Design & Fabrication of a Safe-Distance Maintaining Car to Prevent Accidents

A project report submitted to the Department of Mechanical Engineering of Sonargaon University (SU) in partial fulfillment of the requirements for the award of the degree of Bachelor of Science in Mechanical Engineering
Department of Mechanical Engineering

Sonargaon University

Submitted By

Md Rakib Hossen	ID: ME2201026276
Md Bodiuzzaman Rafi	ID: ME2201026261
Al Amin Kazi	ID: ME2201026269
Yeanur Sheikh	ID: ME2201026264
Mohidul Islam	ID: BME2001020354

Under the Supervision of

.....

Md. Minhaz Uddin
Assistant Professor
Department of Mechanical Engineering
Sonargaon University

September- 2025

APPROVAL

This is to certify that project on **‘‘Design & Fabrication of a Safe-Distance Maintaining Car to Prevent Accidents’’** By Md Rakib Hossen ID: ME2201026276, Md Bodiuzzaman Rafi ID: ME2201026261, Al Amin Kazi ID: ME2201026269, Yeanur Sheikh ID: ME2201026264 and Mohidul Islam ID: BME2001020354 has been carried out under our supervision. This project work has been carried in partial fulfillment of the requirements of the degree of Bachelor of Science (B.Sc) in Mechanical Engineering of the year 2025 and has been approved as to its style and contents.

…….

Md. Minhaz Uddin
Assistant Professor
Department of Mechanical Engineering
Sonargaon University (SU)

DECLARATION

We, hereby declare that the work presented in this Project **''Design & Fabrication of a Safe-Distance Maintaining Car to Prevent Accidents''** is the outcome of the investigation performed by us under the supervisor of **Md. Minhaz Uddin**, **Assistant Professor**, Department of Mechanical Engineering of Sonargaon University, in partial fulfillment of the requirements of the degree of Bachelor of Science (B.Sc) in Mechanical Engineering.

We also declare that no part of this project has been or is being submitted elsewhere for the award of any degree.

Signature Candidates

_ _ _ _ _ _ _ _ _ _ _ _

Md Rakib Hossen
ID: ME2201026276

_ _ _ _ _ _ _ _ _ _ _ _

Md Bodiuzzaman Rafi
ID: ME2201026261

_ _ _ _ _ _ _ _ _ _

Al Amin Kazi
ID: ME2201026269

_ _ _ _ _ _ _ _ _ _ _ _

Yeanur Sheikh
ID: ME2201026264

_ _ _ _ _ _ _ _ _ _ _ _

Mohidul Islam
ID: BME2001020354

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ABSTRACT

Road accidents are a major concern worldwide, often caused by a lack of proper distance between vehicles. To address this issue, this project focuses on the design and fabrication of a Safe-Distance Maintaining Car that prevents collisions by automatically monitoring and controlling the distance from the vehicle ahead. The system is developed using an Arduino NANO as the central controller, interfaced with an ultrasonic sensor to continuously measure the distance between vehicles. When the distance falls below a predefined threshold, the Arduino activates a buzzer to alert the driver and simultaneously adjusts the gear motor via a motor driver module to reduce the car's speed. A Bluetooth module is incorporated to enable wireless monitoring and control, while an LCD display provides real-time distance information for better situational awareness. The entire system is powered by a 3.7V rechargeable battery, ensuring portability and efficiency.The prototype demonstrates a practical and low-cost solution to minimize rear-end collisions, especially in congested traffic conditions. By integrating sensors, automation, and real-time alerts, this project enhances road safety and paves the way for future intelligent transportation systems.

TABLE OF CONTENTS

SL. NO		Page NO.
1	APPROVAL	ii
2	DECLARATION	iii
3	ACKNOWLEDGEMENT	iv
4	ABSTRACT	v
5	TABLE OF CONTENTS	vi
6	LIST OF FIGURES	viii
7	LIST OF TABLES	viii
CHAPTER 1	**INTRODUCTION**	**1-4**
1.1	Introduction	1
1.2	Problem Statement	2
1.3	Objective of the Project	3
1.4	Background of the Project	3
CHAPTER 2	**LITERATURE REVIEW**	**5**
2.1	Introduction	5
CHAPTER 3	**DESIGN AND CONSTRUCTION**	**06-16**
3.1	Introduction	6
3.2	Block Diagram of This Project	7
3.3	Circuit Diagram of This Project	7
3.4	Software Tools	8
3.5	Programming	9
3.6	Arduino Program Development	9
3.7	Structure	10
3.8	Manipulation	10
3.9	The list of Devices used in the Project	11
3.10	Arduino Nano	11
3.10.1	Technical Specifications	12
3.11	Battery	12
3.12	Buck Module	13
3.13	Motor Driver Module	13
3.13.1	Technical Specifications	14
3.14	DC Gear Motor	14
3.14.1	Technical Specifications	15
3.15	Ultrasonic Sensor	15
3.15.1	Technical Specifications	16
3.16	Buzzer	16

CHAPTER 4	**RESULT AND DISCUSSION**	**18-19**
4.1	Data Analysis	18
4.2	Discussion	19
CHAPTER 5	**CONCLUSION**	**20-21**
5.1	Conclusion	20
5.2	Advantage	20
5.3	Application	21
5.4	Future Recomandation	21
References		22
Appendix		23

LIST OF FIGURES

Page No.

