KAUNAS UNIVERSITY OF TECHNOLOGY
FACULTY OF MECHANICAL ENGINEERING AND DESIGN

Dhinesh Subramanian

Research in Development of Emergency Stop Assistance

Master's Degree Final Project

Supervisor
Assoc. prof. dr. Jurga Ilgakojytė-Bazarienė

KAUNAS, 2017

KAUNAS UNIVERSITY OF TECHNOLOGY

Faculty of Mechanical engineering and design

Dhinesh Subramanian

Vehicle Engineering (M5036N21)

Research in Development of Emergency Stop Assistance

DECLARATION OF ACADEMIC INTEGRITY

___ _____ 20 ____

Kaunas

I confirm that the final project of mine, **Dhinesh Subramanian**, on the subject "Research in Development of Emergency Stop Assistance" is written completely by myself; all the provided data and research results are correct and have been obtained honestly. None of the parts of this thesis have been plagiarized from any printed, Internet-based or otherwise recorded sources. All direct and indirect quotations from external resources are indicated in the list of references. No monetary funds (unless required by law) have been paid to anyone for any contribution to this thesis.

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Reviewer

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KAUNAS, 2017

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FACULTY OF MECHANICAL ENGINEERING AND DESIGN

MASTER STUDIES FINAL PROJECT TASK ASSIGNMENT

Study programme: VEHICLE ENGINEERING

The final project of Master studies to gain the master qualification degree, is research or applied type project, for completion and defence of which 30 credits are assigned. The final project of the student must demonstrate the deepened and enlarged knowledge acquired in the main studies, also gained skills to formulate and solve an actual problem having limited and (or) contradictory information, independently conduct scientific or applied analysis and properly interpret data. By completing and defending the final project Master studies student must demonstrate the creativity, ability to apply fundamental knowledge, understanding of social and commercial environment, Legal Acts and financial possibilities, show the information search skills, ability to carry out the qualified analysis, use numerical methods, applied software, common information technologies and correct language, ability to formulate proper conclusions.

1. Title of the Project

Research in Development of Emergency Stop Assistance

2.Aim of the project

Aim of this project is to prevent accidents caused by individual's abnormal condition by developing in Driver Assistance System.

3.Structure of the project

- To make literature study on the Driver Assistance Systems and its role on avoiding accidents
- Choosing compatible methods for developing
- Brief study about chosen method
- Describing integration methods
- Developing model for integration
- Verifying the working

4.Requirements and conditions

- Existing Methods of Avoiding Accident
- Designing of the Adaptive Systems
- Choosing appropriate module for prototype

5.This task assignment is an integral part of the final project

6. Project submission deadline: 2017 June 6.

Student

Dhinesh Subramanian _____

(Name, Surname of the Student) *(Signature, date)*

Supervisor

Assoc. prof. dr. Jurga Ilgakojytė-Bazarienė _____

(Position, Name, Surname) *(Signature, date)*

Dhinesh Subramanian, Research in development of Emergency Stop Assistance, *Master's* Final Degree project, Assoc. Prof. Jurga Ilgakojyte-Bazariene, Faculty of Mechanical Engineering and Design, Kaunas University of Technology
Research Field: Driver Assistance System
Area: Road Transport
Keywords: *Forward collision System, Emergency stop Assistance, Adaptive Cruise Control System.*
Kaunas 2017, 52 pages

SUMMARY

The main aim of this paper is to develop Driver Assistance System. If in case of any unhealthy situations like heart attacks, this gives assistance to avoid collision. Enhancement of this technologies will pave the way for autonomous driving in Modern future of Automobiles. The distinctive feature of the Emergency Stop Assistance is the fact that it does more than just support the driver – it can "react" and autonomously monitor the possibility of Collison for a brief period of time. As it continues to develop prototypes, the technology is striving to prevent accidents using driver assistance systems. In developing the Emergency Stop Assistance, engineers must address all the technological challenges posed by extremely automated driving. If a driver suffers a heart attack, or should a similar emergency occur, or if the crash is unavoidable the car is programmed to bring assistance to the driver by automatically applying brakes. To do this, algorithms must use sensor data to compute each step of this process, including the impact each step will have on other vehicles in the vicinity. In combination with the Adaptive Cruse Control it also Enhance the Forward Collision Avoidance System. Hence this system will be the future of the autonomous driving which is the first impact on developing road safety and the transportation will be secured. The objective is to monitor driver's health and to send an emergency signal to rescue, medical and road service teams so that help is soon on the way – and all of this must be done without interrupting the flow of traffic.

Dhinesh Subramanian. Avarinio stabdymo pagalbos sistemos vystymo tyrimas. *Magistro* baigiamasis projektas / vadovas Assoc. Prof. Jurga Ilgakojyte-Bazariene; Kauno technologijos universitetas, Mechanikos inžinerijos ir dizaino fakultetas.

Mokslo kryptis ir sritis: Transporto inžinerija

Raktiniai žodžiai: *Susidūrimo sistema, Avarinio stabdymo pagalba, pastovaus greičio palaikymo kontrolės sistema.*

Kauno 2017, 52 puslapiai

Santrauka

Pagrindinis šios tikslas yra išanalizuoti ir parengti vairuotojo pagalbos sistemos patobulinimus. Kilus pavojingai situacai, pvz širdies priepuoliųi, tai ši sistema padeda išvengti susidūrimo. Tobulinant šias technologijas sudaromos pagrindas autonominiam automobilių vairavimui ateityje. Skubios pagalbos išskirtinis bruožas yra tai, kad padeda vairuotojui – reaguoja ir savarankiškai stebi susidūrimo galimybę per trumpą laiką. Toliau plėtojant šiuos prototipus, šiomis technologijomis siekiama užkirsti kelią nelaimingiems atsitikimams, naudojant pagalbos vairuotojui sistemas. Kuriant skubios pagalbos sistemą, inžinieriai turi spręsti visus technologinius iššūkius taikant juos ir automatinio vairavimo režimams. Jei vairuotojas patiria infarktą ar esant panašiai ekstremaliai situacija, arba jei dėl avarijos yra neišvengiamas automobilio susidūrimas automatiškai jungiama stabdymo sistema. Tam naudojami algoritmai turi naudotis jutiklių duomenis, apskaičiuoti kiekvieną šio proceso žingsnį, įskaitant poveikį ir aplinkai. Taigi ši sistema yra ateityje siekiamo autonominio vairavimo, kuris yra pirmamiausia užtikrintų eismo saugumą keliųose. Tikslas yra sekti vairuotojo sveikatos būklę ir siųsti signalą avarinio gelbėjimo, medicinos ir kelių tarnybos komandos, siekiant greičiau suteikti pagalbą kelyje – ir visa tai turi būti vykdoma netrikdant eismo srauto.

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1. INTRODUCTION

This thesis paper works on overviewing the technologies in automobile industries to increase safety factors in the road transport systems. The most important system that helps in developing the road safety is Driver Assistant system. Some of the important system is Adaptive Cruise Control which is the first-generation autonomous system in vehicles. In this, many sensors are used to develop the system. Moreover, Various sensors used to raise problems like collision avoidance.

The main motive of the work is to define functions which has an ability of preventing the collision from the different angle and also to give assistance to the driver in case of driving. These systems involve the driver which gives the autonomous intervention from all aspects of the comfort and notification systems to avoid collision. The main aim is to analyse the information of driver assistance system in the field of the road accidents and its technologies that used for avoiding those accidents in case of the emergency of the driver. This will be the road map for the driver assistance system in road vehicles which focus on the future collision mitigation with the help of the Emergency Stop Assistance.

2. OVERVIEW OF JOURNALS

From our analysis, although there are many application that are helping in assisting the driver and also the road transport.

In 1988, Leutzbach described a physical model based on individual driver's knowledge of the safe distance driving and after that in 2000 Widmann et al briefed the model in to four situations:

1. Uninfluenced driving – the driver will not be influenced by other cars on the road but the driver drives at preferred velocities.
2. Approaching – the driver when exceeds his desired distance of the driving behind car, driver will approach it.
3. Braking – When unfortunately, or due to driver's negligence the required distance shrinks and the driver applies brake to keep a desired distance.
4. Car Following – this is just following a lead car over extended period and keep the distance between the vehicle to avoid collision.

When the distance between vehicle goes below the desired distance the application of braking is needed. When it exceeds the uninfluenced driving will occurs. Researchers, Benekohal and Treiterer in 1998, introduced the new begin and end parts in the same model above. Then in 1976 Lee, explained the new approach that happens during the travel, where driver using a simple form of eye sight data to take decision to apply brakes and controlling the action of the braking system. Then in 1990, Van der Herst included his thoughts by means of describing that controlling of braking system and decision of applying brakes are always depends up on the eye sight of pilot. Then Winsum and Heino in 1996 said that time distance in headway are constant with variant velocities but the time headway is consistent of the respected one and it also differs from drivers.

1. Lexus is the division of TOYOTA Motor corporation which is started for producing luxury vehicles. This was first started in 1989 in American market as soon as in to the market it was ranked as a most reliable brand from the survey made by J.D. Power and Associates in 2007. Hence, Lexus became the first company to introduce Adaptive Cruise Control Systems in 1999 and they extended their discovery with laser system in 2001 and due to drawbacks, it again they have changed the system to radar system.
2. Here comes BMW the most important automobile manufacturer which has included the feature of stop and go functions in Adaptive Cruise Control System in this high series vehicle like 5 and 6. This model can adapt to the lead car's speed and function runs

according to the change of state in driving and then it stops the moving car. This function has the run time of three seconds.

3. In 2007, Honda combining with Acura developed the driver assistance system for commercial vehicles and named it as Collision Mitigation Braking System. This car has a capability of slowing the car when it detects any obstacles in front of it and applies full pressured brake in case of nearby objects. Then it was included with real time traffic information system which downloads the real-time traffic information and gives alternative route for driving when there is heavy traffic and notifies about the weather conditions.
4. In 2005, Mercedes Benz company introduced its new S- class model which consists of safety systems which is like an Adaptive Cruise Control that uses the radar system to determine obstacles in vehicle path and automates the braking system and notifies the risk of collision. This also alerts the electronic functions in-vehicle collision avoiding system like side windows closing, seat belt tightening etc. this model also consists of driver and notifies the driver if he or she feels sleep i.e. state of drowsiness, as well as the real-time traffic information as Honda.
5. In Volvo, they introduced Adaptive Cruise Control in the model of Volvo V70 which keeps the desired distance between the car. As an additional feature, it consists of Pre- Collision notification and Automated Braking System. As same as the above system it also detects the obstacles in the driving path but notifies by automatically blinking the headlight and giving audio signals. It has some more features of driver alert control and lane departure Warning that used to monitor the driver's abnormality by comparing the course if road and wheel movement.
6. The journal was published on intelligent information hiding and Multimedia signal processing at Eighth International Conference held on July 2012 with the portion of the brain computer interfaces based smart environmental control system Which was proposed already. But using these technologies the quality of the human life is improved automatically and most recently. Here some examples are some researches going on in the field controlling the environment with human brain or some human actions. Thus, made the advantage of the brain computer interface. For the information, brain computer interface module works based on the plug and play as home networking smart applications. These interface structure probably consists of wireless communication, embedded systems, environmental controller and Power Line Consumption and the host system. This signal makes use of the electrodes which can detect the electric pulse in environment and in human body. Here it is used to detect the signals from brain neurons which are the process called

as Electroencephalogram (EEG). This makes the advantage for all smart home application and now it has been implemented in automobiles which are used for monitoring the driver's mental health and probability of drowsiness and avoids fatigue collision [24].

Andrew et al. (2011) designed a Neuro Phone system, which allows neural signals to drive mobile phone applications on the iPhone using Emotive EPOC EEG headset. However, the reach of these applications was limited [24].

Haapalainen et al. (2012) used a wireless EEG headset and other sensor devices to measure the psychophysiological signals for assessing cognitive load. The number of sensors used here is more and hence is cost inefficient [24].

Yipeng Yu et al. (2012) implemented the EEG device that uses the brain controlled environment system like drones. Here it uses the neuron signals produced from the brain to control the rotor like motors. However, the number of BCI sensors used here is costly and are greater in number [24].

Johan Johanson (2014) used Neurosky Mind wave device to control a quad copter by using Raspberry Pi with Python coding. By using LabVIEW, the signals can be analysed even more proficiently and used monitor health [24].

Finally, the conference paper published on Jan 2007 by an author Eike A. Schmidt at al. from Technical University of Berlin says that vigilance state of a Driver during Monotonous Driving can be assessed by the EEG and ECG signal processing [24]. This implies that the driver in the prolonged period of driving results in drowsiness and reduced state of the vigilance which are most reasons for driving in the traffic areas.

Hence, uses these driver health monitoring systems like discussed above in the vehicle electronics system that reduces the low vigilance system of the driver. This helps in assisting the driver in many applications during the driving. therefore, one project proposed regarding to this emerging technologies which is interdisciplinary called FaSor (Faher als Sensor) which brings together neurologists, psychologists, physiologists and computer researchers.

As said by authors above it is proved that vigilance state of the driver is the main cause of the accidents. Many technologies have improved to give medical assistance of those accidents such as E-CALL Systems. But preventing the accidents in road transport are always a challenge for many automotive industries.

In 2016, the paper was published in international conference on Smart Electronics system by Savita patil [21], who has invented the idea of implementing the wearable health monitoring sensors with Electronics Control Unit of the Vehicle in terms of IoT (internet of things), Activity Tracking, Cloud Computing, Health Care, Automotive Industry.

Moreover, Tata ELXSI team have also described about the system of health monitoring of a driver which is call as In-Car health and Wellness Monitoring. This system paid a way for many automobile manufacturers to invent new ideas in the road transport safety systems.

Several publications are involved in this section to improve the ideas in driver assistance system by addressing the cause to the accidents of driver's fatigue [18].

- In 2013, Australian publication identified that main factors that cause the risk of fatigue and offered the suggestion for controlling it.
- In 2011, the article in the journal addressed about the challenges and opportunities which can be expressed in term of technologies to assess fatigue.
- In 2009, the Federal Motor Carrier Safety Administration have described two developed areas like mathematical model that observes the consciousness and performs at various times in vehicle based system.
- In 2009, European Civil Servant Luc Tytat in 1999 at the conference held by European commission proposed severity of technologies in driver's dimensionless fatigue. In this the difference between the fatigue are explained as drowsiness and other negligence caused due to prolonged period of driving that also leads to mental and behavioural changes which comes from mental stress of the driver.

  For this Emergency call system (eCall) is going to be introduced in European union from April 2018 to give assistance in case of accidents anywhere in European Union.

Then, NAFMP proposed different ideas to avoid driver's fatigue with some relative approaches they are explained as follows.

- Giving solutions for reducing driver's fatigue by developing the corporate culture that enhances the driver transport system.
- Educating the drivers and their families, their executive, managers, shippers etc about fatigue management.
- Preventing sleeping disorder by giving treatment to the drivers before getting in to the road transport.
- And again, by scheduling proper trip or calculated trip based on the fatigue management techniques.

Whatever the technologies emerge or remedies emerge to avoid the driver's fatigue accidents there should be an explained solution to make the efforts come true and some practical works to adapt to the system. This thesis works will be the step forwards to avoid accident in very particular cases like driver's negligence. It is absorbed from the reports that

released by Scania the accident occurring in the European union on yearly basis says that about 46% percent out of 100% accidents are occurred due to driver's negligence and sudden death of the driver. On taking in account, they have been working towards the technologies that gives solution. By taking the aspects of these works this thesis emerged with new type of solution.

"Driver Sleepiness Level Detection Based on the Heart Rate Variability" [24]. though many technologies have improved in decades which can be used to monitor the driver's health there lack of improvements in parallel of those techs. hence in this paper it is improved the parallel driver assistance system which playing key role in assisting the driver's fatigue. In this thesis, it is discussed about the one of the driver assistance system trending now that is Adaptive Cruise Control which can be developed regarding the driver health measurement. Let have a look up on with what are improvements can be made in the existing system and how it will ensure the safety of the driver and also the road travellers.

