# Faculty of Information Technology

# IS 1900 Business Project

# Object Detection Line Following Smart Toy Car

# Interim Report

**Group No: 22**

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# 1. Introduction

As the world gets more connected through technology, each and every field is stepping and must step to a higher level. Toy industry is also one of the major industries that should grow and be revolutionized in the modern society.

Children are eager to learn about the world around them. Every new colour, texture and shape is a learning experience for them. Use of toys are one of the best ways to entertain a child. Not only for entertainment but also, they can discover and explore the world around them through toys. As everything in the world is connected through IOT (Internet of things), everything has become digitalized, smart and automated. So, the children's toys also should become smart and automated with this technological development.

Now a days almost all the parents are busy with their career lives. So, their children get isolated. Use of a smart toy is an excellent way to compensate the isolation and the lack of communication when no one is around the child. Smart toys can also improve the analytical power and the imaginary power of a child as they enter to a digital world. With the same old toys and games children become disappointed and bored. Traditional entertainment methods are not enough for them.

So toys should become smart and the functions that can be done using a toy should become enhanced. There are some toys that have unique functionalities but with few or more bugs. Toy cars are a type of toy that is prominent among kids, teenagers as well as some adults .There are various types of toy cars. Majority of them are controlled manually. Some can be controlled remotely but they are not able to ascertain objects. Furthermore, those toy cars must be controlled every single second while playing. These cars are unable to function automatically.

So in this project we are designing a multifunctional, interactive smart toy car called, 'Object Detection Line Following Smart Toy Car'.

## 2. Literature Survey

Toys are the objects that are most popular among age groups below 12 years. Children use these toys, just to pass time while enjoying those, as small children do not have much to do other than play or cry. Among all the types of toys, there are various types of toy cars with or without specified functions for them.

Nowadays, there is a variety of toy cars in the market for higher prices. Some of them are controlled manually, some can be controlled remotely and the user can drive the toy car in any direction as they wish.

There are cars that can detect the obstacles and stop functioning [1]. There are some toy cars that can follow a unique color line so that the car is able to go on that line [2].

Our project is different from those cars as it is a multifunctional and interactive smart toy car. In our project, the toy car will move on a black color line. If any obstacle is identified, a buzzer will ring informing the child to remove that object from the path. This toy car is also able to control remotely through a mobile phone using a mobile application. Moreover, a LED will be switched on when the car is turning to a side as signal lights of normal vehicles.

# 3. Aim and Objectives

## 3.1 Aim

The main aim of this project is to design and develop a smart, automated and multi-functional toy car that can be used as an entertainment medium for children, which will also help them to explore the world around them and develop their creativity.

## 3.2 Objectives

- To make the car be able to follow a line automatically.
- To alert the user if there are any obstacles in the path of the car.
- To indicate the turning of the car.
- To work as a remotely controlled car using a mobile phone

# 4. System Description

Mainly this car will be able to follow a black line drawn by the child in a white paper or any white colour surface, with the use of two IR sensors. To make the car move, go forward, backward, left and right, four servo motors will be used for the four wheels. A motor driver will be used to drive the four motors. When the car turns left or right LEDs will work as signal lights, indicating the turning directions.

This toy car will also be able to detect objects in its path (on the black line), with the use of an ultrasonic sensor. If an object is detected on the black line, the car will be automatically stopped and a buzzer will ring, alerting the child to remove the object from the path. Once the object is removed car will start moving along the line again.

Aside from the automatic line following and object detection function, this car will also be able to use as a remotely controlled car, by the mobile phone with the use of a Bluetooth module.

Block diagram of the system is shown below.

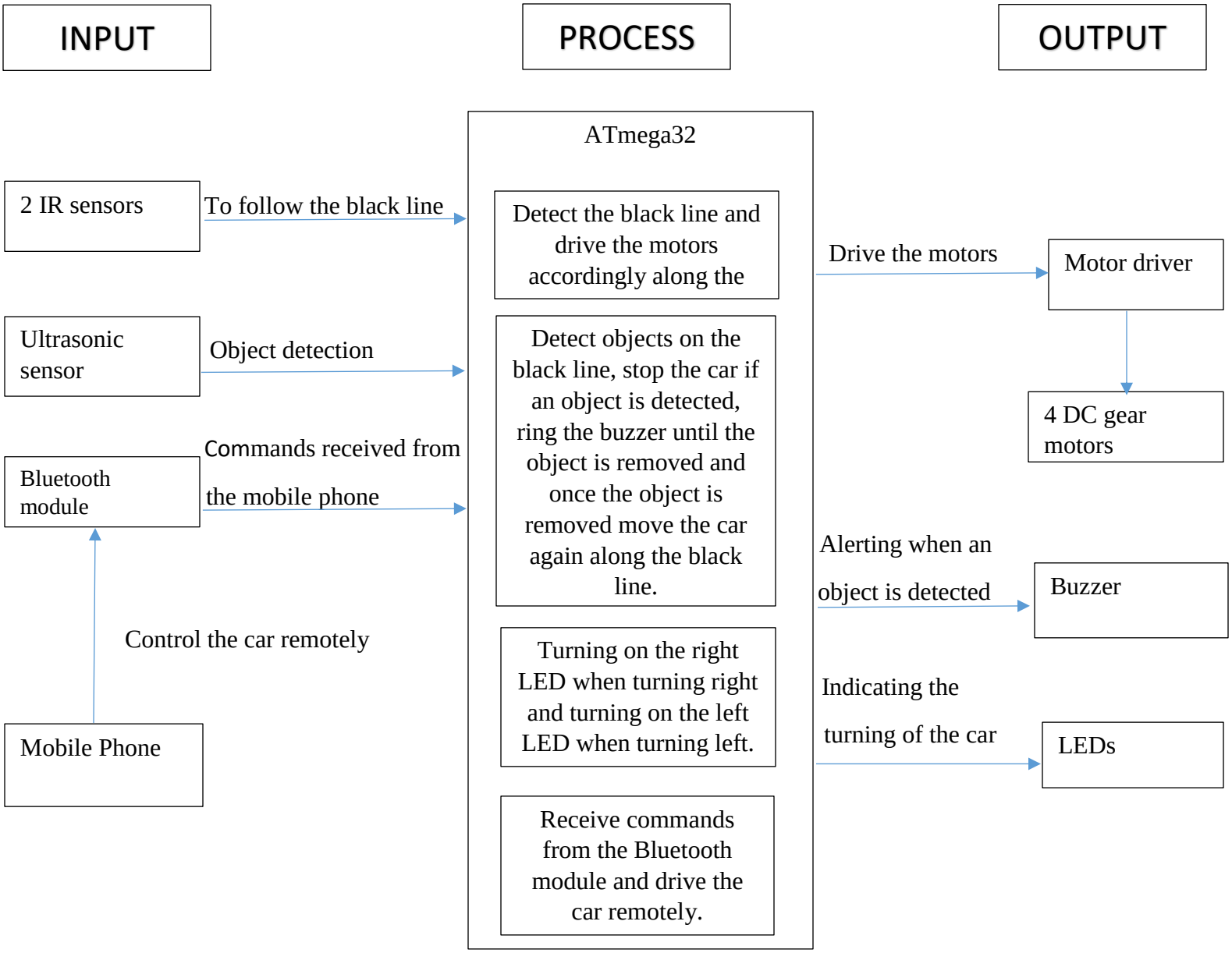


Figure 1 Block Diagram of the System

3D design of the Object Detection Line Following Smart Toy Car is shown below.