Figure 3.1	Project Picture-01	6
Figure 3.2	Project Picture-02	6
Figure 3.3	Block Diagram	7
Figure 3.4	Circuit Diagram	7
Figure 3.5	Program Installation Process	8
Figure 3.6	Flow Chart of the Compiling Process	9
Figure 3.7	Arduino UNO	11
Figure 3.8	Lipo Battery	12
Figure 3.9	LM2596 Voltage Converter	13
Figure 3.10	Motor Drive Module	14
Figure 3.11	Gear Motor	15
Figure 3.12	Ultrasonic Sensor	16
Figure 3.13	Buzzer	17

LIST OF TABLES

Page No

Table 1	Ultrasonic Sensor Distance Readings	18
Table 2	System Response Data	18
Table 3	Motor Performance Data	19

CHAPTER 1

INTRODUCTION

1.1 Introduction

Road safety has become one of the most critical issues in modern society due to the increasing number of vehicles on roads and the resulting rise in accidents. Every year, millions of people lose their lives or suffer serious injuries because of traffic collisions, many of which are caused by inadequate distance maintained between vehicles. In congested urban traffic, high-speed highways, and sudden braking situations, maintaining a safe distance between cars is often overlooked by drivers, leading to rear-end collisions. To overcome this problem, technological interventions have become essential to ensure safety, reduce human error, and create an intelligent transportation ecosystem. The project titled "Design and Fabrication of a Safe-Distance Maintaining Car to Prevent Accidents" addresses this challenge by designing an automated prototype vehicle that uses modern sensors, controllers, and communication modules to actively monitor the distance between vehicles and prevent accidents.The project utilizes an Arduino NANO as the central processing unit, integrating multiple electronic components such as an ultrasonic sensor, Bluetooth module, buzzer, LCD display, gear motor, motor driver module, and a rechargeable 3.7V battery. Together, these components create a compact, efficient, and functional prototype that demonstrates how autonomous distance maintenance can be achieved in vehicles. The system continuously monitors the forward distance through the ultrasonic sensor. If the gap reduces below a critical threshold, the Arduino triggers corrective actions such as slowing down the motor and activating an alert system. At the same time, real-time information is displayed on the LCD, while Bluetooth connectivity allows wireless monitoring and remote interaction with the vehicle.Human drivers are often distracted or miscalculate the distance needed for safe braking. In urban environments, frequent stopping and starting increase the likelihood of collisions. On highways, tailgating and overspeeding make the situation worse. Traditional driver assistance systems, such as simple warning buzzers or mirrors, rely heavily on driver attentiveness. However, an automated safe-distance maintaining system reduces dependency on human reaction time and ensures consistent performance.Several advanced vehicles in developed countries already integrate adaptive cruise control systems, radar-based collision avoidance technologies, and automated emergency braking. However, such systems are often expensive and unavailable in low-cost vehicles, particularly in developing countries. This project seeks to develop an affordable, small-scale, and energy-efficient prototype that can serve as a stepping stone for safer driving practices. By using widely available

components like Arduino NANO and ultrasonic sensors, the design emphasizes cost-effectiveness and accessibility without compromising on functionality. The prototype car functions as a fully integrated system where hardware and software interact seamlessly. The Arduino NANO, being compact and powerful, is programmed with algorithms to analyze distance data from the ultrasonic sensor. When the sensor detects that the distance has dropped below the threshold, the Arduino commands the motor driver to reduce or cut motor power, thereby slowing down the gear motor and preventing forward motion. Simultaneously, the buzzer is activated to notify the user of a potential collision. The LCD display shows continuous updates of the distance, ensuring visibility of system status. Additionally, the Bluetooth module provides the flexibility of wireless connectivity, allowing the vehicle to be monitored or controlled from a smartphone or computer.The applications of this project extend beyond a simple demonstration model. In the future, the design could be scaled up and integrated into real vehicles to provide an affordable driver-assistance system. The same principles could also be applied in robotics for collision avoidance in automated guided vehicles (AGVs) used in warehouses, industries, and autonomous delivery systems. Furthermore, by adding IoT-based features, the system could transmit data to centralized monitoring centers, contributing to the development of smart cities and intelligent traffic management systems.The Design and Fabrication of a Safe-Distance Maintaining Car to Prevent Accidents project demonstrates a practical solution to one of the major causes of road accidents—failure to maintain safe distances. By integrating widely available and low-cost electronic components such as Arduino NANO, ultrasonic sensors, and gear motors, the project creates a reliable prototype that is both educational and applicable in real-life contexts. It not only highlights the role of automation in enhancing road safety but also opens new pathways for research and innovation in intelligent transportation systems.

1.2 Problem Statement

Road accidents caused by rear-end collisions are a major concern worldwide, often resulting from a driver’s inability to maintain a safe distance from the vehicle ahead. Human errors such as distraction, misjudgment of distance, and delayed reaction time significantly increase the risk of accidents. Traditional vehicles rely heavily on the driver’s alertness, with little to no automated assistance to monitor proximity and prevent collisions.In many low-cost vehicles, advanced driver-assistance technologies such as adaptive cruise control or collision avoidance systems are not available due to their high cost and complex implementation. As a result, there is a pressing need for a simple, affordable, and reliable system that can help drivers maintain safe distances automatically, thereby reducing the probability of accidents.This project addresses the problem by designing and fabricating a safe-distance maintaining car prototype using Arduino NANO, ultrasonic sensors, and motor driver modules to detect obstacles and control vehicle speed. A buzzer provides immediate alerts when the

car approaches unsafe distances, while an LCD display shows real-time distance measurements. A Bluetooth module allows for external control and monitoring. The system is powered by a 3.7V battery, ensuring portability and energy efficiency.The proposed solution aims to demonstrate how embedded systems and IoT-based approaches can provide a cost-effective alternative to high-end safety technologies, making accident-prevention features more accessible and practical for everyday vehicles.

1.3 Objective of the Project

- To implement an automatic distance monitoring system using an ultrasonic sensor.
- To alert the user with a buzzer when the car approaches a dangerous proximity.
- To enable wireless control for flexible operation.
- To integrate motor driver and gear motors for smooth and controlled movement.

1.4 Background of the Project

Road safety has become a critical concern in modern society due to the alarming rise in traffic accidents, particularly those caused by rear-end collisions. A significant proportion of these accidents occur because drivers fail to maintain an adequate distance from the vehicle ahead. Factors such as fatigue, distraction, poor judgment of speed and distance, and delayed reaction times often contribute to unsafe driving conditions. While advanced technologies like Adaptive Cruise Control (ACC) and Automatic Emergency Braking (AEB) are available in high-end vehicles, their high cost and complexity prevent widespread adoption, especially in developing countries.In this context, there is a growing demand for low-cost, reliable, and efficient accident-prevention systems that can be implemented even in simple vehicle models. This project explores the design and fabrication of a Safe-Distance Maintaining Car prototype that uses affordable components to replicate the functionality of advanced safety systems.The proposed system is built around an Arduino NANO microcontroller, which acts as the brain of the project. It processes real-time data from ultrasonic sensors that measure the distance between the car and obstacles ahead. If the car gets too close to an obstacle, the system triggers a buzzer alarm to warn the user and automatically controls the speed through a motor driver module connected to gear motors. Additionally, an LCD display provides continuous feedback on distance measurements and system status, enhancing user interaction.To improve flexibility and modern functionality, the project also integrates a Bluetooth module that allows wireless monitoring and control, simulating IoT-based safety applications in smart vehicles. A compact 3.7V rechargeable battery ensures power efficiency and portability of the system.