Driver Assistance System is the technological module that supplements the cruising of the automobile which are provided in fatuous of message emergency signal, driver assistance semi-autonomous interface or an amalgam of the former variants where the difference between each other is delicately insignificant.

The commonly found driver assistant system sub categorised such as message, emergency signal, coexist with other unspecified yet significant aspects. The objective of the application aids zeroing the category of driver assistance system where each state relates to various individual degrees of drive assistance.

2.1 FATIGUE ACCIDENT CAUSES

The driver's fatigue is a very dangerous condition created when a person suffer the cardiovascular disease or unconsciousness which are the symptoms of driving while driving which is always a hypothetic collision during the night time. The driver when fall asleep or another exhausted to make serious and driving errors. The increase in number of traffic accidents due to the reduced vigilance state has become a fundamental problem for the society. Statistics shows that 20% of all the traffic accidents and up to one quarter of fatal and serious accidents are due to driver's negligence. Therefore, accidents due to the driver's reduced vigilance state are more serious now. Here the sleepiness of the driver became a big problem for the accidents. This sleepiness is caused due to long distance driving and driving with mental illness these may also a major cause of the fatigue of the driver.

2.2 DRIVER ASSISTANCE SYSTEM

Automotive technology has varied developed technologies to improve the safety of the driver and also the road safety which are comes around the knowledge called Driver Assistance System. At before it called as Anti-lock braking system is one of the driver assistance system that can prevent accidents from happening. When luxuries are raised now the technologies are needed most to develop the safety of the vehicle according to the customer need and environment.

Therefore, the driver assistance system is also an impact that gives driver's information and also automated tasks with the role of increasing the improved driver experience to enhance the driver safety. These systems the overall safety to the people on the road at all angles.

Some of the driver assistance system is existing the world which help in developing the road safety and also the driver's experience in driving. for example, cruise control and lane keeping assistant and so on.

There are many assistance systems is right away in the automotive technologies, and still some of them are out of focus. These systems will have to stick around for helping the driver at all circumstances and building of the car to car communication is also major aspect of the driver assistance system to make clear ideas about the traffic.

Advance Driver Assistance System are also the major part which are tweaked every year and here are some most important things which plays key role in safety systems.

2.3 IN DRIVING PHASE

`Driver assistance system has a main motive to give comfort and convenience features to the driver in Driving Phase which gives the message about the car to the driver and in some cases, it supports the driver as settling.

2.3.1 ADAPTIVE CRUISE CONTROL SYTEM

Adaptive Cruise control have an excellent feature of adaptive control of the vehicle speed which can be used of automatic acceleration, deceleration and braking of the vehicle which results in cruise control of the system. In addition to it, consists of the maintaining the vehicle's distance to the vehicle in the front. The figure 3.1 existing function in Adaptive cruise control system. If the host vehicle has no obstacles in front of it, cruise control set back the normal speed which as before. If in case of any vehicles it detects the speed of the car using the radar and PID controller and bring the vehicle to the desired speed to maintain the desired distance between the vehicle. This feature uses the braking system and acceleration system. This feature also works in the case if the front vehicle leaves the driving path.

By using features the Adaptive cruise control can reduce the mental, physical and fatigue of the driver which results in safe and comfort driving. Using this system driver can focus on the other driving tasks that improves safety and road lane. Moreover, deceleration in the adaptive cruise control also helps in avoiding accidents and by keeping the distance between two vehicles.

Since, this system is controlled by the driver that is the engage and disengage of the cruise control system can be switched on or off at any time by the driver using brakes as same as the normal cruise control system. This system works only when the host vehicle speed exceeds 30km/hr and keeps the standard distance according to the rule and regulations of the country the car is used.

Thus, the difference between cruise control and adaptive cruise control is explained simply and brief of the adaptive cruise control system is described below as it is a part of thesis.

2.3.2 ADAPTIVE CRUISE CONTROL FOLLOW AND STOP

Cruise Control is defined as a combination of follow and stop. It is said as the host vehicle will follow the preceding vehicle for long distance in headway and if in case of any standstill position of the preceding vehicle the host vehicle can able to stop and react according to the situation of the preceding vehicle.

2.3.3 FULL SPEED RANGE

When the vehicle is moving in full speed of about 140 km/hr with the function of Adaptive cruise control, over a distance when the sensor predicts the preceding vehicle is moving on with lowest speed than the host vehicle (120 km/hr) then the speed of the vehicle is reduced parallel to the speed of preceding vehicle. So that it can avoid collision, if in case the preceding vehicle moves right or out of the road speed of the host vehicle again comes back to normal speed as it was before as shown in figure 3.1.

2.3.4 STOP AND GO OF CRUISE CONTROL

This ACC stop and go is addition of the Full Speed Range method where it is used mostly in place of urban areas and in road traffic to avoid collision at low speed range where if accepts the speed of the rear vehicle, if the vehicle is stable without moving it manages to it [9].

2.3.5 SPEED CONTROL IN CURVED ROADS

Speed Control in curved roads is the technology that used to modify the vehicle's speed when the road curves right or left if there is any possibility to avoid movers in stability [9].

Were the vehicle predicting the curves using lane sensor and acts according to the vehicle behind or in front of it.

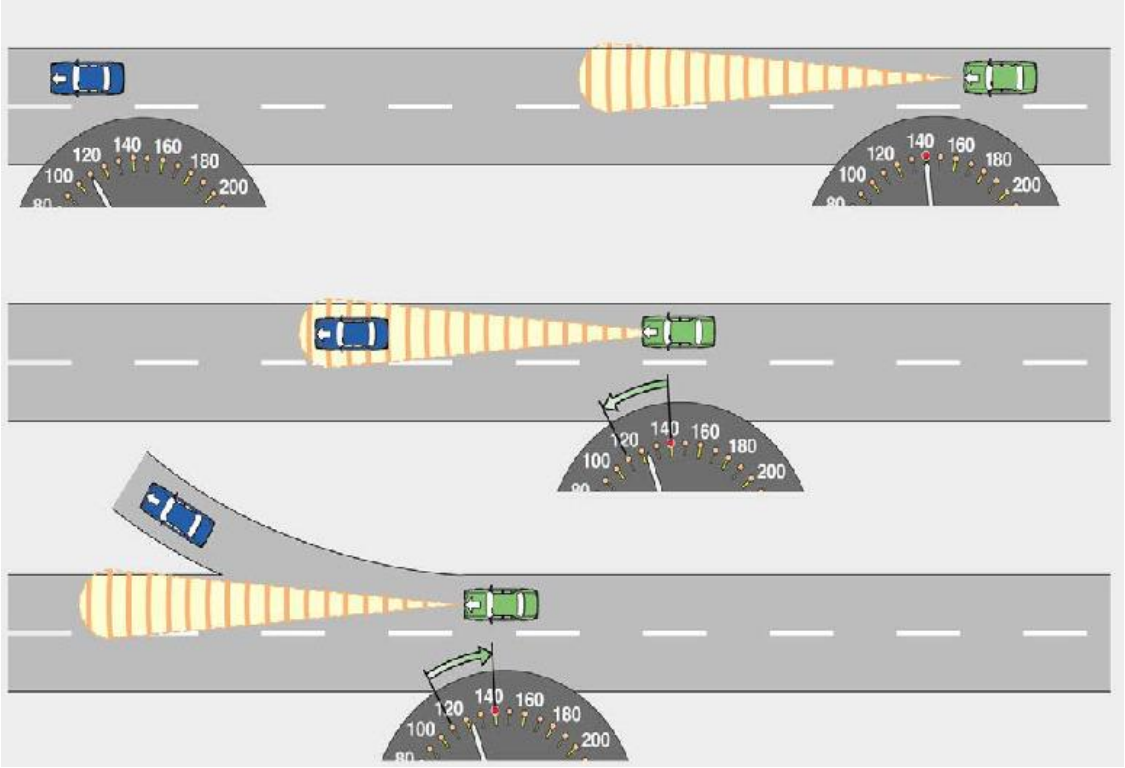

Figure 2.1 Normal Cruise and Acceleration and Deceleration

2.3.6 ROAD SIGN RECOGNITION

Road Sign Recognition, key for system for limiting the speed Figure 3.2 [9]. Road Sign Recognition intimates the driver about the road traffic and limit of the speed in the lane or the road or headway where he is driving and therefore it reduces the speed according the allowed speed of the vehicle in that area. So that, it assists the speed limit and help in improving driver control [9].

Figure 2.2 Speed Limit Assistant [9]

2.4 EMERGENCY PHASE

In case of emergency driver will be given information about the collision in road. It may be another car or it may be an obstacle which may lead to the road accident so that the driver who is travelling in area will be given warning about the incident and about the severance of the collision.

So, that the driver can choose another route for travelling and the speed will be reduced according to the distance between the vehicle and the collision occurred in the road.

2.4.1 FORWARD COLLISION AVOIDANCE

Forward Collision Avoidance assists the driver in case of obstacles when the car moves in the forward direction, and in emergency conditions it supports the driver by intimating when the braking should be applied in case of slowing of the preceding vehicle. Emergency Signals, provides the information about the information about the hazardous situations i.e. the obstacles in the Headway Distance. The emergency warnings sometimes increase gradually. In such cases, the driver can adjust the sensitivity of the system according to his driving style and can give response to it. The motive of a FCW system is to give warning signal to the driver of a forthcoming accidents that are going to occur which allows the driver to take responsible action at correct situations to avoid collisions due to the suddenly passing of moving objects. This also provides the information about the road transport and changes in weather condition to give assistance by deceleration.

2.4.2 REAR COLLISION AVOIDANCE

Rear collision system is same as like the forward collision system where the it is used only when the car moves in the reverse direction. Therefore, it is said when the car moves in reverse direction and if there are any obstacles behind it or any children or pedestrian crossing it gives warning to the system using object sensor so that the it gives information about the distance between the object and desired distance to avoid collision with the object.

It really uses the reverse camera to know about the obstacle size and angle to avoid attachment and in lane changing to avoid collision with the rear vehicles and support the driver to apply brake and move according to the rejection of the obstacle.

2.4.3 BLIND SPOT IN ROAD VEHICLES

Blind spot detection systems are systems which can show dangerous objects that are not visible to the driver. It is system which mostly assists the driver of the truck using the sensors and it helps avoid object collision

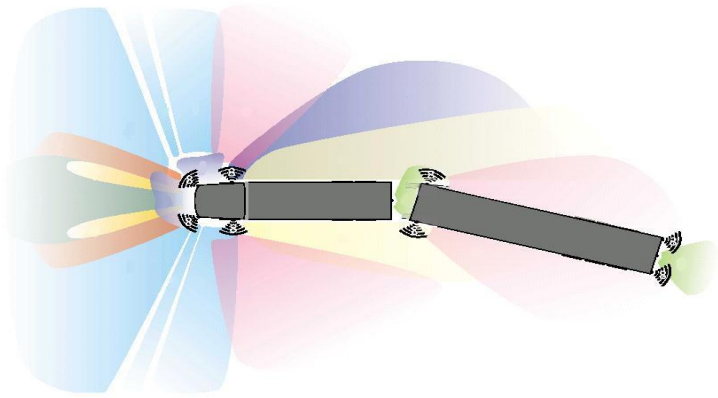

Figure 2.3 Blind spot areas of a heavy truck [9]

As seen in figure 2.3, there are some gaps shown in the field of vision which is close to the truck front. There are some additional blind spot areas where they are not in the passenger car. Usually blind spot detection in the car used to monitor the objects surroundings the vehicle as shown in figure 3.3. if there are any objects predicted in the blind spot an acoustical or optical emergency signal is notified. Sometimes it assists the driver by showing the emergency signal in the vehicle screen presented in the dashboard.

In case of trucks this blind spot, detection can monitor all objects in the blind spot as seen in the figure 2.3[9]. Figure 2.4a and figure 2.4b shows the blind spots caused by front pillars blocking the view and 2.4c shows the area which are not covered by the mirror.

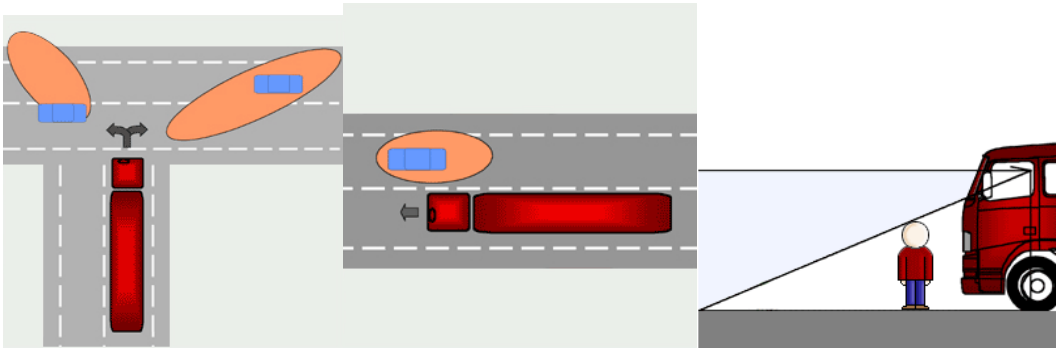

Figure 2. 4 Examples of objects in blind spots of a heavy truck [11]

For blind spots are major problem which vehicle turns or turning at intersections. Figure 2.5 shows the places where the objects are not visible to discover the blind spot.

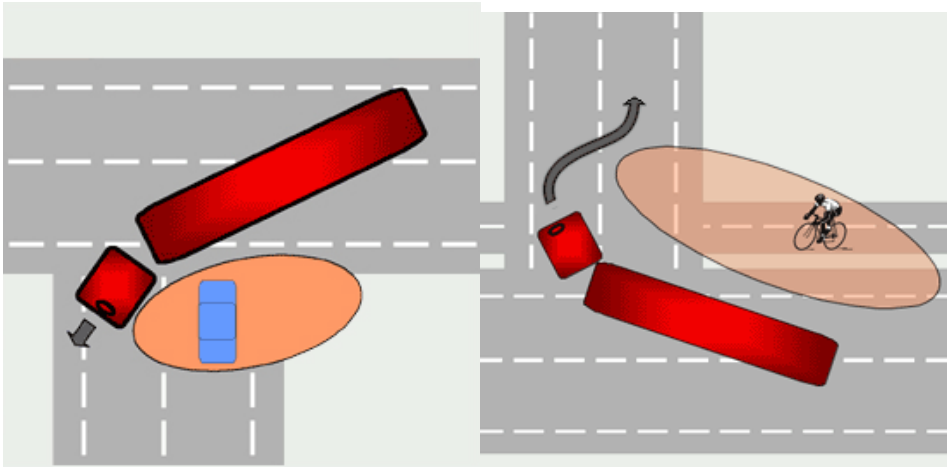

Figure 2.5 Blind Spot of the Truck [11]

As in figure 2.5 it is very hard to give notification to the driver in the truck about the obstacle in side of the vehicle so that it rare challenge to system of BDS. So that it will be helpful if the sensor surrounds a truck and senses the object in the area.

MAN is developing such a system which they call Turn-off Assistant [11].

2.4.4 LANE CHANGE ASSISTANT

For a Lane Change Assistant (LCA) system it is important to discover the object in the nearby lane to give assistance to the driver in case of the lane change. It uses the rear sensor and side mirror now a day to give the warnings about the cars coming nearby. Using this system, LCA systems require monitoring the lanes and vehicle nearby also the obstacles. This assistance system is used to detect the obstacles present in the lane where the car is travelling and parallel moving cars also shown. This assistant system will be suitable for all mode of vehicles which are going to change the lane and lane change motivation of the driver in those vehicles [9]. It intimates through the warning signals when there is any objection in changing of the lane wherever the driver cannot pass through the mirror vision in some scenarios. At the stage of implementation of these system it is used for avoiding the use of out of sight car that cannot be seen through the side mirrors.

2.4.5 LANE DEPARTURE ASSISTANT

LDA is an emergency notification module used to keep an look on the lane markings and displays the lane in the form of digital videos in the dashboard and also it warns the driver in case of unwanted lane change. This works based on the time to line crossing thresholds to avoid unusual turning or turning without the signals and wheel angle alignment in case of driver's drowsiness and negligence of the driver. Here the driver habit is adapted to the vehicle system.