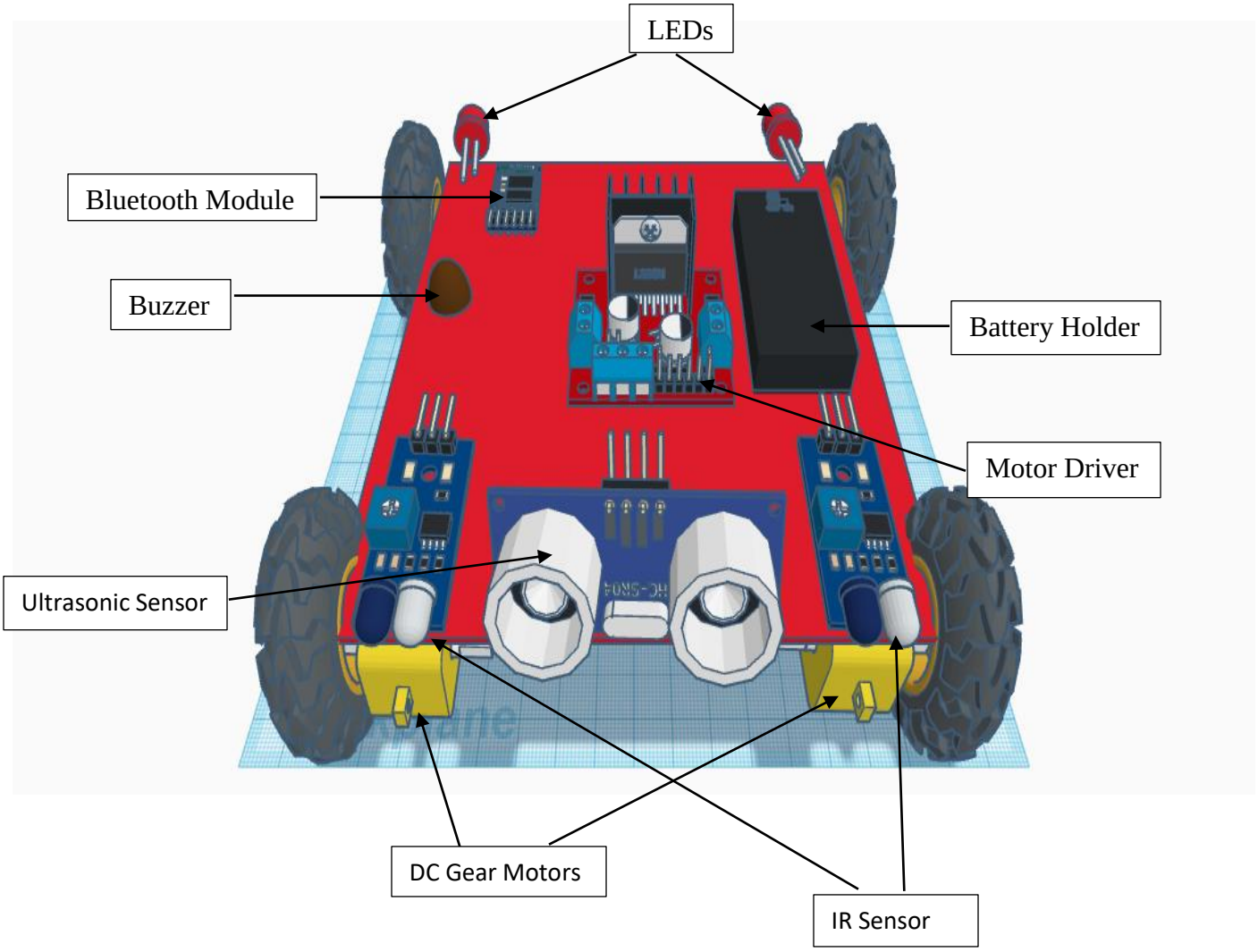


Figure 2 3D Design of Object Detection Line Following Smart Toy Car

# 5. Testing and Implementation

For testing and implementation, first we studied about the ATmega32 microcontroller as it is the used microcontroller in this project. Then we divided the sensors and the actuators among our group members and further studied about the specifications, how each component should be connected to the MCU, designed the circuit diagram of each component using PROTEUS software and started programming, following relevant websites, tutorials and online videos. (individual contribution is further explained under section 8 Individual Contribution)

## 5.1 Microcontroller Unit

ATmega32 microcontroller is used in this project to connect all the other hardware components such as sensors and actuators. The ATmega32 is powered by a supply voltage of 4.5V-5.5V. All the sensors and actuators are wired and connected to the MCU through its ports, PORTA, PORTB, PORTC and PORTD. The microcontroller unit performs corresponding actions for received values from the ports.

## 5.2 Sensors and Actuators

In this project two IR sensors, four DC gear motors, a motor driver for the DC gear motors, an Ultrasonic sensor, Bluetooth module, two LEDs and a buzzer is used. Specifications of each component, a brief description of the component technique and how the component is connected to the MCU is stated below.

### 5.2.1 IR sensor (205032R – Gunasinghe H.G.C.A)

Specifications of IR sensor is as follows [3].

Table 1 Specifications of IR Sensor

| | |
|---|---|
| Operating Voltage | 3.3V to 5V |
| Operating Current | 20 mA supply current |
| Detection Range | 2 cm to 30 cm (Adjustable using potentiometer) |
| Active output level | The output is 0 (Low) when an obstacle is detected |

In this project we are using two IR sensors to detect the black line (distinguishing between black and white colors ). IR sensor is a simple electronic device that emits and detects IR radiation in order to find out certain objects/obstacles in its range. IR Sensor Module has a built in IR transmitter and IR receiver that sends out infrared light and looks for reflected infrared light to detect the presence of any obstacle in front of the sensor module. There are three pins in the IR sensor, VCC, GND and OUT.

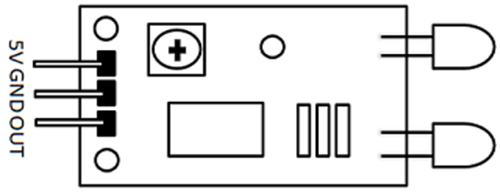


Figure 3 Pinout Diagram of IR Sensor

Circuit diagram of how the pins of two IR sensors should be connected to the MCU is shown below.