By combining these components, the project demonstrates a practical, cost-effective solution that not only helps prevent accidents but also serves as a foundation for more advanced intelligent transportation systems. This background emphasizes the importance of developing accessible road safety technologies that can contribute to reducing accidents and saving lives.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Road accidents are one of the leading causes of injury and death worldwide, with rear-end collisions being among the most common types. These accidents often occur because drivers fail to maintain a safe distance from the vehicle ahead due to distraction, fatigue, or misjudgment of speed and distance [1]. While advanced vehicles now include safety features such as adaptive cruise control and automatic braking systems, these technologies remain expensive and inaccessible for most low-cost vehicles, especially in developing countries [2].

To address this problem, there is a strong need for affordable, efficient, and reliable accident-prevention solutions that can be implemented at a smaller scale [3]. The Design and Fabrication of a Safe-Distance Maintaining Car project is aimed at developing a prototype that automatically monitors the distance between the vehicle and obstacles in its path, alerting the driver and controlling movement when unsafe distances are detected [4].

The system is built around the Arduino NANO microcontroller, which acts as the central processing unit. An ultrasonic sensor is used to measure the distance to objects in front of the car. If the distance falls below a predefined threshold, a buzzer is activated to provide an audible alert, and the motor driver module controls the gear motors to slow down or stop the car [5]. An LCD display provides real-time distance readings and system status, enhancing user awareness. Additionally, a Bluetooth module enables wireless monitoring and external control, simulating smart vehicle safety features. The entire system is powered by a 3.7V battery, ensuring portability and energy efficiency [6].

This project not only demonstrates a low-cost approach to collision avoidance and safe-distance maintenance but also serves as a foundation for future enhancements in intelligent transportation systems. By combining sensors, microcontrollers, and IoT-based control, the prototype provides a practical example of how embedded systems can contribute to improving road safety and reducing accidents[7].

CHAPTER 3

DESIGN AND CONSTRUCTION

Road accidents remain one of the most pressing safety concerns worldwide, often caused by the inability of drivers or automated vehicles to maintain a safe distance from obstacles or other vehicles. Technological advancements in embedded systems and IoT have paved the way for intelligent solutions that enhance vehicle safety through automation and real-time monitoring. One such solution is the Safe-Distance Maintaining Car, which is designed to automatically detect obstacles, maintain a minimum safe distance, and prevent potential collisions.