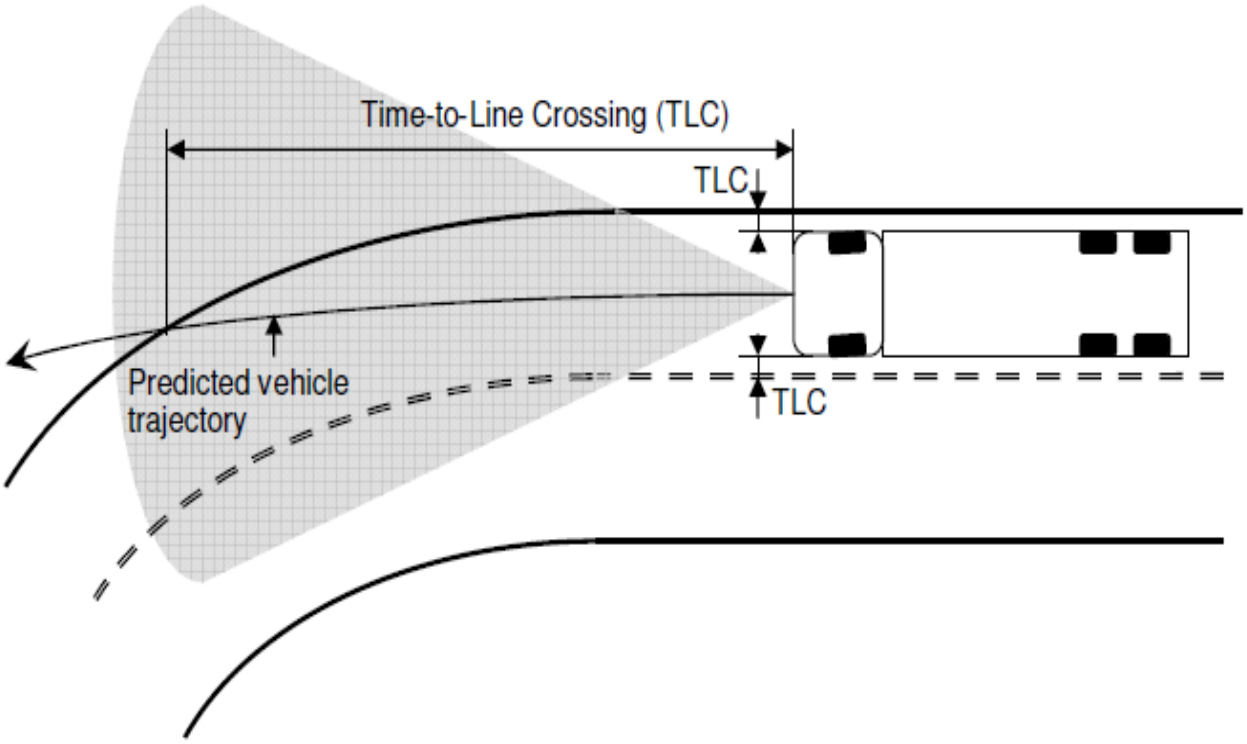

Figure 2. 6 Time-to-line crossing threshold for lane departure

2.5 ACCIDENT UNAVOIDABLE PHASE

In this Phase, the main motive is to avoid the collision of the vehicle in the road transport in autonomously intervention or manual intervention. But the system can take the control the vehicle to avoid collisions at any circumstances.

2.5.1 LANE KEEPING ASSISTANT

Lane Keeping Assistant is with the use of the Lane Departure Warning helps the driver to keep the vehicle on the lane. If in case of the driver fatigue or drowsiness the vehicle has a chance of movement from the proposed trajectory. The LKA includes the function of lane detection and steering angle control on the defined trajectory to avoid the change of lane without driver's unconsciousness and therefore it helps the driver to avoid the collision in case of lane change accident.

2.5.2 LANE CHANGING ASSISTANT

Lane change assistant have the capability of the giving assistance to the driver. It helps the driver by using the blind spot sensors and rear mirror sensors to avoid collision and that can help in motivated manner of system. By giving information about the vehicles coming behind the host vehicle and detecting the speed it clearly shown when and how to change the lanes.

2.5.3 EMERGENCY BRAKE ASSISTANCE

Emergency Brake Assistance has a work of applying full brake pressure in case of the emergency occurs. First this system uses the surrounding radar system that gives information about the object at all angle and give the information about the surrounding objects and allows the brake assistance to apply brakes and stops the vehicle at distance. This can avoid the forward collision of the vehicle. This also calculates the desired distance at which place of braking will avoid collision. By acquired distance how much the load must have applied for the brake to stop the vehicle also calculated and so that vehicle stops at desired distance to avoid accident. It system works without the knowledge of the driver even in case in of negligence of the driver.

2.5.4 PRE-COLLISION NOTIFICATION SYSTEM

Pre-Collision is a technological system which uses the restraint devices [7] i.e. the system shows the forthcoming collision and triggered the use of the restraint device. As discussed above the pre-collision system is used to alert the in vehicle assistance system to avoid damage to the driver those systems are like airbags, seat belts etc. and also to apply brakes in case of Pre-collision emergency system. The system offers the information about the severity of the accidents which are going to be happened [7]. The second system help in accident cases to avoid the driver and passenger damage by activating the in-vehicle sensor which are said a seat belt tightening and air back sensor [7]. This system also consists of the available anti-lock system to apply brakes that helps to decelerate and lowers the speed and applies the brake in case of the emergencies. In current technology, this system always focuses on the forward collision avoidance and declares the safety of the vehicle with the possibilities of the available driver assistance systems.

Research studies on these cases of accident avoiding systems in several scenarios they have failed to construct the ideas about the rare cases of the accidents which are now becoming usual due to the variability of human health conditions in the world. In that cases, the impact of driver in the road transport and his consciousness in driving is reduced rapidly now a day. Ignorance, negligence, drug consumption, driver's fatigue and disable people, health variability are usual things that are major causes for the road accidents. Thus, in this research thesis to avoid lives from death the impact of driver assistance system is reconfigured according to the rare system scenarios and introduced the impact of the driver negligence by reconstructing the Advanced Cruise Control System.

3. RESEARCH METHODOLOGIES

Over the investigation of accidents and its causes, there are many remedies that can prevent accident to occur. Even though, accident caused due to driver's relinquished steering control is always a challenging factor for those systems. Many accident studies have evolved to avoid this accident scenario that focus on the adaptive cruise control which is the latest technology in automotive environment that enhances driver assistance systems. To prevent humans from accident which is unavoidable that is when the driver is in drowsy state and sudden death of driver. Different cases of study have done and results is that when driver suffers from illness or any abnormal things state of driver is mentally disturbed or horrified in that confused state, what if the driver gives acceleration instead of braking? The driver was supposed to severe accident that not only cause injury to driver. It also injures co passenger, if in case accident in traffic it injures pedestrians some it also leads to death and if it occurs in case of trucks, this disturbs the co-vehicle and lead to unavoidable host vehicle and to the preceding vehicle.

The main objective of this thesis study is:

- To prevent unavoidable collision in the road by enhancing the driver assistance systems and to avoid Fatigue
- To study the existing Driver Assistance System and developing.

3.1 FLOW OF RESEARCH PROJECT

This research is a development of Driver Assistance System based on the avoiding Fatigue Accidents by enhancing adaptive Cruise Control Design. The thesis is organised in to five diverse types of methods which are shown below:

From the below, mentioned methodology, the first step or process is the analysing accident data in various aspects and role of Adaptive cruise control systems which are currently in the market to avoid those accidents. The next step is to investigate the drawbacks of adaptive cruise control systems which are failed to react in case of fatigue accidents and developing the design of the system.

This development brings the next step of the research, where the implementation ideas of the driver health monitoring is described and development of adaptive cruise control to avoid fatigue accidents and accidents occurred due to driver's drowsiness. The last step is to develop automated emergency braking to avoid or mitigate collision.

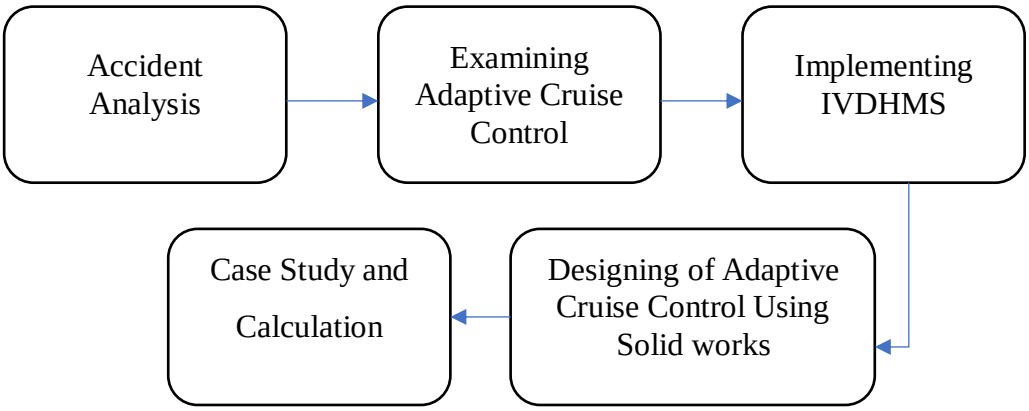

Figure 3. 1 Flow of Thesis

3.2 ACCIDENT STATISTICS

Accidents are unpredictable, unavoidable thing that occurs irrespective of time and place. As per the saying 'Prevention is better than Cure', accidents can be avoided and are prevented up to a certain extent. Whereas, on the other hand accidents that happens due to driver's health illness are severe in nature because the emergency case not even known to the driver himself before the accident. This kind of accidents can lead to death of the driver and co passengers and can also lead to collision with other vehicles, signboards, lamp posts etc., causing a huge damage to mankind and surroundings. In this section accident data's around the Europe and world are collected and the severity of driver's medical emergency cases is discussed.

3.2.1 ACCIDENT STATISTICS OF EUROPE

The commission for Europe pledges to reduce the fatality rate on its roads to zero by the year 2020. Safety of passengers travelling by roads is one of the focus area of European union. The European union as well as the economic commission for Europe have implemented many regulations to avoid accidents and increase the passenger safety in road transports and regulation were implemented in Europe prior to other countries.

The 'European Agency for Safety and Health at work' is a statutory body of the European union that reviews about the injuries caused to the road transport worker/driver and based on its report around 5 to 10 percentage of car accidents in European roads occurs due to medical emergencies of drivers such as chronic medical disorders, cerebrovascular disorders, low blood pressure, strokes etc., causing a death of about 2000 to 4500 persons per year [1]. All age group of drivers are subjected to this type of accidents and the ratio is higher for old age drivers ranging from 45 to 70 years. Several laws are implemented stating regular medical

check-ups for old age drivers and drives having a pre-medical report. Driver's with pre-medical report like heart attacks and other cerebrovascular disorders are constantly monitored and are advised to avoid driving to eliminate this kind of accidents.

3.2.2 ACCIDENT STATISTICS AROUND THE WORLD

In case of world, safety of road passengers is still an alarming fact as there was no single common regulation for safety. Accidents are more common in many low and middle income countries because of the fact of less liberal regulations in those countries. This will be greater in the case of accidents discussed in this thesis. Higher income countries implemented many safety features such as call system whereas, in lower and middle income countries no such systems are available which makes it one of the severe type of accident. This type of accident is common among all kind of driving age groups whereas for older age groups ranging about 45 to 70 year cerebrovascular disorders are the main cause of accidents. The following table shows about the number of deaths that happened during year 699 to 2004 around the world [2].

Table 3. 1Number of Deaths by Age Groups

Age Group	Number of Deaths due to Cerebrovascular & Hearth Diseases
4 to 29 Years	4380
30 to 8 Years	23000
45 to 69 Years	314900
70+ Years	1020200

From the above table, the accident related with driver's health is more common in older age group drivers. To avoid those accidents the system associated with existing Driver Assistance System is described and developed in this thesis and the different scenarios for developing those systems are also proposed in this project.

3.3 ADAPTIVE CRUISE CONTROL

Adaptive Cruise Control System is the one which can be said as extension of the existing cruise control in all vehicle currently. This system working can be said as follows: this feature cruise control system to run automatically without driver's intervention i.e., this includes the radar system to the vehicle which has an ability to detect the obstacles in vehicle path or a vehicle moving in traffic. This radar system uses the high frequency signal and calculates the state of the preceding vehicle i.e., if the preceding vehicle slowing down or

stopped. If this system detects those changes of state it adapts the vehicle adaptive cruise control according to it. In simple words, when the vehicle in front of the Adaptive Cruise Control vehicle slows down it automatically slows the down the vehicle to avoid collision and maintains the time gap and control the clearance between two vehicles.

This feature works if there is any vehicle in the path of driving. if there is no longer a vehicle in path this system automatically set back to the normal speeding of the cruise control. This system is purely autonomous but in current it can be controlled by driver whether it should on or not. Although the system is autonomous it works without driver intervention. This method of Adaptive Cruise Control controls the throttle of the engine and braking system to achieve its function.

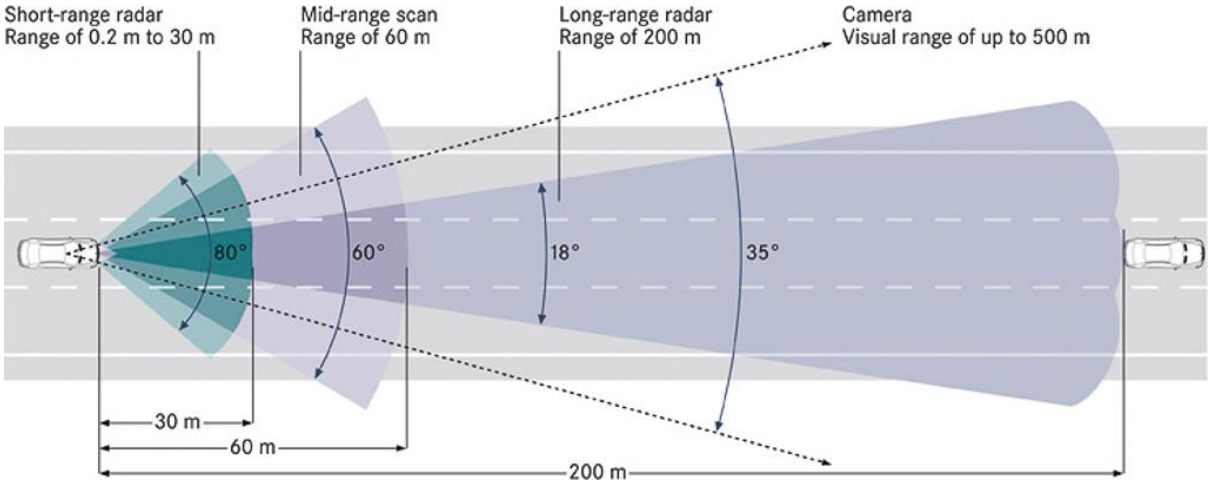

Figure 3. 2 Advanced Cruise Control System [21]

3.3.1 DESIGN AND WORKING OF CRUISE CONTROL SYSTEM

In the name, itself the working of the system can be describes as follows: Cruise can be said in different words they are throttle or acceleration. The control of throttle or acceleration is called as Cruise Control. This cruise control system consists of the actuator as shown in the figure 4.3 which controls or actuates the throttle valve of the engine with the cable connected to actuator. Generally, the throttle valve works on passing the air into the engine which controls the speed of the car by taking in the fuel according to the inlet of the air. Controlling the air inlet can adjust the fuel intake so that speed of the engine varies. In simple words, throttle valve controls the power and speed of the engine by passing the air, then how much the air comes in it takes in the fuel injection system.