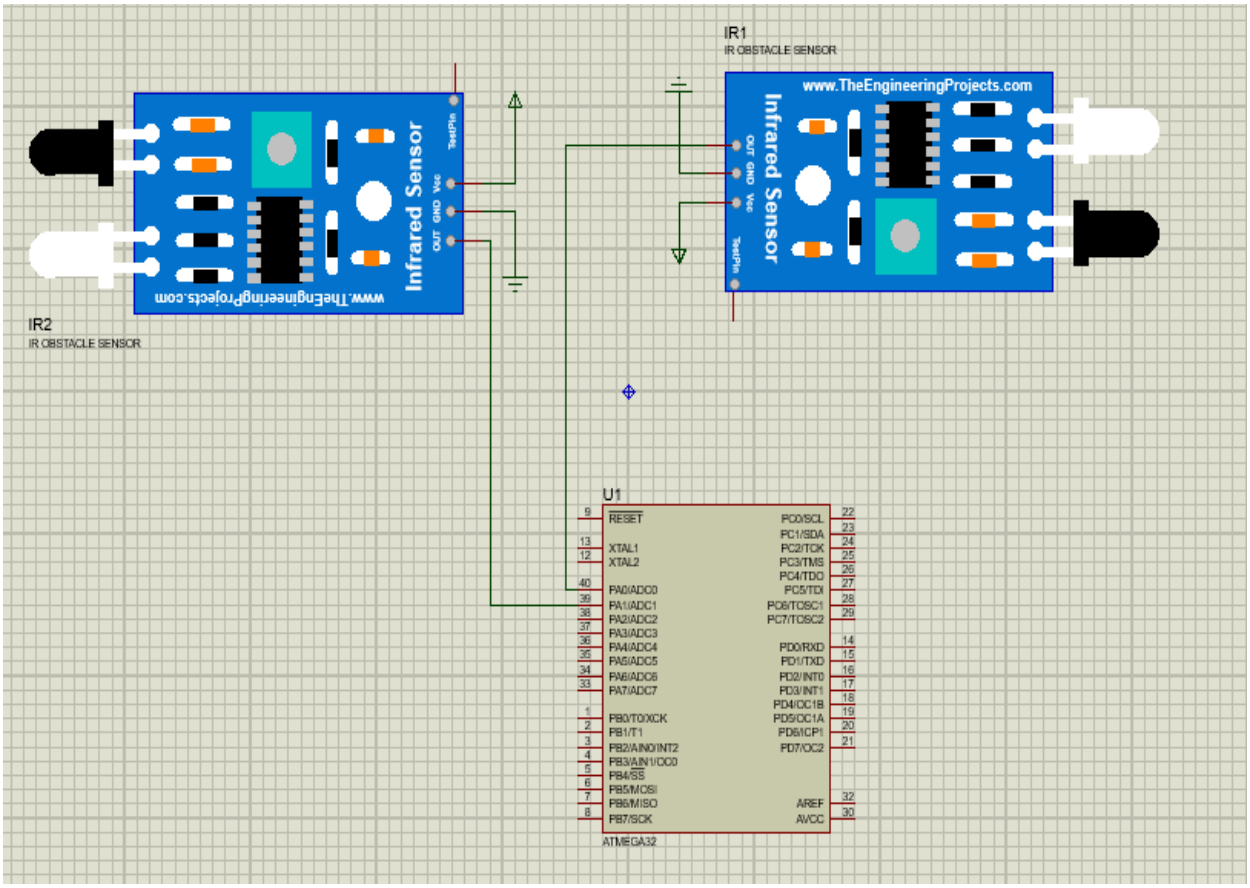


Figure 4 Circuit diagram IR Sensors

## 5.2.2 HC-SR04 Ultrasonic Sensor (205047R – Kalyanapriya K.B.V.T.R)

Specifications of Ultrasonic sensor is as follows [4].

Table 2 Specifications of Ultrasonic Sensor

| | |
|---|---|
| Operating Voltage | 5V |
| Operating Current | 15mA |
| Operating Frequency | 40KHz |
| Max Range | 4m |
| Min Range | 2cm |
| Ranging Accuracy | 3mm |
| Measuring Angle | 15 degree |
| Trigger Input Signal | 10µS TTL pulse |
| Dimension | 45 x 20 x 15mm |

In this project ultrasonic sensor is used to detect objects on the black line. Ultrasonic sensor measures the distance to an object using ultrasonic sound waves. The ultrasonic sensor uses a transducer, (a device that converts energy from one form to another) to send and receive ultrasonic pulses that relay back information about an object's proximity (nearness of an object). There are four pins the Ultrasonic sensor. VCC, TRIGGER, ECHO and GND.

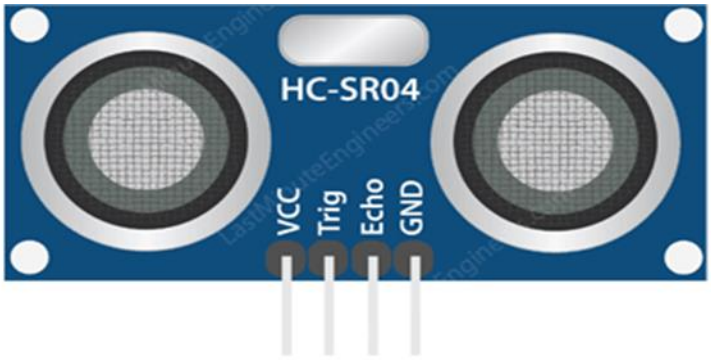


Figure 5 Pinout Diagram of HC-SR04 Ultrasonic Sensor

Circuit diagram of how the Ultrasonic sensor should be connected to the MCU is shown below.

