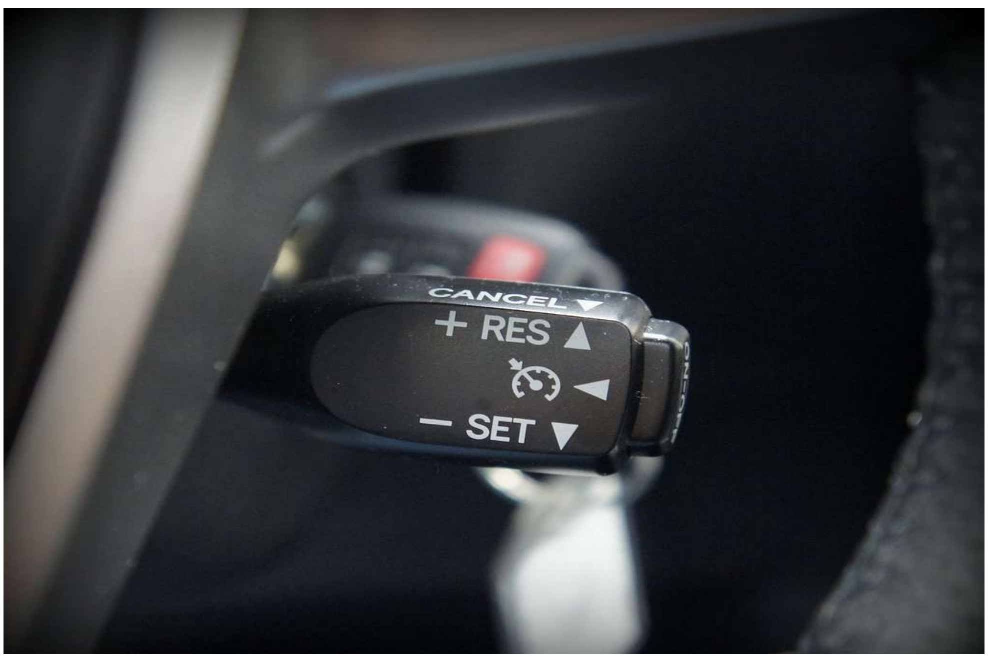

Fig 7.1 Control shaft for a cruise control inside a vehicle

7.2 General operation of a Cruise Control:

The driver must bring the vehicle up to speed manually and use a button to set the cruise control to the current speed. The cruise control takes its speed signal from a rotating driveshaft, speedometer cable, wheel speed sensor from the engine's RPM, or from internal speed pulses produced electronically by the vehicle. Most systems do not allow the use of the cruise control below a certain speed - typically around 25 mph (40 km/h). The vehicle will maintain the desired speed by pulling the throttle cable with a solenoid, a vacuum driven servomechanism, or by using the electronic systems built into the vehicle (fully electronic) if it uses a 'drive-by-wire' system. All cruise control systems must be capable of being turned off both explicitly and automatically when the driver depresses the brake, and often also the clutch. Cruise control often includes a memory feature to resume the set speed after braking, and a coast feature to reduce the set speed without braking. When the cruise control is engaged, the throttle can still be used to accelerate the car, but once the pedal is released the car will then slow down until it reaches the previously set speed. Modern "adaptive" systems (like the one tried to be implemented here in this project) include the ability to automatically reduce speed when the distance to a car in front, or the speed limit, decreases. This is an advantage for those driving in unfamiliar areas.

7.2.1 Cruise Control Acceleration and Deceleration:

The cruise control system controls the speed of your car the same way you do -- by adjusting the throttle position. But cruise control actuates the throttle valve by a cable connected to an actuator, instead of by pressing a pedal. The throttle valve controls the power and speed of the engine by limiting how much air the engine takes in.

Fig 7.2 One of the cables is connected to the gas pedal, the other to the vacuum actuator.

In the picture above, you can see two cables connected to a pivot that moves the throttle valve. One cable comes from the accelerator pedal, and one from the actuator. When the cruise control is engaged, the actuator moves the cable connected to the pivot, which adjusts the throttle; but it also pulls on the cable that is connected to the gas pedal -- this is why your pedal moves up and down when the cruise control is engaged.