In the figure 4.3 shows the two cables connected to the actuator that control the movement of the throttle valve. Here one cable is connected to the acceleration pedal of the car

and another one is connected to the throttle valve pulley with is responsible of air intake. Whenever the car is in cruise control mode the cable connected to the throttle valve from the actuator is adjusted which in parallel moves the acceleration pedal so that there will be the movement of the acceleration pedal whenever the actuator pulley control the throttle valve.

Figure 3. 3 the electronically-controlled vacuum actuator that controls the throttle

In the current society, there are almost 75% of the vehicle is equipped with cruise control system. This uses the small electronic controller which controls the function of the actuator which regulates the intake of the air in the vacuum of the throttle valve. In the same way, this controller consists of the several system and sensors connected to it to monitor the driving state of the vehicle. One of the main system connected to it is brake control system which is an actual worker of the speed control if in case of emergency, it provides cover by the braking system. Mostly cruise control system comes with Anti-lock braking system which is best for cars now a day. This cruise control consists of the small computer that can be found under the hood or a dashboard with the LCD monitor which always notifies the state of the car to the driver. As well as speed sensors to give instant notification about the current speed of the vehicle.

Thus, the figure 3.4 shows the mostly used control system of the Cruise Control in the current generation cars which are all connected to various system for giving support to the driver in all worst cases by enhancing the driver assistance system as discussed above.

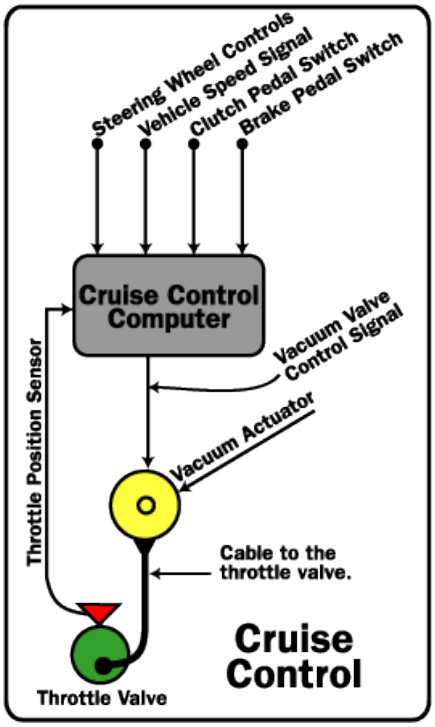

Figure 3. 4 Cruise Control System [6]

The perfect cruise control system adjusts the acceleration according to the input given by the driver and maintains the speed given as input over an extended period without any intervention or deviation from the external source. No matter it takes how much the weight in the car and where the car travels it may be a hill or a slope the speed of the car maintained according to the travelling environment. This works as a classic application over where the other system cannot give assistance in such efforts. As said before whether it is a hill or slope it automatically adjust the speed of the car by the throttle position and the speed of the tires. It also can monitor the desired speed where it is driven and notifies the driver when and where to disengage the system.

3.3.2 ADAPTIVE CRUISE CONTROL ACTUATORS

The throttle system of adaptive cruise control consists of an DC motor that controls the throttle which consists of kinematic links. This kinematic links consists of the master gear and Slave gear. Master gear which is attached directly to the slave gear. Slave gear is attached with moving rod which is connected to the Throttle pully and Acceleration Gas pedal pulley. As shown in figure 4.5 there is the controller connected to the actuator which consists of the solenoid valve either it can be vacuum solenoid or electronic solenoid. This solenoid has the gear connection attached to the DC motor which runs depending on the input signal given. For the maintain the desired speed the solenoid locks the DC motor controlled gear for increase

and decrease of the speed the solenoid along with the gear rotates to avoid the disengage of the cruise control.

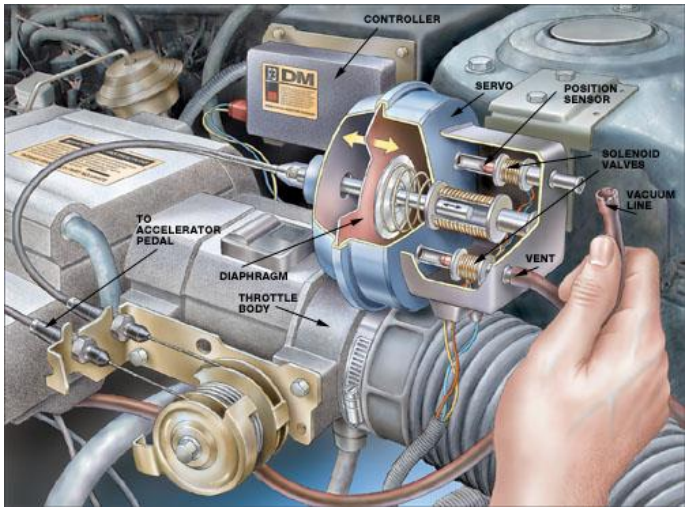

Figure 3. 5 Actuators

Meanwhile the slave gear relates to solenoid which is the working as a lock system for cruise control i.e. if cruise controller sends the set signal to the actuator, solenoid is used to lock the gear is desired speed which is sensed by the speed sensor. This solenoid moves with the slave gear whenever the DC motor rotates the gear for increasing and decreasing of the throttle where the throttle pully and gas pully attached with the rod. Here the development of the cruise control actuator is involved to enhance the driver assistance system. For knowledge purpose the working of the solenoid is given as follows.

Linear Solenoid Actuator

As said before there are two types of solenoid are working in the cars they are vacuum solenoid and electronic solenoid. Here the electronic solenoid is taken in account for the purpose of the brief working description. There are motions in the solenoid they are rotational motion and linear motion. Here used is linear motion solenoid it is an electromagnetic solenoid which converts electrical signal into magnetic field which produces the linear motion.

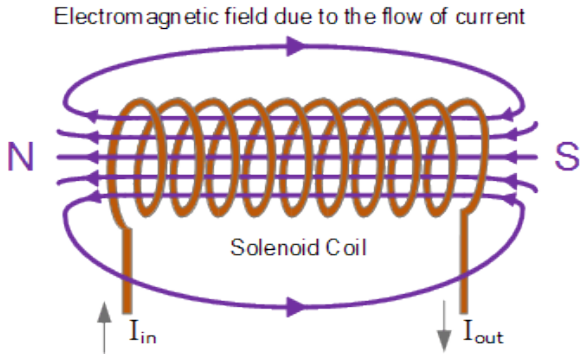

Figure 4. 6 Linear Solenoid Actuator

This works on the principal of electromechanical relay that can be switched on and controlled using transistors which are the part of the controller (controller consists of more than one transistor for different control function). In this design, the used linear solenoid used on the basis of the electromagnetic device which converts electrical signal for push and pull force for the gears attached to it.

This linear solenoid consists of an electric copper coil which wounded around cylindrical tube with the ferro magnetic rod or plunger which is free to move in linear direction that is IN and OUT of the cylindrical body. The main area where these solenoids are applied is electric doors and latches, open and close valves, operating robotic arms and mechanisms and even actuate the electrical switches in the industries by using the electrical energy which produces the magnetic field for the motion around the coil.

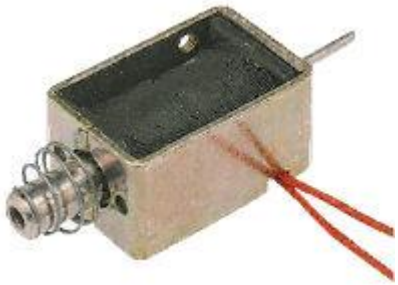

Figure 4. 7 Linear Solenoid

Hence the solenoids are available in different formats of motion the most commonly used is linear solenoid. The actuator using this solenoid is known as Linear Electromagnetic Solenoids.

The most common function of all types of solenoids is to either holding or latching which is being energised or not energised applications which is said as latching type solenoids continuously energised regarding the input power. These solenoids can also be designed for the proportional motion for controlling were the plunger can be positioned according to the power input. When the power input is given electric current flow through the conducting coil that produces the magnetic field and the magnetic field is directed with proportional to the North and South poles which can be controlled by the flow direction of the current within the wire. Hence the coil become magnetised as same as the permanent magnet which moves according to the north and south poles.

The magnetic field strength can be increased or decreased by either limiting the flow of current or by increasing it through the coil. It can also be done by changing the number of coils wounded around the cylindrical tube. By changing the above parameter, the motion of the coil also be controlled simultaneously.

Here when the current is passed by means of the electrical energy through the coil's windings the behaviour of the coil is changed to Electromagnet. Then the plunger inside the coil attracted towards the centre of the coil by magnetic flux. The coil body is set up as the magnetic flux producing material. In turn this flux compresses the small spring to another end of the plunger. Hence the movement of the plunger describes the strength of the magnetic flux produced within the coil.

For the opposite motion the supply of the current is stopped or the coil is de-energised then the electromagnetic field generated by the coil collapses and the stored energy in the compressed spring forces the plunger to come back to its normal or original set position. This movement of the plunger inside the coil is called as solenoid stroke which is other words said as the distance at maximum the plunger can move either in IN and OUT direction as pull and push. For information in the normal or common solenoid, distance the plunger can move is around 0-30mm.

Figure 3. 8 An Actuator Used In Toyota Corolla

Thus, the speed locking, increasing and decreasing occurs in adaptive cruise control is truly depends upon the solenoid used in it. So, whenever the cruise control of the car is engaged the actuator of the cruise control runs the DC motor to adjust the throttle position and solenoid used for locking the set speed over an extended period of the time. This actuator has a two-connected pulley one is connected to the acceleration pedal and another one to the throttle valve pulley. So that to manually control the throttle valve of the engine when the cruise control is disengaged on cruise control mode the pedal moves simultaneously as actuator moves the throttle pulley. Here the figure 4.4 shows the current model of Toyota Corolla cruise control Actuator.

3.3.3 CRUISE CONTROLLER SYSTEM

The cruise control system always works in the basis of the input signal from the sensors which is processed by different controllers. They are proportional controller, proportional integral controller and Proportional Integral Derivative Controller (PID) controller. Here most used and new to technologies is PID controller. As the proportional has its function on its name here are the simple working of other working parameters. They can be explained in simple words as:

- The speed of the car using distance is calculated by Integral
- The speed of the car using acceleration is calculated by derivative

In the Adaptive Control System, the most used controller is PID controller which is implemented for calculating car's speed that also be helpful in detecting the desired speed. This PID controller uses the three control factors they are proportional, integral and derivative as said before and calculates those parameters individually and adds them to set the throttle position for desired speed. In this controller, the integral factor is used to calculate the time integral error of the vehicle speed. In simple words, it compares the distance travelled by the host car and distance travelled by the preceding car or vehicle if the preceding were going at the speed of desired level it calculates and set the desired speed in host car. Therefore, this integral factor helps the car to change its state of increasing the speed if it was travelling in the hills. It is noticed that, in hills speed of the vehicle stampers at that it increases the car speed to get rid of that stamper position and smooths the driving. proportional factor is used to increase the throttle little bit in that stamping state of the car. Then after, the integral factor increases the speed of the car more and more when the car maintains low speed than desired speed. This function works the distance between the cars exceeds the desired distance.

At last the derivative factor is here, as explained above the derivative is used to calculate the speed by acceleration, it can be used for quick response of the cruise control according to the place of driving such as hills. That is if the car slows down it speeds up the acceleration before the car attains the very lowest speed and changes the throttle position according to it. Hence this adaptive cruise controller works based on the three mathematical parameters which are used to calculate the speed of the car leading forward and to maintain the speed of the host car according to the assistance system's desired speed control and distance control. In this thesis, it shown how to avoid the low response time of the cars controller using this PID controller to take proper action in case of the collision.

3.3.4 FUNCTIONS OF ADAPTIVE CRUISE CONTROL

As the additional information for this thesis works which the users can get clear idea about the working the functions of the adaptive cruise control system is explained in different controller sections below:

Adaptive Cruise Control: The main function of the Adaptive Cruise Control System is to process the radar sensor information and to detect is there any object or a moving vehicle is on the path of driving at distance which the radar capable of. Therefore, the ACC System passes the information to the Engine control and Brake Control to maintain the distance of the two vehicles in travel

Engine Control System: Here this engine control system get the distance information for slowing down and speeding up from the adaptive cruise control system according to acquired function signal. This after getting the information control the speed of the vehicle. This speed control is functioned by adjusting the throttle valve of the engine. For these functions, it also gets the information from the instrument switcher.

Brake Control System: thereafter comes the brake control system, this is basically an anti-lock braking system which is a hydraulic brake with electronic control take by wire. This anti-lock braking system as known, look for vehicle speed by the wheel speed sensor and reduces the speed by decelerating which is done by applying the brakes. This function will be a request from the adaptive cruise control system to avoid any abnormal functions.

Instrument Switcher: Then function of the instrument switcher is explained from its name. its function is to control the switches of the cruise control and send back the processing information to Control system of the adaptive cruise control. This switcher also displays the notification of the state of the cruise control to the driver as a tell-tale.

CAN: this CAN system is a Controller Area Network which is a wired network that behave as an intermediate communication link between the control system described above. This system consists of a wired bus that can transmit the data and receive the data between control systems. This is based on the packet data transformation which being used for telecommunication system. In this transformation consists of header, 0 to 8 bytes of data and the checksum. Header is the one which gives priority to the message and where it must be transferred. Thus, information's are transferred only when the bus is free to pass information. If there are multiple information from different nodes that tries to transmit data at same time, the arbitration scheme is used to choose which should be given priority to control the bus. At that time, it looks for the header of the data in the packets of the node and priority header will

win the arbitration scheme and message in that header transferred. The lost message will be sent again as soon as the bus is free.

Cruise Control Switches: Here comes the cruise switches that can be seen in the steering wheel of the implemented vehicle, consists of different button for different command that can be sent to the adaptive cruise control system. Here is some description about those switches:

ON	Engage the Cruise Control System
OFF	Disengage the Cruise Control System
SET +	Increase the Speed by 10 km/hr
SET -	Decrease the speed by 10 km/hr
COAST	Decelerate rapidly
RESUME	Back to desired set speed
TIME GAP +	Increase the time gap
TIME GAP -	Decrease the time gap

Table 3. 2 Cruise Control Switches and its Functions

Figure 3. 9 Cruise Control Switches

In this system, it is shown the throttle control in adaptive cruise control consists of an actuator and solenoid. From the case of the accidents due to driver's drowsiness is prevented in case of implementing health monitoring system and redesigning of actuator used to avoid the acceleration in case of Automated braking.

3.4 AUTOMATED BRAKING SYSTEM

(A) Physical Model

Here the inertia of the vehicle is omitted. Considering the friction, the vehicle is obtained from the motion of the vehicle where is used for obtaining the desired distance of calculation. By the mass of the vehicle the cruise control structure is calculated using the below formulas and the parameters for obtaining the desired value is shown in the figure below.

From the Newton's second law of motion, a differential equation for the cruise control model is obtained as shown in Eqn. (1).

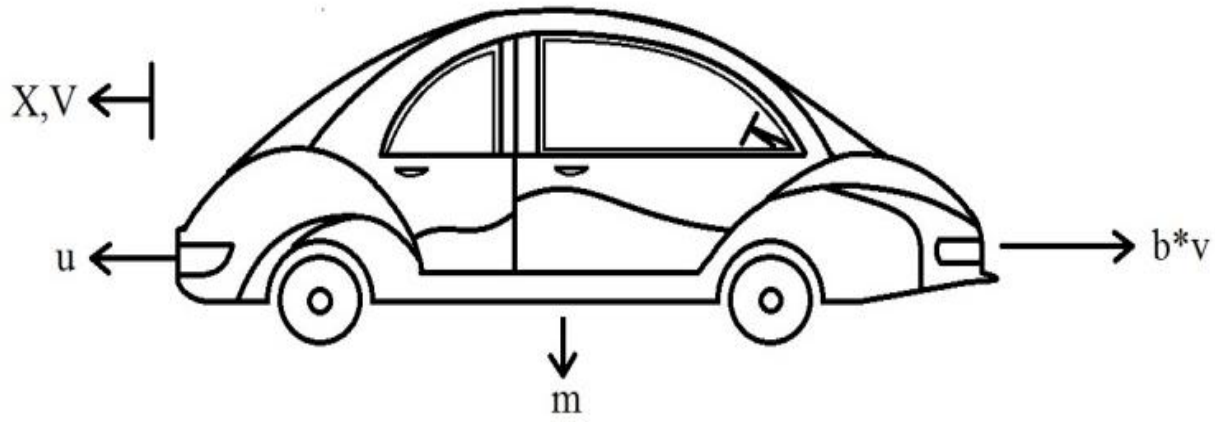

Figure 3.10 Car Parameter and Load

$$\mathrm{m}\frac{\mathrm{d}v}{\mathrm{d}t} + bv(t) = u(t) \qquad (1)$$

Where, v is the velocity of the car, b is the friction acquired from the motion of the car and u is the force given out of the engine.

