Design and Development of Intellegent Braking with brake Failure Indicator System for Bus

Yonas Woldu Lakew

A Thesis Submitted to

The Department of Mechanical Systems and Vehicle Engineering

School of Mechanical, Chemical and Materials Engineering

A Thesis Submitted in Partial Fulfillment of the Requirement for the Award of the Degree of Master of Science in Automotive Engineering

Program: M.Sc. in Automotive Engineering

Office of Graduate Studies

Adama Science and Technology University

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By

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Advisor: Dr. Ramesh Babu Nallamothu

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APPROVAL OF BOARD OF EXAMINERS

We, the undersigned, members of the Board of Examiners of the final open defense by Yonas Woldu Lakew have read and evaluated his thesis entitled "Design and Development of Intelligent braking with Brake Failure indicator system for Bus" and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement of the Degree of Master's in Automotive Engineering

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To: Mechanical Systems and Vehicle Engineering department

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This is to certify that the thesis entitled “Design and Development of Intellegent Braking with brake failure indicator system for Bus” submitted in partial fulfillment of the requirements for the degree of Master’s in Automotive Engineering, the Graduate Program of the Department of Mechanical Systems and Vehicle Engineerin*g* and has been carried out by Yonas Woldu Lakew Id. No PGR/18430/11, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby he can submit the thesis to the department.

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Dr. Harish Kalla	_______________	_____________
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DECLARATION

I hereby declare that this MSc Thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

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This MSc Thesis has been submitted for examination with my approval as a thesis advisor.

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Date of submission: ________________________

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ACRONYMS

IR	Infrared sensor
WHO	World health organization
ABS	Anti lock braking system
ASS	Active safety system
AEBS	Advance emergency braking system
TC	Traction control
EBD	Electric brake force disribution
BA	Brake assist
ESC	Electronic stability control
IBS	Intellegent braking system

ABSTRACT

Buses are the most widely and frequently used mode of transportation in Ethiopia since they are inexpensive and serve a greater number of passengers in a single trip for long distance journey and cross-country travel. Also, it has been observed that buses are causing a wide range of accidents compared with their total number. They cover 0.73% of the total number of vehicles in Ethiopia but they are responsible for 8.03% of death, 3.6% of serious injury, 4.9% of a slight injury, and 6.9% of property damage caused by public means of transportation. Even though there are many different reasons, brake failure, and brake system efficiency are some of the problems behind such collision. The purpose of this thesis is to improve the conventional brake system of a bus by improving the braking system to an intelligent braking system and by adding an extra brake failure indicator system for increasing the braking efficiency and minimizing accidents. The methods employed for this work are modeling parts using Arduino programming software and preparing a prototype. The model was developed with ultrasonic sensors and controllers such as Arduino Uno microcontroller, ultrasonic sensor, pressure sensor, etc. to apply the brakes before a collision can occur. Furthermore, the prototype of the intelligent braking system was constructed for demonstration and checked its functionality. The overall design was based on the Arduino Uno microcontroller. Also, the Ultrasonic sensor is used for detecting an object, and a pressure sensor is detecting the usable pressure amount for the air brake system during applying a brake force for stopping the Bus. Also, the microcontroller acts as the bridge between the sensor and relay by receiving an electrical signal from the pressure sensors and sending the signal to the relay to the activated s – cam. It was observed that the new intelligent braking system reduced to 49.4m at maximum speed (105km/h) compared to the existing one (62.1 m). Using an electrical signal sent from a pressure sensor primarily warns the driver on the dashboard to take an action and finally send a signal to the relay to actuate s-cam for stopping a bus if the driver didn't take an action. As a result, this thesis contributes to efforts of increasing road safety and minimizing collision by reducing the stopping distance of the bus.

Keywords: Arduino Uno microcontroller, pressure sensor, ultrasonic sensors, relay.

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Human beinges move from one place to another place either to work or to study to do business or to enjoy using several transport choices. Vehicles are the most broadly used transport alternatives and the major source of road traffic coincidences in the world. Due to road traffic coincidences, a larger part of road users could not be coming back to home: farewell this world for once and all, expended long days, weeks, months, and even years in health centers or hospitals, and never be able to work or play as they used to do before.

Nowadays, road traffic coincidence has been both public health and growth issue and attracted the attention of administrations. Conferring to the World Health Organization WHO report, each year more than 1.25 million people now pass away on the world's road and about 50 million people are disabled or hurted because of road traffic crashes. If business as a usual uninterrupted, according to WHO, "Road traffic injuries are assessed as a ninth top cause of passing away of all age groups in the world and are forecasted to be the seventh-leading contributor to the global weight of disease and injury by 2030."According to the World Health Organization (WHO), Ethiopia consumes the highest rate of traffic mortalities per vehicle in the world. Roads in Ethiopia poorly keep up, ineffectively marked, and poorly lighted. Road travel after dark outside Addis Ababa and other cities is unsafe and discouraged due to dangers posed by damaged vehicles left in the road, pedestrians walking in the road, stray animals, and the option of armed robbery. Road lighting in cities is insufficient at the best and absent outside of cities. Excessive speed, unpredictable local driving habits, foot-travelers and livestock in the street, and the lack of observance of basic safety standards for vehicles are daily dangers on Ethiopian roads. Many vehicles are uninhibited and many drivers lack basic driver working out or insurance. Emergency services are limited or absent in many parts of the country. Drivers would always carry spare tires, fuel, and tools on long tours as there is no pavement assistance. Public transport is unregulated and hazardous; if explorers do use public transport, they must use taxis, not vans or large buses, and should ensure they are the only travelers in the vehicle.

Jilcha, (2016) There is presently no national policy on the inhibition of road traffic coincidences; however, there are draft plans on street safety. Road traffic coincidences are a huge public health and growing problem in Ethiopia. Its present state requires a high-level commitment from higher level officials, fast decisions, and actions to control the growing problem. Else, it will get inferior from day-to-day as motorization and population increase quickly.

Figure 1. 1: Traffic accident of bus

1.2 Statement of the problem

Traffic accidents in Ethiopia are serious problems that cause fatalities and injuries of passengers, pedestrians, and all road users. The rates of fatalities and injuries are very high compared to developed, middle income even some other developing countries. This is caused by different reasons for traffic accidents including: over speed, brake failure, longer stopping distance, difficult road infrastructure and driving conditions.

According to Ethiopian transport authority 2019 vehicle stastics report the total registered vehicles in the country is only 1,071,345. Among this total public transportation vehicles cover 71.23%, cargo means of transportation vehicles cover 26.24% and the remaining 2.53% is covered by machinery type vehicles.

Federal police commission ten years report shows that buses in Ethiopia cover 0.73% of the total number of vehicles in Ethiopia but they are responsible for 8.03% of death, 3.6% of serious injury, 4.9% of a slight injury, and 6.9% of property damage caused by public means of transportation. Even though there are many different reasons, brake failure, and brake system efficiency are some of the problem reasons behind such collision. Because of these reasons, several victim families live on roadsides. This covers the averages of 99.1 lives death, 56.1numbers of serious injury, 66.6 numbers of slight injuries and about 23 million birrs of property damage per year.

So, this thesis work introduces a new intelligent braking with brake failure indication system for minimizing traffic accidents and fatalities by optimizing the stoping distance and alerting to the pressure lose in reservoir for warninig the driver of the buses before losses caused by accidents.

1.3 Objective

1.3.1 General objective

The general objective this thesis is to design and develop intelligent braking with automatic brake failure indicator system for bus.

1.3.2 Specific objective

The specific objectives are:

- ✓ To design programming for intelligent braking system.
- ✓ To design circuit for brake failure indicator system.
- ✓ To develop a system of programming code and simulate the circuit of automatic brake failure for bus.
- ✓ To construct a prototype.
- ✓ To test the prototype

1.4 Significance of the thesis

The main advantage of this study is;

- ✓ It introduces new system of braking and brake failure indicator for bus.
- ✓ It helps in reducing the traffic accidents and property damages.
- ✓ It helps to reduce the death and traffic injuries of pedestrians.
- ✓ Minimizes public health and growth issue of our country Ethiopia.

1.5 Beneficiaries

All road traffic users including vehicle owners, researchers**,** drivers, pedestrians, traffic police, society and country as a whole get benefitted from this study.

1.6 Delimitation (Scope)

This work includes all the steps to designing, programming with Arduino program and developing of intelligent braking system with brake failure indicator system for bus.

1.7. Organization of the study

The thesis will be organized into five chapters. **Chapter one:** introduces the background of the study, statement of the problem, objectives, significance, beneficiaries, scope, and limitations. **Chapter two:** discuss extensive literature reviews related to the application of intelligent braking and brake failure systems by improving the main findings of the studies and for knowing the main reasons behind the limitations. **Chapter three:** refers to the materials which are used for the study and methods that the study step by step following up. Also in this chapter, the raw data and numerical designs are analyzed. **Chapter four:** discusses the different comparisons between the existing system and this thesis work in optimization of stoping distance, showing pressure loss in brake reservoir by simulating with software. Finally, concluding remarks with key findings of the present investigation with a recommendation and future research scopes have been summarized in **Chapter five**.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Review of articles

P. Saravanan et al, (2016) This paper focused on the knowledge of pneumatics has gained tremendous significance in workplace reasoning and automation from old- fashioned timber works and cold mines to modern machine shops and space robots. It is good to have good skill and knowledge that experts and engineers of the pneumatic system, air-operated valves, and accessories. The air compressor compresses the air and from the compressor, the plant flow medium is conveyed through a well-laid tube system to the pneumatic cylinder. For preserving the maximum efficiency of the pneumatic system, it is very important that pressure drop between usage and generation of compressed air to be very low. The objective is to design and develop a system of measured automatic braking system based on an intelligent system which controls electronically called “INTELLIGENT REVERSE BRAKING SYSTEM”. In the system, the Sensor with an IR transmitter operated pneumatic brake is consisting and control unit, a receiver circuit, pneumatic braking system. The IR sensor is used to sense the obstacle. The path is difficult, the IR sensor senses the stumbling block and giving the control signal to the braking system. The pneumatic braking system is used to break the system.

Gajanan Koli et al, (2017) studied on the coincidences in four-wheeled automobiles occur because of failure of braking systems. A manual method of applying brakes is always hazardous as it leads to coincidences. Unconsciousness of the driver, disappointment in the linkages of braking systems, road conditions, irrepressible speed of the vehicle, and manual process of braking systems are the reasons for accidents. It is necessary to control brakes automatically through electronic devices to minimize accident problems. In this research paper, the auther propose an effective methodology for automatic control of the braking system to avoid accidents. In this technology, the authors used Arduino, relays, an IR transmitter, and an IR receiver for the effective function of a braking control system. This complete system can be fitted on to the dashboard of a vehicle and effectively used for automatic control of the braking system

Hemalatha B K et al, (2016) Focused on Automotive vehicles which are gradually being equipped with crash avoidance and warning systems for forecasting the potential crash with an external object, such as an additional vehicle or a pedestrian. Upon distinguishing a potential crash, such systems typically initiate an action to avoid the collision and/or provide a caution to the vehicle operator. The aim is to design and develop a control system based on an automatic, intelligent, and electronically controlled automotive braking system for automobiles is called as “INTELLIGENT BRAKING SYSTEM”. This Braking system contains an IR transmitter and receiver circuit and the vehicle. The IR sensor is used to sense the stumbling block. There is any stumbling block in the path, the IR sensor senses the obstacle and giving the governor signal to the microcontroller, which in turn sends a sign to the motor to stop and also to the solenoid to stop the vehicle as programmed. This project helps the electromagnetic braking system using a solenoid. Here in the construction module include a circular disc-related to a dc motor and a solenoid. The Embedded system module contains a microcontroller with a solenoid and sensor.

Tushar Kavatkar et al, (2017) also emphases about the braking system which was designed and practical for a car to make the driving process security using embedded system design. Most of the coincidence occurs due to the postponement of the driver to hit the brake, so in this project work braking system is established such that when it is active it can apply brake depending upon the body sensed by the ultrasonic sensor and speed of the vehicle. Presently, vehicles are often well-found with active safety systems to decrease the risk of accidents, many of which happen in urban surroundings. The most popular include Antilock Braking Systems (ABS), Traction Control, and Stability Control. All these schemes employ different types of sensors to constantly monitor the circumstances of the vehicle, and answer in an emergency. An intelligent mechatronic system contains an ultrasonic wave emitter provided on the front portion of a car creating and emitting ultrasonic waves ahead at a predetermined distance. An ultrasonic receiver is also placed on the front portion of the car operatively getting a reflective ultrasonic wave signal. The reflected wave (detected pulse) gives the remoteness between the problem and the vehicle and the RPM counter gives the speed of the vehicle. The microcontroller is used to governor the braking of the vehicle based on the detection pulse information to push the brake pedal and apply the brake to the car impressively for safety purposes.

Sandeep Thorat et al, (2016) This paper emphasizes the vehicle technology which is increased quickly in recent years, mainly about braking systems and sensing systems. ASS (active safety systems) are being investigated and developed to prevent coincidences and target mitigation. Among many valuable active safety systems, it has been informed that AEBS (Advanced Emergency Braking Systems) excellently prevents accidents and decreases casualties concurrently. The project aims to differentiate between systems presently in production like traction control (TC), electronic brake-force distribution (EBD), brake assist (BA), and electronic stability control (ESC) functions and future systems that are currently in growth. The project aims to develop a prototype system that offers crash functionality in construction vehicle, a system which can operate automatically with the help of great profile sensors based relay circuit and some alteration in the traditional braking system that can alert the driver in front crash and apply the brake automatically in an emergency or serious situation.

Sourabh Santosh et al. (2017) This study investigated that the design and construction of a model of automatic braking system for vehicles in the hill station are to be established. The mechanism has been advanced to stop the vehicle from rolling back word when the vehicle is moving on the hill roads. This product is made of two stages in a first deigns of ratchet and pawl mechanism, frame, shaft, etc. is done and in second sensor selection and interfering is done. Ratchet and pawl mechanism has been invented and assembly with sensor interface is tested.

Hitesh Kumar et al. (2019) This paper focuses on a very important source for human beings in the currents world, the brakes in vehicles are a critical area that can save and take life. So, we developed the intelligent reverse braking system which consists of a Microcontroller and ultrasonic sensors. This ultrasonic sensor detects objects and brakes automatically so this avoids accidents and saves the car also life present in it. In this work, the authors aim is to avoid accidents in the back of the car also there are many systems used in front for the automatic brake but in case of ditch presence while reversing is a problem for the driver's safety. So, The authors came to implement an intelligent braking system to sense ditches and objects then applies brake automatically.

Jadhav Amol et al. (2018) In this paper various accidents happen with automobile vehicles that cause serious injury, and inefficient braking is the most probable reason. It is indisputable, statistically proved fact, that year on year events involving a reversing vehicle account for between 20-30% of all reported work linked serious injuries or fatalities. While parking or taking an opposite turn, the driver unable to see what is after the vehicle and clearly up to what distance, eventually vehicle strike with the stumbling block behind. Presently, cars have an alarm system where when the car becomes too close to an object an alarm is activated which warns the driver about an object close by. But this feature has formed a lot of problems and is prone to human error. We have enhanced the facility by using the same system but we have altered it so that the car brakes automatically when a stumbling block is close by. This paper introduces a control system based on an electronically controlled automotive braking system is called “Intelligent Reverse Braking System”. A Sensor Functioned Pneumatic Brake consists of an IR transmitter and Receiver circuit, Control Unit, Pneumatic breaking system. The IR sensor is used to sense the stumbling block. There is any stumbling block in the path, the IR sensor senses the obstacle and giving the control signal to the braking system. The pneumatic braking system is used to brake the system. So basically here the car brakes on its possession by determining the distance from the object.

Abhay Bendekar et al. (2016) In this paper Braking is nothing but bringing a moving vehicle or moving body to a stopover. Nowadays security is an important feature in the automotive industry. The intelligent braking system is the succeeding step to automation. Presently cars have an alarm system where when the car gets too close to an object an alarm is triggered which warns the driver about an object nearby. But this feature has created a lot of problems and is prone to human error. The authors improved the facility by using the same system. So that, the car brakes automatically when a stumbling block is close by. The authors aim to design and advance a control system based on an intelligent electronically measured automotive braking system is called “Intelligent Reverse Braking System”. Sensor Functioned Pneumatic Brake consists of Opto transmitter and Receiver circuit, Control Unit, Pneumatic breaking system. The Opto sensor is used to sense the obstacle. There is any stumbling block in the path, the Opto sensor senses the stumbling block and giving the control signal to the braking system. The pneumatic braking system is used to break the system. So fundamentally here the car brakes on its own by defining the distance from the object.

Milind Deotale et al, (2016) In this paper focuses on Road accidents that are commonplace in today’s scenario. Accident prevention has been one of the leading areas of research. This paper emphases a system known as the 'Intelligent braking system' (IBS) which employs several sensors to reply when emergency conditions occur. The system includes an infrared wave emitter delivered on the front portion of the car. An infrared receiver is also fitted to accept the signal. The reflected wave gives the remoteness between the stumbling block and the vehicle. Then a microcontroller is used to sense the pulses and apply brakes to the vehicle. IBS car provides the sight into the future of automotive safety. With the IBS system, we can prevent more coincidences and save more lives.

Shubham Pawar et al, (2017) This paper focuses on now a day's vehicle accidents are the main problem and this braking system used an inventive Technique to inhibit accidents that happen in the restricted roadways. The purpose of this system is based on an intelligent electronic control with an automatic bumper beginning system is known as “Automatic braking with the pneumatic bumper system”. This system is accumulated on a four-wheeler vehicle. Generally, this system consists of two mechanisms and these are an automatic braking system and a pneumatic bumper system. An automatic braking system uses the infrared sensor (IR) which detects the vehicle which comes in front of our system and which may be cause for coincidence. Then the sensor gives feedback to the engine through the relay to stopover the working of the engine. During the working of the Automatic braking system concurrently the driver of the vehicle also try to stop the vehicle by pressing the brake pedal. The limit switch is provided below the brake pedal which is used to stimulate the pneumatic bumper and disc brake concurrently to decrease the damage to our vehicle which occurs if both vehicles fail on each other. This delivers pre-crash safety for the vehicle. as this stem advance these time of vehicle braking to keep a safe distance between two vehicles. By using this system we control the speed of the vehicle at a small distance.

Li Gangyan et al, (2017) This paper focuses on autonomous driving as the main growth direction of the automobile in the present and the future. Intelligence braking is the key assembly to understand autonomous driving. The pneumatic brake system is the standard part of a commercial vehicle to brake. To meet the necessities of autonomous driving, this paper proposed the concept of intelligent braking and pneumatic automatic braking, and then a kind of pneumatic automatic braking circuit is designed. The pressure alteration rate is used as a new index to evaluate automatic braking and control. This study delivers a new theoretical basis for the design and application of the pneumatic braking system.

Venkatesh Babu et al, (2017)The technology of pneumatics has gained tremendous importance in the field of workplace rationalization and automation from old-fashioned timber works and coal mines to modern machine shops and space robots. It is therefore important that technicians and engineers should have a good knowledge of the pneumatic system, air-operated valves, and accessories. The air is compressed in an air compressor and from the compressor plant, the flow medium is transmitted to the pneumatic cylinder through a well-laid pipeline system. To maintain optimum efficiency of the pneumatic system, it is of vital importance that pressure drop between generation and consumption of compressed air is kept very low. The aim is to design and develop a control system based on an intelligent electronically controlled automotive braking system is called "AUTOMATIC REVERSE BRAKING SYSTEM". This Braking system is consists of an IR transmitter and Receiver circuit, Control Unit, Pneumatic breaking system. The IR sensor is used to detect the obstacle. There is an obstacle in the path, the IR sensor senses the obstacle and giving the control signal to the braking system. The pneumatic braking system is used to break the system.

Palak Desai et al, (2017) In this world of automation, various systems have been developed just to reduce time and human error. The paper is about a system for assisting a car driver while parking in the reverse direction and to reduce blind spots area around a vehicle that cannot be seen while looking either forward or through the side or rearview mirror. The automatic reverse braking system with blind-spot reduction technology will process the sensor data and control the vehicle to prevent accidents caused by careless driving or difficulty in detecting objects in the reverse path and on the road while driving. This is an integrated circuit based setup that is useful in automobiles as an intelligent vehicle assistant for safe driving.

S. Sudhakar et al, (2019) In present scenarios safety is an important feature in the automotive industry. In automobiles, the braking system plays a major role in driver and passenger safety. In which our project mainly concentrates on the braking system The intelligent braking system is the next step to automation. Presently cars have an alarm system where when the car gets too close to an object an alarm is triggered which warns the driver about an object close. But these features have produced a lot of problems and are prone to human error. We have enhanced the facility by using the same system but we have altered it so that the car brakes automatically when an obstacle is close to our automobile. This project mainly to design and develop a control system based on an intelligent electronically controlled automotive braking system is called “AUTOMATIC REVERSE BRAKING SYSTEM”. Sensor Operated Pneumatic Brake consists of an IR transmitter and Receiver circuit, Control Unit, Pneumatic breaking system. The IR sensor is used to detect the obstacle. There is an obstacle in the path, the IR sensor senses the obstacle and giving the control signal to the braking system. The pneumatic braking system is used to brake the system. So basically here the car brakes on its own by determining the distance from the object.

Nivesh Thepade et al , (2016) In almost all of the cases of vehicle accidents, the basic reason cited is a failure to apply the brakes at the right time. If the brakes are applied at the right time the accidents can be prevented. Automation can assure higher reliability of braking as compared to fully manual braking. The use of a pneumatic system can prove to be useful in automation due to its simplicity and ease of operation. So, the aim is to design and develop a system based on automatic control of the vehicle. So, we aim to design an "Intelligent Braking system with Pneumatic Bumper”.

Radhakishan Maske et al, (2017) Automatic brake failure indicator and braking system, it is a genuine project which is fully equipped and designed for automobile vehicles. This forms an integral part of good quality. One of the main reason is brake failure, it caused due to very poor maintenance as well as a product defect, to safeguard valuable human from the accident monitoring of brake is a very important thing in automobile Vehicle safety is the avoidance of automobile accidents or the minimization of harmful effects of accidents, in particular as a concern to human life and health. Special safety features have been built into the vehicle's occupants only, and some for the safety of others. Automatic brake failure indicator and braking system is the most effective solution to this problem .it is the most effective and the simplest methodology used to reduce the rate of the accident due to brake failure. In this system, the components used are a two-way relay, buzzer, battery, motor, wiring system. And finally, the braking system installed in the two-wheelers by using these components the most effective system is to be generated. In this system, if brake failure occurs then the buzzer indicates the driver in the form of sound and simultaneously alternative braking system start their working and apply the secondary brakes by using motor fitted to the chassis, as the result of these the speed of the vehicle gets reduced and the vehicle is stopped in some second. The main advantage of the system is that it is compact, and the installation cost is very less. If this system is installed in a vehicle then accident due to brake failure get reduced, as the result of these, the rate of the accident due to brake failure get reduce.