Fig- 3.1: Project Picture- 01

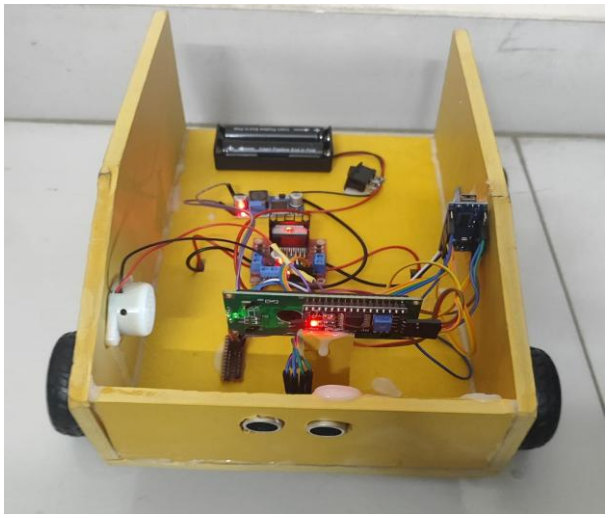


Fig- 3.2: Project Picture- 02

3.2 Block Diagram of This Project

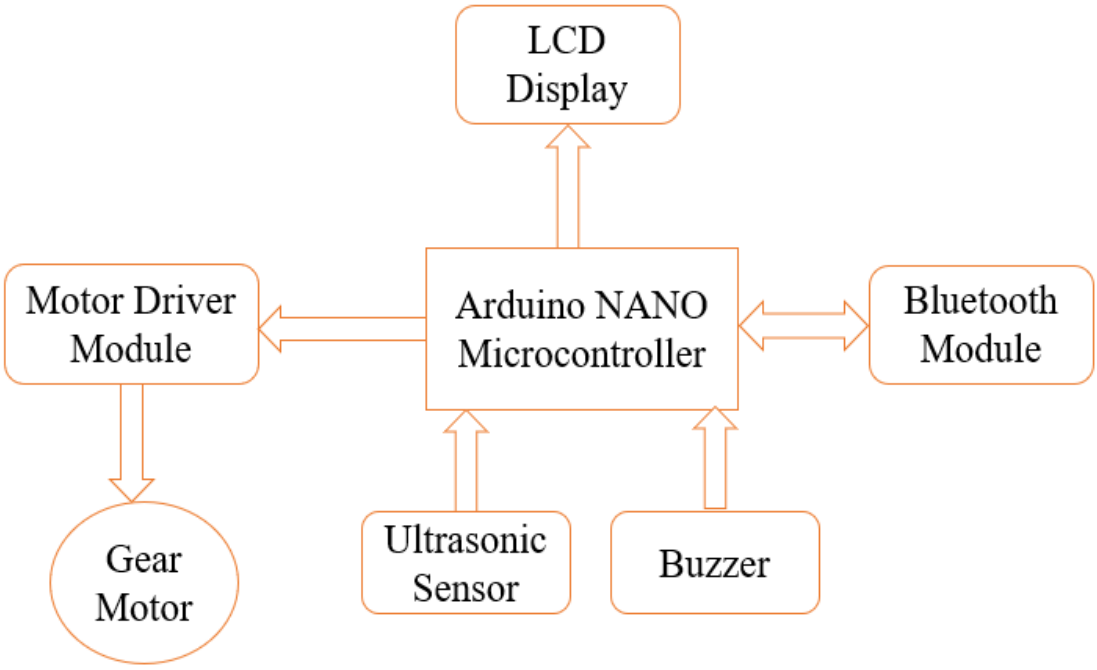


Fig-3.3: Block Diagram

3.3 Circuit Diagram of This Project

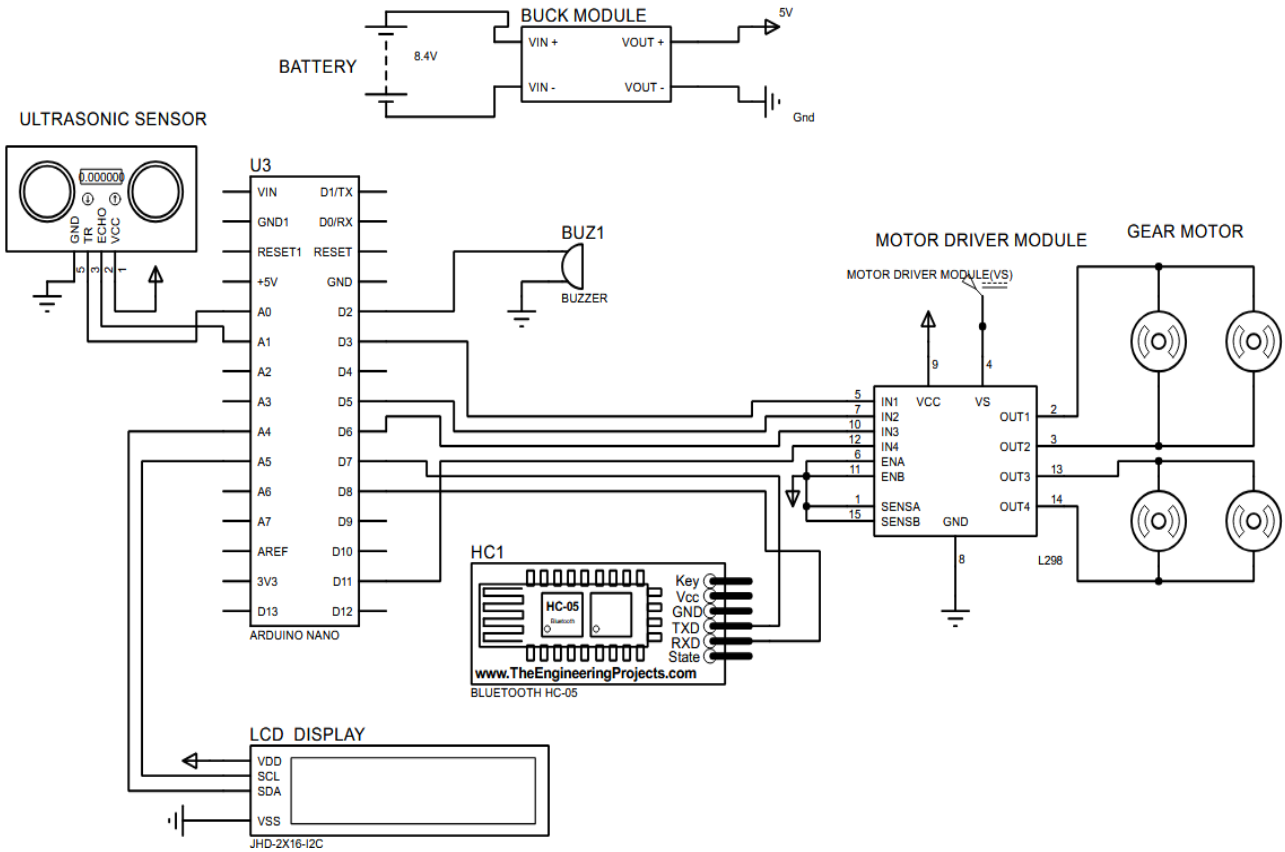


Fig-3.4: Circuit Diagram

3.4 Software Tools

The software that is used to program the microcontroller is open-source-software and can be downloaded for free on www.arduino.cc. With this “Arduino software” we can write little programs with the microcontroller. These programs are called “Sketch”. In the end the sketches are transferred to the microcontroller by USB cable. More on that later on the subject “programming”.

- **Installation** Now one after another the Arduino software and the USB driver for the board have to be installed.

- **Installation and setup of the Arduino software**

1. We have downloaded the Arduino software from www.arduino.cc and installed it on the computer (This was NOT connected to the PC). After that we opened the software file and installed the program named arduino.exe.

Two set ups on the program are important and should be considered.

a) The board that we want to connect has to be selected on the arduino software. The “Arduino Uno” is here known as “Arduino / Genuino Uno”.

b) We have to choose the right “Serial-Port”, to let the Computer know to which port the board has been connected. That is only possible if the USB driver has been installed correctly. It can be checked this way:

At the moment the Arduino wasn’t connected to the PC. If we now choose “Port”, under the field “Tool”, we will already see one or more ports here (COM1/ COM2/ COM3…). The quantity of the shown ports doesn't depend on the quantity of the USB ports on the computer. When the board gets connected to the computer, we will find one more port.