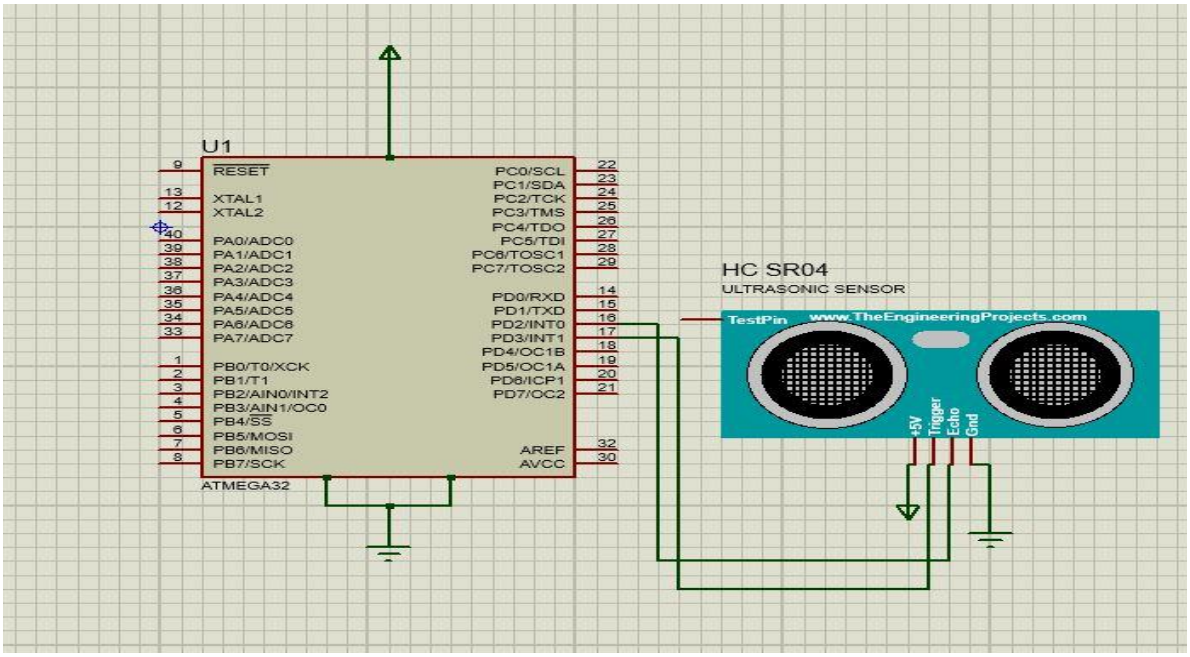


Figure 6 Circuit Diagram of HC-SR04 Ultrasonic Sensor

## 5.2.3 DC Gear Motors and L298N Motor Driver (205107D – Thathsaranee K.T)

Specifications DC gear motor 200 RPM is as follows [5].

Table 3 Specifications of DC Gear Motor

| | |
|---|---|
| Operating Voltage | 3V~6V |
| Operating Current | 150mA +/- 10% |
| Min. Operating Speed (3V) | 90+/- 10% RPM |
| Min. Operating Speed (6V) | 200+/- 10% RPM |
| Stall Torque (3V) | 0.4kg.cm |
| Stall Torque (6V) | 0.8kg.cm |
| Gear Ratio | 1:48 |
| Body Dimensions | 70 x 22 x 18mm |
| Wires Length | 200mm & 28 AWG |

In this project, four DC gear motors are used to move the toy with the aid of a motor driver. A gear motor is an all-in-one combination of a motor and gearbox. The addition of a gear head to a motor reduces the speed while increasing the torque output. The most important parameters in regards to gear motors are speed (rpm), torque (lb-in), and efficiency (%). In order to have complete control over the DC gear motor, we have to control its speed and rotation direction. This can be achieved by combining these two techniques. (PWM, H-Bridge).

The L298N is a dual-channel H-Bridge motor driver capable of driving DC motors. That means it can individually drive up to two motors making it ideal for building two-wheel robot platforms. Here, 4 motors will be connected with a parallel connection so that it is able to connect all the 4 motors to one L298N module. Pins of L298N Motor driver are VCC, GND, 5V, ENA pins, IN pins and OUT pins. DC gear motors are connected to the L298N module. Then L298N module is connected to the Atmega32.

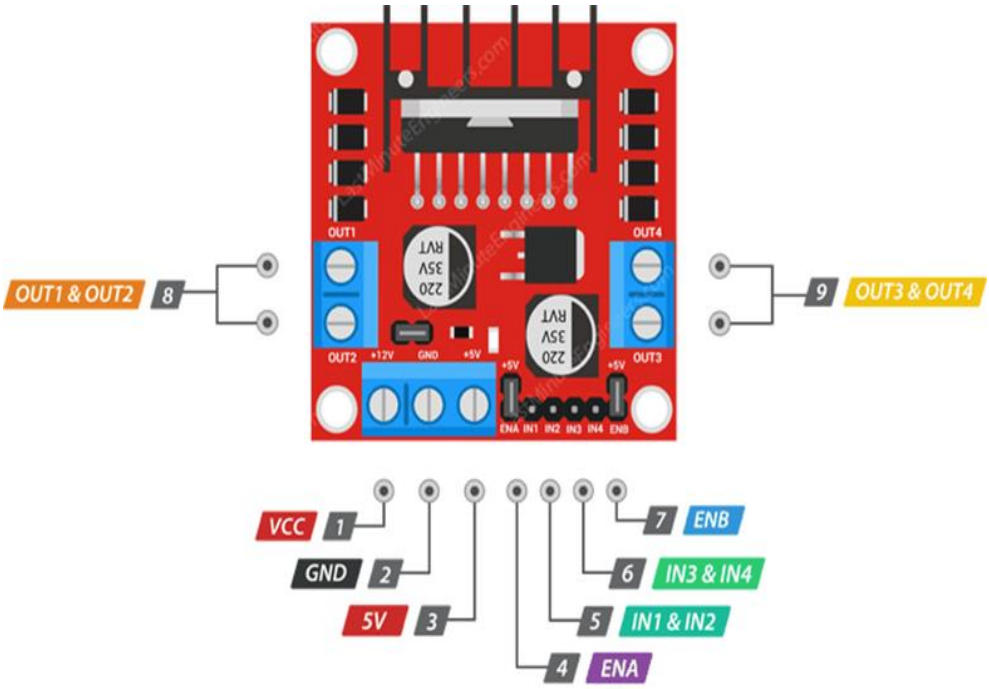


Figure 7 Pinout Diagram of L298N Motor Driver

Circuit diagram of how the DC gear motors and the L298N Motor driver should be connected to the MCU is shown below.