Anant W. et al, (2018) Road accidents are an outcome of the interplay of various factors, some of which are the length of the road network, vehicle population, human population and adherence/enforcement of road safety regulations, vehicle component failure, etc. of which some parameters are difficult to control or can be controlled by external factors such as strict traffic norms, rigorous driving tests for the license, traffic separation, etc. But accidents due to failure of vehicle brakes a prime responsibility of the vehicle manufacturer, the brakes must work properly without failure of any component in its assembly. Road accident causes injuries, fatalities, disabilities, and hospitalization with severe socio-economic costs across the country. Consequently, road safety has become an issue of concern both at the national and international levels. The United Nations has rightly proclaimed 2011-20 as the Decade of Action on Road Safety. India is also a signatory to Brasilia Declaration and is committed to reducing the number of road accidents and fatalities by 50 percent by 2020

N.Venkatachalapathi et al, (2016) The braking system of a car is undoubtedly one of its more important features. This work aims to create a better braking system with an indicator. Brake failure occurs only because of the worn-out brake shoe and cuts in a liner. It consists of two sensors. One sensor is connected with the brake shoe. The other sensor is the brake liner. The signal from the two sensors is given to a microcontroller. When the brake shoe is worn out, the sensor senses a signal to the microcontroller. Also if the brake liner is cut, the sensor sends a signal to the microcontroller. The microcontroller analyses the signal and operates the corresponding indicator. Its nothing wrong, the vehicle will move and if anyone critical, the vehicle will stop and the screen shows the indication of brake failure. Since this indicates the status of the brake, the user can identify the condition of the brake and thus limiting the chances of malfunction.

K. Mohan et al, (2017) Brakes are implemented in cars to stop the vehicle. The increase in the number of deaths and accidents is due to brake failure. Hydraulic Brake failures mainly occur due to oil leakage and result in pressure loss. This paper aims to diagnose a faulty braking system and application an auxiliary secondary braking system in case of brake failures. This project helps in ensuring the safety of the passengers before the failure occurs and helps in preventing accidents. The brake failure alarming system is empowered by the electronic control unit. When the primary hydraulic disc brake fails, the sensor detects the pressure loss and gives a warning signal to the driver, and also activates the power supply to the secondary braking unit which is a hub motor in rear wheels. This functions as a secondary braking unit and helps the driver to stop the vehicle and thus ensures the safety of the passengers. The project also includes the stopping of a vehicle by switching off the supply of the ignition to the engine.

Akilan. M et al, (2018) The aim is to design and develop a control system based on an automatic brake failure detector and acceleration locking system using IR sensors and the control unit. The main theme of the project is to monitor the brake system at every moment and if there is any brake failure the acceleration is locked automatically, i.e. the driver cannot accelerate the vehicle furthermore. An IR sensor is placed on the brake kit assembly. The sensor is connected to the control unit; the output of the control unit is connected with the fuel pump that pumps fuel from the fuel tank to the fuel injector. Hence, when the brake fails, the control unit sends signals to the fuel pump such that it stops pumping fuel from the fuel tank to the fuel injector.

G. Venkata S. et al, (2018) Nowadays accidents may occur due to various reasons, the foremost reason is brake failure and is caused due to poor maintenance as well as a product defect. To safeguard valuable human life from these accidents; there is a need for monitoring of the braking system in automobiles. Vehicle safety is the avoidance of automobile accidents or the minimization of harmful effects of accidents, in particular related to human life and health. Special safety features have been built into the vehicle's occupants only, and some for the safety of others. This is a brake failure indicator circuit that constantly monitors the condition of the brake and gives an audio-visual indication to the rider.

2.2 Summary of the review

Most of the studies try to developed the intelligent braking system for various vehicles based on object sensed by the ultrasonic sensor and speed of vehicle, a Microcontroller and ultrasonic sensors, Sensor Operated Pneumatic Brake, using ratchet and pawl mechanism, using IR sensor in order to see the necessities of vehicle control and archiving of reducing traffic accidents as well as road users injuries and death.

Also some of the studies try to show how Develop brake failure indicator circuit that constantly monitors the condition of the brake using the different condition like wire and alerting the rider before it gets cut, using the sensor which detects the leakage and gives warning signal to the driver, using the sensor which senses brake shoe is worn out and sends a signal to the microcontroller and using two-way relay, buzzer, battery, motor, wiring system for indicating brake failure. This provides pre-crash safety for vehicle. As this stem advance these time of vehicle braking to retain safe distance between two vehicles. By using this system the papers focus to control the speed of vehicle in lesser distance.

2.3 Research gap

All investigations have their own research gaps. In intelligent braking the studies mostly limited to the range, process speed, and response speed of the studies are narrow and limited. This affects when the vehicles taking a turn sensor can give the false indication of obstacle. Also, most systems are effective for lighter vehicles only.

In brake failure indicator system Brake failure is notified to the surrounding traffic via buzzer so, this disturbing the environment. Also systems are doesn't take an measurement action if the driver overlooks to take an action, The traction control system and an engine stops for control of the vehicle is a major drawback. But in all investigations they only focused on either autonomus braking or brake failure indicator system. So This study aimed to fill that gap by combining both systems.

2.4 System components

An automatic pneumatic brake system consists of two main components. These are:

- ✓ The conventional air brake components and
- ✓ The electronic components.

2.4.1 The conventional air brake components

Air brakes are the most preferred type of braking system for buses and truck for various reasons. An air brake is used to transfer the pressure from the driver's control to the service brake.

There are five main components in the air braking system i.e., Reservoirs, Compressor, Brake chambers, Foot valve, and brake shoes and drums.

Compressor — Compressor's function is to build up and maintain the air pressure. These air pressures are required for operating air brakes and air powered accessories. Air compressor can be either driven from the engine directly or can be belt driven.

Most of the compressor uses the truck's lubrication and cooling system but there is some compressor that is self-lubricated and air cooled. The air can be drawn from either its own air filter or from engine's intake system.

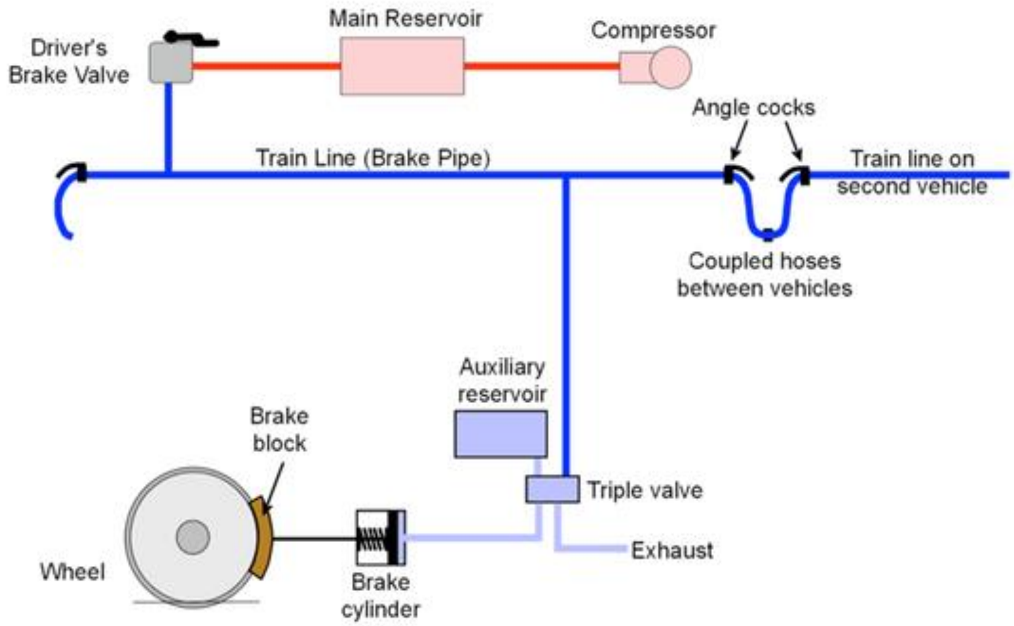


Figure 2. 1: Conventional air brake components

Reservoirs — It is used to store the compressed air. It is a pressure rated tank which holds compressed air until it is required for braking. The amount of compressed air in the reservoirs decides the air pressure for brake applications.

You cannot make high-pressure brake application than the air compressed in the reservoirs. Reservoirs are essential for the air brake system as it plays a very important role by holding compressed air that is used for braking. Moreover, the reservoirs must be drained completely at least once in a day.

Foot valve — Foot valve as the name suggests is a foot operated a valve that is used to apply the air to operate the brakes. The amount of brake is decided by the driver according to the distance and pressure applied at Treadle.

Brake chambers — It is used to transfer the compressed air pressure into mechanical force and movement that applies the brake.

Brake shoes and drums — It is used to create the friction that is needed to stop the vehicle. We are the leading dealer and supplier of CV brake pads. It is developed specifically for highway vehicles to give a consistent braking performance. It gives the ability to the huge vehicles that run on the highway carrying lots of weights to stop smoothly. It is used to provide the stopping power with reliability which modern vehicle needed. There is consistent compatibility around the pads that gives better durability and protection.

2.4.2 Air brake system

To move a vehicle, an internal combustion engine must convert its heat energy to mechanical energy. This mechanical energy goes from the engine to the driving wheel tires by means of a system of connecting rods, shafts and gears. The final factor that moves a vehicle is the amount of traction its tires have on the road surface

Traction is the ability of a tire to grip the road surface on which it rolls. The vehicle's acceleration rate depends on the power the engine develops and the amount of traction thetires have on the road surface.

Friction is the force which resists movement between two surfaces in contact with each other. To stop a vehicle, brake shoe linings are forced against the machined surfaces of the brake drums, creating friction. This friction produces heat.

The engine converts the energy of heat into the energy of motion, the brakes must convert this energy of motion back into the energy of heat. Friction between brake drums and linings
generates heat while reducing the mechanical energy of the revolving brake drums and wheels. The heat produced is absorbed by the metal brake drums, which dissipate heat by passing it off into theatmosphere.

The amount of heat the brake drums can absorb depends on the metal thickness of which they are made. When enough friction is created between brake linings and drums, the wheels stop turning. The final factor that stops a vehicle is not the brakes, but the traction between tires and road surface.

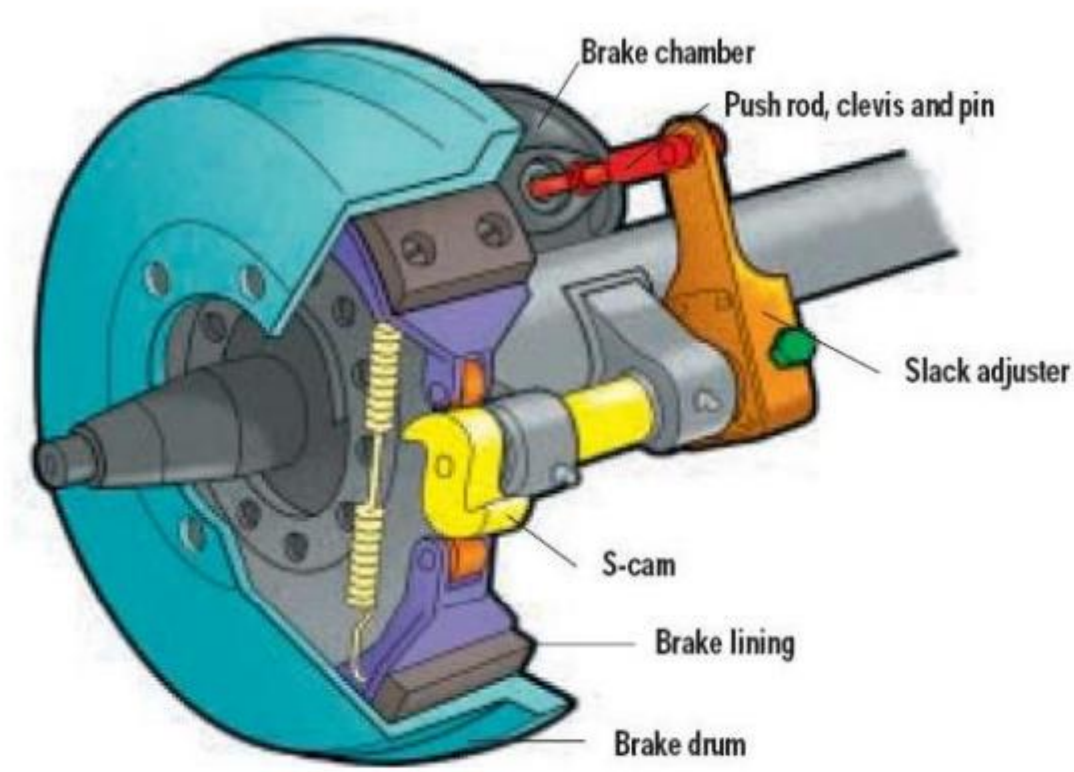


Figure 2. 2: A typical drum brake assembly

2.5 Electronic Components

These are components that are integrated to the conventional brake system components to make an automatic brake system. These are:

- ✓ Relay module
- ✓ Arduino UNO
- ✓ Breadboard
- ✓ Buzzer
- ✓ Ultrasonic sensor
- ✓ LED lights

2.5.1. Relay module

A relay is an electrically operated switch of mains voltage. It means that it can be turned on or off, letting the current go through or not. Controlling a relay with the Arduino is as simple as controlling an output such as an LED. The relay module shown in Figure 2.3.

Figure 2. 3: Relay Module

In relation to mains voltage, relays have 3 possible connections:

- ✓ **COM:** common pin.
- ✓ **NO (Normally open):** there is no contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and supply is provided to a load.
- ✓ **NC (Normally closed):** there is contact between the common pin and the normally closed pin. There is always a connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to a load. plunger gets power, the magnetic fields push the plunger and the foot valve delivery portopens.

2.5.2 Arduino UNO Microcontroller

Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller and developed by Arduino.cc (What is Arduino?".Learn.sparkfun.com, 2018). The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards (shields) and other circuits (Arduino UNO for beginner's makerspaces.com, 2018). The board features 14 Digital pins and 6 Analog pins. It is programmable with the Arduino Integrated Development Environment via a type B USB cable (Introduction to Arduino priceton.edu, 2018). It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

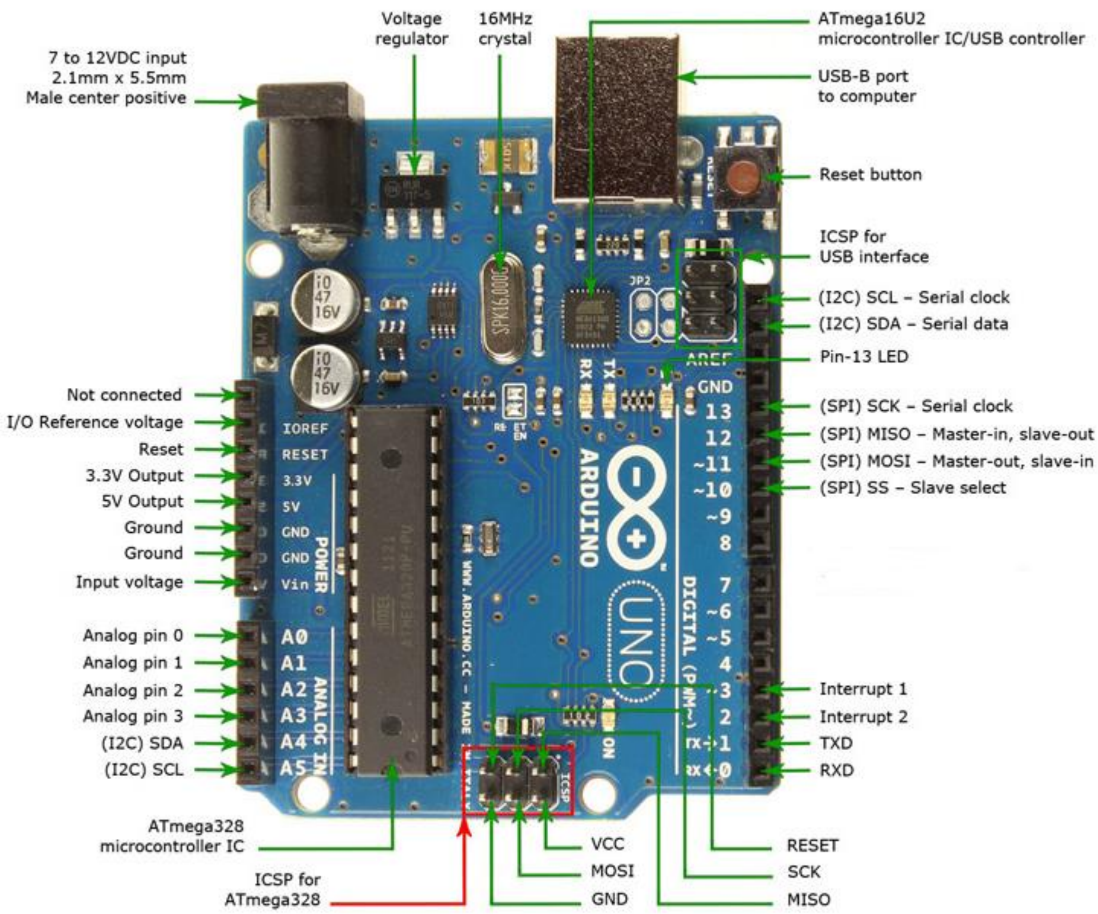


Figure 2. 4: Schematic structur of Arduino uno microcontroller

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supplies. It's not allowed to use a power supply greater than 20 Volts as you will overpower and thereby destroy the Arduino. The recommended voltage for most Arduino models is between 6 and 12 Volts. The pins on the Arduino are the places where it will connect wires to construct a circuit probably in conjunction with a breadboard and some wire. They usually have black plastic ‘headers’ that allow you to just plug a wire right into the board. Arduino Uno Microcontroller. The Arduino Uno which is shown in Figure above has several different kinds of pins, each of which is labeled on the board and used for different functions.

2.5.3 Breadboard

Breadboard is a device to make prototype circuits. It has several sockets in which electronic components get inserted. It has power line sockets that provide power to the circuit. The arrow line shows the breadboard internal connectivity. Image of a plus one size breadboard is shown in Figure 2.5 below.

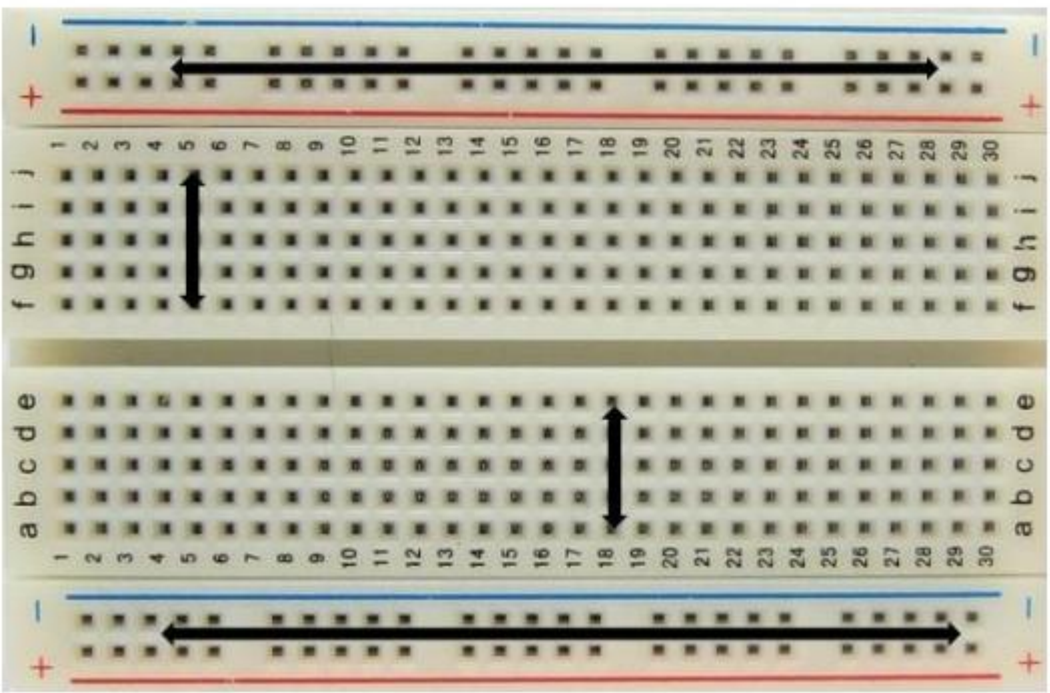


Figure 2. 5: Breadboard

The plus one size breadboard has two power lines which are internally connected. If power is given to one power line, it can be taken out from all other socket of the power line. If a circuit uses two types of power, for example, 5V and 3.3V, in this condition one power line can be used for 5V and the other power line can be used for 3.3V. Socket of main sections are internally connected in a set of 5 sockets from A to E and from F to J. A plus one breadboard has such 30sets.

2.5.4 Buzzer Module (5v rated)

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has elapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially, this device in Figure 2.6 was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulse the sound on and off.

Figure 2. 6: Buzzer Module

Active buzzer 5V Rated power can be directly connected to a continuous sound, this section dedicated sensor expansion module and the board in combination, can complete a simple circuit design. The buzzer is used to alarm the driver to take a further safety action like depressing the clutch pedal in order to prevent the load on the engine during automatic braking.

2.5.5 Ultrasonic sensor

Ultrasonic sensor (sometimes called ultrasonic transducers), is non-contact distance measurement module. It is perfect for measuring distance between two moving or nonmoving bodies. Ultrasonic sensors measure the distance to or the presence of a target object by sending a sound pulse, above the range of human hearing (ultrasonic), toward the target and then measuring the time it takes the sound echo to return. Knowing the speed of sound, the sensor determines the distance of the target and sets its outputs accordingly. The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module.

Figure 2. 7: Ultrasonic Sensor

Ultrasonic sensor has four pins. These are: Vcc, Trigger, Echo and Ground

- ✓ **Vcc:** The Vcc pin powers the sensor, typically with +5V
- ✓ **Trigger:** Trigger pin is an input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
- ✓ **Echo:** Echo pin is an output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
- ✓ **Ground:** This pin is connected to the Ground of the system.

Sensor outputs are set based on the measured distance, or under override conditions, a lack of target detection or user-selected response algorithms. Outputs can be:

- ✓ An analog voltage or current signal proportional to the measured distance.
- ✓ Switches or relay contact closures that open or close at specific distances.
- ✓ Distance data transmitted digitally as serial data communications.

The maximum range of these products is presently 30 meters and varies by model. The distance at which an object is detected depends on its size, shape, and orientation. In general, the target must be larger to be detected at longer distances – the object must reflect a sufficiently strong ultrasonic echo back to the sensor to be detected. Curved objects or sound-absorbing materials such as fabrics or non-wovens reflect less energy directly back to the sensor. Granular materials may absorb sound or deflect sound energy away from the sensor due to surface variation and/or angle of repose. Sensor maximum range should be derated for these targets.

2.5.6 Light Emitting Diodes (LEDs)

An LED is a small light (it stands for "light-emitting diode") that works with relatively little power. LEDs have polarity, which means they will only light up if you orient the legs properly. The long leg is typically positive, and should connect to a digital pin.

Arduino board. The short leg goes to GND; the bulb of the LED will also typically have a flat edge on this side. To blink the LED takes only a few lines of code. The first thing we do is define a variable that will hold the number of the pin that the LED is connected to. We don't have to do this (we could just use the pin number throughout the code) but it makes it easier to change to a different pin. We use an integer variable (called an int). Current flows from the anode to the cathode and never the opposite direction.

Figure 2. 8: Light Emitting Diodes (LED)

2.6 Working Principle

The whole system starts with the starting of engines of the vehicle. In the sensor unit, the ultrasonic sensor transmitter will transmit the wave. If there is any obstacle in the vehicle path, the sound waves will reflect. These reflected waves are received by the receiver circuit is called ultrasonic receiver.