On applying Laplace Transform theorem,

$$mS \cdot V(s) + bV(s) = U(S) \qquad (2)$$

By rearranging the above equation, the transfer function of the open loop is shown below.

$$\frac{y(s)}{U(s)} = \frac{1}{mS + b} \qquad (3)$$

b) Controller Action

(i) P controller

The closed loop control system is shown as below with the proportional control K_p where it is shown proportional to the system is

$$\frac{y(s)}{U(s)} = \frac{K\mathrm{p}}{mS + (b + Kp)} \qquad (4)$$

(ii) PI Controller

Proportional control (K_p) and integral control (K_i) are taken in account, the closed loop transfer function for the cruise control in case of proportional function is shown, as in Eqn. (5).

$$\frac{Y(s)}{U(s)} = \frac{KpS + Kl}{mS2 + (b + Kp)S + Kl} \quad (5)$$

(iii) PID Controller

In this case of the controller the all type of the parameters is added in account which are used is proportional Kp, integral Ki and derivative Kd is used in this section and derived below

$$\frac{Y(s)}{U(s)} = \frac{Kd\ S2 + KpS + Kl}{(m + Kd)S2 + (b + Kp)S + Kl} \quad (6)$$

(c) Braking Model

The brake model is descried in the following equation in the basis of the mass and velocity of the vehicle and how much the forced applied at that mass and velocity here the mass and velocity calculation is form of the acceleration to avoid the misunderstandings,

$$F = ma \quad (7)$$

$$a = \frac{v_1}{t} \quad (8)$$

m - Mass of the Vehicle, a - Acceleration, v_1- Vehicle Speed, D_1 - Stopping Distance,F - Braking Force Therefore

$$F = m\frac{1}{2}\frac{v_{1^2}}{D_1} \quad (9)$$

Stop and Go manoeuvres

The automobile manufactures have developed the cruise control systems with advanced technologies which are over a vast environment and has a capability to avoid collision if the vehicle is moving at the speed of 15km/h by using the automatic braking system. But the time taking to restart the vehicle causes the traffic jam and a disturbance to the other vehicle in the road. And it is very difficult to stop the vehicle the if in case of the applying the brake and acceleration simultaneously. Thus, the manoeuvres are taken account to avoid collision that are about happen. the system which can stop the vehicle and moving the vehicle if there are no objects are trespassers in the road. For using this methodology, it is needed to make decision in differential manners so that the accident can be avoided at any circumstances.

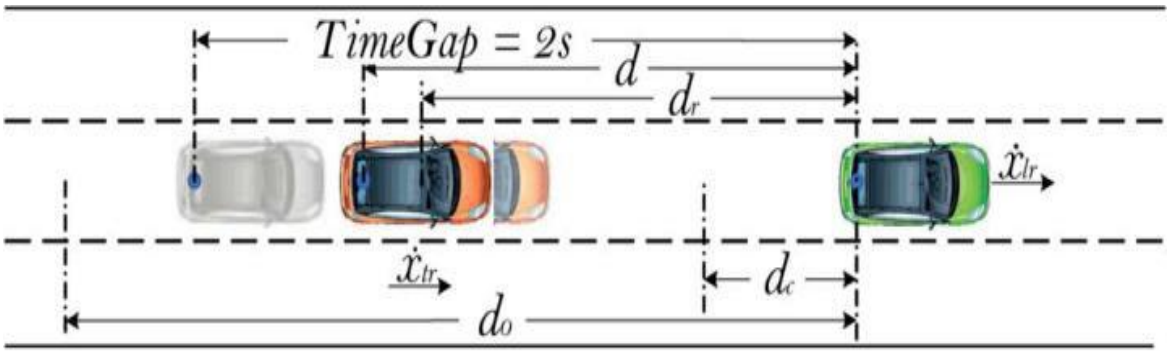

Figure 3.11 Distance Calculation

4. IMPLEMENTATION

4.1. WHAT IF IN CASE?

However, the monitoring of drivers Stopping the car in this case of emergency is the challenging point and many question has raised about working of the Adaptive Cruise Control in different case like

- What if the driver in unconscious state, paralyzed leg on the acceleration gas pedal or rise the acceleration unknowingly or in confused state instead of applying brake increasing acceleration?
- What if there is preceding car nearer to the host car? what if the pedestrians crossing when driver feels drowsy?

To give solutions to these problems, this thesis project discovered the modern design of the throttle control actuator and automated braking system in different scenarios which shown described as follows.

4.2 DESIGN OF ADAPTIVE CRUISE CONTROL ACTUATOR

To give solution to the first question, the throttle control actuator of adaptive cruise control is designed by comparing the existing model. In this thesis, the existing model of TOYOTO COROLLO model Cruise control actuator is taken in account. From, the analysis it is shown that solenoid in the actuator plays key role in controlling the throttle. Since the gas pedal pully is also attached with the cruise control actuator rod when the driver in case of horrified state unknowingly accelerates the throttle instead of applying brake or if the adaptive cruise control applies the brake in case of sudden pedestrian crossing. The rotation of wheel and braking works simultaneously it defects the Brake disc almost it leads to heavy damage hence detaching the gas pedal pully in case of emergency will be the only solution for preventing the fatigue accident. Hence the redesigning of the Actuator according to the emergency case of driver needs to be designed and implemented and health monitoring sensors also to predict the mental state of the driver. This thesis research will guide the future of technology in this case of emergencies where the redesigning of actuator is carried out and the processing of automatic braking system .in case if there are any vehicles preceding before is the automated braking system is analysed and calculated as follows.

Here the design of existing cruise control actuator is shown below in figure

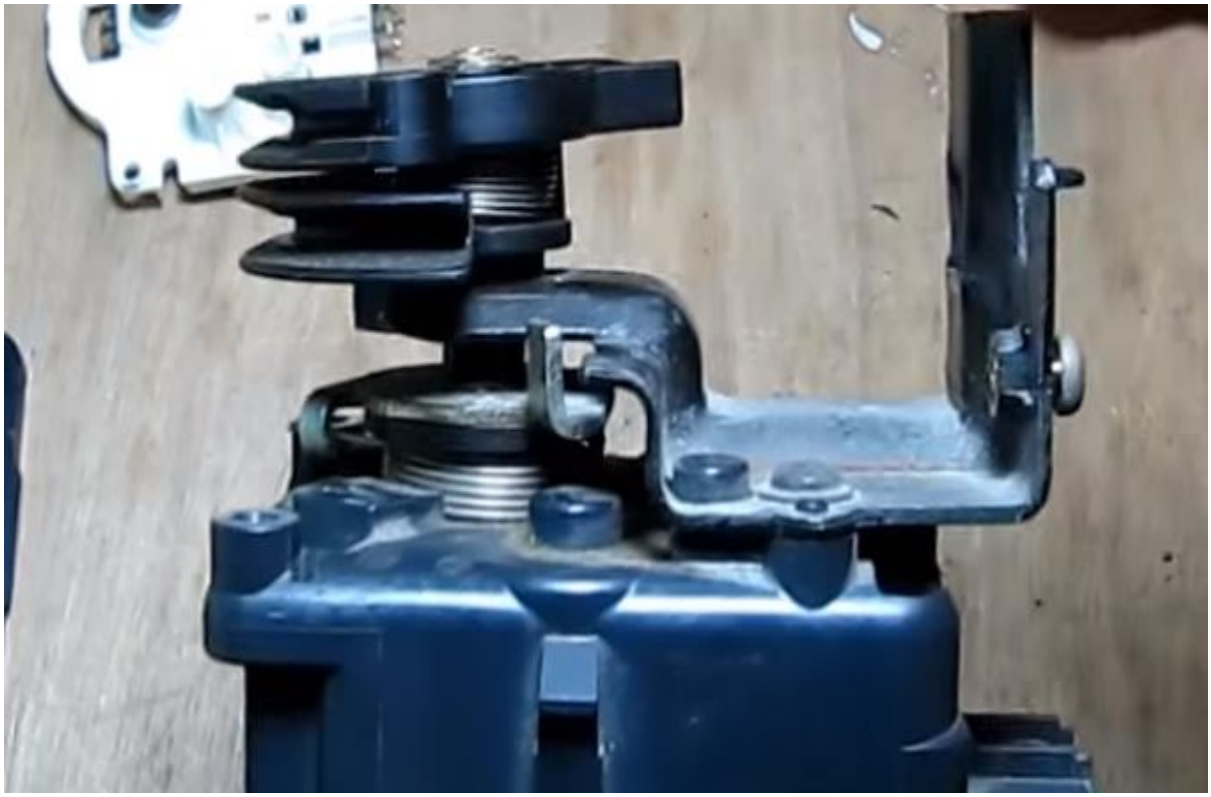

Figure 4.1 Existing Cruise Control Actuator

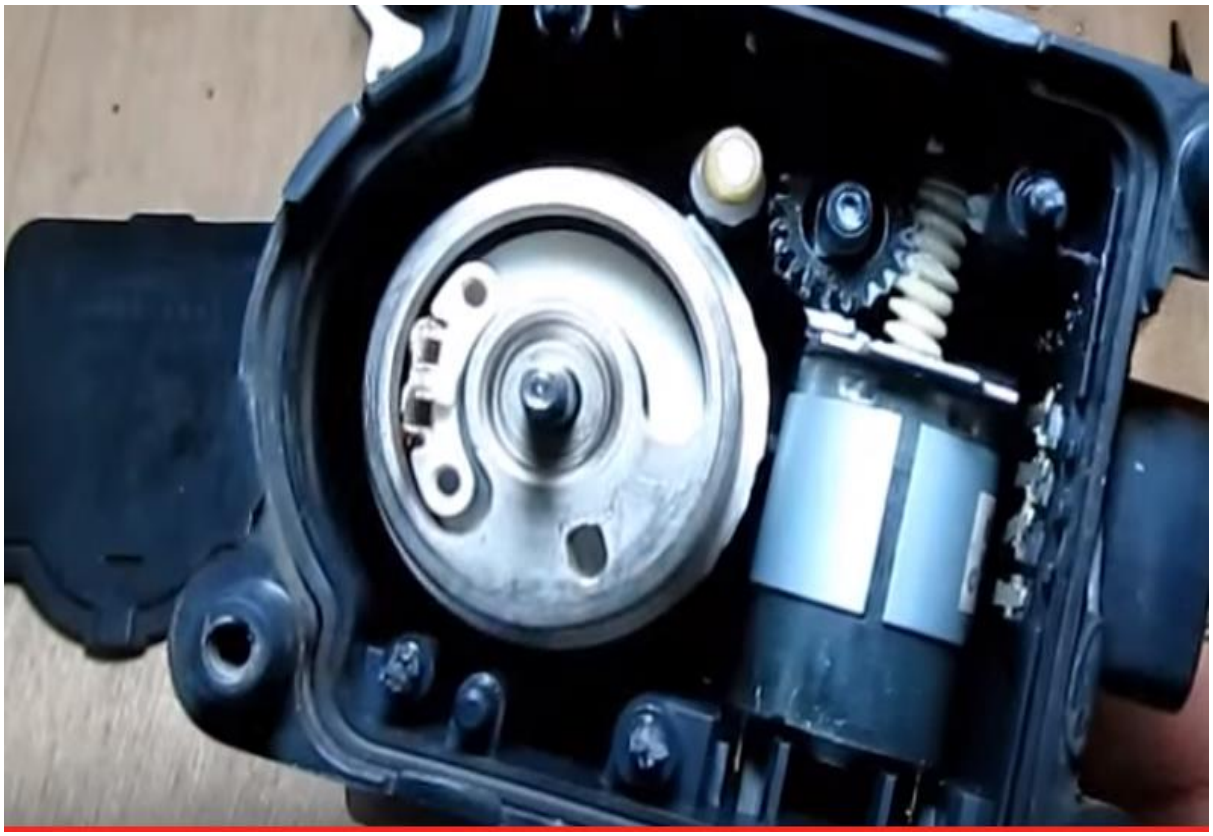

Figure 4.2 Interior of ACC Actuator

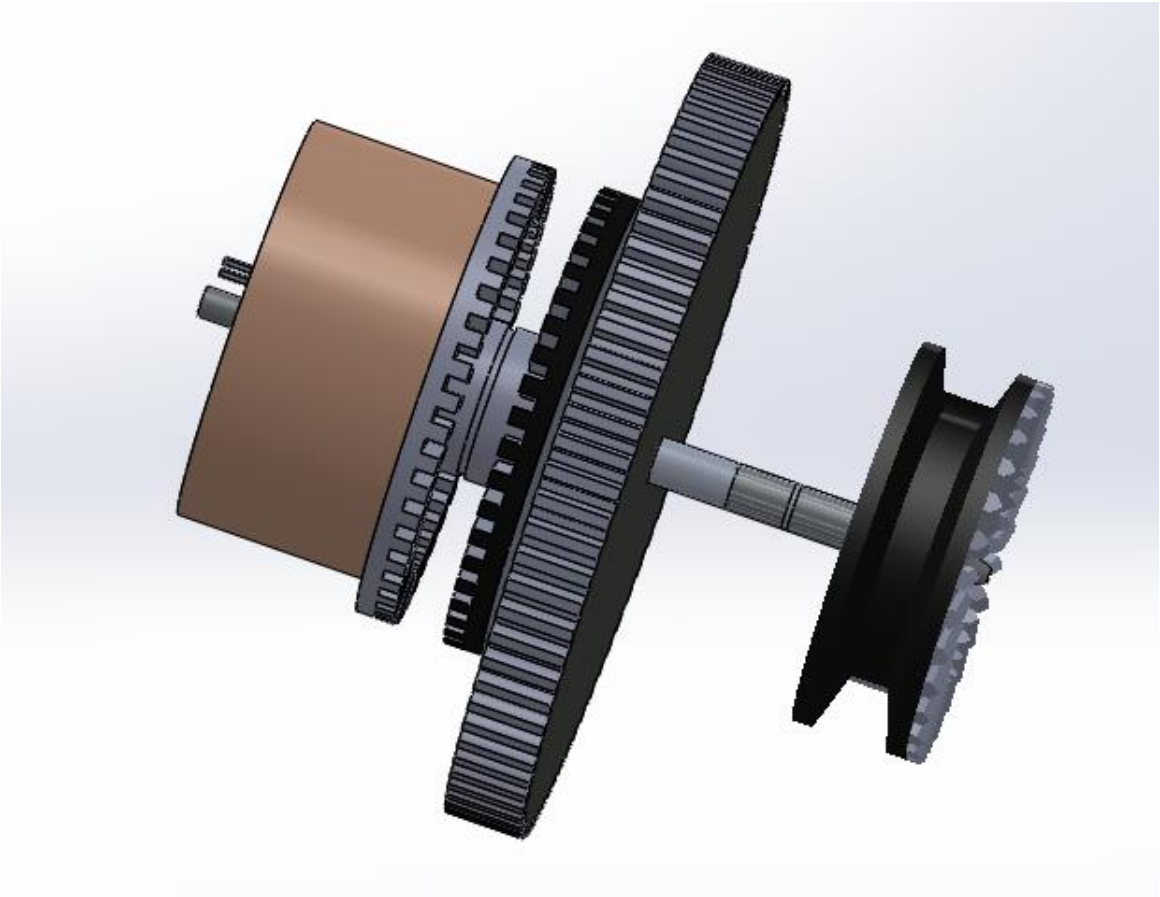

Figure 4.3 Design of Existing Actuator

This figure shows the attachment of the solenoid to the throttle pully that is controlled by the DC motor in actuator for cruise increase and decrease is shown. Also, the throttle pulley of the gas pedal is attached to the pulley. Detaching the gas pedal throttle pulley will give the solution to the brake disc damage in case of the automated braking. Hence designing the solenoid attached to the gas pedal pulley opposite to the Cruise control pulley in actuator helps the cruise control system to enable automated braking without affecting disk brakes.