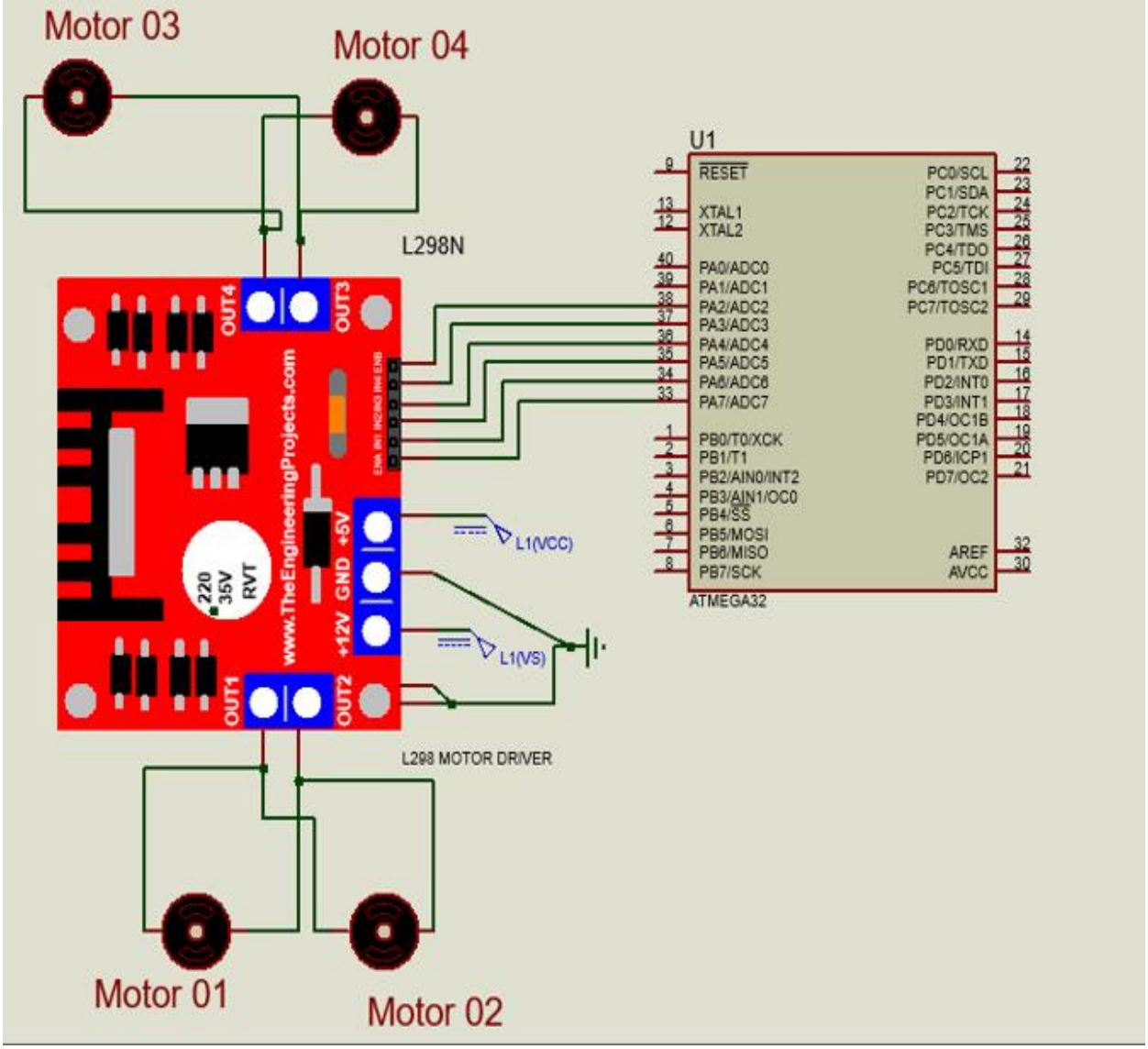


Figure 8 Circuit Diagram of DC Motors and L298N Motor Driver

## 5.2.4 HC-05 Bluetooth Module (205124C – Sandamini M.D.R)

Specifications of HC-05 Bluetooth Module is as follows [6].

Table 4 Specifications of HC-05 Bluetooth Module

| | |
|---|---|
| Bluetooth protocol | Bluetooth Specification v2.0+EDR(Enhance Data Rate) |
| Frequency | 2.4GHz ISM band |
| Modulation | GFSK(Gaussian Frequency Shift Keying) |
| Emission power | ≤-84dBm at 0.1% BER |
| Speed | Asynchronous communication: 2.1Mbps(Max) / 160kbps, Synchronous communication: 1Mbps / 1Mbps |
| Security | Authentication and encryption |
| Profiles | Bluetooth serial port |
| Supply Voltage | +3.3V to 6.0 V |
| Supply Current | 30mA |
| Working temperature | -20 ~ +75Centigrade |
| Dimension | 26.9mm x 13mm x 2.2 mm |

HC-05 Bluetooth module is a Bluetooth to serial converter that connects the microcontroller to other Bluetooth enabled devices(mobile phone).The Bluetooth module is used to control the car remotely using a mobile phone apart from its main functions, line following and object detection. Especially if the car is not on a black line, by using Bluetooth we are able to take it to the correct path. Bluetooth module has six pins. ENABLE, VCC, GROUND, TX(Transmitter), RX(Receiver) and STATE.

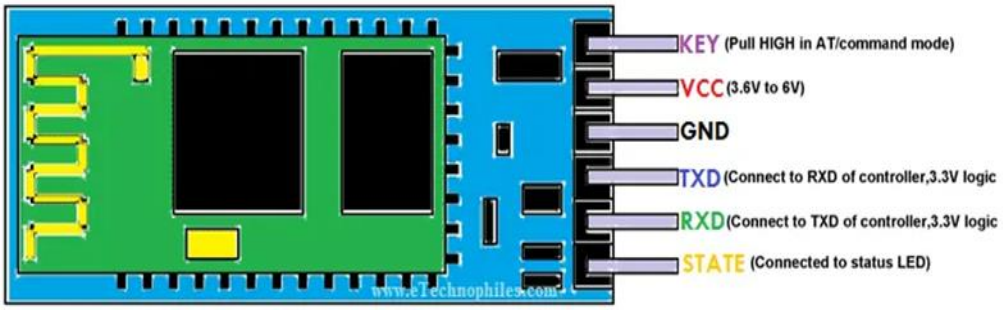


Figure 9 Pinout Diagram of HC-05 Bluetooth Module

Circuit diagram of how the HC-05 Bluetooth module should be connected to the MCU is shown below.