If there is no obstacle in a path, the receiver circuit will not receive any signal and the solenoid valve remains closed. But if there is an obstacle the microcontroller will receive an input signal and sends an output signal to the relay module to open supply valve for compressed air to actuate the push road.

Also, if there is no any air pressure loss in a brake system, the receiver circuit will not receive any signal and the relay valve remains closed. But if there is any pressure loss in a brake system the microcontroller will receive an input signal from pressure sensor and sends an output signal to the LED for less harm full lose, LED and buzzer module for serious lose for warning the driver and finally sends an output signal to the relay module to open supply valve for compressed air to actuate the push road.

The compressed air activates the braking circuit moves the push rod of the brake chamber. If the piston moves forward, then the breaking arrangement activated. During this situation a brake will be held. After the obstacle is removed from the vehicle path, the supply valve of the relay closed and it will back to the former position.

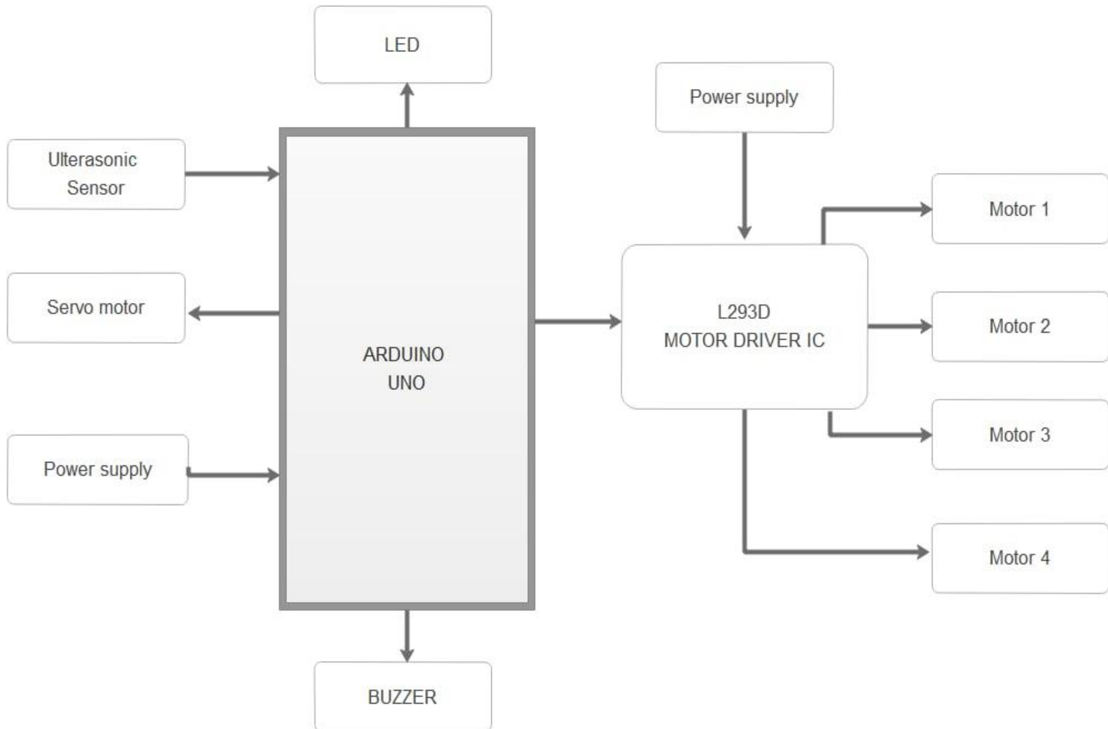


Figure 2. 9: Working principle of intelligent braking system

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Materials

The materials and equipment required for this thesis work are listed in table 3.1 given below.

Table 3. 1: The materials required

No	Item	Unit	specification	Quantity
1	Arduino uno microcontroller	Set	SMD 3D	02
2	Motor gear	Pc	DC 3-6v	04
2	Bread board(half size)	Pc	5.5 x 8.5 cm	1
3	Ultrasonic Sensor	Pc	HC-SR08	4
4	Relay module	Pc	2	2
5	Buzzer module	Pc	6V DC-2300Hz Continuous beep	1
6	Battery	Pc	2 x (3.7V by 2000 mah)	4
7	Servomotor	Pc	Micro Servo 99- SG 90	2
8	Light Emitting Diode(LEDs)	Pc	2	5
9	Circuit wires/jumper wire/	Pc	Male to male & Male to female	----

3.2 Methods

3.2.1 Literature review

Literature survey about both the existing vehicle braking system and automatic braking control system in related to accident avoiding system is the key methodology of this study that will help me to have enough knowledge about what others done and identify where the problem does exist so that my thesis will be based on the research gap that the study found.

3.2.2 Data Collection

The necessary data for intelligent braking and brake failure system problems of vehicles will be collected by following methods

- ✓ By collecting traffic accident data related to brake failures or long stopping distance from Ethiopian federal police commission, ministery of transportation and Ethiopian transport authoriy.
- ✓ By interviewing pedestrians, traffic polices and drivers about major causes of traffic accident related to brake failure or long stopping distance.
- ✓ By visiting various literatures from websites in the area of vehicle design and dynamic analysis, SAE and other publications.

3.2.3 Design

After reviewing the literature and collection of significant data, design of the intelligent braking components was carried out. In this part there will be a conceptual design process which helps the study variety of mechanisms and select the appropriate design path by considering different criteria's. After accomplishing the design of parts, a prototype will be constructed.

3.2.4 Assembly

Once the design part is completed, the next step is assembling the systems and components. Then the assembly process will be discussing clearly using exploded view of the parts.

3.2.5 Testing

The design process includes multiple loops and circles nearby the final solution. It will likely test the solution, find difficulties and make changes, test the new solution, discover new problems and make variations and so on, before settling on a final design. Since prototypes are by description the first of their kind, they are used in product design for testing, testing and more testing. So finally prototype was prepared for demonstration and testing. The methodology that will be followed is shown in the form of flow chart 3.1 given below.

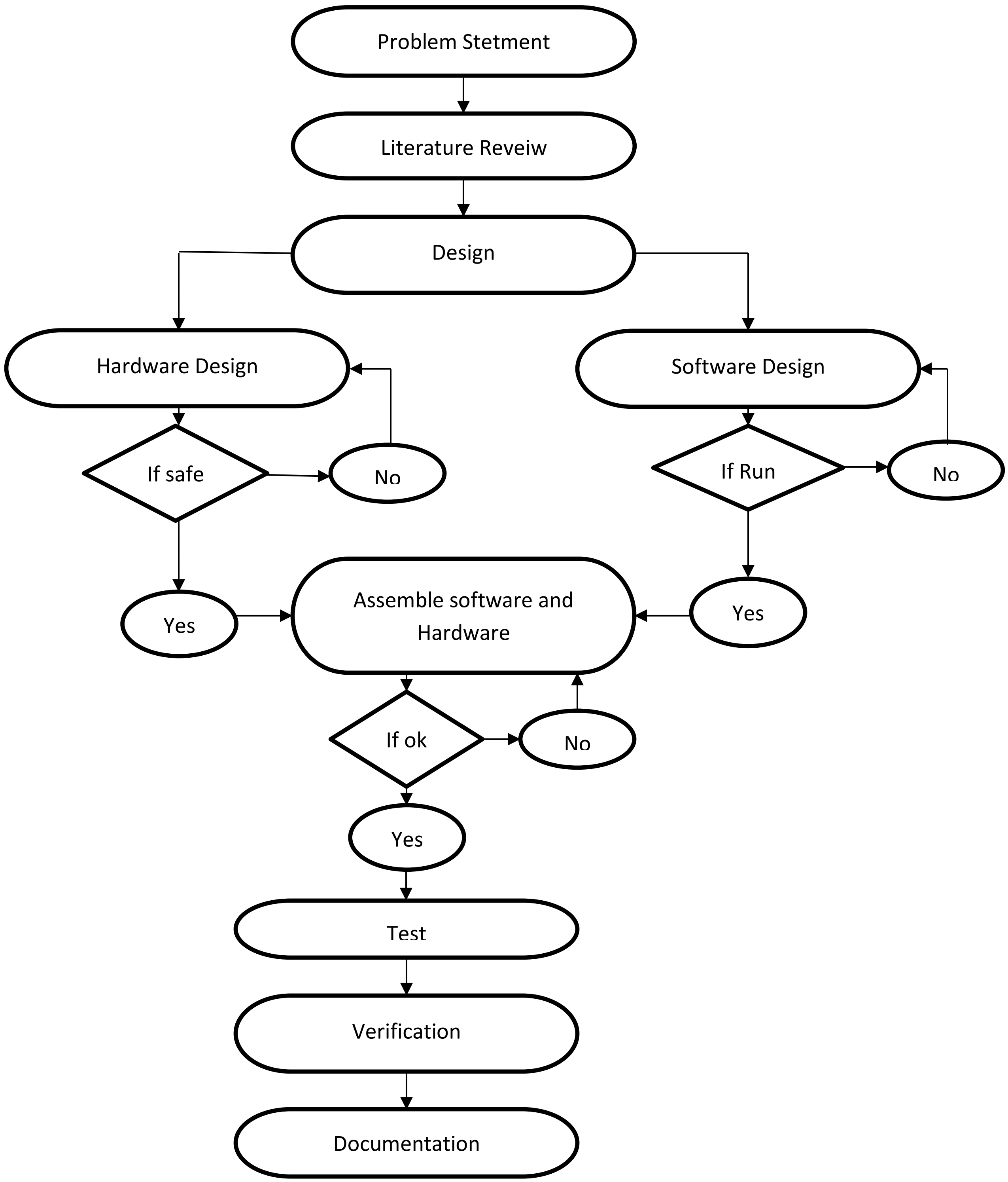


Figure 3. 1: Flow chart of the methodology of thesis

3.3 Analysis of raw data

3.3.1 Conceptual design

According to the Ethiopian federal police commission's ten years total traffic accidents statistical data report, traffic accidents are the serious and gradually increasing cause for death, serious injury, light injury, and property damage. According to the report, ten years aggregate summary is shown in figure 3.2 below.

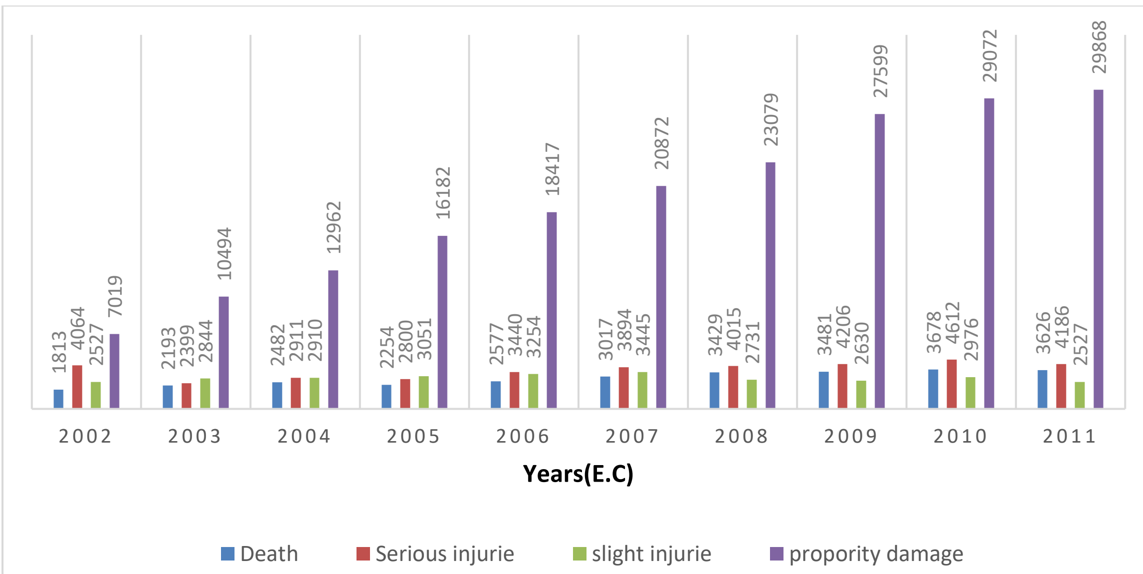


Figure 3. 2: Ten years aggregate traffic accident report analysis in Ethiopia

According to the report, all parameters are increasing year to year. This shows traffic accidents in Ethiopia are very serious and need very serious attention. Let's see the traffic accident according to vehicle category.

In this study, the first analysis categorizes all ten years' data into three categories according to the functions of the vehicles. These categories are:

All public means of vehicles: this category includes bicycles, motorbikes, automobiles, station wagons, taxis, minibusses up to 12 seats, medium buses from 13 to 45 seats, buses above 46 seats, and trains.

This ten years traffic report analysis for public means of transportation takes the maximum amount of death, serious injury, slight injury, and property damage.

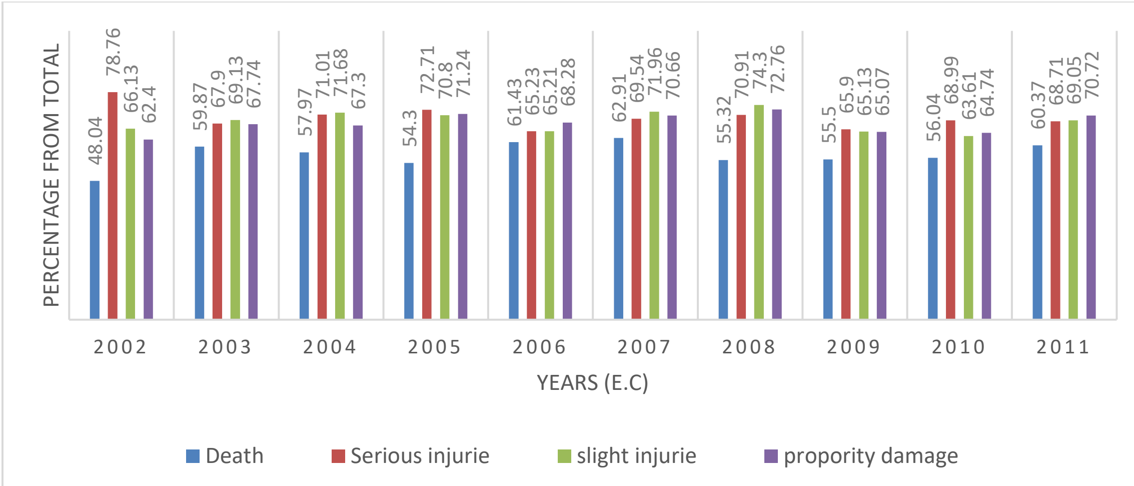


Figure 3. 3: Ten yerars traffic accident analysis for public means of transportation vehicles

All cargo means of vehicles: this category includes carts, pick-ups up to 1-tonne capacity, trucks from 1 tonne to 4-tonne capacity, trucks from 5 tonnes to 10-tonne capacity, and heavy tracks with trailer.

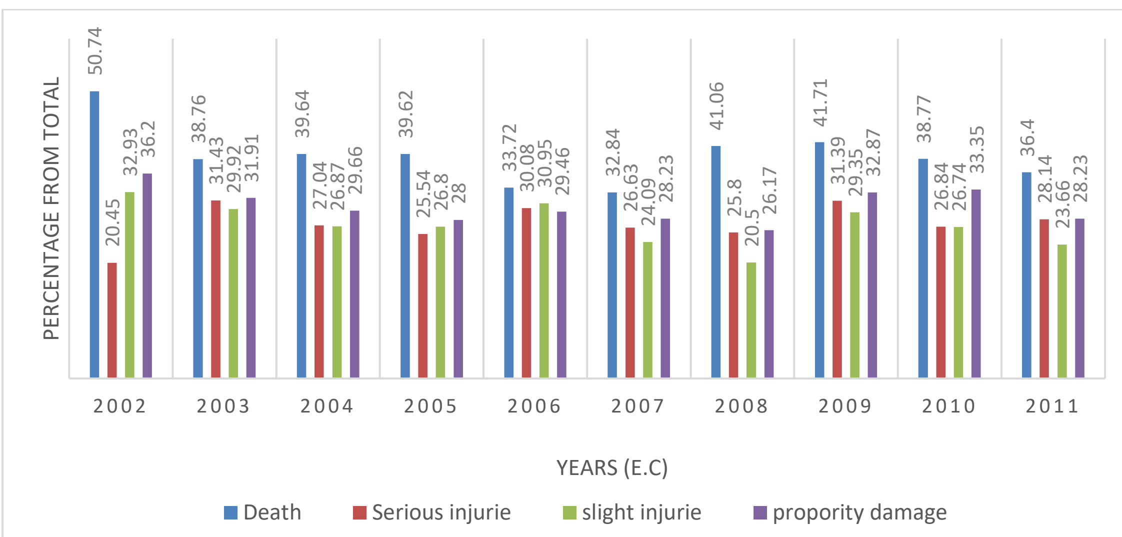


Figure 3. 4: Ten years traffic accident analysis for cargo means of transportation vehicles

This ten years traffic report analysis for cargo means of transportation takes relatively lower numbers of death, serious injury, slight injury, and property damage compared to public means of transportation. From these statistics, death takes the maximum credit among the rest three parameters.

All machinery type vehicles: this includes construction vehicles, construction machinery, and others.

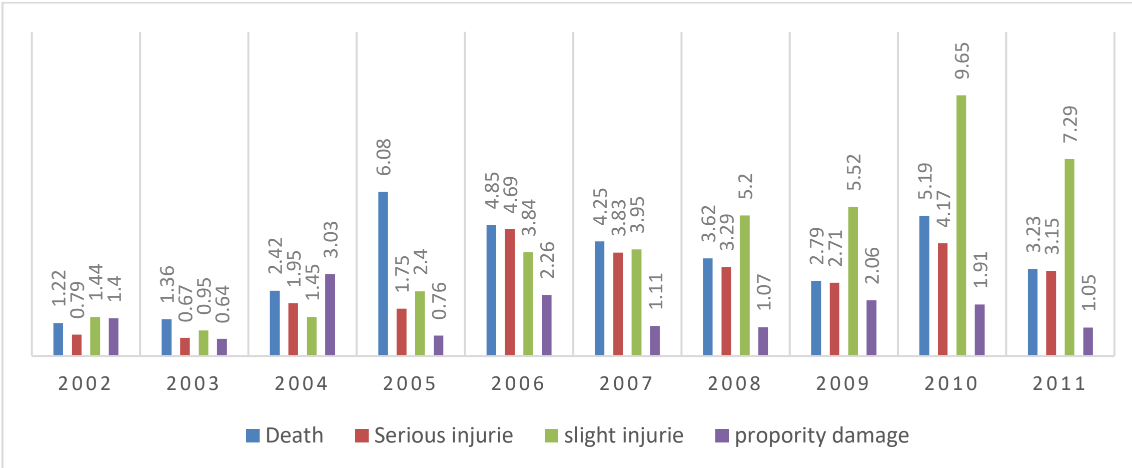


Figure 3. 5: Ten years traffic accident analysis for machinery type vehicles

To generalize the category we can make the average 10 years traffic accident report. In this analysis, the aggregate statistical result shows that death, slight injury, and serious injuries almost have nearby value compared to property damage.

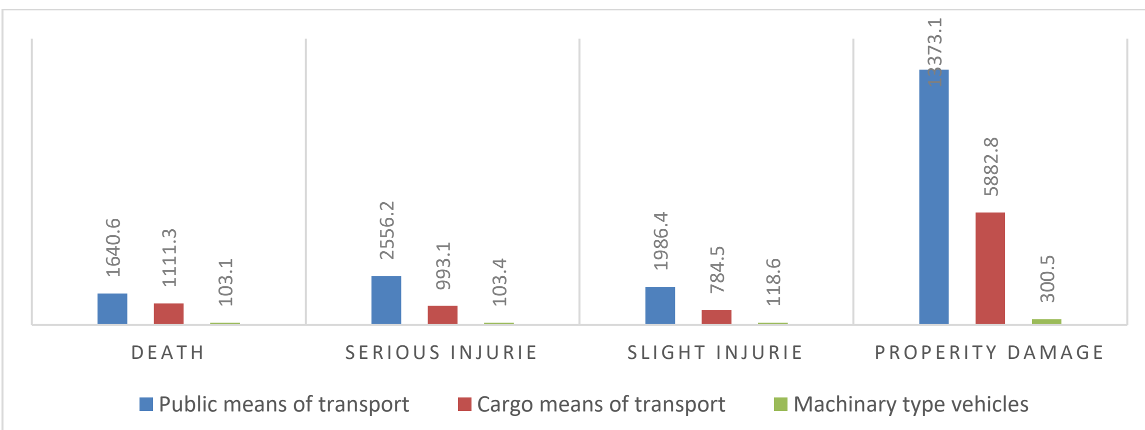


Figure 3. 6: Ten years average traffic accident analysis in Ethiopia

3.3.2 Catagory screening

Here the statistical result shows public means of vehicles take more credit in death, serious injury, slight injury, and property damage than cargo means of vehicles and machinery type vehicles. So this study focuses on public means of vehicles.

Table 3. 2: Category screening

Parameters	Public means of transportation vehicles	Cargo means of transportation vehicles	Machinery type vehicles
Death	1640.6	1111.3	103.1
Serious injury	2556.2	993.1	103.4
Slight injury	1986.4	784.5	118.6
Property damage	13373.1	5882.8	300.5
Rank	1	2	3
Remark	Selected	---	---

Public means of transportation vehicles > Cargo means of transportation vehicles >> Machinery type vehicles

According to the statistics, public means of vehicles take the maximum credit. So it is selected for this study.

Public means of vehicles

This category contains different types of vehicles. But the study needs further analysis to select a single type of vehicle for this study. So for the study, this category is further classified in to:

Private transport vehicles: this category includes bicycles, motorbikes, automobiles, and station wagons.

According to ten years of statistical data, this category takes the minimum ratio of death, serious injury, slight injury, and property damage compared to public means of vehicles.

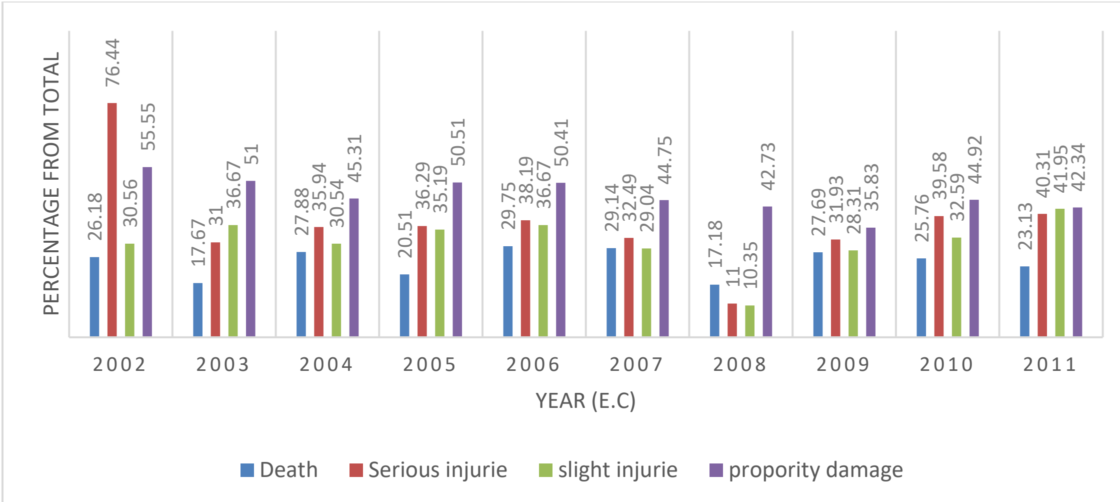


Figure 3. 7: Ten years traffic accident analysis for private transportation vehicles

Public transportation vehicles: this category includes taxis, minibusses up to 12 seats, medium busses from 13 -45 seats, buses above 46 seats, and trains.