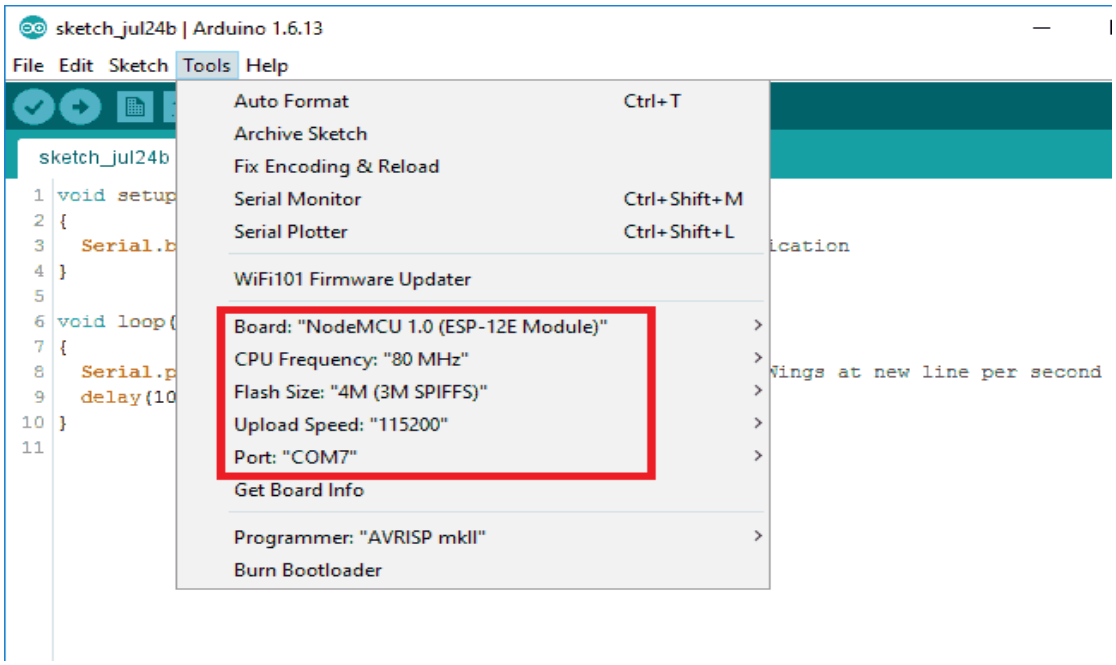


Fig-3.5: Program Installation Process

3.5 Programming

The development cycle is divided into 4 phases:

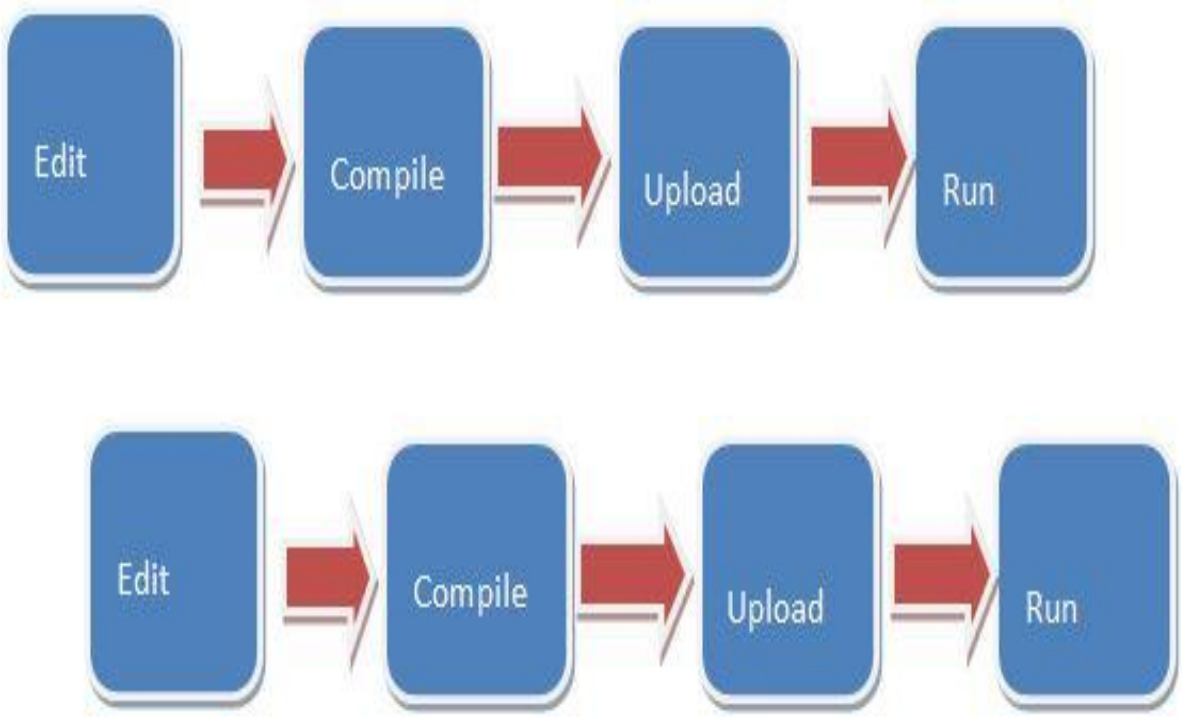


Fig-3.6: Flowchart of the Compiling Process

Compile: Compile means to translate the sketch into machine language, also known as object.
Code Run: Arduino sketch is executed as soon as terminates the step of uploading on the board.

3.6 Arduino Program Development

- Based on C++ without 80% of the instructions.
- A handful of new commands.
- Programs are called 'sketches'.
- Sketches need two functions:
- void setup ( )
- Void loop ( )
- Setup ( ) runs first and once.
- loop ( ) runs over and over, until power is lost or a new sketch is loaded.

3.7 Structure

The Design and Fabrication of a Safe-Distance Maintaining Car to Prevent Accidents project is systematically organized into different sections to ensure clarity, proper workflow, and easy understanding. The structure is outlined as follows:

- Provides an overview of the importance of road safety and accident prevention.
- Explains the motivation for developing a low-cost, embedded system–based prototype.
- Introduces the role of Arduino NANO, sensors, and other components in the project.

3.8 Manipulation

The Design and Fabrication of a Safe-Distance Maintaining Car to Prevent Accidents project requires systematic manipulation of both hardware and software components to achieve the desired functionality. Manipulation in this context refers to how different modules, circuits, and control logic are configured, adjusted, and optimized to make the prototype fully operational.

Arduino NANO as the Controller: Acts as the central processing unit, receiving inputs from the ultrasonic sensor and controlling outputs to the buzzer, motor driver, LCD, and Bluetooth module.

Ultrasonic Sensor Adjustment: Manipulated to continuously send sound pulses and measure the time taken for echoes, thereby calculating the exact distance from obstacles. The detection threshold is set (e.g., < 20 cm) to trigger alerts.