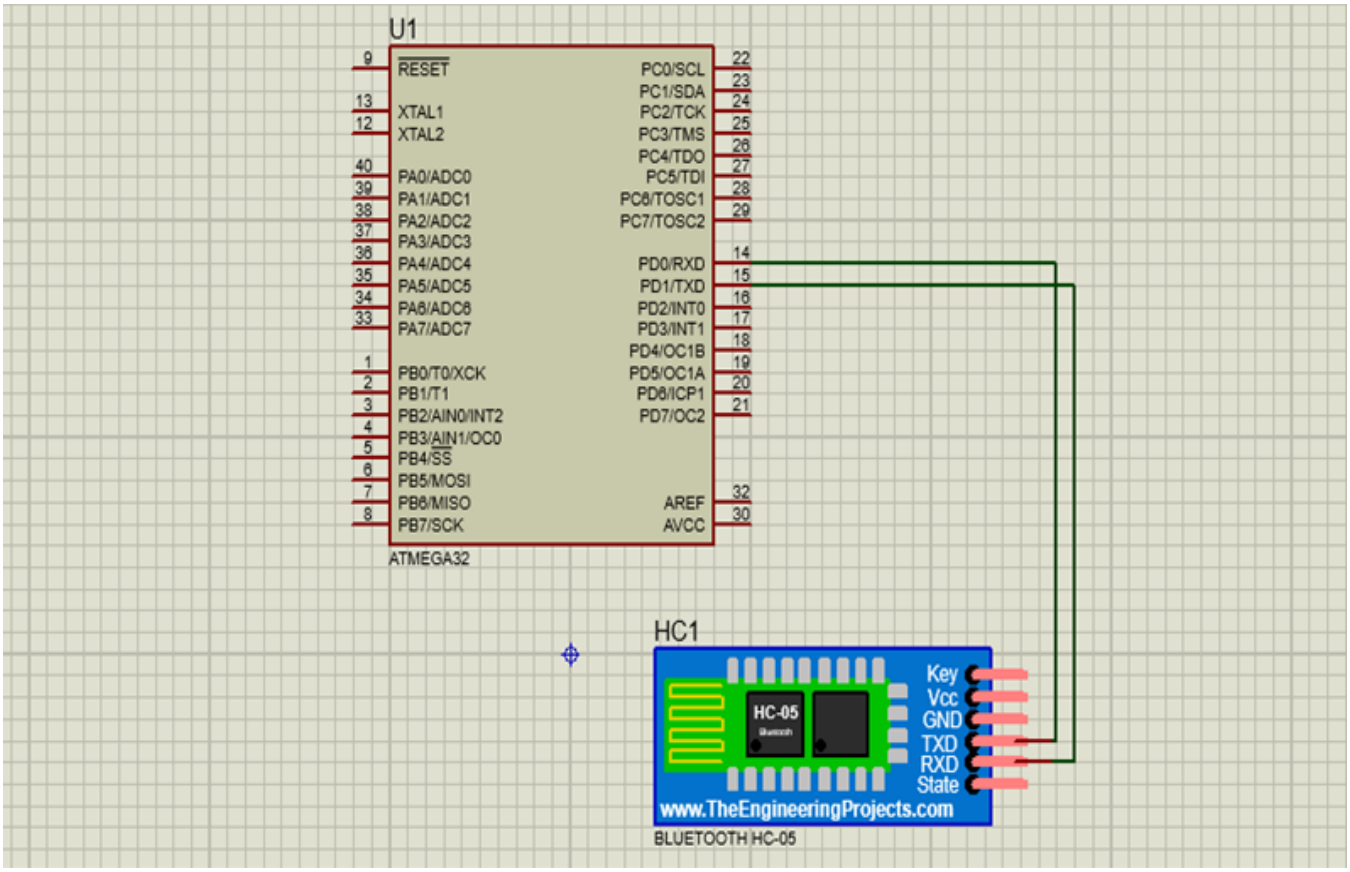


Figure 10 Circuit Diagram of HC-05 Bluetooth Module

## 5.2.5 Buzzer and the LEDs (205070F – Nimesha M.K.B)

Specifications of the buzzer is as follows [7].

Table 5 Specifications of Buzzer

| | |
|---|---|
| Frequency Range | 3300Hz |
| Operating Temperature | – 20° C to +60°C |
| Operating Voltage | 3V to 24V |
| Sound Pressure Level | 85dBA or 10cm |
| Supply Current | below 15mA |

In this project a buzzer is used in order to produce a beeping sound when the toy car detects an obstacle on the black line by using an ultrasonic sensor. The buzzer starts to produce a beeping sound until the object is removed. The buzzer is a sounding device that can convert audio signals into sound signals. It is usually powered by DC voltage.

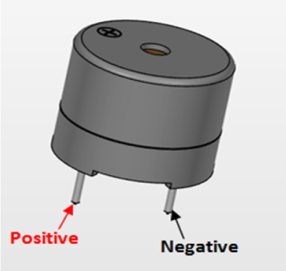


Figure 11 Pinout Diagram of Buzzer

Circuit diagram of how the buzzer should be connected to the MCU is shown below.

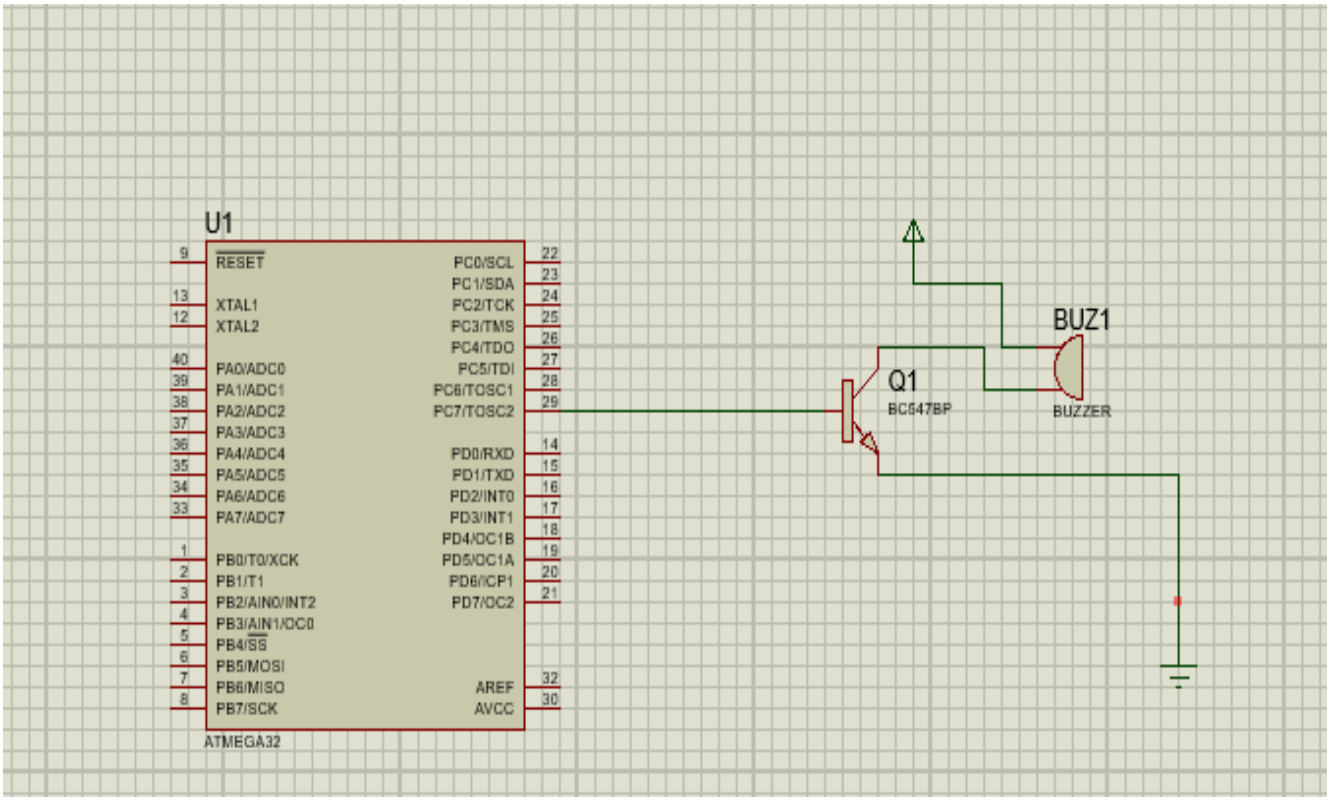


Figure 12 Circuit Diagram of Buzzer

Specifications of the LED is as follows [8].

Table 6 Specifications of LED

| | |
|---|---|
| Forward Current (IF) | 30mA |
| Forward Voltage (VF) | 1.8V to 2.4V |
| Reverse Voltage | 5V |
| Operating Temperature | -30℃ to +85℃ |
| Storage Temperature | -40℃ to +100℃ |
| Luminous Intensity | 20mcd |

In this project LEDs are used to indicate the turning of the car. When the car turns left the left LED will blink and when the car turns right, the right LED will blink. A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. It has two pins, ANODE and CATHODE.