According to ten years of statistical data, this category takes the maximum ratio of death, serious injury, slight injury, and property damage than private transport vehicles.

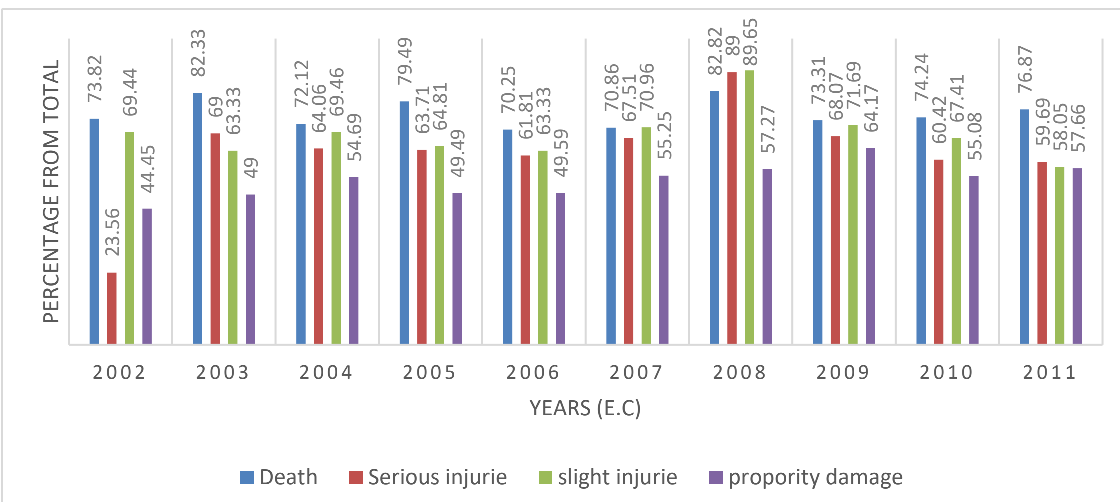


Figure 3. 8: Ten years traffic accident analysis for public transportation vehicles

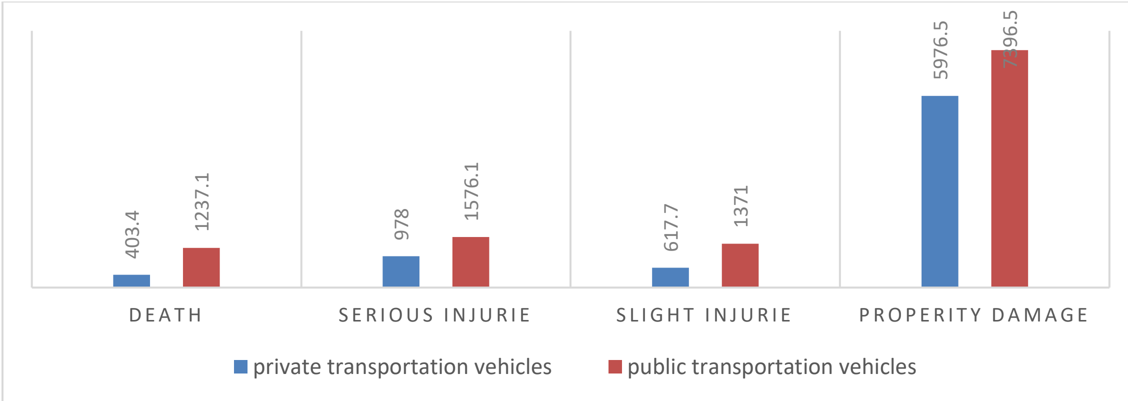


Figure 3. 9: Ten years average traffic accident analysis public means of transports

Table 3. 3: Concept screening

Parameters	Private transport vehicles	Public transportation vehicles
Death	403.4	1237.1
Serious injury	978	1576.3
Slight injury	617.7	1371
Property damage	5976.5	7396.5
Rank	2	1
Remark	---	Selected

private transportation vehicles < public transportation vehicles

Public transportation vehicles

This category contains different types of vehicles. So for the study, this category shows how much percentage of death, serious injury, slight injury, and property damage that buses having above 46 seats from the totals of public transportation vehicles.

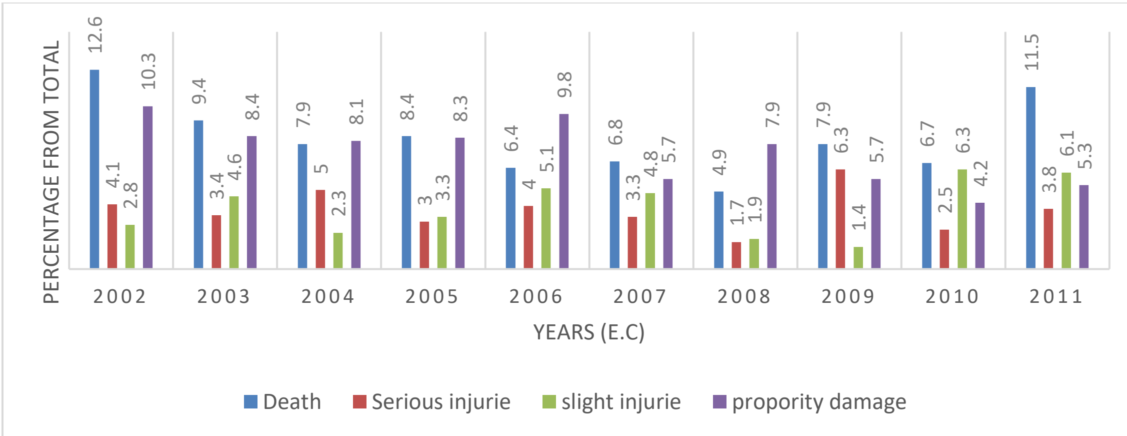


Figure 3. 10: Ten years traffic accident analysis for bus above 46 seat

The average statistics of death, serious injury, slight injury, and property damage that buses having above 46 seats shown below

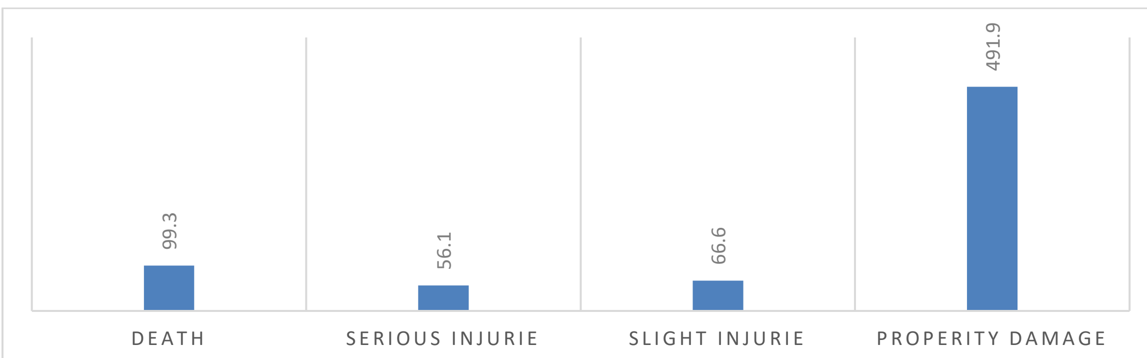


Figure 3. 11: Ten years average traffic accidents caused by bus

This date in percentage shows that:

Table 3. 4: Parameters in percentage from total public transport vehicles

	Parameters in percentage from total public transport vehicles			
	Death	Serious Injurie	Slight injurie	Properity damage
Buses above 46 seats	8.03%	3.6%	4.9%	6.7%

3.3.3 Property damage

Aggregate property damage in Ethiopia

According to the Ethiopian federal police commission's years total traffic accidents statical data report, traffic accidents are the serious and gradually increasing causes of property damage. Because of these accidents our country Ethiopia losses in billion birrs of property.

Table 3. 5: Six years aggregate property damage report in Ethiopia

Year(E,C)	Total property damage in ETB
2006	1,001,604,812
2007	668,322,806.8
2008	874,611,141.5
2009	1,187,486,803
2010	920,771,314.8
2011	872,884,881

Six years aggregate summary of the report is shown in the figure below.

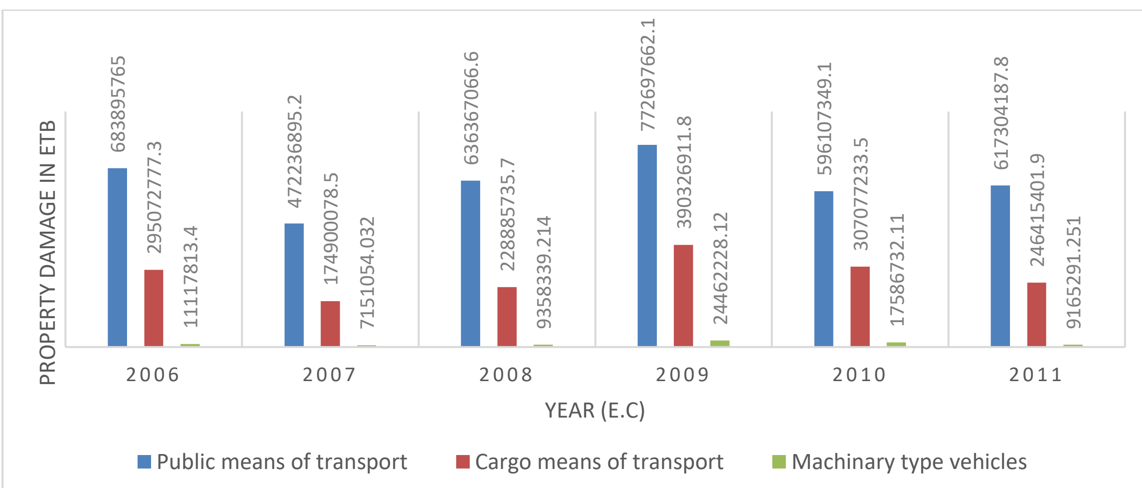


Figure 3. 12: Six years aggregate property damage

Here the statical result shows public means of vehicles take more credit in property damage than cargo means of vehicles and machinery type vehicles.

Property damage due to Public means of vehicles

This category contains different types of vehicles. But the study needs further analysis to select a single type of vehicle for this study. So, for the study, this category is further classified in to:

Private transport vehicles: this category includes bicycles, motorbikes, automobiles, and station wagons

Public transport vehicles: this category includes taxis, minibusses up to 12 seats, medium busses from 13 -45 seats, buses above 46 seats, and trains.

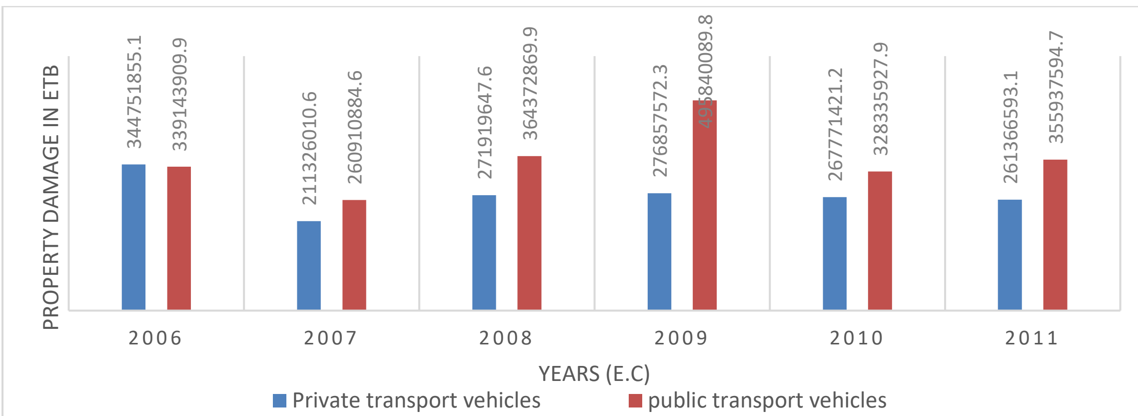


Figure 3. 13: Property damage comparison of public means of transportation

Here the statical result shows public transport vehicles take more credit in property damage than private transport vehicles.

Property damages due to buses above 46 set

For the study, it is very important to know the accidental damages of buses. Because most Ethiopian passengers are preferring to travel using buses since they are inexpensive and the most available means of public transportation.

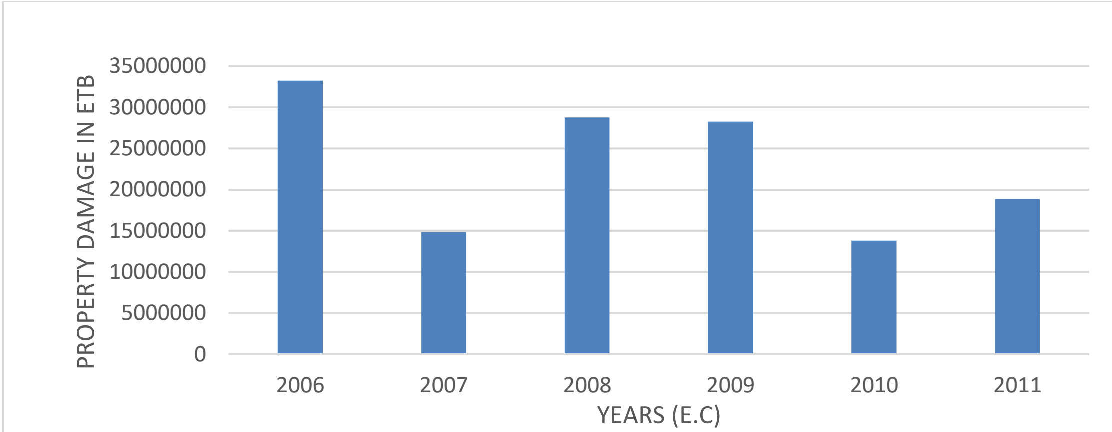


Figure 3. 14: Property damage caused by buses

This result shows these means of transportation need serious attention. Because the average property damage of the six years equals with the budget which needed to build a ***full-cycle elementary school*** in countrysides.

3.4 Vehicle statics in 2011

According to the Ethiopian transport authority report:

Table 3. 6: Ethiopian vehicle stastics

Total number of vehicles	1071345
Total numbers of public means of transportation vehicles	763146
Total public transport vehicles	343813
Total number of buses (mini to higher)	151591
Total number of buses more than 46 seat	5553

The number of higher buses from total:

- ✓ Numbers of vehicles in Ethiopia

$$Buses > 46\ set = \frac{5553}{1071345} \times 100\% = 0.52\%$$

- ✓ Number of public means of transportation

$$Buses > 46\ set = \frac{5553}{763146} \times 100\% = 0.73\%$$

✓ Number of buses (mini to higher)

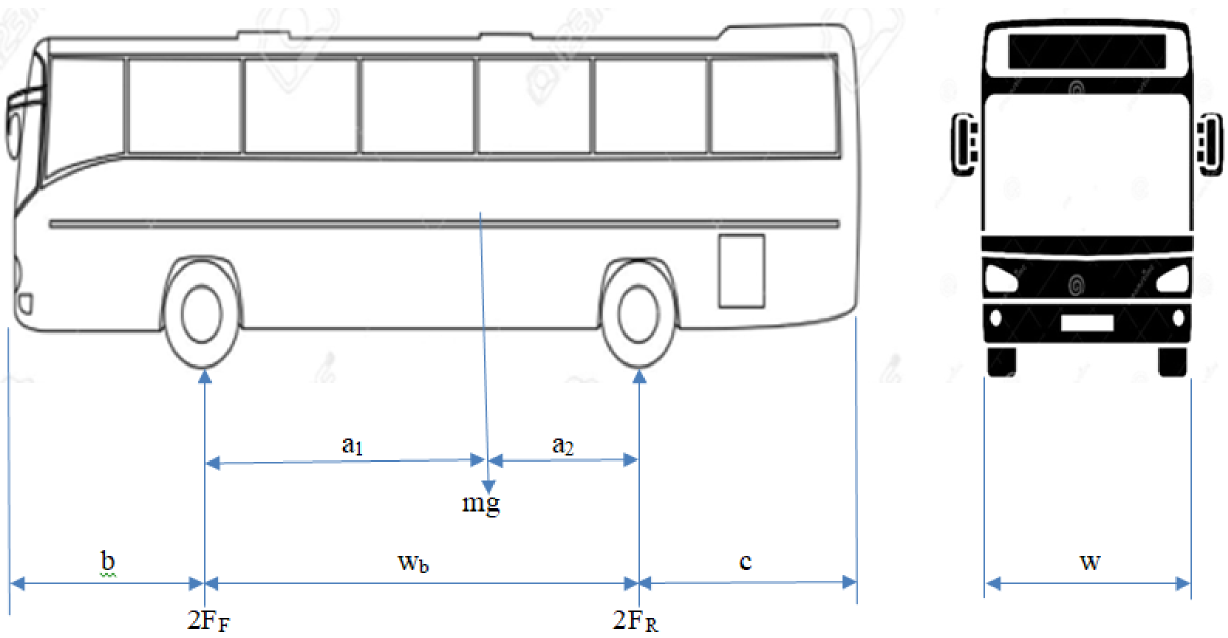
$$Buses > 46\ set = \frac{5553}{151591} \times 100\% = 3.66\%$$

3.5 Design Analysis

Specification

Table 3. 7: Vehicle specification

Vehicle type	LPO 1618 Tata Bus
Engine	CUMMINS 6BT 5.9-180-30,BSIII; water cooled; Turbo charged; Diesel engine capacity - 5883 cc (Bore = 102 mm: Stroke = 119 mm)
Maximum power	131 Kw (180 HP) at 2500 rpm
Maximum torque	675 Nm at 1400 rpm
Tyre size	11R22.5-16PR (Over all width = 274 mm: overall diameter = 1064 mm: laden radius = 498 mm)
Wheel base	6200 mm
Front overhang	2250 mm
Rear overhang	3400 mm
Overall length	11850 mm
Maximum width	2580 mm
Turning circle radius	23661 mm
Maximum speed	105 Kmph
RA ratio	5.857:1
GVW	16200 Kg



a_1 - The distance of the buses CG to the front axle = 3.7 m

a_2 - The distance of the buses CG to the rear axle = 2.5 m

b - Front overhang = 2.25 m

c - Rear overhang = 3.4 m

w_b - Wheel base = 6.2 m

w - Maximum width = 2.58 m

l - Overall length = 11.85 m

m – Gross vehicle mass= 16200 Kg

The vertical reaction of each frontal wheels can be calculated as:

$$F_F = \frac{1}{2} mg \times \frac{a_2}{w_b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.1)$$

$$= \frac{1}{2} \times 16200\ kg \times 9.81 \frac{m}{s^2} \times \frac{2.5\ m}{6.2\ m}$$

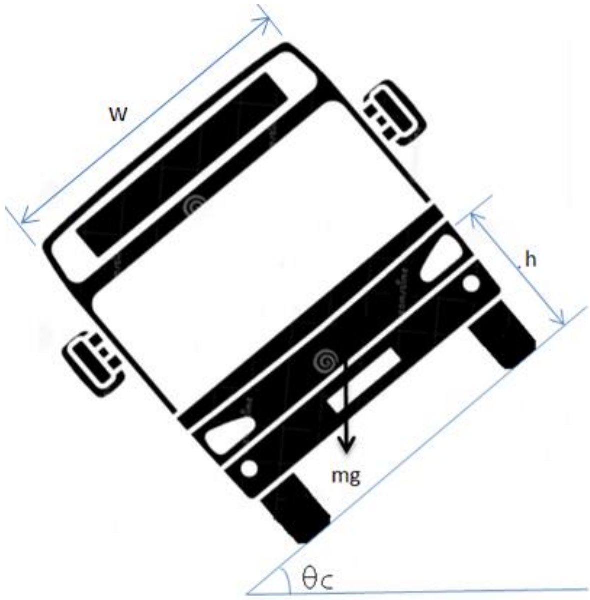
$$= 32040.7\ N$$

The vertical reaction of each rear wheels can be calculated as:

$$F_F = \frac{1}{2} mg \times \frac{a_1}{w_b} \quad \text{(4.2)}$$

$$= \frac{1}{2} \times 16200\ kg \times 9.81 \frac{m}{s^2} \times \frac{3.7\ m}{6.2\ m}$$

= 47420.3 N



where

θ_C - Critical angle = 40^0

w - Width of the bus = 2.58 m

h - Height from the ground

m - Mass of the bus = 16200 Kg

g - Acceleration due to gravity = 9.81 $\frac{m}{s^2}$

$$\theta_C = tan^{-1}\left(\frac{w/_2}{h}\right) \quad \text{(4.3)}$$

$$\tan \theta_C = \frac{w/_2}{h}$$

$$h = \frac{w/_2}{\tan \theta_C}$$

$$= \frac{2.58\ m/_2}{tan\ 40^0}$$

= 1.54 m

3.5.1 Bus dynamics

Static Axle Load Distribution

The value of static axle load distribution changes with the loading of the vehicle so laden and unladen figures are often different. So, the value of static axel load distribution for gross vehicle weight is:

$$\Psi = \frac{m_R}{m} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.4)$$

Where: Ψ – static axel load distribution

m_R – Static rear load (Kg)

$m_R = \frac{2F_R}{g} = \frac{2\times 47420.3\ N}{9.81\ \frac{m}{s^2}}$ = 9667.75 Kg

m – Total vehicle mass (Kg)

$$\Psi = \frac{9667.75\ Kg}{16200\ Kg} = 0.6$$

Relative center of gravity height

$$X = \frac{h}{w_b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.5)$$

Where: X - Relative center of gravity height

h – Vertical distance from CG to ground on the level (Kg)

w_b– Wheel base

$$X = \frac{1.54\ m}{6.2\ m} = 0.25$$

Dynamic axel load

The front axle load cannot be greater than the total vehicle mass. The rear axle load is the difference between the vehicle mass and the front axle load and cannot be negative.

m_{Dy}= ((1−Ψ) + (X × a) × m) …...……………………..……..…………(4.6)

where: m_{Dy}– Dynamic axel load

Ψ – Static axel load distribution

X – Relative center of gravity height

a – Deceleration (g units)

m – Total vehicle mass (Kg)

m_{Dy} = ((1−0.6) + (0.25 × 1) × 16200 Kg)

= 10530 Kg

Braking force

The total braking force required can simply be calculated using Newton's Second Law.