Motor Driver and Gear Motor Control: The motor driver module manipulates the movement of the gear motors by receiving PWM (Pulse Width Modulation) signals from Arduino. This ensures speed variation, stopping, or forward motion based on safe-distance logic.

Buzzer as a Warning Device: Manipulated to provide immediate audible alerts whenever the measured distance falls below the critical safety limit.

LCD Display Usage: Manipulated to present real-time distance readings and system messages such as "Safe Distance" or "Warning: Too Close."

Bluetooth Module Integration: Manipulated to allow wireless communication with a smartphone, enabling external commands or remote monitoring.

Battery Management: A 3.7V rechargeable battery is manipulated as the portable power source, providing continuous supply while maintaining energy efficiency.

Sensor Data Processing: The Arduino code manipulates ultrasonic sensor readings, filtering noise and converting time-of-flight values into distance measurements.

Motor Speed Regulation: PWM signals are manipulated in the code to vary the motor speed dynamically based on distance.

LCD Display Updates: The code manipulates LCD output to continuously update distance values in real time.

Bluetooth Command Handling: Manipulated code allows Arduino to interpret incoming serial data from a smartphone and execute corresponding actions (e.g., start, stop, or manual override).

3.9 The list of Devices used in the Project is Given Below

- Arduino NANO
- Battery.
- Buck Module.
- Motor Driver Module.
- LCD Display
- DC Gear Motor.
- Bluetooth Module.
- Ultrasonic Sensor.
- Buzzer

3.10 Arduino Nano

Arduino Nano is a surface mount breadboard compatible embedded version of Arduino with integrated USB. It is the smallest, complete and breadboard friendly Arduino module. It has everything that Diecimila/ Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing a power jack. The Nano automatically senses and switches to the higher potential source of power, so, there is no need for the power select jumper.The Nano 3.0 has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX).ACH340G chip (replaces FTDI FT232RL) on the board channels this serial communication over USB and the CH40G drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RXand TX LEDs on the board will flash when data is being transmitted via the CH340G chip and USB connection to the computer (but not for serial communication on pins 0 and 1).



Fig- 3.7: Arduino NANO

3.10.1 Technical Specifications

- Microcontroller: Atmel ATmega328
- Operating Voltage (logic level): 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O: Pin 40mA
- Flash Memory: 32KB (of which 2KB used by bootloader)
- SRAM: 2KB
- EEPROM: 1KB
- Clock Speed: 16MHz

3.11 Battery

The 18650 battery cell model became the most optimized lithium battery to be produced in 2013, although it has been around since 1994 as Panasonic first debuted this cell. The battery was longer and wider than the standard AA batteries as the numbers designate the cell model's size. For the 18650, it was 18mm diameter and a length of 65mm. These batteries provide 2,300 mAh to 3,600 mAh capacities and about 3.6 volts to 3.7 volts.



Fig- 3.8: Lipo Battery

The cells neared a peak reaching 2011, yet then came into new demand with the rollout of electric cars such as the Tesla. The production of drones, medical devices, and mil-aero equipment also required these batteries. In 2013, nearly 2.55 billion 18650 cells were produced. The batteries had a good reliability rate and were low in costs to produce per watt hour.When looking at the current market, many electronics have gone through drastic design changes. Equipment that required greater levels of power was becoming slimmer and flatter, such as tablets and smartphones. While the demand waned in these market sectors, the fear of battery shortages for the electric vehicle, mil-aero, and medical industries caused manufacturers to create an oversupply of these types of cells. However, the

increasing power demands of electronics will soon cause a need for cells with greater capacity. Due to this scenario, the 21700 cell models may meet this rising demand.

3.12 Buck Module

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed frequency oscillator. The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators. Available in a standard 7-pin TO-220 package with several different lead bend options, and a 7-pin TO-263 surface mount package.



Fig- 3.9: LM2596 Voltage Converter

3.13 Motor Driver Module

The L298 is an integrated monolithic circuit in a 15-lead Multi watt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the input signals. The emitters of the lower transistors of each bridge are connected together and the corresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage. Check here for L298 datasheet.

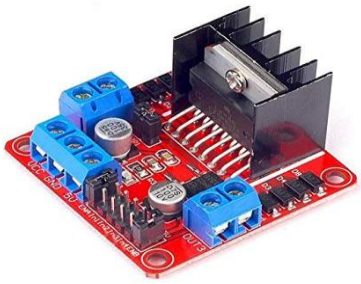


Fig- 3.10: Motor Driver Module

3.13.1 Specifications

- Driver: L298
- Driver power supply: +5V~+46V
- Driver peak current: 2A
- Logic power output Vss: +5~+7V (internal supply +5V)
- Logic current: 0~36mA
- Controlling level: Low -0.3V~1.5V, high: 2.3V~Vss
- Enable signal level: Low -0.3V~1.5V, high: 2.3V~Vss
- Max drive power: 25W (Temperature 75 ℃)
- Working temperature: -25℃~+130℃

3.14 DC Gear Motor

A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by induced magnetic fields due to flowing current in the coil. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor. DC motors were the first form of motors widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor, a lightweight brushed motor used for portable power tools and appliances can operate on direct current and alternating current. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.



Fig- 3.11: Gear Motor

3.14.1 Technical Specifications

- 200RPM 12V DC motors with Metal Gearbox and Metal Gears.
- 700 RPM base motor.
- 6mm Dia shaft with M3 thread hole.
- Length 63 mm without shaft.
- Shaft length 30mm.
- 375gm weight.
- 20 kg cm torque.
- No-load current = 0.15 mA, Load current = upto 4 A(Max).

3.15 Ultrasonic Sensor

Ultrasonic transducers and ultrasonic sensors are devices that generate or sense ultrasound energy. They can be divided into three broad categories: transmitters, receivers and transceivers. Transmitters convert electrical signals into ultrasound, receivers convert ultrasound into electrical signals, and transceivers can both transmit and receive ultrasound.This HC-SR04-Ultrasonic Range Finder is a very popular sensor that is found in many applications where it requires measuring distance and detecting objects.The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The HC-SR04 ultrasonic sensor uses sonar to determine the distance to an object like bats or dolphins do.This Ultrasonic Sensor module is a transmitter, a receiver, and a control circuit in one single pack!! It has very handy and compact construction. It offers excellent range accuracy and stable readings in an easy-to-use package. Its operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect).The Trigger and the Echo pins are the I/O pins of this module and hence they can be connected to the I/O

pins of the microcontroller/Arduino. When the receiver detects the return wave the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return to the sensor.