Many cars use actuators powered by engine vacuum to open and close the throttle. These systems use a small, electronically-controlled valve to regulate the vacuum in a diaphragm. This works in a similar way to the brake booster, which provides power to your brake system.

Fig 7.3 The electronically-controlled vacuum actuator that controls the throttle

7.2.2 Controlling the Cruise Control:

The brain of a cruise control system is a small computer that is normally found under the hood or behind the dashboard. It connects to the throttle control seen in the previous section, as well as several sensors. The diagram below shows the inputs and outputs of a typical cruise control system.

A good cruise control system accelerates aggressively to the desired speed without overshooting, and then maintains that speed with little deviation no matter how much weight is in the car, or how steep the hill you drive up. Controlling the speed of a car is a classic application of control system theory. The cruise control system controls the speed of the car by adjusting the throttle position, so it needs sensors to tell it the speed and throttle position. It also needs to monitor the controls so it can tell what the desired speed is and when to disengage.

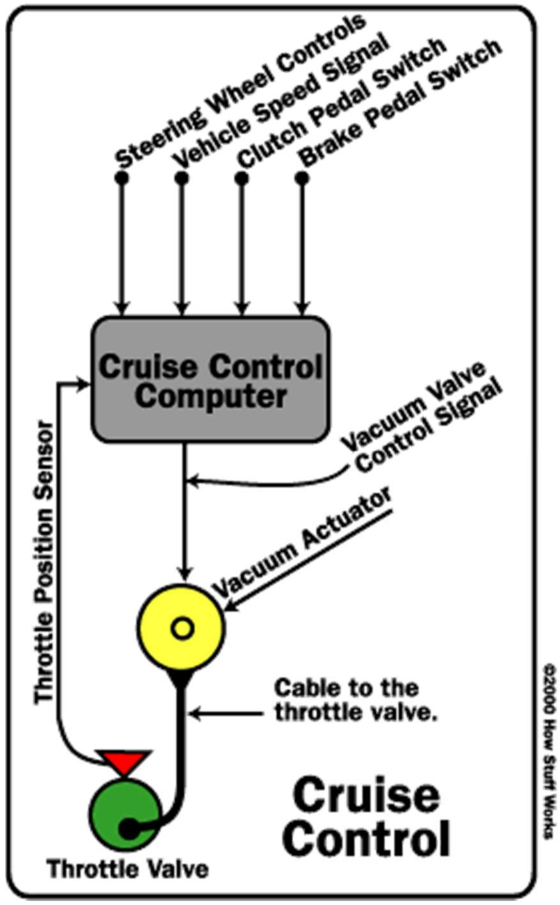

Fig 7.4 Cruise Control Implementation

7.3 Cruise Control Block:

In cruise control state, set point speed of the host vehicle is feed to low level controller as reference speed of vehicle. Host vehicle tracks the set point speed in cruise control state($\overline{DCS}$& ACC &SS =1).It is kept in the cruise control state when there is no vehicle front of the host vehicle and set point speed is close to host vehicle speed ($\overline{DCS}$& ACC &SS =1). If there is atarget vehicle and target vehicle speed is bigger than setpoint speed of host vehicle ($\overline{DCS}$& ACC &SS =1) then state is still kept in cruise control state.

CHAPTER 8

WORKING

- In our Project, we have designed and constructed the prototype of a vehicle with the Adaptive Cruise Control (ACC) System. In our working model, an ultrasonic sensor is used in place of a Radar in front of the car, Arduino is used as a controlling unit or a controller, an H-bridge is used in place of throttle actuator and brake controller and the dc motor is used as the wheel of the car.
- Once the Adaptive cruise control is switched on, our system becomes active and the ultrasonic sensor starts detecting if there is any vehicle in the safe zone.
- If any vehicle is detected, the Arduino commands the H-bridge to reduce the speed of the dc motor as per the distance between the two vehicles in such a way that a safe distance is always maintained between the two vehicles..
- In case, any vehicle is decelerated improperly and enters the unsafe zone causing an unsafe distance between two vehicles, the ACC system is programmed in such a way that the vehicle will stop immediately which will avoid a collision. If any person or a vehicle suddenly enters the sight of the ultrasonic sensor from sideways, the ACC systems will command the H-bridge to stop the dc motor immediately.
- In our Program, the reaction distance is kept as 15 centimetres to 30 centimetres i.e. if the ultrasonic sensor detects anything within this range the speed is reduced by half. The motor speed is kept as 250 rpm as normal and is reduced to 125 rpm if a vehicle is detected within this range. If a vehicle is detected within 15 centimetres zone, the dc motor is stopped immediately to avoid a collision.
- With reference to the state diagram of our Adaptive cruise control system, considering an example and a graphical representation is as follows:

  There is a target vehicle which is moving at 20 m/sec constant speed and host vehicle is in the ACC off (ACC=0) state between 0-20th sec. In this figure the relative distance, host vehicle speed, and the host vehicle acceleration are given in the first, second and third row respectively. The driver sets ACC on mode (ACC=1) at the 20th sec with a set point speed of the 24 m/s. The time headway was selected as small. When the ACC is on there was a relative distance of 100 m. The state machine switches to the cruise control state ($\overline{DCS}$ & ACC & SS =1) $x_{react} < x_r$. Then state machine switches to distance control state(ACC=1 and DCS=1) at 32nd sec and the control algorithm track the safety distance of 37 m. Note that the host vehicle speed was decreased to target vehicle speed (20 m/sec).

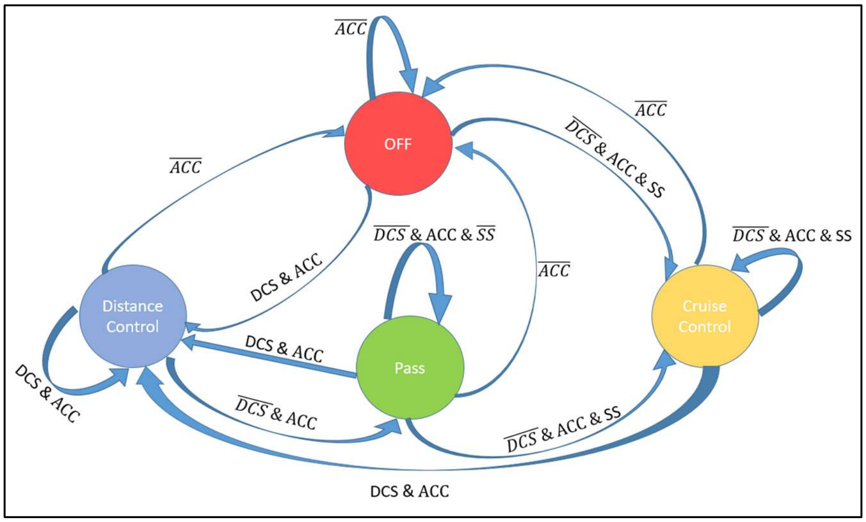

Fig 8.1 State Diagram

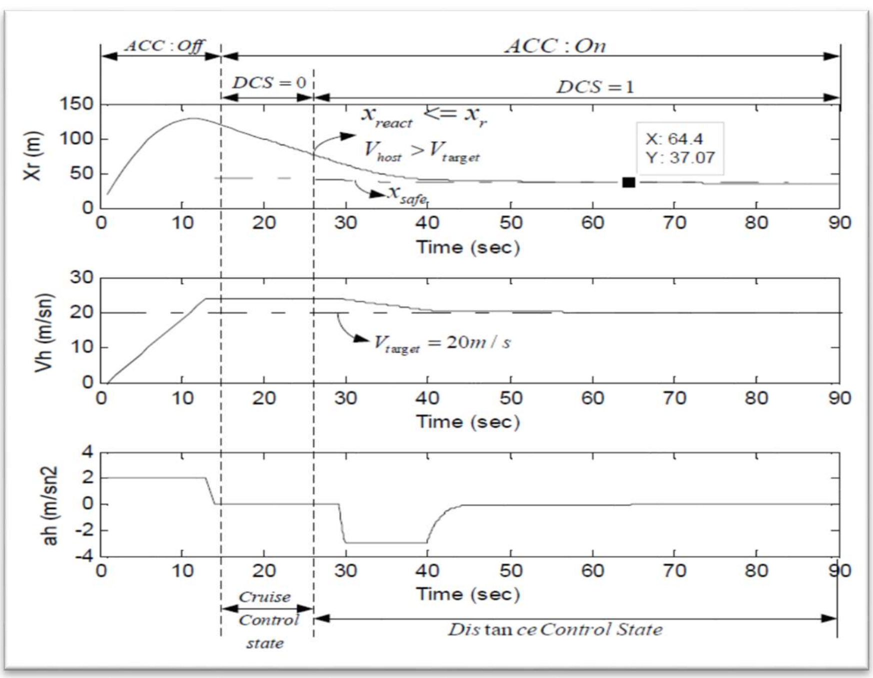

Fig 8.2 The high level controller test result

CHAPTER 9

ADVANTAGES AND APPLICATIONS

Advantages:

- Accurate steering within the desired zone.
- Smooth hole profile.
- Automated trajectory control by Geo-Pilot tool.
- Use to drill accurate tangent section for artificial lift equipment installation.
- Use for extended reach horizontal wells.

Application:

Most of the High end expensive vehicles have implemented ACC for better safety to their customers and a step towards automatic driving .These are some top automobile manufacturers who have implemented this design and Research is also going on on this technology.

- Mitsubishi was the first automaker to offer a laser-based ACC system in 1995 on Japanese Mitsubishi Daimante.
- In August 1997, Toyota began to offer a "radar cruise control" system on the celsior.
- Mercedes Benz introduce "DISTRONIC" in late 1998 on the S-Class.
- Jaguar began offering this system in 1999.
- BMW's Activity Cruise Control system launched in 2000 in 7-series.
- Volkswagen and Audi introduce their own system in 2002.

Since, any kind of failure may result in a severe injury to the driver and all the components in ACC has to be of top notch. This costs the car manufacturers a lot. So, this technology is not much popular in less expensive vehicles. But research are going on to implement this design on less expensive automobiles.

CHAPTER 10
EXPECTED OUTPUTS

Constraints:

Safe Distance: Above 30 cm

Reaction Distance: 15 to 30 cm

Danger Zone: Less than 15 cm