F_B = mag ………..…...……………………………………………………(4.7)

where: F_B – Braking force

m – Total vehicle mass

a – Deceleration (g units)

g – Acceleration due to gravity

F_B = 16200 Kg ×1×9.81 $\frac{m}{s^2}$

= 158922 N

Wheel lock

The braking force can only be generated if the wheel does not lock because the friction of a sliding wheel is much lower than a rotating one. The maximum braking force possible on any particular axle before wheel lock is given by:

$F_A = m_{Dy} \times g \times \mu_f$ ……….................…………………………….…..…………(4.8)

where: F_A – wheel lock

m_{Dy}– Dynamic axel load

g – Acceleration due to gravity

μ_f – Coefficient of friction between road and tyre

For this parameter the study considers two cases:

Case 1: for normal tyre and dry road condition the value of the coefficient of friction between road and tyre (μ_f= 0.7)

$F_A = 10530\ Kg \times 9.81\ \frac{m}{s^2} \times 0.7$

= 72309.5 N

Case 2: For normal tyre and wet road condition the value of the coefficient of friction between road and tyre (μ_f= 0.4)

$F_A = 10530\ Kg \times 9.81\ \frac{m}{s^2} \times 0.4$

= 41319.7 N

Brake torque of each wheel

$T_w = \frac{F_{Bw} \times R}{r}$ ………...…………………………………………………..…………(4.9)

where: T_w – Brake torque

F_{Bw} – Braking force for the wheel

$F_{Bw} = \frac{F_B}{4} = \frac{158922 \text{ N}}{4}$ = 39730.5 N

R – Static laden radius of the wheel

r – Speed ratio between the wheel and the brake

$T_w = \frac{39730.5\ N\times 0.498\ m}{5.857}$

= 3378.14 Nm

Total break torque of the four wheels of the bus is equal to:

T = 4× T_w

= 4 × 3378.14 Nm

= 13512.6 Nm

Clamp load

The clamping load is assumed to act on all friction surfaces equally. Newton's Third Law state every force has an equal and opposite reaction and a reaction force from a sliding of s cam is the same as the expansion of braking shoes.

$C = \frac{T_w}{r_e \times \mu_f \times n}$ ……………………………………………………………………(4.10)

where: C – clamp load

T_w – Brake torque

μ_f – Coefficient of friction of lining material on disc material

r_e – Effective radius

r_e = 0.98 r_g(for radial tyre) = 0.98×0.532m = 0.52m

r_g – Unloaded geometric radius of tyre n – Number of friction faces

$$C = \frac{3378.14\ \text{Nm}}{0.52\ m \times 0.4 \times 2}$$

$$= 8120.53\ \text{N}$$

System pressure

Pressure is a function of the required clamp load and the piston area. So,

$$P = \frac{C}{A} \qquad \text{……………………………………………………………………(4.11)}$$

Where: P – system pressure

C – Clamp load

A – Total piston area

$$A = \frac{\pi D^2}{4} = \frac{\pi \times (0.05\ m)^2}{4} = 1.9635 \times 10^{-3}\ m^2$$

$$P = \frac{8120.53\ \text{N}}{1.9635 \times 10^{-3}\ m^2}$$

$$= 4135752\ \text{Pa}$$

$$= (41.36 \approx 42)\ \text{bar}$$

Stopping distance

$$V_f = V_i + at \qquad \text{……………………………………………………………………(4.12)}$$

where: V_f – Final velocity

V_i – Initial velocity

a – Acceleration

t – Time

For stopping a vehicle the final velocity is zero and the addition sign is changed to subtraction

$$0 = V_i - at$$

$$t = \frac{V_i}{a} \qquad (4.13)$$

$$S = \frac{1}{2}\, V_i \times t \qquad (4.14)$$

Substituting (4.13) in (4.14) gives:

$$S = \frac{1}{2}\frac{{V_i}^2}{a}$$

$$= \frac{1}{2}\frac{(29.2\frac{m}{s})^2}{9.81\frac{m}{s^2}}$$

$$= 43.5 \text{ m}$$

For stopping distance the study considers two cases

- ✓ Case 1: For dry road condition the value of coefficient of friction between normal tyre and the road is 0.7. So the value of stopping distance from table above is:

  S = 62.1 m

- ✓ Case 2: For wet road condition the value of coefficient of friction between normal tyre and the road is 0.4. So the value of stopping distance from table above is:

  S = 108.6 m

Rate of change of Speed while braking for 1 g deceleration

$$v = \sqrt{{V_i}^2 - 2as} \qquad (4.15)$$

where: v – Speed of the vehicle

V_i – Initial velocity

S – Stopping distance

a – Declaration

$$0 = \sqrt{\left(29.2\ \frac{m}{s}\right)^2 - 2 \times 9.81\frac{m}{s^2} \times s}$$

$$S = \frac{\left(29.2\ \frac{m}{s}\right)^2}{2 \times 9.81\frac{m}{s^2}} = 43.5\ \text{m}$$

Rate of change of Speed while braking in normal tyre and dry road condition is 0.7 g deceleration

$$S = \frac{\left(29.2\ \frac{m}{s}\right)^2}{2 \times 0.7 \times 9.81\frac{m}{s^2}} = 62.1\ \text{m}$$

Rate of change of Speed while braking in normal tyre and dry road condition is 0.4 g deceleration

$$S = \frac{\left(29.2\ \frac{m}{s}\right)^2}{2 \times 0.4 \times 9.81\frac{m}{s^2}} = 108.6\ \text{m}$$

Stopping time

Stopping time for 1 g deceleration can be calculated as:

$$t = \frac{V_i}{a} \quad \text{……………………………………………………………………..(4.16)}$$

where: t – Stopping time

V_i – Initial velocity

a – Deceleration

$$t = \frac{29.2\ \frac{m}{s}}{9.81\ \frac{m}{s^2}} = (2.97 \approx 3\ \text{sec})$$

Braking distance for intelligent braking system can be calculated as:

$$S = \frac{(v_i)^2}{2g \times a_{av}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4.17)$$

where: S – Braking distance

v_i – Initial velocity

a_{av} – Average acceleration for the hole speed (g – units)

$a_{av} = \frac{v}{v/_{a} + 0.4\ g}$ where: v – test speed ($\frac{m}{s}$)

a – deceleration (g – units)

$$= \frac{29.2\frac{m}{s}}{29.2\frac{m}{s}/_{1} + 0.4 \times 9.81\frac{m}{s^2}}$$

= 0.88

g – Acceleration due to gravity

$$S = \frac{(29.2\frac{m}{s})^2}{2 \times 9.81\frac{m}{s^2} \times 0.88} = 49.4 \text{ m}$$

Stopping distance using intelligent braking system decreases the braking distance by increasing braking efficiency.

Kinetic energy

$$KE = \frac{1}{2}\,mv^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4.18)$$

where: KE – Kinetic energy

m – Total mass of vehicle

v – Test speed ($\frac{m}{s}$)

$$KE = \frac{1}{2} \times 16200\ kg \times (29.2\ \frac{m}{s})^2$$

= 6906384 J

The code on Arduino software is written using the following block diagram.

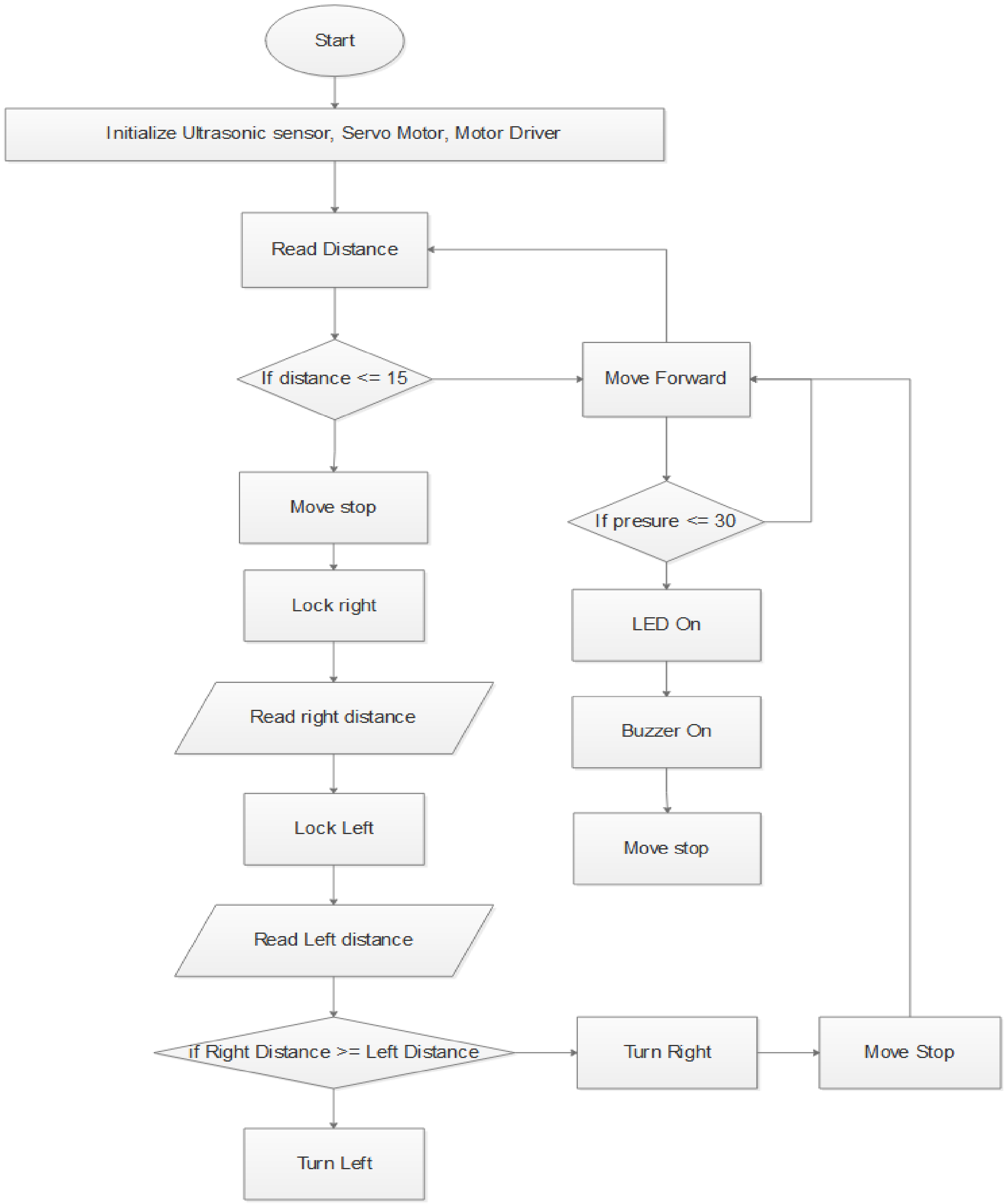


Figure 3. 15: Block diageram for simulation

CHAPTER FOUR

4. RESUT AND DISCUSSION

The analytical calculation result has shown that the proposed intelligent braking system provides a reduction of stopping distance at a maximum speed of the vehicle to 49.4 m in 3.42 sec as shown in Table 4.1.

Table 4. 1: Result summery

Determined quantities	Obtained outcomes
Braking force	158922 N
Braking torque	13512.6 Nm
System pressure	42 bar
Stoping time	3.42 s
Stoping distance	49.4 m
Kinetic energy	680638 J

4.1 Comparison with stopping distance

If the vehicle speed increases the existing brake system stopping distance is rapidly increase compared to the new one but the new brake system stopping distance is slowly increases compared to the existing ones. And the vehicle speed is decreased the existing brake system stopping distance is slowly decreases compared to the existing one but the new brake system stopping distance is rapid decreases compared to the existing one as shown in Table 4.2 and Figure 4.1.

Table 4. 2: Stopping distance comparison between existing and new braking systems

No	Vehicle speed (Km/h)	Stopping distance(m)	
		Existing braking system	New braking system
1	10	0.56	0.45
2	20	2.25	1.79
3	30	5.05	4.02
4	40	8.99	7.15
5	50	14.04	11.17
6	60	20.23	16.09
7	70	27.52	21.89
8	80	35.95	28.6
9	90	45.51	36.2
10	100	57.42	47.7
11	105	62.1	49.4

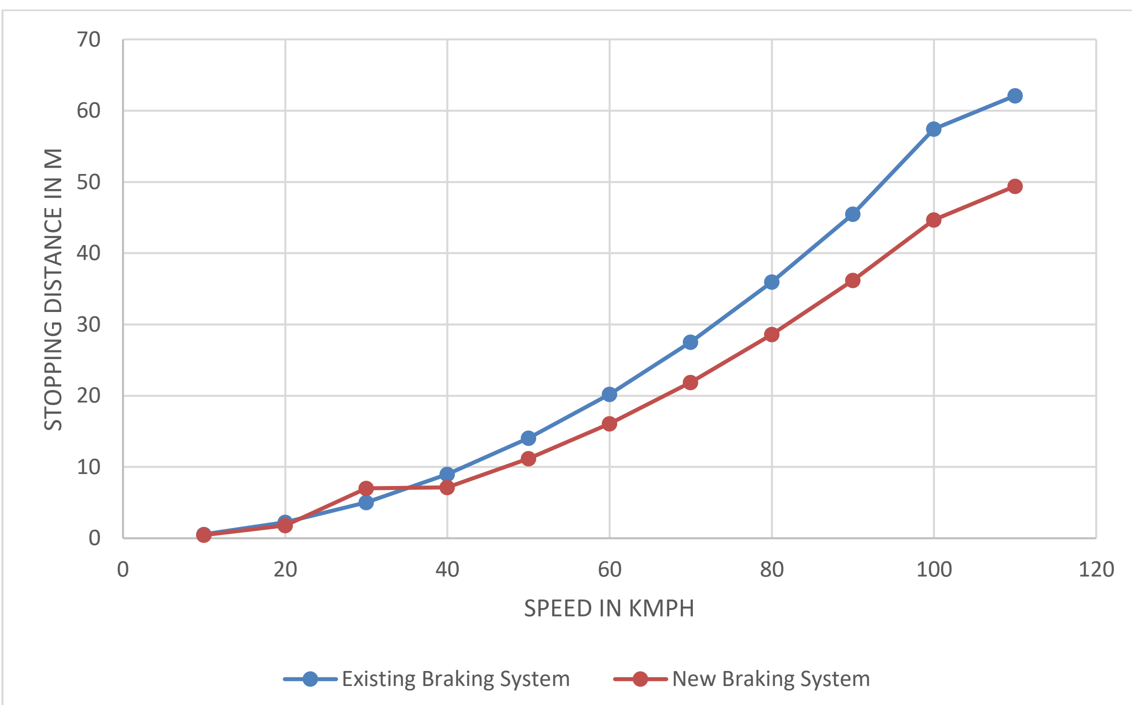


Figure 4. 1: Comparison of stopping distances

For 1g braking the vehicle can stop in 43.5 m. but it is impossible for applying to the ground.

Table 4. 3: Comparison of stoping distance and stoping time

S. No	Deceleration g units	Stopping distance (m)	Stoping time (sec)
1	0.1 g	434.5 m	29.8
2	0.2 g	217.5 m	14.9
3	0.3 g	144.9 m	9.92
4	0.4 g	108.6 m	7.44
5	0.5 g	86.9 m	5.95
6	0.6 g	72.4 m	4.96
7	0.7 g	62.1 m	4.22
8	0.8 g	54.3 m	3.72
9	0.9 g	48.3 m	3.33
10	1.0 g	43.5 m	2.97
11	1.1 g	39.5 m	2.71
12	1.2 g	36.2 m	2.48
13	1.3 g	33.4 m	2.29
14	1.4 g	31.0 m	2.13
15	1.5 g	29.0 m	1.98
16	1.6 g	27.2 m	1.86
17	1.7 g	25.6 m	1.75
17	1.8 g	24.1 m	1.65
19	1.9 g	22.9 m	1.57
20	2.0 g	21.7 m	1.49

For the normal driving condition, it is difficult to control the vehicle in 1g deceleration. Because there is a standard coefficient of friction for the vehicle's normal tire condition and the road condition. Here in this work, this study considers two road conditions i.e dry and wet road conditions. The results of these conditions from the table are

- ✓ For dry road and normal tyre condition the coefficent friction is μ_f= 0.7, the stopping distance is 62.1 m in 4.22 second
- ✓ For dry road and normal tyre condition the coefficent friction is μ_f= 0.4, the stopping distance is 108.6 m in 7.44 second

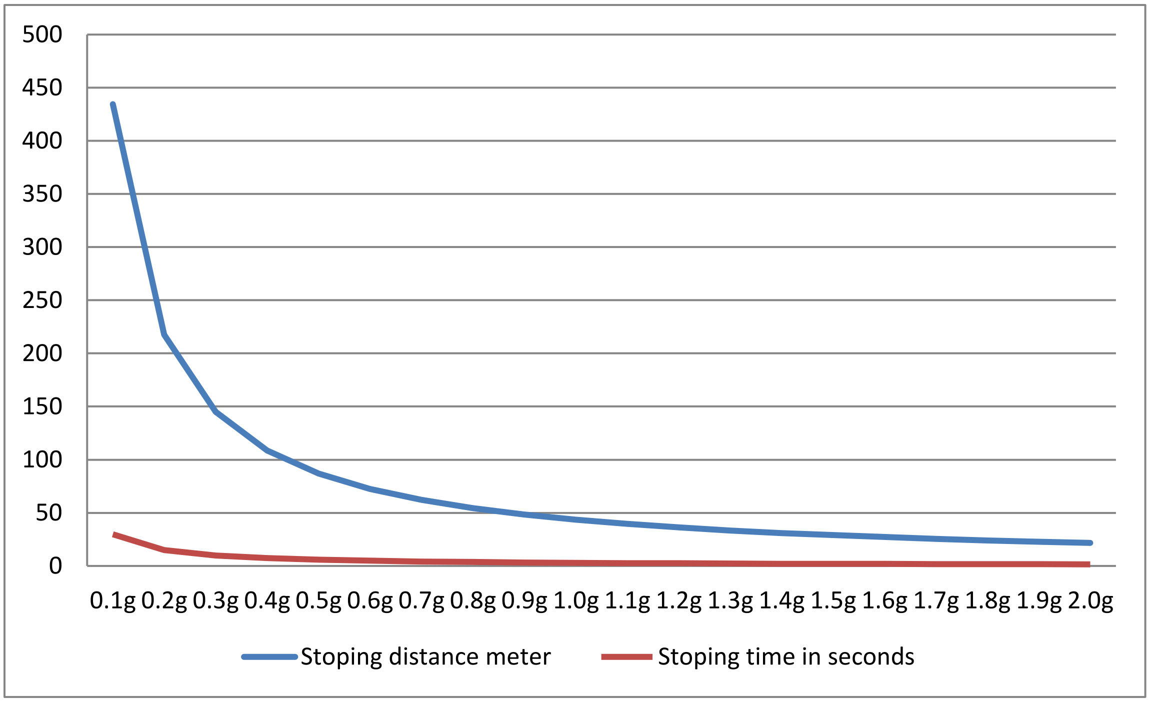


Figure 4. 2: Comparison of stoping time and stoping distance

The stopping distance of a bus can be determined according to different working conditions of frictional contact between the road and the tire condition. For wet road and normal tire condition the stoping takes the longest distance while the dry road and normal road condition take lower distance than wet road condition but this distance also too long.

The newly introduced intelligent braking system decreases the braking distance of the bus by 12.7 meters which are 20.45% of the existing stoping distance. Statistical Illustrations are presented in table and figure.

Table 4. 4: Summary of different deceleration for stoping distance

S. No	Distance in Meter	Speed of vehicle $(\frac{m}{s})$			
		Deceleration (1 g)	Deceleration (0.7 g)	Deceleration (0.4 g)	Intelligent Deceleration
1	0	29.2	29.2	29.2	29.2
2	10	25.6	26.7	27.8	26.28
3	20	21.5	24	26.4	22.75
4	30	16.2	21	24.8	18.58
5	40	8.2	18.6	23.2	13.18
6	43.5	0	15.9	22.6	10.09
7	49.4	-	13.13	21.56	0
7	50	-	12.9	21.4	-
8	60	-	5.34	19.5	-
9	62.1	-	0	19.1	-
10	70	-	-	17.4	-
11	80	-	-	15	-
12	90	-	-	12.1	-
13	100	-	-	8.2	-
14	108.6	-	-	0	-

In intelligent braking, it is difficult to use 1g deceleration, because of different features of the coefficient of frictions. The basic aim of this study is to optimize the stopping distance of the bus. So, different stopping distance conditions are clearly shown in the figure below.

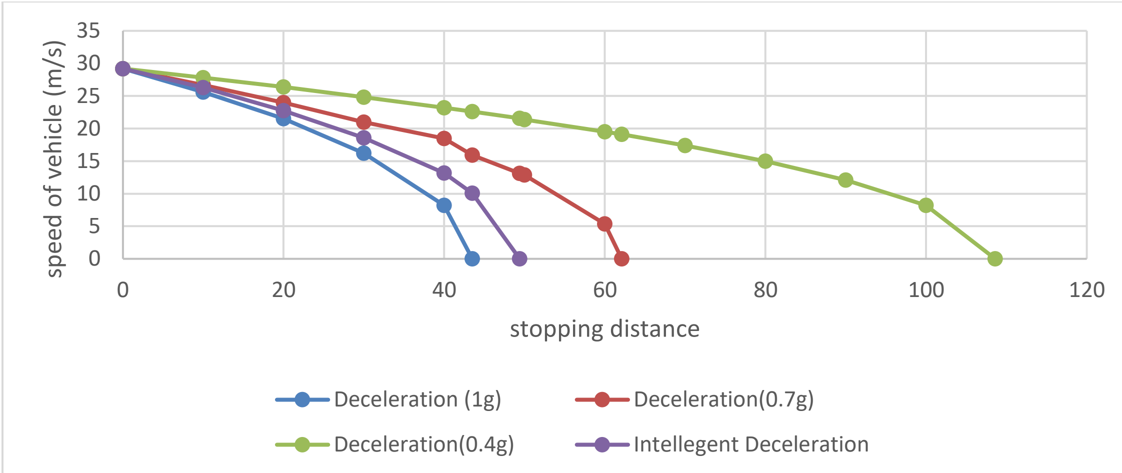


Figure 4. 3: Different stoping distance comparisons

Schematic Circuit Diagram of the Electronic System

The prototype of the intelligent braking control system circuit diagram shown in Figure 4.4 works as the code written in Appendix E. And the result of stopping distance is safe as tested on the proteus software also, the vehicle prototype is working using the programming code written in Appendix E.