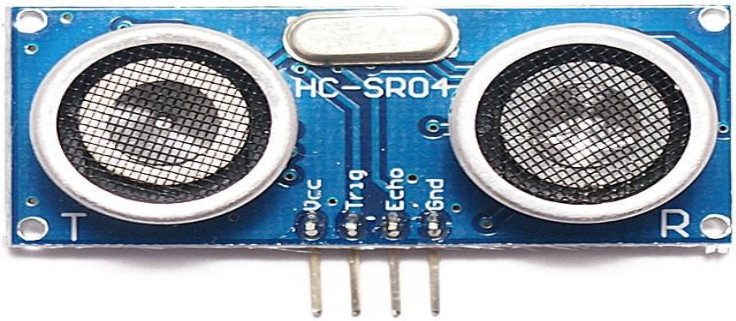


Fig- 3.12: Ultrasonic Sensor

3.15.1 Technical Specifications

- Operating Voltage: 5 V
- Sonar Sensing Range: 2-400 cm
- Max. Sensing Range: 450 cm
- Frequency: 40 kHz

3.16 Buzzer

A buzzer is an electromechanical or piezoelectric device that produces a sound when an electrical signal is applied. In wearable electronics and assistive devices, buzzers are commonly used to provide auditory alerts for notifications, warnings, or obstacle detection. In smart garments for visually impaired persons, buzzers complement vibration motors by giving immediate audio feedback about nearby obstacles.Active Buzzer: Produces a continuous sound when powered, no external signal required.Passive Buzzer: Vibrates a piezoelectric element when driven by a PWM signal, allowing customizable tones and patterns.The sound serves as a warning or alert when a signal is received from the controlling microcontroller.Instant audio feedback: Alerts the user immediately about obstacles.Works with vibration motors: Combines tactile and auditory cues for safer navigation.Compact and low-power: Suitable for battery-operated wearable devices. Customizable alerts: Tone, duration, and pattern can be adjusted to indicate distance or urgency.In smart garments for visually impaired persons, buzzers:Activate when an ultrasonic sensor detects a nearby

obstacle.Complement vibration motors by giving a clear audio alert for imminent hazards.Help users navigate safely in environments where tactile feedback alone may not be enough.Can provide multi-level alerts: short beeps for distant obstacles, continuous beeps for very close obstacles.



Fig- 3.13: Buzzer

CHAPTER 4

RESULT AND DISCUSSION

4.1 DATA ANALYSIS

Data collection is a crucial step in evaluating the performance of the Safe-Distance Maintaining Car. It involves recording and analyzing measurements from the ultrasonic sensor, motor responses, buzzer alerts, and LCD outputs to ensure the system reliably maintains safe distances. The data helps in calibration, validation, and optimization of the prototype.

Ultrasonic Sensor Distance Data

- The HC-SR04 ultrasonic sensor continuously measures the distance between the car and obstacles.
- Data is recorded at different positions and speeds to assess accuracy and responsiveness.
- Sample data is collected in centimeters (cm) using Arduino IDE serial monitor or LCD display.

Test No.	Actual Distance (cm)	Sensor Reading (cm)	Error (cm)
1	100	101	+1
2	70	69	-1
3	50	51	+1
4	30	29	-1
5	20	20	0

Table- 01: Ultrasonic Sensor Distance Readings

Distance from Obstacle (cm)	System Response	Motor Action	Buzzer Alert
>100 cm	Normal Driving	Full Speed	Off
50-100 cm	Warning Mode	Moderate Speed	Intermittent Beep
30-50 cm	Critical Warning	Slow Speed	Faster Beeping
<30 cm	Emergency Stop	Stop Immediately	Continuous Loud Beep

Table- 02: System Response Data

Voltage supply (V)	Motor RPM (calculated)
3.7	123
4.0	133
4.2 (full Charge)	140

Table- 03: Motor Performance Data

4.2 DISCUSSION

The project successfully demonstrates a simple and effective system to maintain a safe distance between vehicles, helping to prevent rear-end collisions. Using ultrasonic sensors and a microcontroller, the prototype detects obstacles ahead and either slows down or alerts the driver when the distance becomes unsafe. This system simulates basic functions of modern safety technologies like Adaptive Cruise Control.While the prototype performs well in controlled conditions, it has limitations such as sensor range, response time, and environmental sensitivity. For real-world use, more advanced sensors like radar or LiDAR and better algorithms would be needed. Overall, the project shows the potential of using automated systems to improve road safety and reduce accidents.

CHAPTER 5

CONCLUSION

5.1 CONCLUSION

The development of the Safe-Distance Maintaining Car to Prevent Accidents demonstrated the successful integration of embedded electronics, sensors, and motor control systems to enhance vehicle safety. The prototype highlights how simple, low-cost components such as the Arduino NANO, ultrasonic sensor, buzzer, LCD display, and Bluetooth module can be combined to create an effective accident-prevention system. Overall, the project successfully achieved its aim of designing and fabricating a Safe-Distance Maintaining Car that can prevent accidents through real-time obstacle detection, motor control, and user alerts. While there are limitations due to sensor range, speed, and power, the results prove that such a system can serve as the foundation for more advanced autonomous vehicle safety applications.

5.2 Advantage

- Accident Prevention: The car can automatically detect obstacles and maintain a safe distance, reducing the risk of collisions.
- Real-Time Monitoring: Distance is continuously measured by the ultrasonic sensor and displayed on the LCD, allowing real-time awareness of surroundings.
- Audible Alerts: The buzzer warns the user immediately when the car approaches an obstacle, enhancing safety.
- Low-Cost and Portable: Uses affordable components like Arduino Nano, HC-SR04 sensor, and 3.7V battery, making the system cost-effective and portable.
- Educational and Prototype Value: Demonstrates practical applications of sensors, motor control, and microcontroller programming.