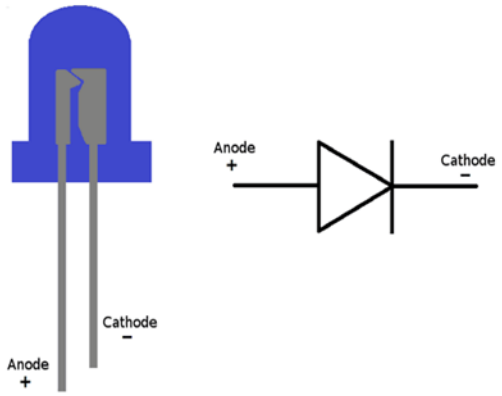


Figure 13 Pinout Diagram of LED

Circuit diagram of how the buzzer should be connected to the MCU is shown below.

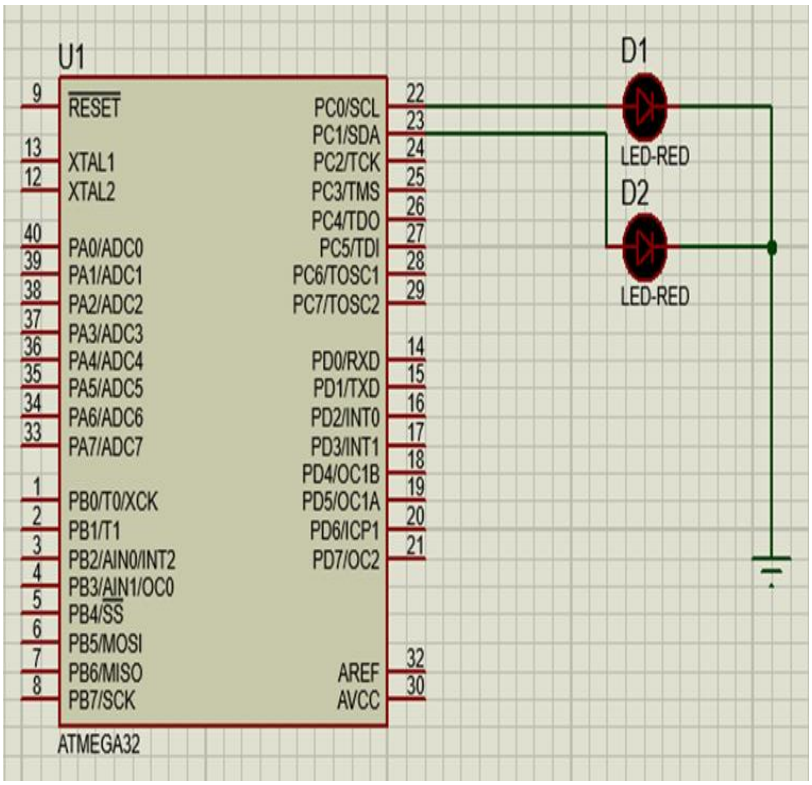


Figure 14 Circuit Diagram of LEDs

Full schematic diagram after integrating all the individual component circuits together are shown below.

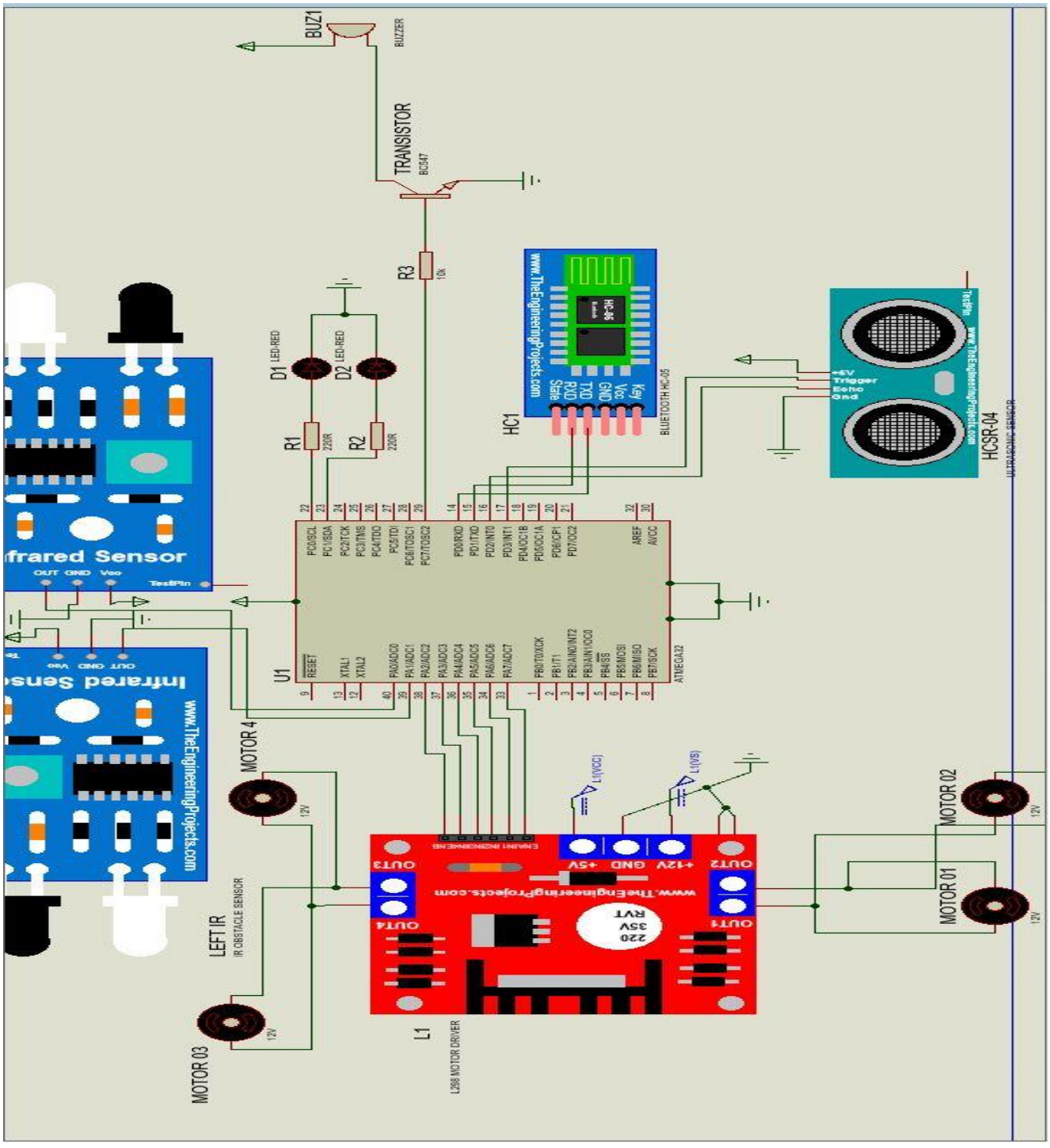


Figure 15 Full Schematic Diagram

# 6. Estimated Cost and Expenditure

Table 7 Cost Estimation

| **Components** | **Price** |
|---|---|
| 2 IR sensors | Rs.320.00 |
| Ultrasonic sensor | Rs.300.00 |
| Bluetooth module (HC-05) | Rs.850.00 |
| L298N motor driver | Rs.360.00 |
| 4 DC gear motors | Rs.2800.00 |
| Buzzer | Rs.150.00 |
| LEDs | Rs.500.00 |
| 4 Rubber wheels | Rs.1400.00 |
| 2 18650 Li-on battery | Rs.600.00 |
| Micro controller (Atmega32) | Rs.600.00 |
| Total cost | Rs.7880.00 |

# 7. References


[1]“Obstacle Avoiding Robot using Arduino”. [Online]. Available: https://www.electronicshub.org/obstacle-avoiding-robot-arduino/. [Accessed: 30-Nov.-2021].