4.3 SIMULATION

A) Constructional View

Adaptive Cruise Control is the new feature added to the cruise control (CC)—CC which allows the driver to set a driving speed that can follow the leading car at the desired speed which can be useful for long distance driving. These existing systems are works at the speed of 30 km/hr where the it cannot be useful in the urban areas and can be avoidable.

Adaptive cruise control system is divided in to two parts they are outer loop control and inner loop control which are described as follows. First, this outer loop control is used to maintain the distance between the Adaptive Cruise control equipped vehicle and leading vehicle. This can controller using the P controller which has the proportional P that calculates

the derived distance from the desired distance and maintaining for extended period. Therefore, the outer loop control gives the desired the distance between the vehicle to follow and differentiates the calculated distance. Outer loop control also can transfer the vehicle running state from cruise control to Adaptive cruise control and back to the cruise control. Second, the inner loop control is used to track the velocity of the vehicle acquired from outer loop control and takes the responsibility of braking and acceleration. Thus, the schematic diagram is shown as follows

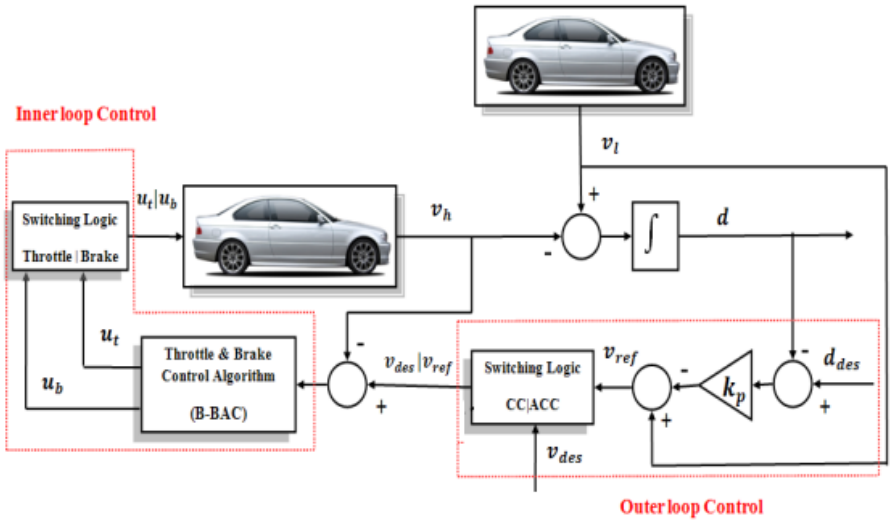

Figure 4.4 ACC Model

(B) PID Controller

The PID controller is called as the Proportional Integral Derivative controller as the name itself shown it consists of the three tuneable parameters that has the active variable AV which are gives the output with respect to the time and using this the desired distance is calculated according the moving distance. thus, the working of the calculated thing is obtained in the form of the equation given below.

$$u(t) = Av(t) = K_p e(t) + K_i \int_{0^e}^{t} (t)\, dt + K_D \frac{d}{dt} e(t)$$

K_p: gain in Proportional

K_i: gain in integral

K_D: Gain in Derivative

E: error

S: desired point

$c.s$: signals to control

O: Outcome signal

The above compiled systems are simulated described in Algorithm below

START

Step1: Engine Starts

Step2: the acceleration is operated manually using gas pedal and a brake

Step3: Hence checking whether the Acceleration using Adaptive Cruise Control is turned ON

Step4: If Adaptive Cruise Control turned OFF step back to 2 for activating it.

Step5: Information about the objective in the driving path is passed to Adaptive System

Step6: If there is no object in the driving path the speed of the host vehicle is set to the desired speed given by driver.

Step7: If there is any object in the driving path the distance between the two vehicle is calculated using the time different technique.

Step8: Calculating the speed of the host vehicle using speed sensor

Step9: Then increasing or decreasing the host vehicle speed to the lead vehicle speed. (lead vehicle speed is calculated by distance obtained)

Step10: Adjustment of the acceleration and brake pedals are made to achieve the safe speed required to avoid collision.

Step11: In case, there is any external reaction on the acceleration pedal or the brake the Adaptive Cruise Control is Deactivated.

Step12: Notifies the Driver whether the Adaptive Cruise Control is in ON condition or OFF condition

Step13: Therefore, the process is repeated and again to drive the car in safe path.

STOP

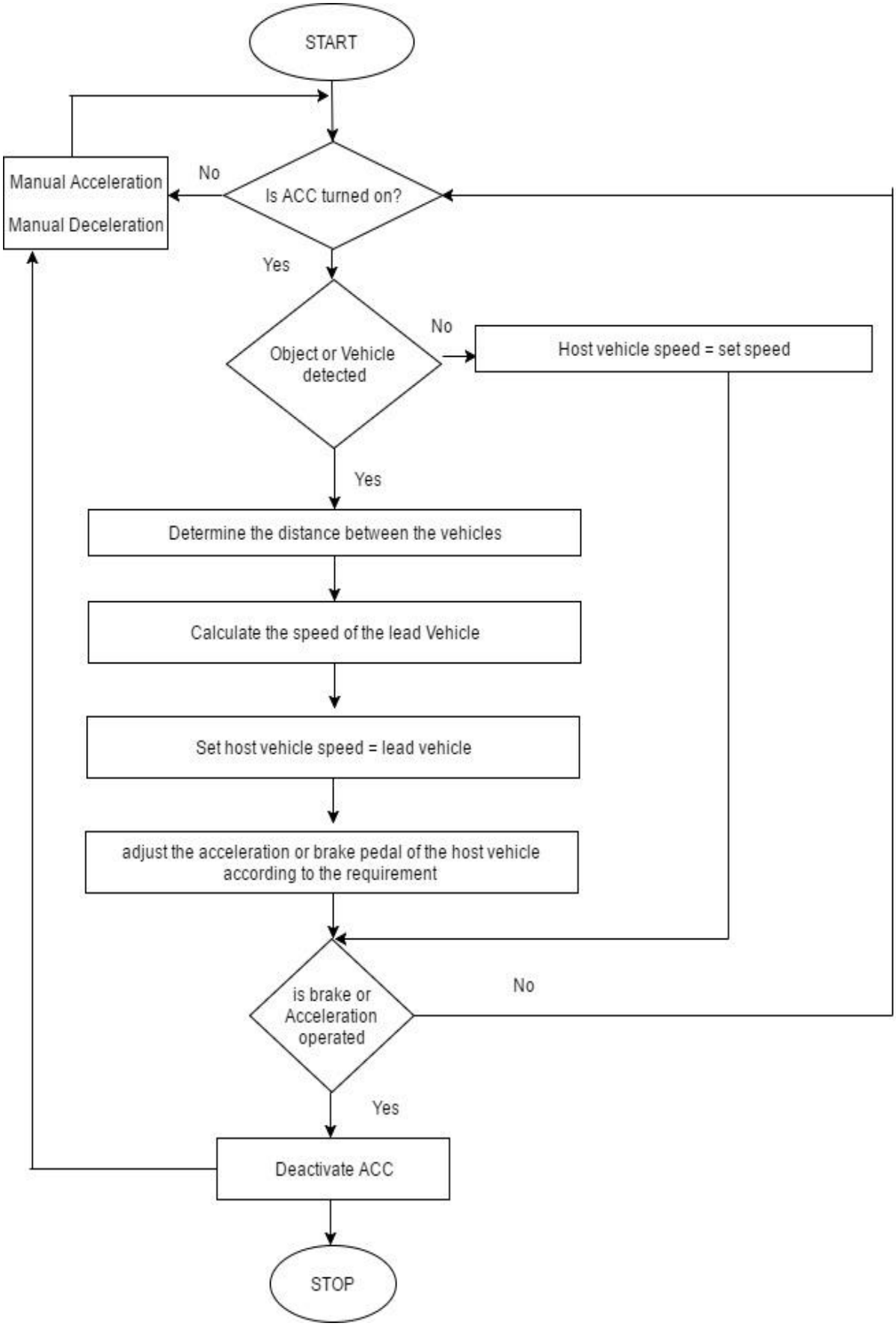

Figure 4.5 Algorithm of ACC

Calculations

For the above solution at the speed of 10 m/s at desired distance of 2m the time to stabilize is calculated manually by setting the speed of the preceding vehicle as 12m/s and its acceleration speed as 7 m/s^2 and the speed of the host vehicle as same 10 m/s and its acceleration speed of 3m/s [14].

Therefore, the time taken to stabilize is derived as given below:

For host vehicle time

$$t_{HV} = \frac{V_{HV}}{a_{HV}} \qquad (10)$$

From Equation 10, $t_{HV} = 3.9s$

For preceding vehicle time

$$t_{PV} = \frac{V_{PV}}{a_{PV}} \qquad (11)$$

From Equation 11, $t_{PV} = 1.7s$

Time to stabilize or braking

$$t_s = t_{HV} - t_{PV} \qquad (12)$$

$$t_s = 2.2s$$

Thus, the time to stabilize (TTS) the car or braking is derived and it says that at the distance of 2m in the vehicle on the roads, the time required by ACC to control the car and apply brakes to avoid collision only 2.2s this scenario is only based on the traffic accidents at that distance between cars will be less than 3m in those cases this scenario will work for reduction of traffic accidents.

Using this stabilization time (TTS) it is easy to predict the percent of collision that can avoid by host vehicle. This made as below function

For this case first the collision speed of the host car will be noticed

$$Cs_{HV} = V_{HV} - a_{HV}.TTS \qquad (13)$$

From Equation (13), $Cs_{HV} = 3.4m/s$

Using collision speed the percent of collision avoidance can be done as follows:

$$E_{k,saved} = 1 - ({Cs_{HV}}^2/{V_{HV}}^2) \qquad (14)$$

From Equation (14), $E_{k,saved} = 88.44\%$

Thus, the kinetic energy of the vehicle with adaptive cruise control decreases to 88.44% in case of braking. The capability of the car to absorb the energy in the collision is reduced by the way. Therefore, the accident's collision will not fatal.

5. RESULTS

After the vast calculation and designing of the systems the model of actuator in Adaptive Cruise Control System is modified to avoid accidents due to drowsiness and due to driver's fatigue. The modified model designed in solid works and its description as follows:

5.1 SIMULATION OF AUTOMATED BRAKING SYSTEM

Adaptive Cruise Control in Simulink as shown in Figure.5.1.

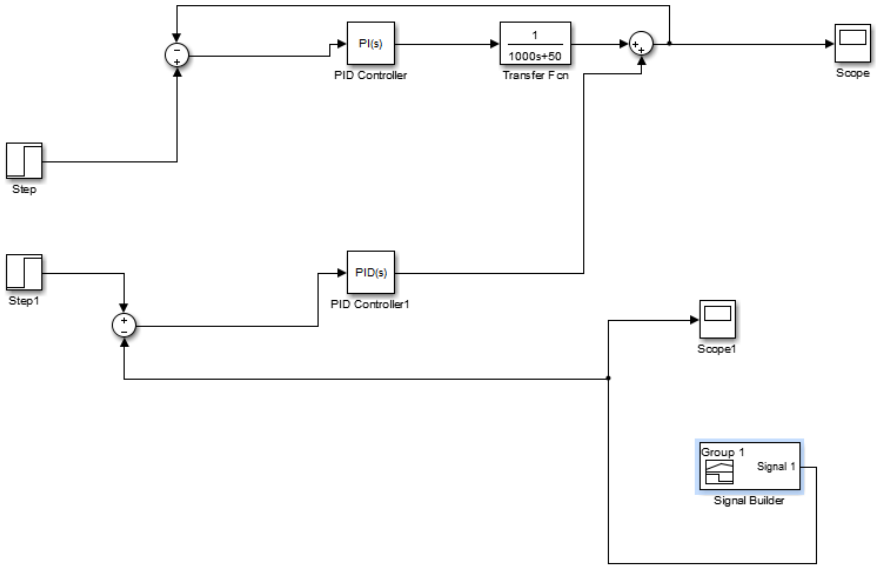

Figure 5.1 A trial of ACC Simulation model

The PID controller is implemented in vehicle cruise control model so that used in the simulation. The distance between the two vehicle is measured and given as a signal using the signal builder block as shown in the figure above. The signal builder is transmitting the signal to the PID controller with the addition of the step signal where in case of the vehicle running time or the moving time. And, it is connected to the signal emitter in order check the desired input. The PID controller processing the desired working time to react to the acquired distance and calculated on being the main part of the simulation.

Here the signal of about 4 secs is taken to acquire the vehicle at 5 secs it passes the information to the control process and moved over a short distance intimation is carried out. hence the time transient is carried out and the reaction signal is passed for vehicle stabilization. From another lane, finally at 6 secs the distance of vehicles calculated is set immediately to desired distance. this acquired processing time plotted in the form of the graph which is shown as follows.