5.3 Application

- Autonomous Vehicle Prototype: Serves as a miniature model for autonomous cars that maintain safe distance on roads.
- Robotics Education: Useful in academic and research projects for learning Arduino programming, sensor integration, and motor control.
- Obstacle Avoidance Systems: Can be applied in robotic vehicles or drones that need automatic obstacle detection and avoidance.
- Industrial Automation: Can be adapted for automated guided vehicles (AGVs) in factories or warehouses for safe navigation.
- Research and Development: Serves as a testing platform for developing advanced driver assistance systems (ADAS) like collision warning or emergency braking.
- Prototype for Future Smart Cars: Demonstrates how ultrasonic sensors, Bluetooth control, and motor driver systems can be combined for intelligent transportation solutions.

5.4 Future Recomendation

- Integration of Multiple Sensors: Adding additional ultrasonic or infrared sensors around the car for 360-degree obstacle detection.
- IoT and Cloud Connectivity: Integrate Wi-Fi or GSM modules to monitor the car remotely via a smartphone or web application.
- Advanced Autonomous Features: Implement automatic path planning and navigation algorithms using microcontrollers or single-board computers like Raspberry Pi.
- Enhanced Safety Mechanisms: Incorporate speed control based on obstacle proximity to prevent abrupt stops or collisions.
- Improved Power Management: Use higher-capacity batteries or solar-powered systems to extend runtime.
- Motor and Load Upgrades: Upgrade to high-torque gear motors for carrying heavier loads or for larger-scale vehicles.
- Machine Learning and AI Integration: Use AI-based obstacle recognition with cameras or LIDAR for better detection of irregular objects.

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Appendix:

Program for Arduino NANO:

```
#include <SoftwareSerial.h>
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27, 16, 2);

SoftwareSerial mySerial(7, 8);  // RX, TX

const int trigPin = A0;
const int echoPin = A1;
// defines variables
long duration;
int distance;

char command;
int MOTOR_A1 = 3;   // MOTOR_A1 connected to digital pin 7
int MOTOR_A2 = 5;   // MOTOR_A2 connected to digital pin 6
int MOTOR_B1 = 6;   // MOTOR_B1 connected to digital pin 5
int MOTOR_B2 = 11;  // MOTOR_B2 connected to digital pin 4
// for motor


int buzzer = 2;

void setup() {

  Serial.begin(9600);
  mySerial.begin(9600);  // Starts the serial communication

  pinMode(MOTOR_A1, OUTPUT);  // initialize MOTOR_A1 pin as an output
  pinMode(MOTOR_A2, OUTPUT);  // initialize MOTOR_A2 pin as an output
  pinMode(MOTOR_B1, OUTPUT);  // initialize MOTOR_B1 pin as an output
  pinMode(MOTOR_B2, OUTPUT);  // initialize MOTOR_B2 pin as an output

  digitalWrite(MOTOR_A1, LOW);
  digitalWrite(MOTOR_A2, LOW);
  digitalWrite(MOTOR_B1, LOW);
  digitalWrite(MOTOR_B2, LOW);

  pinMode(buzzer, OUTPUT);  // Sets the trigPin as an Output
```

```
  pinMode(trigPin, OUTPUT);  // Sets the trigPin as an Output
  pinMode(echoPin, INPUT);   // Sets the echoPin as an Input

  lcd.init();  // initialize the lcd
  lcd.backlight();
}

void loop() {


  if (mySerial.available()) {
    command = mySerial.read();
    Serial.println(command);
  }

  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10 micro seconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
  duration = pulseIn(echoPin, HIGH);
  // Calculating the distance
  distance = duration * 0.034 / 2;
  // Prints the distance on the Serial Monitor
  // Serial.print("Distance: ");
  // Serial.println(distance);


  // delay(500);
  // lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Car:");
  lcd.print(distance);
  lcd.print("Cm     ");

  if (distance >= 25) {


    if (command == 'F')  //forward
    {
      analogWrite(MOTOR_A1, 0);
      analogWrite(MOTOR_A2, 100);
      //run left motors clockwise
```

```
  analogWrite(MOTOR_B1, 100);
  analogWrite(MOTOR_B2, 0);

 } else if (command == 'B')  //Reverse
 {
  analogWrite(MOTOR_A1, 100);
  analogWrite(MOTOR_A2, 0);
  //run left motors anti-clockwise
  analogWrite(MOTOR_B1, 0);
  analogWrite(MOTOR_B2, 100);
  //digitalWrite(spker, LOW);
 }

 else if (command == 'L')  //Left
 {
  analogWrite(MOTOR_A1, 150);
  analogWrite(MOTOR_A2, 0);
  //run left motors clockwise
  analogWrite(MOTOR_B1, 150);
  analogWrite(MOTOR_B2, 0);

 } else if (command == 'R')  //Right
 {
  analogWrite(MOTOR_A1, 0);
  analogWrite(MOTOR_A2, 150);
  //run left motors anti-clockwise
  analogWrite(MOTOR_B1, 0);
  analogWrite(MOTOR_B2, 150);

 } else if (command == '0')  //stop
 {
  analogWrite(MOTOR_A1, 0);
  analogWrite(MOTOR_A2, 0);
  //stop left motors
  analogWrite(MOTOR_B1, 0);
  analogWrite(MOTOR_B2, 0);
 }

 digitalWrite(buzzer, LOW);
 lcd.setCursor(0, 1);
 lcd.print("               ");
}

if (distance <= 35) {
 lcd.setCursor(0, 1);
 lcd.print("Be Careful!     ");
```

```
   digitalWrite(buzzer, HIGH);
  }


  if (distance <= 25) {
   lcd.setCursor(0, 1);
   lcd.print("Danger! Be Safe.");
   digitalWrite(buzzer, HIGH);

   digitalWrite(MOTOR_A1, LOW);
   digitalWrite(MOTOR_A2, LOW);
   digitalWrite(MOTOR_B1, LOW);
   digitalWrite(MOTOR_B2, LOW);
   command = '0';
  }


  //command = 's';
}
```