Motor Speed: 250 rpm normal

Outputs:

Case 1:

If there is no car in front of the user vehicle or the distance between the target vehicle and the user vehicle is greater than safe distance, then the car operates under the cruise control block and thus is taken to the desired speed of 250 rpm as set by the user initially.

Case 2:

If a car is detected in front of the user vehicle and the distance between the user vehicle and the target vehicle lies in the range of the reaction distance then the control is transferred from cruise control block to distance control block. Distance Control Block tries to detect the speed of the vehicle preceding the user vehicle and then manipulates the speed of the user vehicle (i.e. decrease the speed to half of the initial value of 250 rpm which becomes 125 rpm) to increase the distance between the user vehicle and the target vehicle such that the distance between the two vehicles again goes in the range of safe distance.

Case 3:

If a car suddenly cuts in and comes in front of the user vehicle or the preceding vehicle applies the brakes suddenly and the distance between the user vehicle and the preceding vehicle goes in the range known as Danger Zone our system too applies the brakes for the user vehicle and stops the vehicle to avoid collision.

CHAPTER 11
CONCLUSION

This project aim is to avoid accidents happening in highways. Despite the introduction of the system to market, these are still to be advanced. The current system can measure up to 150m ahead of a car and reduces the cars speed if an obstacle appears. Whatever happens, the automobile market looks to explode. In 2002 there are not more than 100,000 vehicles equipped with ACC, but now it is set to reach millions in future years, with Europe, South Asia, East Asia and the US. Around 17% of European built cars are likely to have ACC fitted as standard. Some automakers use two radars — one for close range out to about 100 feet and a second that sees out to about 600 feet. Thus, we have seen how adaptive cruise control system differs from conventional cruise control system.We have also seen the latest modifications and additional functions for an ACC system as modeled on the Audi A8.It shows how safety and ease of driving can be achieved using ACC. he main disadvantage of the system being the accidents caused due to system malfunctioning.

CHAPTER 12

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