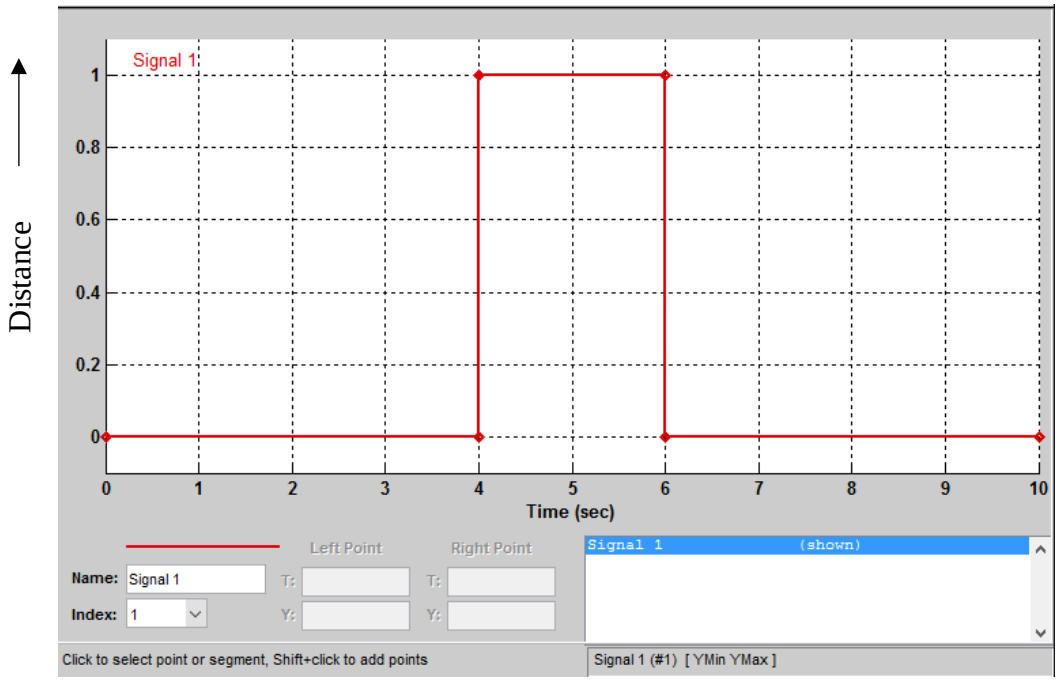

Figure 5.2 Input Signal for Distance

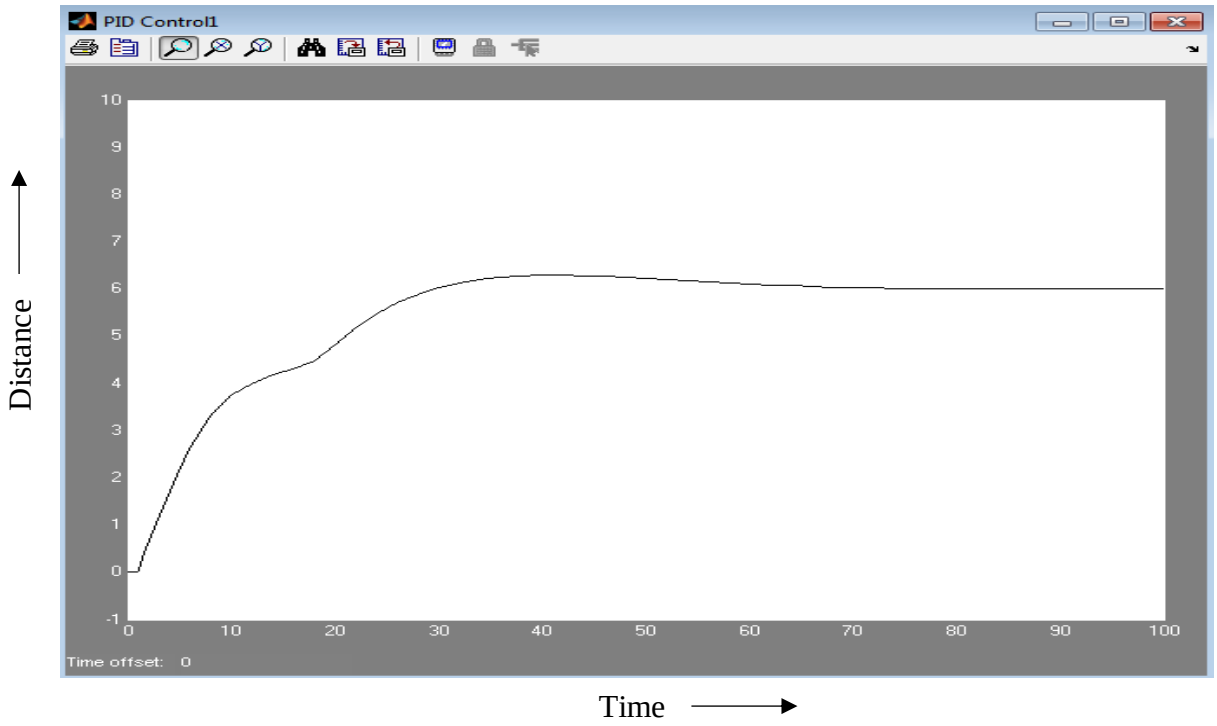

Figure 5. 3 Existing Adaptive Cruise Control Model

As the change in the old set desired speed to the new desired set speed. The system response will provide damping oscillations and comes to rest wit increase in time. It is viewed

from the trail ACC Model; the systems stabilize at a range of 2ms when the distance between is shown as 2m

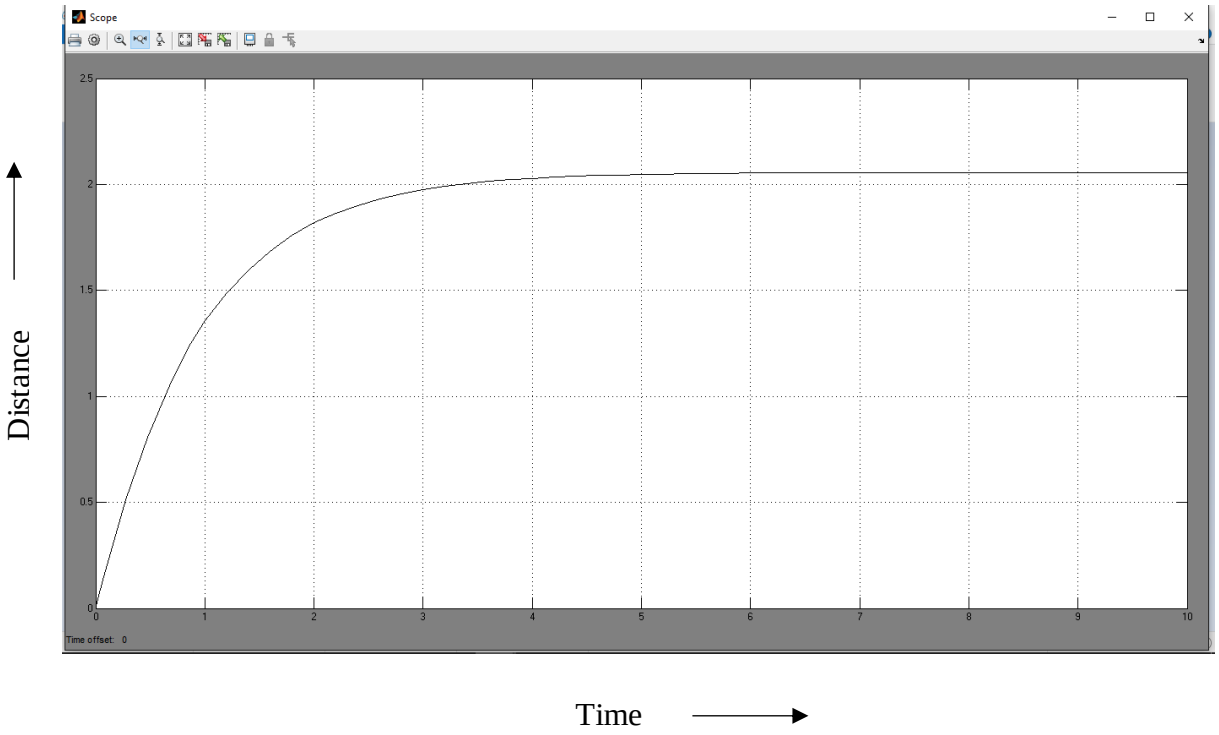

Figure 5.4 Response of the trial ACC model

5.2 FINAL MODEL RESULT

The advanced structure of the adaptive cruise control actuator is modelled using the solid works. This model includes different part which are additional to the actuator. They are,

- Modified Throttle Pulley
- Newly Designed Linear Motion Solenoid
- Normal Assembly of Cruise Control Actuator
- Modified Assembly of Cruise Control Actuator
    - Normal position of the Actuator
    - Position of Actuator in Case of Emergency

5.1.1 DESIGN OF THROTTLE PULLEY

The design of throttle pulley for advanced throttle control system is consist of spur gear attach at the back of the pulley in order fix pully with newly designed solenoid connected gear. This gear is fixable in both the phases of rod attached to the actuator DC motor.

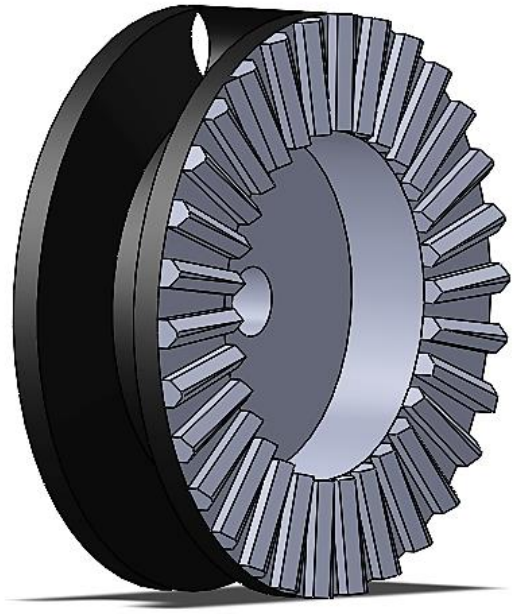

Figure 5.5 Modified Throttle Pulley

5.1.2 LINEAR MOTION SOLENOID

Construction

The solenoid used in this section is called as Linear Solenoid due to the linear movement of the plunger inside the solenoid magnetic field area. Linear solenoids have two basic configurations which is called a “Pull-type” where it pulls the connected load forward according to the electric field applied, and the “Push-type” which push the load in backward motion. hence both the push and pull mechanism used for moving the load connected to the plunger in linear motion.

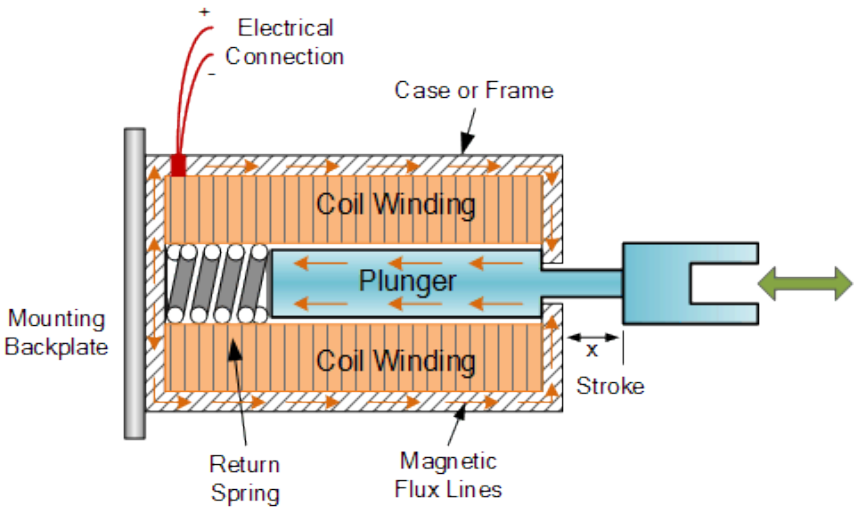

Figure 5.6 Pull-type Linear Solenoid Construction

Linear solenoid has many applications in such as door lock, hatch lock etc. as it moves in the up and down in latitudinal or longitudinal manner where ever it is placed in the working environment. This linear solenoid hence used in this technologies of unplugging the throttle connection form the driver contact gas pedal. Thus, the use of this cannot be the only solution and it can be redesigned in the controller section of the cars.

Modelled Solenoid

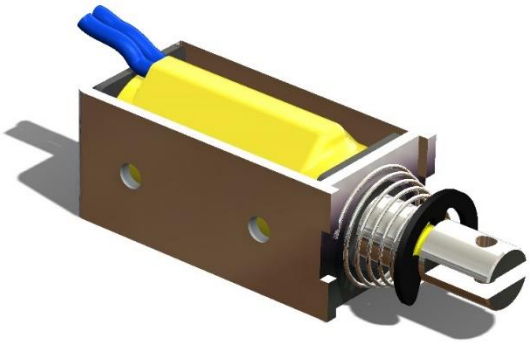

Figure 5.7 Solenoid Modelled

This solenoid consists of the metallic rod which moves in linear motion when the electric field is applied between the magnetic plates. In this rod, the newly designed throttle pulley is attached and placed linear to the existing solenoid in actuator. Here is the solenoid with attached Throttle pulley with gears.

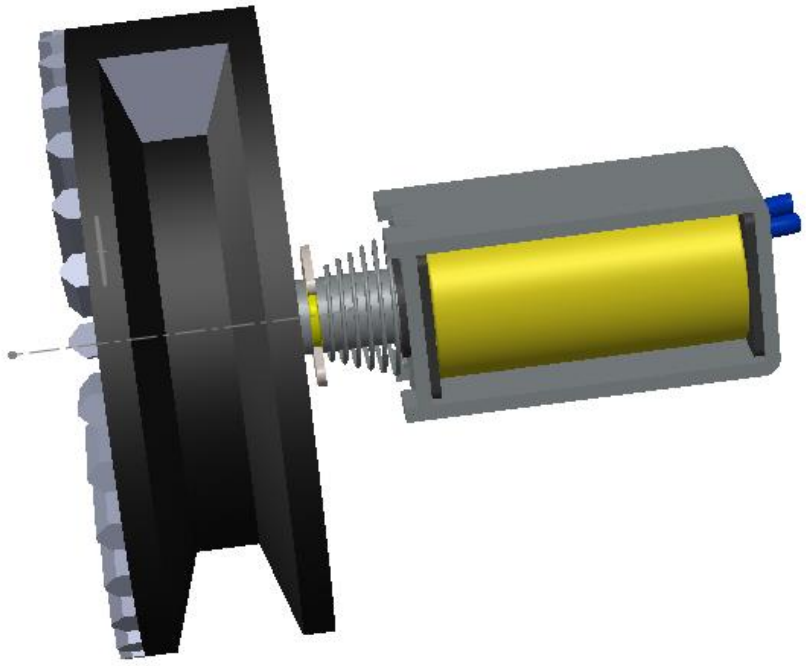

Figure 5.8 Modelled Solenoid Attached with Throttle Pulley

5.1.3 NORMAL CRUISE CONRTROL ACTUATOR

This normal cruise control of a metal rod that is attached with the solenoid for the function of locking and unlocking when the set command runs from the ACC control Module. This rod of the solenoid is attached with throttle pulley where is used to adjust the acceleration of the vehicle. The normal assembly of the Cruise Control Actuator is Shown below.

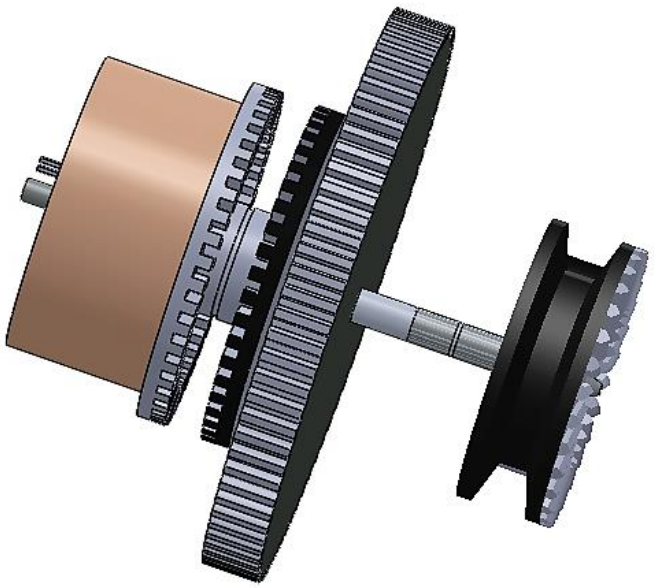

Figure 5.9 Normal Cruise Control Actuator

ASSEMBLY OF MODIFIED CRUISE CONTROL ACUTATOR

This modified cruise control actuator model is nothing but addition of solenoids with the Throttle pulley to the Existing model by replacing that throttle pulley in actuator with newly designed model throttle pulley with spur gears.

The throttle pulley gear of solenoid and actuator will be faced opposite to each other to lock and unlock in two different case of Adaptive Control System. The positioning of newly designed model is shown as follows.