[2]“Arduino Line Follower Robot”. [Online]. Available: https://www.electronicshub.org/arduino-line-follower-robot/. [Accessed: 30-Nov.-2021].

[3]“IR Sensor Module Pinout, Features & Datasheet”. [Online]. Available: https://components101.com/sensors/ir-sensor-module. [Accessed: 30-Nov.-2021].

[4]“Ultrasonic Ranging Module HC - SR04 - Product features”. [Online]. Available: https://cdn.sparkfun.com/datasheets/Sensors/Proximity/HCSR04.pdf. [Accessed: 30-Nov.-2021].

[5]“DC Motor - Definition, Working Principle, Types, Uses, FAQs”. [Online]. Available: https://byjus.com/physics/dc-motor/. [Accessed: 30-Nov.-2021].

[6]“HC-05 Bluetooth Module Pinout, Specifications, Default Settings ...”. [Online]. Available: https://components101.com/wireless/hc-05-bluetooth-module. [Accessed: 30-Nov.-2021].

[7]“Buzzer : Working, Types, Circuit, Advantages & Disadvantages”. [Online]. Available: https://www.elprocus.com/buzzer-working-applications/. [Accessed: 30-Nov.-2021].

[8]“5mm Round LED”. [Online]. Available: https://components101.com/diodes/5mm-round-led. [Accessed: 30-Nov.-2021].

# 8. Appendix

# Appendix A – Individual Contribution

## 1. 205032R – Gunasinghe H.G.C.A

In our project I was responsible for interfacing the two Infrared sensors with the ATmega 32 Microcontroller. Basically the two IR sensors are used to follow the black colored line. Both the sensors are placed on each sides of the toy car. First I studied about the Infrared sensors, purpose, how it works, specifications etc. with the use of several websites, data sheets and YouTube videos. Then I studied about the ATmega 32 microcontroller, its ports and pins and did the implementation by using proteus software. After doing the implementation I started on working with the coding part.

(Further details, specifications and the schematic diagram of interfacing IR sensors with the ATmega32 is in section 5 'Testing and Implementation'.)

I also designed the full schematic circuit diagram of our system and the block diagram.

## 2. 205047R – Kalyanapriya K.B.V.T.R

I was responsible for interfacing the HC-SR04 Ultrasonic sensor with the ATmega32 microcontroller. In this project Ultrasonic sensor is used to detect objects on the black line. In order to interface the Ultrasonic sensor with the ATmega32, first I studied all the specifications related to the HC-SR04 module using several datasheets and websites. I also studied the pins and ports of ATmega32 and the proteus software in order to draw the schematic diagram of interfacing the HC-SR04 module with the ATmega32. Meanwhile I also started to study the ATMEL studio software and implement the coding part of the Ultrasonic sensor.

(Further details, specifications and the schematic diagram of interfacing HC-SR04 Ultrasonic sensor with the ATmega32 is in section 5 'Testing and Implementation'.)

I also did report writing along with another member.

## 3. 205070F - Nimesha M.K.B

In this project LEDs are used as signal lights. When the vehicle turns right the right side LED starts to blink and when it turns left the left LED starts to blink. First I start studying about the specification of LED and then designed the structure of the LED. By referring the data sheets I identified the pins ports that needs when connecting the LED to microcontroller. By using the proteus software I drew the schematic diagram of the LED. After the circuit implementation I started to study about the coding and that part is still in progress.

This automated toy car is able to detect the objects in its path (on the Black line) and when an object is detected the car will stop and at the meantime the buzzer starts to ring until the obstacle is removed from that place. In this component first I started to study about the components and its designing structure then by using the proteus software I have drawn the schematic diagram of the buzzer connecting to the Atmega32 microcontroller. After the circuit implementation I start to study about the coding and that part is still in progress.

(Further details, specifications and the schematic diagrams of interfacing these components with the ATmega32 is in section 5 ‘Testing and Implementation’.)

I also designed the 3D model of our toy car.

## 4. 205107D - Thathsaranee K.T

In our hardware project, I was assigned to connect DC gear motors for the toy car. The purpose of the DC gear motor is to move the toy car. The toy car uses four wheels to move from one point to another point. In order to operate four wheels, each wheel should have a DC gear motor. But gear motor is not able to connect with the microprocessor directly. So, I have studied the ways of connecting gear motor to microprocessor along with the pins through YouTube and other websites. Then I identified that, a motor driver should use to connect motors with the microprocessor. The most commonly used motor driver IC’s are L293 and L298 series such as L293D, L293NE, and L298N, etc. I selected the L298N motor driver that matches our requirements.

(Further details, specifications and the schematic diagrams of interfacing these components with the ATmega32 is in section 5 ‘Testing and Implementation’.)

I also did report writing along with another member.

## 5. 205124C - Sandamini M.D.R

In this project, I was responsible for interfacing the Bluetooth module with the Atmega 32 microcontroller. Basically, in this project Bluetooth is used to control the car remotely. My task is to get the commands from the mobile phone in order to control the car. Therefore, in the first place I studied about the HC-05 Bluetooth module (specifications, pins, etc) using several datasheets, websites and YouTube videos, how the mobile phone connect with the Bluetooth module. I also studied about the pins and ports of Atmega32 and did implementation using Proteus software to get a better understand. After doing the implementation I started working on my coding part.
(Further details, specifications and the schematic diagram of interfacing HC-05 Bluetooth module with the ATmega32 is in section 5 'Testing and Implementation'.)
I also did the animation video showing the functionality of our project.

# Appendix B – Action Plan for Remaining Work

| | Group Member | Task | Duration | Starting Date | 30-Nov | 7-Dec | 14-Dec | 21-Dec | 28-Dec | 04-Jan | 11-Jan | 18-Jan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 205070F | Programming and testing | 3 weeks | 30-Nov | | | | | | | | |
| | | Simulation | 3 weeks | 28 - Dec | | | | | | | | |
| 2 | 205047R | Programming and testing | 3 weeks | 30 - Nov | | | | | | | | |
| | | Simulation | 3 weeks | 28 - Dec | | | | | | | | |
| 3 | 205124C | Programming and testing | 3 weeks | 30 - Nov | | | | | | | | |
| | | Simulation | 3 weeks | 28 - Dec | | | | | | | | |
| 4 | 205107D | Programming and testing | 3 weeks | 30 - Nov | | | | | | | | |
| | | Simulation | 3 weeks | 28 - Dec | | | | | | | | |
| 5 | 205032R | Programming and testing | 3 weeks | 30 - Nov | | | | | | | | |
| | | Simulation | 3 weeks | 28 - Dec | | | | | | | | |