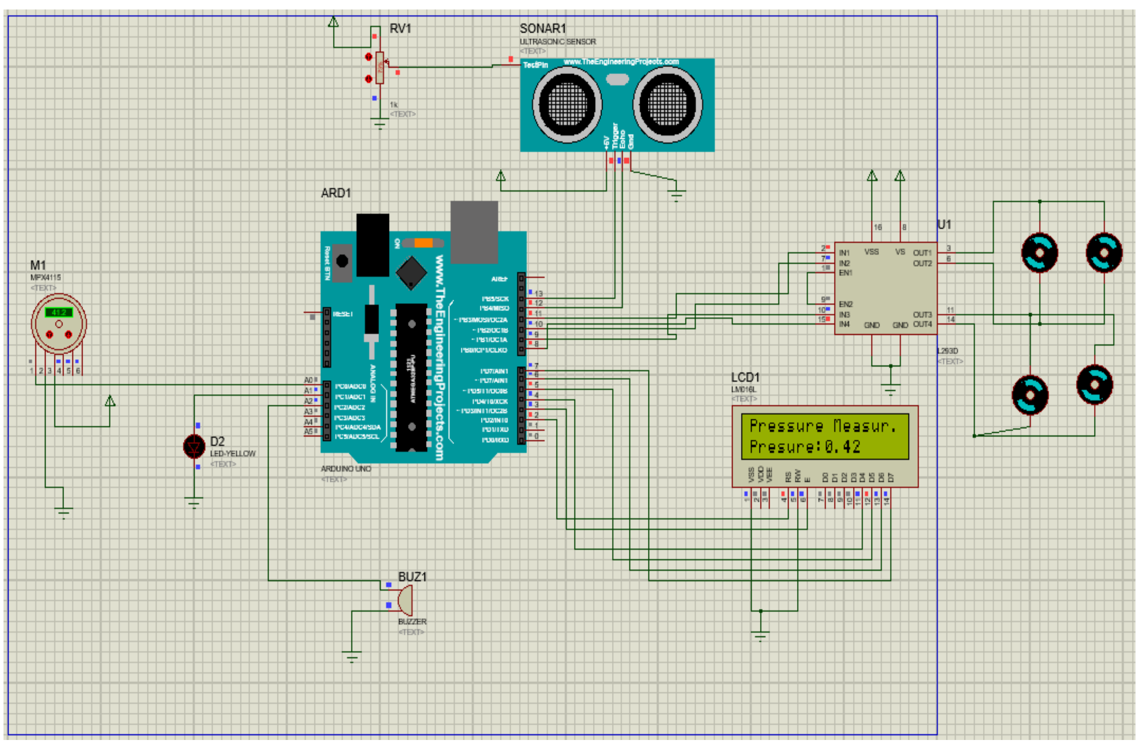


Figure 4. 4:Protus software schematic view of the thesis

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Summary

To accomplish the system all data are collected from the Ethiopian federal police commission, ministry of transportation, and Ethiopian road authority. The collected data are organized and detailed analysis the system is programmed using Arduino software and schematic circuit diagram is made with Proteus software.

The intelligent braking system of bus work using different sensor and electrical component. Ultrasonic sensors work on the principle of reflected sound waves and are used to measure distance. One sensor can detect others operating nearby as well as nearby obstacles. Sound waves are emitted by the ultrasonic sensor and they are reflected back if there is an object in front of it. The sensor detects these waves and measures the time it takes between transmitting and receiving those sound waves.

Also, the pressure sensor sends an input signal to if there is no air pressure loss in a brake system, the receiver circuit will not receive any signal and the relay valve remains closed. But if there is any pressure loss in a brake system the microcontroller will receive an input signal from the pressure sensor and sends an output signal to the LED for less harm full lose, LED and buzzer module for serious lose for warning the driver and finally sends an output signal to the relay module to open supply valve for compressed air to actuate the push road.

Distance is then estimated by the time interval between sensor and object. Then the programmed data in Arduino Uno microcontroller transfer data to yellow Led will on to show the warning distance then the buzzer will make a sound to the driver and on a red led then the relay will on to actuate the solenoid plunger. When the plunger actuates the foot valve will be pressed and the braking system will work.

5.2 Conclusion

Based on the design analysis the result of the following conclusion is drawn.

- ✓ The new brake system is better than that of the existing brake system; the stopping the distance at maximum speed and maximum load is 49.4 m which is reduced by 12.7 m from the existing brake system.
- ✓ It was observed that the intelligent braking system is better than the manual braking system by reducing collision. so that using an intelligent braking system is better than the existing bus brake system.
- ✓ An automatic brake failure indicator system also shows the brake failure of the bus by sensing the pressure loss in the brake system and helps the driver to know about the brake failure before applying the brake.
- ✓ All components of the intelligent braking and brake failure indicator system such as; Arduino Uno, ultrasonic sensor, led, buzzer, relay, etc. can be easily replaced.
- ✓ The system is feasible and less expensive and it can be implemented simply by modifying foot valve components of the conventional air brake and also, the driver does not require to have an additional skill of driving.

5.3 Recommendation

5.3.1 Recommendation to the study

- ✓ It is recommended that it is better if the system is implemented for other vehicle types like automobiles, trucks, etc other than buses.
- ✓ The system is programmed by relating the obstacle sensing distance with a range of a vehicle moving speed, but it is recommended that the speed of the vehicle and obstacle sensing distance can be related linearly.
- ✓ Immediate response for a warning light and buzzer by the drivers as that of manual brake systems operation is recommended while braking automatically.
- ✓ A model is a good demonstration tool for anyone who wants to research an automatic braking control system.

5.3.2 Recommendation to the school

- ✓ During data collection time I visit about three governmental offices to collect necessary data. But all of these offices kept a few year's data of traffic accidents manually. So I recommended that it is better to give one copy of the studies of such areas to the federal traffic police commission to decreases the gap of source need.
- ✓ There are several studies conducted on traffic accidents in our country Ethiopia. But almost all of the studies are used for academic use only and after graduation these studies are belonging to those scholars. This makes the new researchers struggle to find what is done before. So, I strongly recommend the school to introduce a new online library to easily adders the studies.

5.4 Future work

In this study, it is recommended to further studies of different scenarios related to a traffic accident. So, the following features are better to add for the future:

- ✓ As we know because of lack of transportation accesses and violations of rules most buses allow passengers over their capacity. This condition forces the passengers to stand or to sit on extra movable sites. So, in this condition, if the accidents happen, most of the extra passengers are the primary victims of the accident than the other passengers. For resolving this problem using camera detection should take into consideration for braking.
- ✓ Since we are designing an intelligent braking system, design ECU (electronic control unit) for interpreting sensors sensor information to take any action for controlling the vehicle is mandatory for real vehicle application.

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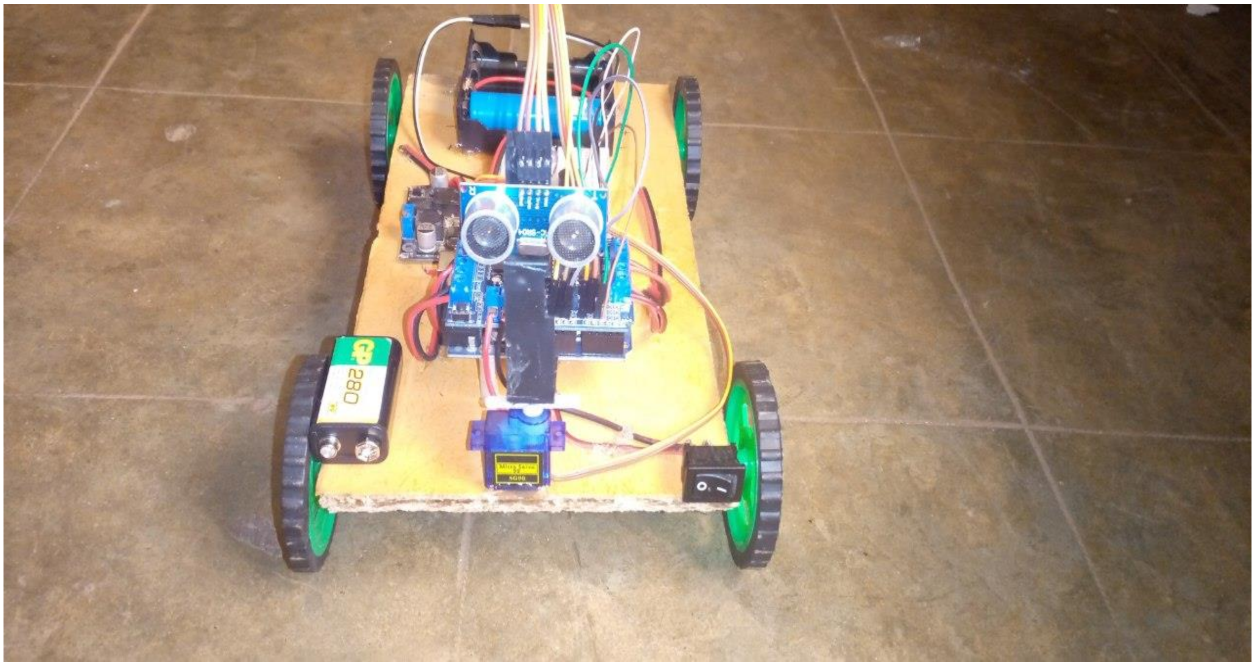
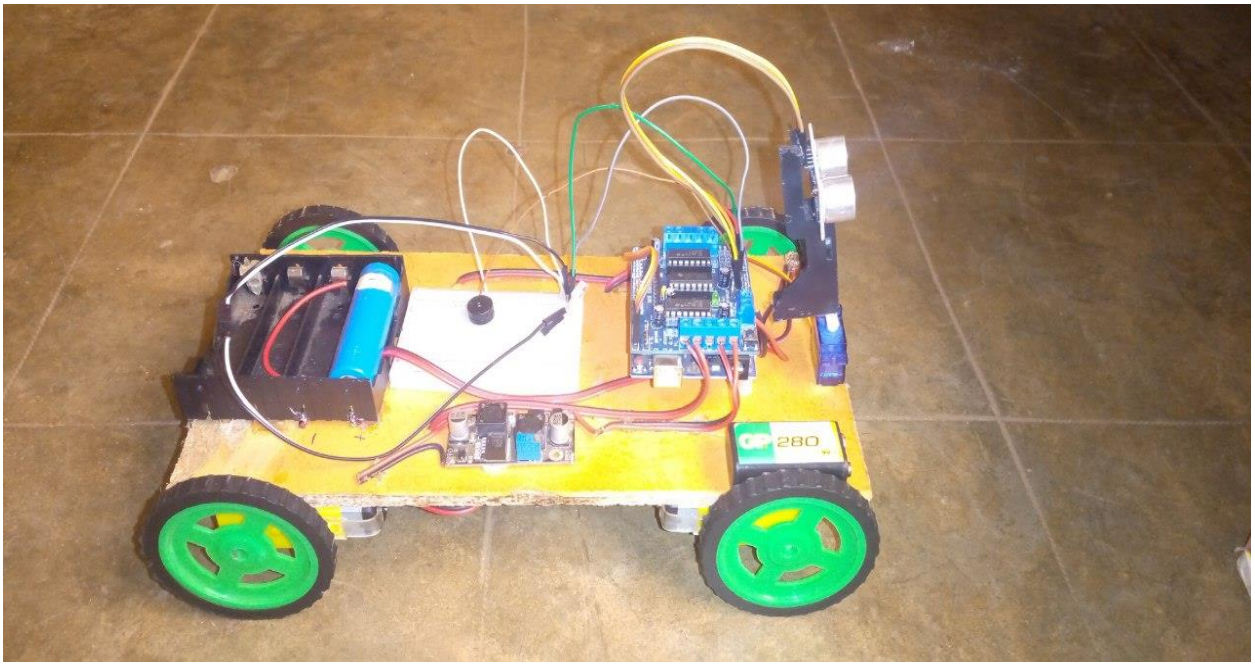
APPINDIEX

Appindex A: Assembled view of prototype



Front view of the prototype



Side view of the prototype

Appendix B: Ten years traffic report by vehicle type

<u>የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን</u>

<u>የ2002 አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ</u>

<u>የሚሸፍነው ጊዜ ከሐምሌ 1/2001 እስከ ሰኔ 30/2002 ዓ/ም</u>

አደጋ የፈፀሙ ተሽከርካሪዎች ዓይነት

ተራ ቁጥር	አደጋው ያስከተለው ጉዳት	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	ድምር
		ተራ ብስክሌት	ሞተር ብስክሌት	አውቶሞቢል	ለትሽን ቀገን	ፒክአፕ እስከ 10 ኩንታል	የጭነት ከ11 - 40 ኩንታል	የጭነት ከ41 -100 ኩንታል	የጭነት ከነተሳቢ	ቦቴ	ታክሲ	የሕዝብ እስከ 1200 መቀመጫ	የሕዝብ ከ13-45 መቀመጫ	የሕዝብ ከ46መ.በላይ	ልዩ ተንቀሳቃሽ መሳሪያ	ልዩ ተንቀሳቃሽ ከነተሳቢ	ጋሪ	ባቡር	ሌላ	ያልታወቀ	
1.	**ሞት**	33	51	66	78	159	417	202	95	43	234	171	157	81	9	2	4	-	11	34	1,852
2.	**ከባድ የአካል ጉዳት**	56	72	2173	146	200	292	310	21	8	445	130	148	31	14	4		-	14	43	2,107
3.	**ቀላል የአካል ጉዳት**	45	88	243	154	215	262	274	49	30	745	282	134	34	7	4	2	-	13	39	2,620
4.	**የንብረት ጉዳት**	27	122	1437	847	781	703	787	204	46	1,114	484	149	200	27	54	24	-	13	79	7,098
	ድምር	161	333	1,919	1,225	1,355	1,674	1,578	369	127	2,538	1,067	588	346	57	64	30	-	51	195	13,677

የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን

የ2003 አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ

የሚሸፍነው ጊዜ ከሐምሌ 1/2002 እስከ ሰኔ 30/2003 ዓ/ም

ተራ ቁጥር	አደጋውያስከተለው ጉዳት	1 ተራ ብስክሌት	2 ሞተር ብስክሊት	3 አውቶሞቢል	4 ስቴሽን ዋገን	5 ፒክአፕ እስከ 10 ኩንታል	6 የጭነት ከ11 - 40 ኩንታል	7 የጭነት ከ41 -100 ኩንታል	8 የጭነት ከነተሳቢ	9 ቦቴ	10 ታክሲ	11 የሕዝብ እስከ 1200 መቀመጫ	12 የሕዝብ ከ13-45 መቀመጫ	13 የሕዝብ ከ46መ.በላይ	14 ልዩ ተንቀሳቃሽ መሳሪያ	15 ልዩ ተንቀሳቃሽ ከነተሳቢ	16 ጋሪ	17 ባቡር	18 ሌላ	19 ያልታወቀ	ድምር
1.	**ሞት**	45	54	80	53	133	233	287	114	79	417	226	336	102	11	7	4	-	12	57	2,250
2.	**ከባድ የአካል ጉዳት**	44	79	237	145	261	167	237	52	26	742	206	138	38	6	3	11	-	7	74	2,473
3.	**ቀላል የአካል ጉዳት**	48	187	321	165	201	151	401	50	33	723	356	109	57	18	5	15	-	4	58	2,902
4.	**የንብረት ጉዳት**	25	59	2590	935	832	675	954	433	125	1694	853	631	291	42	10	330	-	15	350	10,844
	ድ ም ር	162	379	3,228	1,298	1,427	1,226	1,879	649	263	3,576	1,641	1,214	488	77	25	360	-	38	539	18.469

የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን

የ2004 አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ

የሚሸፍነው ጊዜ ከሐምሌ 1/2003 እስከ ሴኔ 30/2004 ዓ/ም

		አደጋ የፈፀሙ ተሽከርካሪዎች ዓይነት																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
ተራ ቁጥር	አደጋው ያስከተለው ጉዳት	ተራ ብስክሌት	ሞተር ብስክሊት	አውቶሞቢል	ለትሸን ቀገን	ፒክአፕ እስከ 10 ኩንታል	የጭነት ከ11 - 40 ኩንታል	የጭነት ከ41 -100 ኩንታል	የጭነት ከኑተሳቢ	ቦቴ	ታክሲ	የሕዝብ እስከ 1200 መቀመጫ	የሕዝብ ከ13-45 መቀመጫ	የሕዝብ ከ46መ.በላይ	ልዩ ተንቀሳቃሽ መሳሪያ	ልዩ ተንቀሳቃሽ ከኑተሳቢ	ጋሪ	ባቡር	ሌላ	ያልታወቀ	ድምር
1.	ሞት	38	85	191	87	225	218	295	107	102	511	260	184	82	12	24	37	-	24	39	2,521
2.	ከባድ የአካል ጉዳት	45	131	345	222	258	231	180	75	35	806	292	160	66	25	4	8	-	28	70	2,981
3.	ቀላል የአካል ጉዳት	42	134	297	164	301	210	171	44	44	968	310	138	33	9	1	12	-	32	77	2,987
4.	የንብረት ጉዳት	43	95	2,544	1,271	1,334	801	1,011	365	318	2649	1,109	629	384	104	12	16	-	277	217	13,179
ድ ም ር		168	445	3,377	1,744	2,118	1,460	1,657	591	499	4,934	1,971	1,111	565	150	41	73	-	361	403	21,668

የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን

የ2005 አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ

የሚሸፍነው ጊዜ ከሐምሌ 1/2004 እስከ ሰኔ 30/2005 ዓ/ም

ተራ ቁጥር	አደጋ የፈፀሙ ተሽከርካሪዎች ዓይነት																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
	አደጋው ያስከተለው ጉዳት	ተራ ብስክሌት	ሞተር ብስክሌት	አውቶሞቢል	ለትሽን ቀገን	ፒክአፕ እስከ 10 ኩንታል	የጭነት ከ11 - 40 ኩንታል	የጭነት ከ41 -100 ኩንታል	የጭነት ከነተሳቢ	ቦቴ	ታክሲ	የሕዝብ እስከ 1200 መቀመጫ	የሕዝብ ከ13-45 መቀመጫ	የሕዝብ ከ46መ.በላይ	ልዩ ተንቀሳቃሽ መሳሪያ	ልዩ ተንቀሳቃሽ	ጋሪ	ባቡር	ሌላ	ያልታወቀ	ድምር
1	ሞት	46	47	82	76	287	197	201	95	47	496	233	162	82	38	37	66	-	62	79	2,333
2	ከባድ የአካል ጉዳት	31	91	420	197	269	194	154	44	42	800	330	128	39	6	8	12	-	35	95	2,895
3	ቀላል የአካል ጉዳት	30	98	421	197	273	171	130	31	8	866	359	144	45	16	3	204	-	55	86	3,137
4	የንብረት ጉዳት	12	123	4,172	1,516	1,659	1,071	1,134	466	163	3,077	1,454	701	473	42	19	38	-	62	440	16,622
ድ ም ር		119	359	5,095	1,986	2,488	1,633	1,619	636	260	5,239	2,376	1,135	639	102	67	320	0	214	700	24,987

የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን

የ2006 አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ

የሚሸፍነው ጊዜ ከሐምሌ 1/2005 እስከ ሰኔ 30/2006 ዓ/ም

አደጋ የፈፀሙ ተሽከርካሪዎች ዓይነት

ተራ ቁጥር	አደጋው ያስከተለው ጉዳት	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	ድምር
		ተራ ብስክሌት	ሞተር ብስክሌት	አውቶሞቢል	ስቴሽን ዋገን	ፒክአፕ እስከ 10 ኩንታል	የጭነት ከ11 - 40 ኩንታል	የጭነት ከ41 -100 ኩንታል	የጭነት ከነተሳቢ	ቦቴ	ታክሲ	የሕዝብ እስከ 1200 መቀመጫ	የሕዝብ ከ13-45 መቀመጫ	የሕዝብ ከ46መ.በላይ	ልዩ ተንቀሳቃሽ መሳሪያ	ልዩ ተንቀሳቃሽ ከነተሳቢ	ጋሪ	ባቡር	ሌላ	ያልታወቀ	
1	ሞት	42	149	172	108	215	213	262	71	64	540	314	187	71	31	37	44	0	57	54	2,631
2	ከባድ የአካል ጉዳት	38	149	490	180	487	214	194	77	45	682	467	183	55	61	27	18	0	73	59	3,499
3	ቀላል የአካል ጉዳት	39	157	424	158	403	204	181	108	24	691	442	143	68	37	34	87	0	54	84	3,338
4	የንብረት ጉዳት	31	107	4,566	1,636	1,995	1,221	1,226	648	195	2,951	1,919	756	610	143	153	139	0	121	261	18,678
ድ ም ር		150	562	5652	2082	3,100	1,852	1,863	904	328	4,864	3,142	1,269	804	272	251	288	0	305	458	28,146

<u>የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን</u>

<u>የ2007 አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ</u>

<u>የሚሸፍነው ጊዜ ከሐምሌ 1/2006 እስከ ሰኔ 30/2007 ዓ/ም</u>

ተራ ቁጥር	አደጋው ያስከተለው ጉዳት	አደጋ የፈፀሙ ተሽከርካሪዎች ዓይነት																			ድምር
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
		ተራ ብስክሌት	ሞተር ብስክሊት	አውቶሞቢል	ለትሸን ቀ ገን	ፒክአፕ እ ስከ 10 ኩንታል	የጭነት ከ11 - 40 ኩንታል	የጭነት ከ41 -100 ኩንታል	የጭነት ከነተሳቢ	ቦቴ	ታክሲ	የሕዝብ እ ስከ 1200 መቀመጫ	የሕዝብ ከ13-45 መቀመጫ	የሕዝብ ከ46መ.በላይ	ልዩ ተንቀሳቃሽ መሳሪያ	ልዩ ተንቀሳቃሽ ከነተሳቢ	ጋሪ	ባቡር	ሌላ	ያልታወቀ	
1	ሞት	132	153	153	115	179	229	234	163	29	777	279	197	92	31	37	157	-	60	130	3,147
2	ከባድ የአካል ጉዳት	40	226	407	207	395	276	146	82	20	1,095	495	178	60	28	38	118	-	83	113	4,007
3	ቀላል የአካል ጉዳት	49	153	335	184	220	152	173	80	38	1,173	357	144	84	16	9	167	-	111	45	3,490
4	የንብረት ጉዳት	63	215	4,341	1,981	2,426	1,398	1,306	624	112	4,543	2,377	766	463	70	67	26	-	94	345	21,217
ድ ም ር		284	747	5,236	2,487	3,220	2,055	1,859	949	199	7,588	3,508	1,285	699	145	151	468	-	348	633	31,861

የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን

የ2008 አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ

የሚሸፍነው ጊዜ ከሐምሌ 1/2007 እስከ ሰኔ 30/2008 ዓ/ም

ተራ ቁጥር	አደጋው ያስከተለው ጉዳት	አደጋ የፈፀሙ ተሽከርካሪዎች ዓይነት																			ድምር
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
		ተራ ብስክሌት	ሞተር ብስክሊት	አውቶሞቢል	ለትሽን ቀ ገን	ፒክአፕ እ ስከ 10 ኩንታል	የጭነት ከ11 - 40 ኩንታል	የጭነት ከ41 -100 ኩንታል	የጭነት ከኑተሳቢ	ቦቴ	ታክሲ	የሕዝብ እ ስከ 1200 መቀመጫ	የሕዝብ ከ13-45 መቀመጫ	የሕዝብ ከ46መ.በላይ	ልዩ ተንቀሳቃሽ መሳሪያ	ልዩ ተንቀሳቃሽ ከኑተሳቢ	ጋሪ	ባቡር	ሌላ	ያልታወቀ	
1.	ሞት	40	140	62	84	317	302	399	190	91	874	311	309	77	51	29	109	-	44	26	3,455
2.	ከባድ የአካል ጉዳት	30	155	43	85	193	145	515	75	20	2,098	252	142	42	25	45	88	-	62	7	4,022
3.	ቀላል የአካል ጉዳት	17	101	34	58	108	99	207	47	9	1,524	177	84	34	24	25	90	-	93	6	2,737
4.	የንብረት ጉዳት	41	953	4,100	2,082	3,096	970	1,277	400	205	4,947	2,701	1,205	764	63	63	92	-	120	36	23,115
ድ ም ር		128	1,349	4,239	2,309	3,714	1,516	2,398	712	325	9,443	3,441	1,740	917	163	162	379	-	319	75	33,329