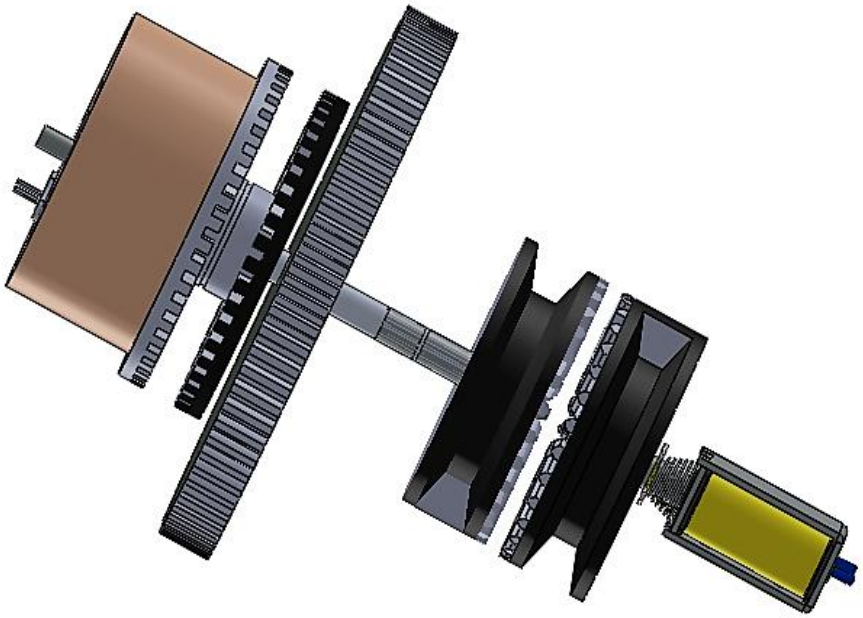

Figure 5.10 Unlocked position of the Solenoid in Case of Emergency

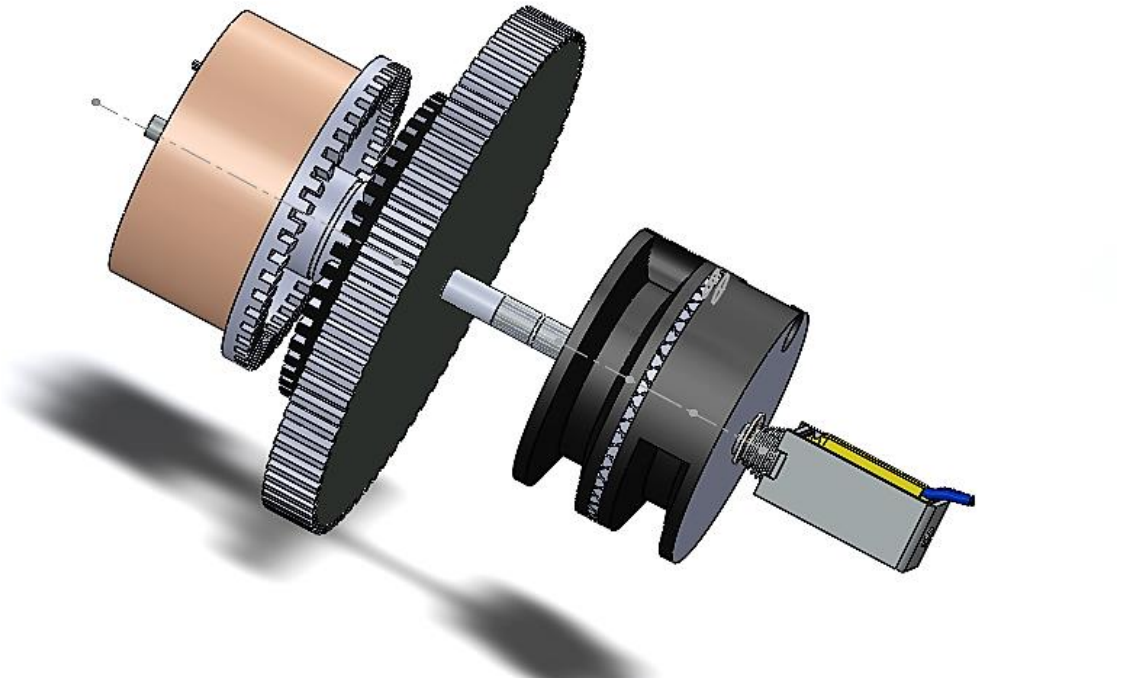

Figure 5.11 Locked Position of Solenoid (Normal State Solenoid position)

From the above constructed model is it shown the working process of the connection is proposed in the below final diagram with the possibility of working condition. It shown that one part of the pulley is connected to the acceleration pedal and another part is connected to

throttle valve of the engine which is used to adjust the speed of the vehicle. In this proposed system, the model is defined with new type throttle pulley. The load here is applied to the gears with the pulley and are mention the stress and strain analysis.

Figure 5.12 Final Proposed Model

ANALYSIS

This newly proposed pulley is subjected to the stress and strain analysis and the load for normal pulley is taken in account as 50 N which is describes as follows.

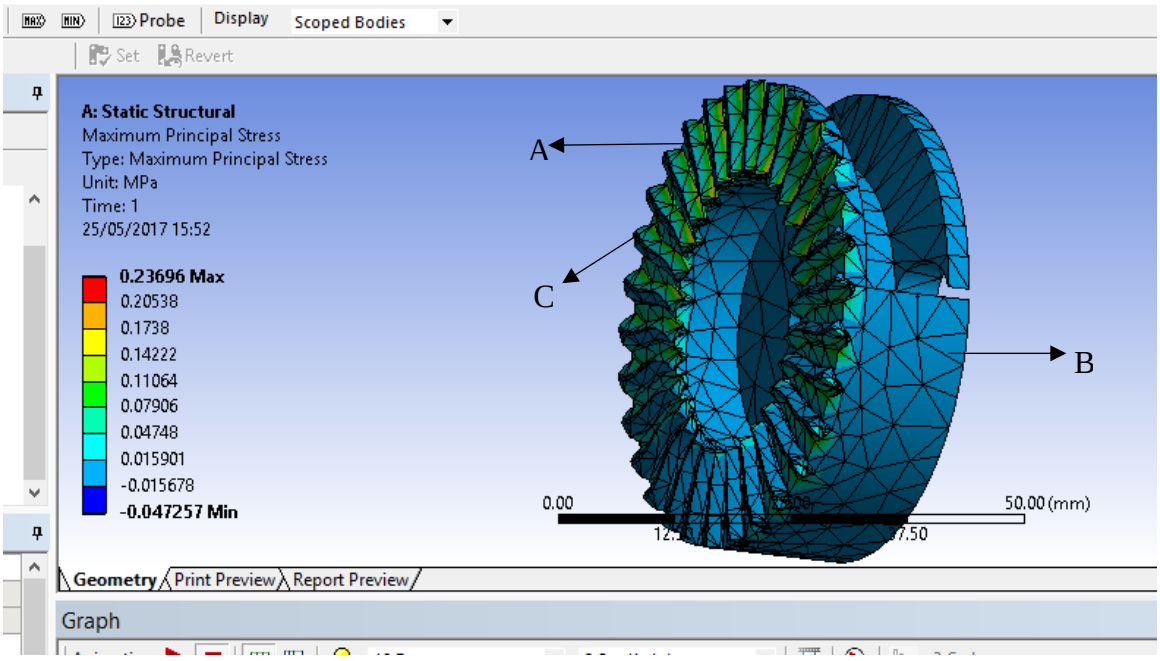

Figure 5.13 Stress Analysis

This above figure 5.13 shows the impact of the gear contact and the stress for the gears here the only used for analysis is positioned in opposite direction for bevel contact and movement of the gear is transferred according to the rotation of the gears. Here the used material is stainless steel for better contact and movement. From the figure 5.13 it is shown with point, the maximum, minimum and moderate stress of design pulley which be implemented in future automobiles.

Point A shows the maximal stress of 0.23696 MPa

Point B shows the maximal stress of -0.0472 MPa

Point C shows the maximal stress of 0.07906 MPa

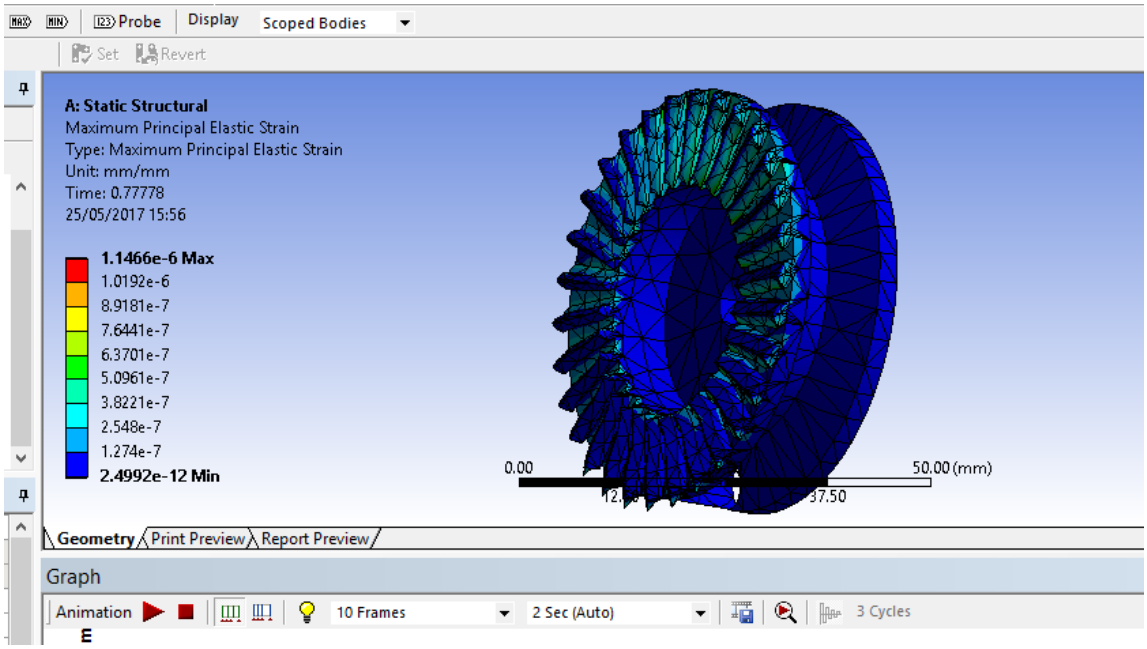

Figure 5.14 Strain Analysis

5.3 DISCUSSION

The Emergency stop designed in this report has only the front collision avoidance as an objective. Here the possibility of the rear end collision is taken in account in the traffic. This collision is avoidable if in case there is car moving in front of the truck which has the possibility of collision when there is a short distance between the car and truck. Before to reduce the processing time of the adaptive cruise control it is taken in account of the knowledge about the time lap between the vehicle in the road. Therefore, researchers conquered with the solution of the reaction time with is more affordable to avoid collision by means of the driver's negligence of braking.

6. CONCLUSION

1. The research and analysis of the emergency stop assistance is modelled and obtained the result which described as follows.

2. From the analysis of this driver assistance system the existing model of the ACC system has a capability to stop the car where the distance between the host car and the preceding car exceeds 10m and its response time for applying the brake is 16 sec.

3. This new model is currently designed to predict the short distance braking and avoiding collision at very short of 2 s using the additional short distance sensor

- Existing time response and its distance is 16 secs at distance of 20 m
- Acquired Time Response and its distance is 2 secs at distance of 2m
- The results shows the stabilization time can reduce the car's energy impacting between 50 to 95%

Hence it is proved that the host vehicle time response is directly proportional to the gap between host car and the preceding vehicle whenever the gap increases, response time for host vehicle to set speed increases to apply midlevel braking and avoid disk damage.

4. Where, if the distance of the gap between vehicles increases parallelly increase time for the controller to adapt to front speed car.

5. The roadmap presented is one of the important aspects that should be considered in case of the driver assistance systems which always considers sensors and the degree of the driver assistance are the other aspects. The results hence focus on the emergency stop assistance to stop the fatalities.

6. The solution for short distance calculation and its time response have been increased and the possibility of reducing the accidents with emerging technologies can be done.

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APPENDIX

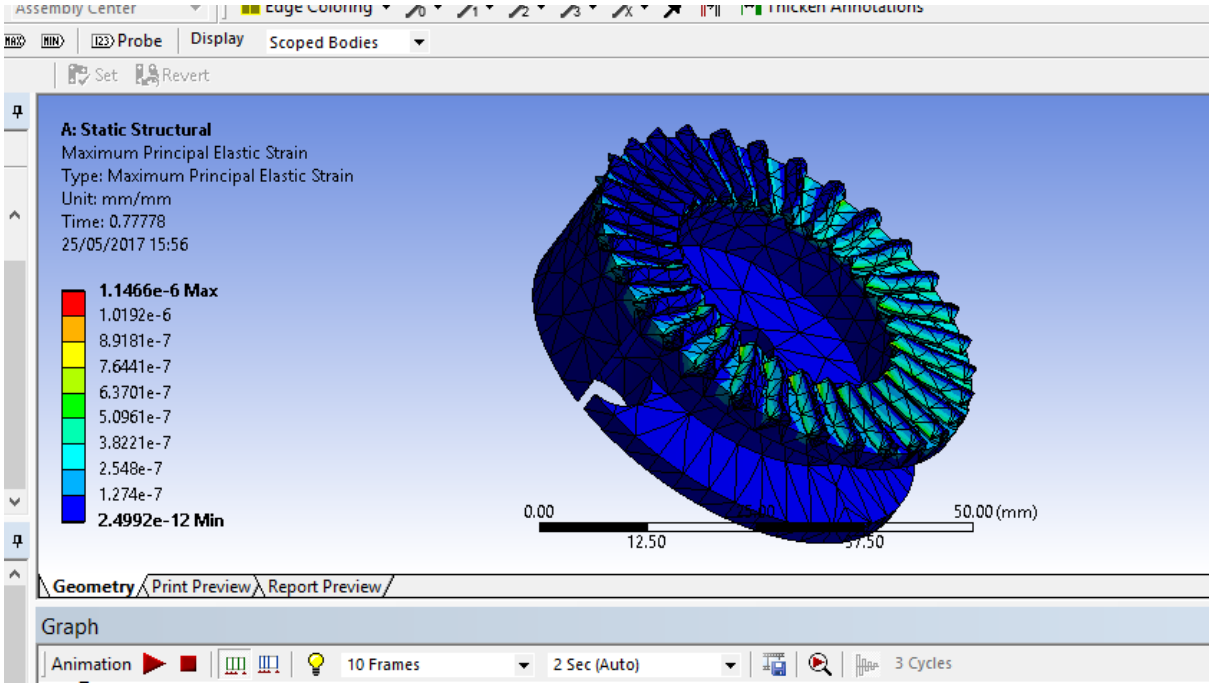

Figure 1 Strain Analysis Model

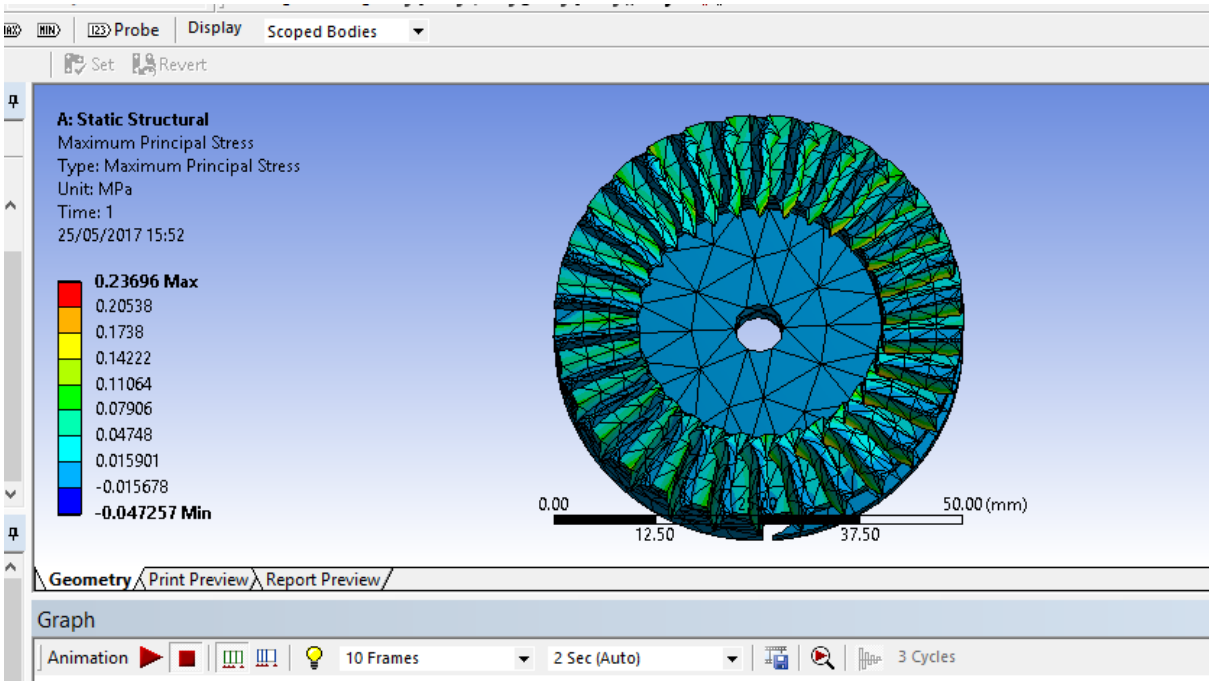

Figure 2 Stress Analysis Model