የ2008 ዓመታዊ የትራፊክ አደጋ ዳታ የቡንሽንጉል ጉሙዝ ክልል መስተዳድር የሚያካትት አይደለም፡፡

የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን

የ2009 አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ

የሚሸፍነው ጊዜ ከሐምሌ 1/2008 እስከ ሴኔ 30/2009 ዓ/ም

ተራ ቁጥር	አደጋውዓ ያስከተልው ጉዳት	አደጋ የፈፀሙ ተሽከርካሪዎች ዓይነት																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
		ተራ ብስክሌት	ሞተር ብስክሊት	አውቶሞቢል	ለትሽን ቀገን	ፒክአፕ እ ስከ 10 ኩንታል	የጭነት ከ11 - 40 ኩንታል	የጭነት ከ41 -100 ኩንታል	የጭነት ከነተባቢ	ቦቴ	ታክሲ	የሕዝብ እ ስከ 1200 መቀመጫ	የሕዝብ ከ13-45 መቀመጫ	የሕዝብ ከ46መ.በላይ	ልዩ ተንቀሳቃሽ መሳሪያ	ልዩ ተንቀሳቃሽ ከነተባቢ	ጋሪ	ባቡር	ሌላ	ያልታወቀ	ድምር
1	ሞት	34	156	214	131	195	397	486	213	125	462	410	415	110	22	21	36		54	94	3,575
2	ከባድ የአካል ጉዳት	19	291	301	274	554	324	297	103	24	859	636	274	118	20	15	18		79	145	4,351
3	ቀላል የአካል ጉዳት	17	193	184	91	260	194	184	69	41	540	410	109	169	24	22	24		99	59	2,.689
4	የንብረት ጉዳት	57	241	4,264	1,873	3,941	2,300	1,792	829	114	6,066	3,374	1434	651	58	34	97		474	236	27,835
ድ ም ር		127	881	4,963	2,369	4,950	3,215	2,759	1,214	304	7,927	4,830	2,232	1,048	124	92	175	0	706	534	38,450

የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን

የ2010 አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ

የሚሸፍነው ጊዜ ከሐምሌ 1/2009 እስከ ሰኔ 30/2010 ዓ/ም

አደጋ የፈፀሙ ተሽከርካሪዎች ዓይነት																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
ተራ ቁጥር	አደጋው ያስከተልውጉዳት	ተራ ብስክሌት	ሞተር ብስክሌት	አውቶሞቢል	ለትሽን ዋገን	ፒክአፕ እ ስከ 10 ኩንታል	የጭነት ከ11 - 40 ኩንታል	የጭነት ከ41 -100 ኩንታል	የጭነት ከነተሳቢ	ቦቴ	ታክሲ	የሕዝብ እ ስከ 1200 መቀመጫ	የሕዝብ ከ13-45 መቀመጫ	የሕዝብ ከ46መ.በላይ	ልዩ ተንቀሳቃሽ መሳሪያ	ልዩ ተንቀሳቃሽ ከነተሳቢ	ጋሪ	ባበ.ር	ሌላ	ያልታወቀ	ድምር
1	ሞት	19	201	182	129	269	370	434	195	123	266	536	625	103	24	19	35	0	148	142	3,820
2	ከባድ የአካል ጉዳት	25	482	501	251	478	376	253	90	30	868	573	433	48	25	18	11	1	149	128	4,740
3	ቀላል የአካል ጉዳት	26	215	220	156	282	227	157	63	45	663	357	176	80	17	16	22	0	254	97	3,073
4	የንብረት ጉዳት	43	773	5798	1839	4756	2314	1646	825	54	4679	3236	2015	436	105	38	103	1	411	293	29,365
ድ ም ር		113	1,671	6,701	2,375	5,785	3,287	2,490	1,173	252	6,476	4,702	3,249	667	171	91	171	2	962	660	40,998

የ ፌ ዴ ራ ል ፖ ሊ ስ ኮ ሚ ሽ ን

የ2011አገር አቀፍ የትራፊክ አደጋ ስታትስቲክስ ሠንጠረዥ

የሚሸፍነው ጊዜ ከሐምሌ 1/2010 እስከ ሰኔ 30/2011ዓ/ም

ተራ ቁጥር	አደጋው ያስከተለው ጉዳት	አደጋ የፈፀሙ ተሽከርካሪዎች ዓይነት																				ድምር
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
		ተራ ብስክሌት	ሞተር ብስክሌት	አውቶሞቢል	ስቴሽን ዋገን	ፒክአፕ እስከ 10 ኩንታል	የጭነት ከ11 - 40 ኩንታል	የጭነት ከ41 -100 ኩንታል	የጭነት ከነተሳቢ	ሐቴ	ታክሲ	የሕዝብ እስከ 1200 መቀመጫ	የሕዝብ ከ13-45 መቀመጫ	የሕዝብ ከ46መ.በላይ	ልዩ ተንቀሳቃሽ መሳሪያ	ልዩ ተንቀሳቃሽ ከነተሳቢ	ጋሪ	ባቡር	ባጃጅ	ሌላ	ያልታወቀ	
1	ሞት	28	238	136	104	256	348	402	161	121	358	599	532	193	22	14	32	1	-	81	112	3,738
2	ከባድ የአካል ጉዳት	34	378	500	240	468	320	238	112	25	768	646	246	64	17	10	15	-	-	105	138	4,324
3	ቀላል የአካል ጉዳት	12	143	375	202	220	158	140	40	23	517	305	129	62	16	13	17	-	-	155	60	2,587
4	የንብረት ጉዳት	48	552	6,288	2,055	3,984	1,919	1,727	599	134	6,641	3,532	1,360	647	74	48	68	-	-	192	354	30,222
ድ ም ር		122	1,311	7,299	2,601	4,928	2,745	2,507	912	303	8,284	5,082	2,267	966	129	85	132	1	-	533	664	40,871

Appendix C: Six years' total traffic accident report

ከሐምሌ 1 ቀን 2005 እስከ ሰኔ 30 ቀን 2006 ዓ/ም ድረስ ባለው የአንድ ዓመት ጊዜ

በአገር አቀፍ ደረጃ የደረሰ የትራፊክ አደጋና በትራፊክ አደጋ ተጎጅ የሆኑ ሰዎች ብዛት በጉዳት ዓይነትና በጾታ

ክልል መስተዳድር	የደረሰው የትራፊክ አደጋ ብዛት					በትራፊክ አደጋ ተጎጂ የሆኑ ግለሰቦች ብዛት									በትራፊክ አደጋ በንብረት ላይ የደረሰ ጉዳት በገንዘብ ሲተመን	REGION
						ሞት		ከባድ የአካል ጉዳት		ቀላል የአካል ጉዳት		ድምር		ጠቅላላ ድምር		
	ሞት	ከባድ የአካል ጉዳት	ቀላል የአካል ጉዳት	የንብረት ጉዳት	ድምር	ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት			
ትግራይ	257	251	59	233	800	256	79	340	136	214	99	810	314	1,124	19,428,756.00	Tigray
አፋር	61	41	14	135	251	84	26	93	26	94	15	271	67	338	16,234,950.00	Afar
አማራ	551	434	758	1,327	3,070	548	243	748	418	1,255	524	2,551	1,185	3,736	292,897,737.65	Amhara
ኦሮሚያ	1,038	733	751	1,490	4,012	843	319	748	249	764	349	2,355	917	3,272	468,834,708.00	Oromia
ሶማሌ	69	72	8	18	167	73	19	121	25	100	18	294	62	356	11,323,000.00	Somalia
ቤን/ገሙዝ	20	37	90	20	167	19	11	90	27	157	54	266	92	358	10,848,400.00	Ben. Gumuz
ደቡብ	222	340	339	234	1,135	233	79	443	132	344	159	1,020	370	1,390	29,516,387.00	S N N P
ጋምቤላ	13	22	46	45	126	14	-	20	5	46	10	80	15	95	1,782,100.00	Gambella
ሐረሪ	21	58	106	110	295	17	8	39	28	57	49	113	85	198	4,999,300.00	Harari
አዲስ አበባ	391	1,484	1,128	14,901	17,904	345	88	1,677	545	1,013	354	3,035	987	4,022	138,956,894.30	Addis Ababa
ድሬዳዋ	21	86	175	230	512	19	8	81	48	136	77	236	133	369	6,782,579.00	Dire Dawa
ድምር	2,664	3,558	3,474	18,743	28,439	2,451	880	4,400	1,639	4,180	1,708	11,031	4,227	15,258	1,001,604,811.95	Total
						3,331		6,039		5,888		15,258				
	Death	Serious Injury	Slight Injury	Property Damage	General Total	Male	Female	Male	Female	Male	Female	Total Male Female		General Total	Total Property Damage Estimate In Birr	
						Death		Serious Injury		Slight Injury						
	NUMBER OF TRAFFIC ACCIDENTS					VICTMS OF MOTOR VEHICLE TRAFFIC ACCIDENTS						ALL CASES				

ከሐምሌ 1 ቀን 2006 እስከ ሰኔ 30 ቀን 2007 ዓ/ም ድረስ ባለው የ1 / አንድ / ዓመት ጊዜ በአገር አቀፍ ደረጃ የደረሰ የትራፊክ አደጋና

በትራፊክ አደጋ ተጎጅ የሆኑ ሰዎች ብዛት በጉዳት ዓይነትና በጾታ

ክልል መስተዳድር	የደረሰው የትራፊክ አደጋ ብዛት					በትራፊክ አደጋ ተጎጂ የሆኑ ግለሰቦች ብዛት								ጠቅላላ ድምር	በትራፊክ አደጋ በንብረት ላይ የደረሰ ጉዳት በገንዘብ ሲተመን	REGION
						ሞት		ከባድ የአካል ጉዳት		ቀላል የአካል ጉዳት		ድምር				
	ሞት	ከባድ አካል ጉዳት	ቀላል የአካል ጉዳት	የንብረት ጉዳት	ድምር	ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት			
ትግራይ	257	310	53	396	1,016	246	65	396	151	313	96	955	312	1,267	65,609,693.75	Tigray
አፋር	48	36	21	118	223	68	8	63	18	78	22	209	48	257	19,618,760.00	Afar
አማራ	612	446	620	1,120	2,798	610	193	704	271	1,214	457	2,528	921	3,449	190,419,904.00	Amhara
ኦሮሚያ	1,310	901	1,100	1,722	5,033	2,073	567	1,541	383	2,175	618	5,789	1,568	7,357	164,353,958.00	Oromia
ሶማሌ	59	46	6	13	124	50	12	65	25	71	13	186	50	236	9,180,000.00	Somalia
ቤን/ገሙዝ	25	39	71	24	159	29	1	44	19	86	26	159	46	205	3,004,330.00	Ben. Gumuz
ደቡብ	371	420	288	182	1,261	351	85	560	168	465	182	1,376	432	1,808	18,701,383.00	S N N P
ጋምቤላ	22	25	50	48	145	18	7	25	19	50	29	93	55	148	3,365,880.00	Gambella
ሐረሪ	27	85	153	109	374	25	9	90	32	151	63	266	104	370	6,094,020.00	Harari
አዲስ አበባ	418	1662	1,100	17,253	20,433	325	118	1376	450	788	381	2,489	949	3,438	184,412,838.00	Addis Ababa
ድሬዳዋ	23	77	98	256	454	20	3	56	28	161	77	217	108	325	3,562,040.00	Dire Dawa
ድምር	3,172	4,046	3,561	21,241	32,020	3,815	1,068	4,920	1,564	4,666	1,842	11,540	4,733	16,273	668,322,806.75	Total
						4,883		6,484		6,508		16,273				
	Death	Serious Injury	Slight Injury	Property Damage	General Total	Male	Female	Male	Female	Male	Female	Total Male	Total Female	General Total	Total Property Damage Estimate In Birr	
						Death		Serious Injury		Slight Injury						
	NUMBER OF TRAFFIC ACCIDENTS					VICTMS OF MOTOR VEHICLE TRAFFIC ACCIDENTS						ALL CASES				

ከሐምሌ 1 ቀን 2007 እስከ ሰኔ 30 ቀን 2008 ዓ/ም ድረስ ባለው የአንድ ዓመት ጊዜ ውስጥ በአገር አቀፍ ደረጃ የደረሰ የትራፊክ አደጋና በትራፊክ አደጋ ተጎጅ የሆኑ ሰዎች ብዛት በጉዳት ዓይነትና በጾታ

ክልል መስተዳድር	የደረሰው የትራፊክ አደጋ ብዛት					በትራፊክ አደጋ ተጎጂ የሆኑ ግለሰቦች ብዛት									በትራፊክ አደጋ በንብረት ላይ የደረሰ ጉዳት በገንዘብ ሲተመን	REGION
	ሞት	ከባድ የአካል ጉዳት	ቀላል የአካል ጉዳት	የንብረት ጉዳት	ድምር	ሞት		ከባድ የአካል ጉዳት		ቀላል የአካል ጉዳት		ድምር		ጠቅላላ ድምር		
						ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት			
ትግራይ	266	356	58	408	1,088	270	92	485	207	283	110	1,038	409	1,447	43,207,762.05	Tigray
አፋር	81	46	18	129	274	101	19	73	21	72	23	246	63	309	36,196,100.00	Afar
አማራ	729	447	515	1,092	2,783	728	206	899	270	1,277	535	2,904	1,011	3,915	139,850,726.00	Amhara
ኦሮሚያ	1,356	623	515	1,446	3,940	1,340	372	1,177	439	1,132	489	3,649	1,300	4,949	290,586,975.00	Oromia
ሶማሌ	53	67	7	20	147	62	12	92	38	89	59	243	109	352	18,270,000.00	Somalia
ቤን/ገሙዝ	20	73	82	43	218	20	16	113	31	223	84	356	131	487	7,595,150.00	Ben.Gumuz
ደቡብ	463	389	201	145	1,198	432	133	545	164	539	224	1,516	521	2,037	18,446,417.00	S N N P
ጋምቤላ	15	29	58	99	201	16	3	43	6	76	28	135	37	172	4,895,995.53	Gambella
ሐረሪ	18	48	60	117	243	18	6	54	31	80	67	152	104	256	14,422,737.00	Harari
አ/አበባ	439	1,924	1,165	19,411	22,939	358	106	1,716	369	1,228	263	3,302	738	4,040	296,615,747.00	A/ Ababa
ድሬዳዋ	35	93	140	248	516	31	11	85	28	136	54	252	93	345	4,523,532.00	Dire Dawa
ድምር	3,475	4,095	2,819	23,158	33,547	3,376	976	5,282	1,604	5,135	1,936	13,793	4,516	18,309	874,611,141.58	Total
						4,352		6,886		7,071		18,309				
	Death	Serious Injury	Slight Injury	Property Damage	General Total	Male	Female	Male	Female	Male	Female	Total Male	Total Female	General Total	Total Property Damage Estimate In Birr	
						Death		Serious Injury		Slight Injury						
	NUMBER OF TRAFFIC ACCIDENTS					VICTMS OF MOTOR VEHICLE TRAFFIC ACCIDENTS						ALL CASES				

<u>ከሐምሌ 1 ቀን 2008 እስከ ሰኔ 30 ቀን 2009 ዓ/ም ድረስ ባለው የአንድ ዓመት ጊዜ በአገር አቀፍ ደረጃ የደረሰ የትራፊክ አደጋና</u>

<u>በትራፊክ አደጋ ተጎጂ የሆኑ ሰዎች ብዛት በጉዳት ዓይነትና በጾታ</u>

ክልል መስተዳድር	የደረሰው የትራፊክ አደጋ ብዛት					በትራፊክ አደጋ ተጎጂ የሆኑ ግለሰቦች ብዛት								ጠቅላላ ድምር	በትራፊክ አደጋ በንብረት ላይ የደረሰ ጉዳት በገንዘብ ሲተመን	REGION
						ሞት		ከባድ የአካል ጉዳት		ቀላል የአካል ጉዳት		ድምር				
	ሞት	ከባድ የአካል ጉዳት	ቀላል የአካል ጉዳት	የንብረት ጉዳት	ድምር	ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት			
ትግራይ	303	339	55	489	1,186	254	117	471	193	254	102	979	412	1,391	59,191,154.70	Tigray
አፋር	90	50	14	201	355	112	19	124	40	58	21	294	80	374	80,558,700.00	Afar
አማራ	796	502	565	1,167	3,030	807	228	860	330	1,355	635	3,022	1,193	4,215	366,798,848.10	Amhara
ኦሮሚያ	1,188	568	518	1,626	3,900	1,157	384	1,068	391	1,056	429	3,281	1,204	4,485	153,004,478.00	Oromia
ሶማሌ	125	171	10	15	321	128	29	327	81	257	139	712	249	961	35,276,000.00	Somalia
ቤን/ጉሙዝ	31	98	114	44	287	26	7	180	44	254	141	460	192	652	9,711,900.00	Ben.Gumuz
ደቡብ	523	553	210	181	1,467	486	148	734	256	688	249	1908	653	2561	28,744,008.00	S N N P
ጋምቤላ	13	23	49	68	153	12	4	30	8	56	45	98	57	155	6,983,860.00	Gambella
ሐረሪ	42	55	206	248	551	43	10	82	41	165	119	290	170	460	23,047,644.08	Harari
አ/አበባ	466	1,996	973	23,510	26,945	367	110	1,619	466	885	347	2,871	923	3,794	417,922,804.00	A/ Ababa
ድሬዳዋ	29	94	89	330	542	26	5	98	43	112	68	236	116	352	6,247,405.00	Dire Dawa
ድምር	3,606	4,449	2,803	27,879	38,737	3,41	1,061	5,593	1,893	5,140	2,295	14,151	5,249	19,400	1,187,486,802.88	Total
						4,479		7,486		7,435		19,400				
	Death	Serious Injury	Slight Injury	Property Damage	General Total	Male	Female	Male	Female	Male	Female	Total Male	Total Female	General Total	Total Property Damage Estimate In Birr	
						Death		Serious Injury		Slight Injury						
	NUMBER OF TRAFFIC ACCIDENTS					VICTMS OF MOTOR VEHICLE TRAFFIC ACCIDENTS						ALL CASES				

ከሐምሌ 1 ቀን 2009 እስከ ሰኔ 30 ቀን 2010 ዓ/ም ድረስ ባለው የአንድ ዓመት ጊዜ በአገር አቀፍ ደረጃ የደረሰ የትራፊክ አደጋና

በትራፊክ አደጋ ተጎጂ የሆኑ ሰዎች ብዛት በጉዳት ዓይነትና በጾታ

ክልል መስተዳድር	የደረሰው የትራፊክ አደጋ ብዛት					በትራፊክ አደጋ ተጎጂ የሆኑ ግለሰቦች ብዛት								ጠቅላላ ድምር	በትራፊክ አደጋ በንብረት ላይ የደረሰ ጉዳት በገንዘብ ሲተመን	REGION
						ሞት		ከባድ የአካል ጉዳት		ቀላል የአካል ጉዳት		ድምር				
	ሞት	ከባድ የአካል ጉዳት	ቀላል የአካል ጉዳት	የንብረት ጉዳት	ድምር	ወንድ	ሴት	ወንድ	ሴ ት	ወንድ	ሴት	ወንድ	ሴት			
ትግራይ	301	459	97	550	1,407	268	106	632	226	447	137	1,347	469	1,816	47,397,561.18	Tigray
አፋር	53	24	6	71	154	66	6	40	9	26	5	132	20	152	89,781,800.00	Afar
አማራ	857	502	575	1098	3,032	882	270	848	333	1349	575	3,079	1,178	4,257	326,101,815.1	Amhara
ኦሮሚያ	1319	729	532	1806	4,386	1475	407	1286	424	1072	514	3,833	1,345	5,178	236,362,117.	Oromia
ሶማሌ	142	219	33	16	410	164	40	391	142	369	78	924	260	1,184	35,850,000.00	Somalia
ቤን/ገሙዝ	24	78	122	42	266	32	4	97	29	157	58	286	91	377	4,970,550.00	Ben.Gumuz
ደቡብ	582	608	199	154	1,543	557	163	829	292	648	274	2,034	729	2,763	29,557,590.00	S N N P
ጋምቤላ	15	15	21	38	89	13	5	13	7	30	18	56	30	86	3,894,677.50	Gambella
ሐረሪ	31	102	286	346	765	25	9	146	78	277	230	448	317	765	22,972,900.00	Harari
አ/አበባ	456	1903	1074	24928	28,361	392	193	1481	323	819	413	2,692	929	3,621	109,882,371	A/ Ababa
ድሬዳዋ	40	101	128	316	585	31	10	97	31	169	110	297	151	448	13,999,933.00	Dire Dawa
ድምር	3,820	4,740	3,073	29,365	40,998	3,905	1,213	5,860	1,8 94	5,363	2,41 2	15,12 8	5,519	20,647	920,771,314.78	Total
						5,118		7,754		7,775		20,647				
	Death	Serious Injury	Slight Injury	Property Damage	General Total	Male	Female	Male	Fem ale	Male	Femal e	Total Male	Total Femal e	General Total	Total Property Damage Estimate In Birr	
						Death		Serious Injury		Slight Injury						
	NUMBER OF TRAFFIC ACCIDENTS					VICTMS OF MOTOR VEHICLE TRAFFIC ACCIDENTS						ALL CASES				

ከሐምሌ 1 ቀን 2010 እስከ ሰኔ 30 ቀን 2011 ዓ/ም ድረስ ባለው የአንድ ዓመት ጊዜ በአገር አቀፍ ደረጃ የደረሰ የትራፊክ አደጋና

በትራፊክ አደጋ ተጎጂ የሆኑ ሰዎች ብዛት በጉዳት ዓይነትና በጾታ

ክልል መስተዳድር	የደረሰው የትራፊክ አደጋ ብዛት					በትራፊክ አደጋ ተጎጂ የሆኑ ግለሰቦች ብዛት								ጠቅላላ ድምር	በትራፊክ አደጋ በንብረት ላይ የደረሰ ጉዳት በገንዘብ ሲተመን	REGION
						ሞት		ከባድ የአካል ጉዳት		ቀላል የአካል ጉዳት		ድምር				
	ሞት	ከባድ የአካል ጉዳት	ቀላል የአካል ጉዳት	የንብረት ጉዳት	ድምር	ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት	ወንድ	ሴት			
ትግራይ	329	483	60	640	1,512	290	96	618	236	257	124	1,165	456	1,621	96,524,434.82	Tigray
አፋር	36	33	11	114	194	52	4	66	7	13	7	131	18	149	35,480,300	Afar
አማራ	881	441	376	893	2,591	833	271	765	267	897	355	2,495	893	3,388	305,167,314	Amhara
ኦሮሚያ	1,209	535	480	1,738	3,962	1,096	382	1,057	391	1,046	340	3,199	1,113	4,312	189,972,568	Oromia
ሶማሌ	93	73	20	15	201	109	23	94	33	80	54	283	110	393	24,400,000	Somalia
ቤን/ጉሙዝ	43	89	114	45	291	88	3	95	41	172	94	355	138	493	3,808,500	Ben.Gumuz
ደቡብ	594	536	105	85	1,320	584	128	865	287	511	214	1,960	629	2,589	30,600,469	S N N P
ጋምቤላ	14	23	22	46	105	12	7	28	15	46	35	86	57	143	7,501,198.17	Gambella
ሐረሪ	48	87	119	152	406	38	17	133	70	113	75	284	162	446	23,891,986	Harari
አ/አበባ	460	1,926	1,143	26,019	29,548	406	122	1,745	465	1,006	268	3,157	855	4,012	141,822,992	A/ Ababa
ድሬዳዋ	31	98	137	475	741	24	12	101	28	178	64	303	104	407	13,715,119	Dire Dawa
ድምር	3,738	4,324	2,587	30,222	40,871	3,532	1,065	5,567	1,840	4,319	1,630	13,418	4,535	17,953	872,884,881	Total
						4,597		7,407		5,949		17,953				
	Death	Serious Injury	Slight Injury	Property Damage	General Total	Male	Female	Male	Female	Male	Female	Total Male	Total Female	General Total	Total Property Damage Estimate In Birr	
						Death		Serious Injury		Slight Injury						
	NUMBER OF TRAFFIC ACCIDENTS					VICTIMS OF MOTOR VEHICLE TRAFFIC ACCIDENTS						ALL CASES				

Appendix D: Vehicle statics in Ethiopia

Vehicle-Type	Before 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Ambulance	97	28	37	18	18	19	2	26	21	13
Automobile	40467	5959	4536	4048	5759	6082	983	1009	590	2163
Crane	240	41	23	51	85	44	10	16	8	49
Double Cabin	7535	1137	1219	894	949	1107	438	565	674	828
Dry Cargo	19470	2266	2618	2823	3624	3487	1226	1487	2061	1625
Dump Truck	3175	304	300	686	1419	408	166	259	131	578
Farm Tractor	38	2	1			17	3	6	17	34
Field Vehicle	9501	1604	1746	1713	1405	1218	474	1043	1263	1073
Fire Fighting	11	5			1		3	3	2	
Glas Van Dry	84	17	11	7	8	18	1	5	5	8
Higher Bus	746	34	44	42	48	33	13	35	31	84
Liquid Cargo	1295	91	76	109	198	179	44	88	96	157
Low Bed	28	1	6	12	14	4		5	18	3
Midium Bus	549	102	111	231	125	143	52	122	97	169
Mini Bus	7927	1739	1231	1239	1654	2298	1027	1175	1558	1182
Mixer	68	5	6	24	35	20	6	7	7	41
Mobile Garage	32	4	1	3	7	4	1	2	1	7

Mobile House	251	39	31	31	52	55	21	25	21	6
Motor Cycle	1773	143	503	1102	1213	1689	1629	1481	1486	1442
Panel Van Dry	180	15	9	8	14	58	24	6	18	96
Pick Up	1228	69	76	42	50	83	53	80	80	311
Power Dry	1189	99	114	211	395	312	188	444	118	165
Power Liquid	60	5	3	43	18	18	4	7	2	5
Refrigerator	2				3					
Refuse Collector	44	5	8	4	1	16	15	1	8	9
Semi Trailer Dry	764	36	23	83	205	63	35	251	154	123
Semi Trailer Liquid	169	8	2	1	14	25	1	55	14	12
Special Trailer	24	3		6	8	4	3	4	3	6
Trailer Dry	4370	241	158	529	795	422	172	560	495	360
Trailer Liquid	790	35	57	16	47	226	13	89	39	74
Not Specified	13918	2358	1564	937	589	479	327	307	374	752
Total	116025	16395	14514	14913	18753	18531	6934	9163	9392	11375
						23701	23701	23701	23701	23701
	116025	16395	14514	14913	18753	42232	30635	32864	33093	35076
Region						50000	5000	5500	6050	17000
	116025	16395	14514	14913	18753	92232	35635	38364	39143	52076

Up to 2005 end													
Region	AF	BG	GA	HR	OR	SP	TG	AMR	DIRE	AA	SOM	ETH	Total
Ambulance	6	8	8	4	19	3	40	27	25	79	34	64	317
Automobile	25	95	21	1275	6270	10231	6500	8420	300	37250	39	453	70879
Bajaj	346	185	185	536	5066	2901	1315	6100	8100	17213	5200	0	47147
Double Cabin	204	60	143	357	1303	126	1240	64	35	6900	51	1007	11490
Dry Cargo	160	26	59	357	4161	1036	361	34	55	4061	117	1474	11901
Dump Truck	0	0	0	20	50	0		55	26	510	25	1637	2323
Field Vehicle	47	55	48	176	1023	339	0	32	34	1720	37	1585	5096
Higher bus	4	6	2	2	400	153	0	25	24	2100	25	146	2887
Liquid	25	1	1	36	98	6592	792	47	20	178	25	376	8191
Medium Bus	37	23	45	445	5180	1581	0	20	19	4173	20	68	11611
Mini Bus	350	53	29	3	8545	1728	0	27	29	2179	36	183	13162
Motor Cycle	68	489	214	317	5123	13029	3096	112	106	1723	383	585	25245
Not specified	1	38	0	385	2570	1	0	9	4195	125782	172	92827	225980
Others	3	44	0	7	510	6	240	10	42	7018	200	77	8157
Passenger	0	1	13	7	288	407	297	0	0	0	0	0	1013
Pick Up	147	43	24	336	1658	423	0	51	52	4892	25	150	7801
Power	0	4	2	0	311	0	4448	121	102	2011	50	798	7847

Quintal	0	0	0	72	0	17	431			895			1415
Semi trailer Dry	1	0	0	1	257	0	947	21	20	39	20	905	2211
Semi Trailer Liquid	3	0	0	0	5	0	3631	26	33	51	25	112	3886
Tractor	0	0	0	0	136	0	0	0	0	61	0		197
Trailer	0	0	0	0	13	0	0						13
Trailer Dry	0	0	0	0	139		138	25	29	38	20	1060	1449
Trailer Liquid	0	0	0	0	1	0	1	25	27	50	25	319	448
Total other													3477
Total	1427	1131	794	4336	43126	38573	23477	15251	13273	218923	6529	103826	474143

Type of Vehicles and Number in the Regions (up2006) 2013/2014 For The Following Region:-													
Region	AF	BG	GA	HR	OR	SP	TG	AMR	DIRE	AA	SOM	ETH	Total
Ambulance	6	8	8	4	19	3	40	27	25	79	34	64	317
Automobile	25	95	21	1275	6270	10231	6500	8420	300	48333	39	453	81962
Bajaj	346	185	185	536	5066	2901	1315	6100	8100	17236	5200	0	47170
Double Cabin	204	60	143	357	1303	126	1240	64	35	6900	51	1007	11490
Dry Cargo	160	26	59	357	4161	1036	361	34	55	6523	117	1474	14363
Dump Truck	0	0	0	20	50	0		55	26	510	25	1637	2323
Field Vehicle	47	55	48	176	1023	339	0	32	34	10522	37	1585	13898
Higher bus	4	6	2	2	400	153	0	25	24	2100	25	146	2887

Liquid	25	1	1	36	98	6592	792	47	20	729	25	376	8742
Medium Bus	37	23	45	445	5180	1581	0	20	19	4173	20	68	11611
Mini Bus	350	53	23	3	8545	1728	0	27	29	3455	36	183	14432
Motor Cycle	68	489	214	317	5123	13029	3096	112	106	6256	383	585	29778
Not specified	1	38	0	195	11533	4046	2188	17172	3843	113642	172	90178	243008
Others	3	44	0	7	510	6	240	10	42	8611	200	77	9750
Passenger	0	1	13	7	288	407	297	0	0	0	0	0	1013
Pick Up	147	43	24	336	1658	423	0	51	52	4892	25	150	7801
Power	0	4	2	0	311	0	4448	121	102	2011	50	798	7847
Quintal	0	0	0	72	0	17	431			895			1415
Semi trailer Dry	1	0	0	1	257	0	947	21	20	39	20	905	2211
Semi Trailer Liquid	3	0	0	0	5	0	3631	26	33	51	25	112	3886
Tractor	0	0	0	0	136	0	0	0	0	61	0		197
Trailer	0	0	0	0	13	0	0			1805			1818
Trailer Dry	0	0	0	0	139		138	25	29	38	20	1060	1449
Trailer Liquid	0	0	0	0	1	0	1	25	27	50	25	319	448
Total other													
Total	1427	1131	788	4146	52089	42618	25665	32414	12921	238911	6529	101177	519816

Type of Vehicles and Number in the Regions (up to 2007) Registration													
Region	AF	BG	GA	HR	OR	SP	TG	AMR	DIRE	AA	SOM	ETH	Total
Ambulance	10	8	8	4	20	3	68	51	27	88	45	64	396
Automobile	46	95	21	1275	6270	10231	6565	8420	408	49674	54	453	83512
Bajaj	1166	185	185	536	5066	2995	2131	6175	8146	17248	5200	0	49033
Double Cabin	204	60	143	357	1569	223	1240	64	35	6900	51	1007	11853
Dry Cargo	406	26	59	357	5176	2001	632	130	468	9225	171	1474	20125
Dump Truck	0	0	0	20	51	0	0	55	26	510	25	1637	2324
Field Vehicle	233	55	48	176	1023	600	65	60	48	12086	39	1585	16018
Higher bus	204	6	2	2	400	281	199	540	56	2634	57	146	4527
Liquid	28	1	1	36	103	3592	840	47	57	861	49	376	5991
Medium Bus	37	23	45	445	5838	2856	0	20	19	4173	20	68	13544
Mini Bus	389	53	23	3	10175	2844	331	27	198	4044	40	183	18310
Motor Cycle	673	489	214	317	6045	15599	3884	1415	106	7442	383	585	37152
Not specified	1	38	0	1692	26324	2057	2111	27057	25	97200	3205	118581	282872
Others	47	44	0	7	636	12	244	35	42	9081	200	77	10425
Passenger	0	1	13	7	288	584	297	0	0	0	0	0	1190
Pick Up	147	43	24	336	1999	779	0	51	52	6599	25	150	10205
Power	0	4	2	0	311	1	4448	121	102	2011	50	798	7848
Quintal	0	0	0	72	0	17	431			895			1415

Semi trailer Dry	1	0	0	1	257	0	947	21	20	39	20	905	2211
Semi Trailer Liquid	3	0	0	0	5	0	3631	26	33	51	25	112	3886
Tractor	43	0	0	0	213	0	25	13	0	105	0		399
Trailer	7	0	0	0	13	0	94	76		2130			2320
Trailer Dry	0	0	0	0	139		138	25	29	38	20	1060	1449
Trailer Liquid	0	0	0	0	1	0	1	25	27	50	25	319	448
Total other													0
Total	3645	1131	788	5643	71922	44675	28322	44454	9924	2E+05	9704	1E+05	6E+05

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Type of Vehicles and Number in the Regions (up to Sene 2009) Registration												
Description	AA	AM	AF	BN	DD	SO	TG	GM	HA	SN	OR	Total
Ambulance	180	0	34	27	9	2	69	0	4	7	165	497
Automobile	171523	1485	55	34	1967	558	927	228	1275	51	6376	184479
Bajaj	0	2132	2302	0	0	0		0	536	4671	5152	14793
Tri Cyle	0	40	0	0	0	0	0	0	0	27	16861	16928
Bus(< 12 Seats)	25929	7146	442	260	1376	755	2799	0	0	50	126	38883
Bus(> 11 Seats)	14524	9747	372	229	457	537	1521	1375	357	178	2126	31423
Combiner	10	17	0	0	1	2	8	0	357	0	6322	6717

Dozer	0	0	3	0	0	1	5	0	20	0	252	281
Dry Cargo(<=10 Quintals)	34446	1602	273	94	847	953	733	0	176	95	1067	40286
Dry Cargo(>10 Quintals)	105150	4099	224	92	3916	2152	4372	0	2	15	527	120549
Dual Purpose Vehicle	43253	3443	339	255	1104	515	1665	0	36	21	131	50762
Field Vehicle	43681	1590	298	138	426	912	1034	0	445	16	7168	55708
Grader	5	2	0	0	1	1		0	3	0	17517	17529
Forklift	145	0	3	0	6	0	2	0	317	0	19880	20353
Not Specified	18370	8121	25	16	214	263	187		0	50762	13480	91438
Gotach	5178	0	0	0	57	0	308	0	1699	0	1305	8547
Liquid Cargo	5057	272	34	2	203	114	621	0	7	65	358	6733
Liquid Trailer	0	11	0	0	0	0		0	336	0	2189	2536
Motor Bicycle	21509	26442	1048	3237	5761	1157	5705	2166	0	4	642	67671
Other	9766	442	35	1	89	33	524	1353	72	22	3	12340
Three wheel dry load	8	0	0	6	2	166	65	0	1	0	263	511
Three wheel public load	506	0	0	1508	299	5145	5046	0	0	0	7	12511
Tractor	1027	281	46	124	20	0	184	0	0	1	239	1922
Trailer	23810	292	8	1	379	1	2485	0	0	0	13	26989
Vehicle with Machinery	367	135	14	1	109	27	62	0	0	0	164	879
Total	524444	67299	5555	6025	17243	13294	28322	5122	5643	55985	102333	831265

From Information Communication Technology Directorate

Type of Vehicles and Number in the Regions (up to Sene 30.2010) Registration											
Description	AA	AM	AF	BN	DD	SO	TG	GM	HA	SN	OR	Total
Ambulance	198	0	37	35	9	2	91	0	4	25	238	639
Automobile	184227	1485	59	49	2057	558	1421	228	1275	16162	4796	212317
Bajaj	0	2132	2644	0	289	0	0	0	536	8721	34339	48661
Tri Cyle	0	40	0	0	0	0	0	0	0	27	0	67
Bus(< 12 Seats)	26408	7146	448	324	1468	755	4768	0	0	709	14174	56200
Bus(> 11 Seats)	15242	9747	449	325	514	537	3335	1375	357	1144	22772	55797
Combiner	20	17	0	0	1	2	5	0	357	0	75	477
Dozer	16	0	3	3	0	1	5	0	20	0	0	48
Dry Cargo(<=10 Quintals)	37384	1602	289	101	890	953	1069	0	176	3070	7063	52597
Dry Cargo(>10 Quintals)	109952	4099	229	98	4089	2152	4886	0	2	1195	1810	128512
Dual Purpose Vehicle	44954	3443	348	301	1157	515	2063	0	36	1435	372	54624
Field Vehicle	45081	1590	303	148	447	912	1185	0	445	117	5421	55649
Grader	7	2	0	0	1	1	4	0	3	0	1	19
Forklift	188	0	4	1	6	0	13	0	317	0	2	531
Not Specified	18154	8121	32	25	222	263	602	0	0	1534	6020	34973
Gotach	5598	0	0	0	59	0	572	0	1699	0	0	7928
Liquid Cargo	6341	272	35	2	206	114	645	0	7	65	189	7876
Liquid Trailer	0	11	0	0	0	0	0	0	336	0	117	464
Motor Bicycle	22931	26442	1152	4129	5891	1157	10744	2166	0	49409	29378	153399
Other	9912	442	36	1	88	33	494	1353	72	36	1763	14230
Three wheel dry load	12	0	0	24	2	166	888	0	1	0	4	1097
Three wheel public load	375	0	0	1909	0	5145	9962	0	0	0	0	17391
Tractor	1059	281	46	134	21	0	265	0	0	7	503	2316
Trailer	25336	292	8	1	394	1	2793	0	0	0	302	29127
Vehicle with Machinery	543	135	15	1	113	27	115	0	0	0	0	949
Total	553938	67299	6137	7611	17924	13294	45925	5122	5643	83656	129339	935888

From Information Communication Technology Directorate

Type of Vehicles and Number in the Regions (up to Sene 30.2011) Registration											
Description	AA	AM	AF	BN	DD	SO	TG	GM	HA	SN	OR	Total
Ambulance	253	0	38	44	7	14	164	0	4	28	365	917
Automobile	205773	1701	66	49	2246	609	1660	228	1275	80	6012	219699
Bajaj	0	4722	2889	0	2318	0	0	0	536	9307	48822	68594
Tri Cyle	0	37	0	0	0	0	0	0	0	27	0	64
Bus(< 12 Seats)	27357	8805	465	347	1607	837	5201	0	0	12503	3024	60146
Bus(> 11 Seats)	16698	12840	532	378	681	677	3886	1375	357	10029	38439	85892
Combiner	23	53	0	0	1	2	5	0	357	0	78	519
Dozer	17	0	3	3	0	1	5	0	20	0	0	49
Dry Cargo(<=10 Quintals)	41333	2396	301	102	993	1036	1163	0	176	102	1868	49470
Dry Cargo(>10 Quintals)	115023	4591	240	103	4313	2348	5030	0	2	153	7188	138991
Dual Purpose Vehicle	47278	3907	380	310	1370	684	2188	0	36	1438	97	57688
Field Vehicle	47059	1767	318	153	487	1037	1228	0	445	123	3299	55916
Grader	6	2	0	0	2	1	4	0	3	0	2	20
Forklift	237	0	4	1	8	0	18	0	317	0	2	587
Not Specified	18943	1462	34	48	248	0	396	436	1179	3118	7929	33793
Gotach	5756	0	0	0	67	2	613	0	1699	0	0	8137

Liquid Cargo	6703	318	35	2	226	148	650	0	7	65	437	8591
Liquid Trailer	0	14	0	0	0	0	0	0	336	0	187	537
Motor Bicycle	24700	40229	1181	4865	6689	1366	12358	2166	1178	54084	49903	198719
Other	10279	643	36	1	105	33	485	1353	72	38	2905	15950
Three wheel dry load	15	9625	0	39	7	233	1417	0	1	0	4	11341
Three wheel public load	368	0	0	2259	0	6106	12953	0	0	0	0	21686
Tractor	1199	392	51	136	21	0	304	0	0	10	530	2643
Trailer	26326	349	8	1	417	1	2891	0	0	0	217	30210
Vehicle with Machinery	738	148	17	1	125	25	132	0	0	0	0	1186
Total	596084	94001	6598	8842	21938	15160	52751	5558	8000	91105	171308	1071345

Appendix E: Code for Protus simulation

```
# include "LiquidCrystal.h"  //lcd libary

#define kpa2atm 0.00986923267

LiquidCrystal lcd(2, 3, 4, 5, 6, 7);

int pressurePin = A0;

int led2 = A1;

// ultra

const int trig = 13;

const int echo = 12;

// motor

int kiriA=11;

int kiriB=10;

int kananA = 8;

int kananB = 9;

 // othervar

long duration;

int distanceCm;

float liquid;

int val;

float pkPa; // pressure in kPa

float pAtm; // pressure in Atm

void setup() {

  lcd.begin(16,2);

  pinMode(trig,OUTPUT);

  pinMode(echo,INPUT);

  pinMode(pressurePin,INPUT);

  pinMode(led2,OUTPUT);
```

```
  pinMode(kiriA,OUTPUT);
  pinMode(kiriB,OUTPUT);
  pinMode(kananA,OUTPUT);
  pinMode(kananB,OUTPUT);
  pinMode(A2,OUTPUT);
  lcd.setCursor(0,0);
  lcd.print("  PRESURE    ");
  lcd.setCursor(0,1);
  lcd.print("  Measurement  ");
  delay(200);
  lcd.clear();
}

void loop() {
  digitalWrite(trig, LOW);
  delayMicroseconds(2);
  digitalWrite(trig, HIGH);
  delayMicroseconds(10);
  digitalWrite(trig, LOW);
  duration = pulseIn(echo, HIGH);
  distanceCm= duration*0.034/2;
   /* get the pressure */
  val = analogRead(pressurePin);
  pkPa = ((float)val/(float)1023+0.095)/0.009;
  pAtm = kpa2atm*pkPa;

  /* send pressure to serial port */
```

```
lcd.setCursor(0,0);
lcd.print("Pressure Measur.");
delay(10);
lcd.setCursor(0,1);
lcd.print("Presure:");
lcd.print(pAtm);
delay(10);
 if (distanceCm>=130&&pAtm>0.35)
 {
  digitalWrite(kiriA,HIGH);
  digitalWrite(kiriB,LOW);
  digitalWrite(kananA,HIGH);
  digitalWrite(kananB,LOW);
 }
 else
 {
  digitalWrite(kiriA,LOW);
  digitalWrite(kiriB,LOW);
  digitalWrite(kananA,LOW);
  digitalWrite(kananB,LOW);
  delay(500);
  }
if(pAtm<0.35)
   {
digitalWrite(kiriA,LOW);
digitalWrite(kiriB,LOW);
digitalWrite(kananA,LOW);
```

```
 digitalWrite(kananB,LOW);
 }
   if(pAtm<0.42)
   {
digitalWrite(led2,HIGH);
delay(30);
digitalWrite(led2,LOW);
delay(10);
   if(pAtm<0.38)
   {
digitalWrite(A2,HIGH);
delay(50);
digitalWrite(A2,LOW);
delay(20);
     }
else
{
digitalWrite(led2,LOW);
delay(10);
digitalWrite(A2,LOW);
delay(50);
 }
}}
```

Appindex F: Code for hardwear simulation

```
#include <AFMotor.h>

#include <NewPing.h>

#include <Servo.h>


#define TRIG_PIN A0

#define ECHO_PIN A1

#define MAX_DISTANCE 200

#define MAX_SPEED 190 // sets speed of DC  motors

#define MAX_SPEED_OFFSET 20


NewPing sonar(TRIG_PIN, ECHO_PIN, MAX_DISTANCE);


AF_DCMotor motor1(1, MOTOR12_1KHZ);

AF_DCMotor motor2(2, MOTOR12_1KHZ);

AF_DCMotor motor3(3, MOTOR34_1KHZ);

AF_DCMotor motor4(4, MOTOR34_1KHZ);

Servo myservo;


boolean goesForward=false;

int distance = 100;

int speedSet = 0;

int led = A2;

int buzzer = A3;

void setup() {


  myservo.attach(10);
```

```
  myservo.write(90);
  delay(1000);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
  pinMode(led,OUTPUT);
}

void loop() {
  int distanceR = 0;
 int distanceL =  0;
 delay(40);
  if(distance<=15)
 {
  moveStop();
  delay(100);
  digitalWrite(led,HIGH);
  delay(100);
  digitalWrite(led,LOW);
  delay(100);
  tone(buzzer,450);
  delay(500);
```

```
  noTone(buzzer);
  delay(500);

   distanceR = lookRight();
  delay(200);
  distanceL = lookLeft();
  delay(200);
 if(distanceR>=distanceL)
  {
    moveForward();
  }else
  {
    moveForward();
  }
 }else
 {
  moveForward();
 }
 distance = readPing();
}
int lookRight()
{
    myservo.write(50);
    delay(500);
    int distance = readPing();
    delay(100);
    myservo.write(115);
```

```
    return distance;
}

int lookLeft()
{
    myservo.write(170);
    delay(500);
    int distance = readPing();
    delay(100);
    myservo.write(115);
    return distance;
    delay(100);
}

int readPing() {
  delay(70);
  int cm = sonar.ping_cm();
  if(cm==0)
  {
    cm = 250;
  }
  return cm;
}
void moveStop() {
  motor1.run(RELEASE);
  motor2.run(RELEASE);
  motor3.run(RELEASE);
```

```
  motor4.run(RELEASE);
  }

void moveForward() {

 if(!goesForward)
  {
    goesForward=true;
    motor1.run(FORWARD);
    motor2.run(FORWARD);
    motor3.run(FORWARD);
    motor4.run(FORWARD);
   for (speedSet = 0; speedSet < MAX_SPEED; speedSet +=2) // slowly bring the speed up to
avoid loading down the batteries too quickly
   {
    motor1.setSpeed(speedSet);
    motor2.setSpeed(speedSet);
    motor3.setSpeed(speedSet);
    motor4.setSpeed(speedSet);
    delay(5);
   }
  }
}
```