BIRZEIT UNIVERSITY

Department of Electrical & Computer Engineering

ENCS4380 - INTERFACING TECHNIQUES

Homework #1: Intelligent Sensor System
Obstacle avoiding robot

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1 System Analysis

1.1 System Description

The main challenge in building mobile robots is the ability to identify and avoid obstacles. An intelligent robot that can automatically detect and avoid obstacles on its route is called an obstacle avoidance robot. It is equipped with an Ultrasonic sensor to identify obstructions in its route and an Arduino UNO Micro-controller to interpret the data. Without it, robot motion would be extremely limited and brittle. This robot is capable of making decisions on its own; if something is in its path, it will change direction. The robot scans left and right first, then turns to move in the direction with the most open space.

1.2 Algorithm

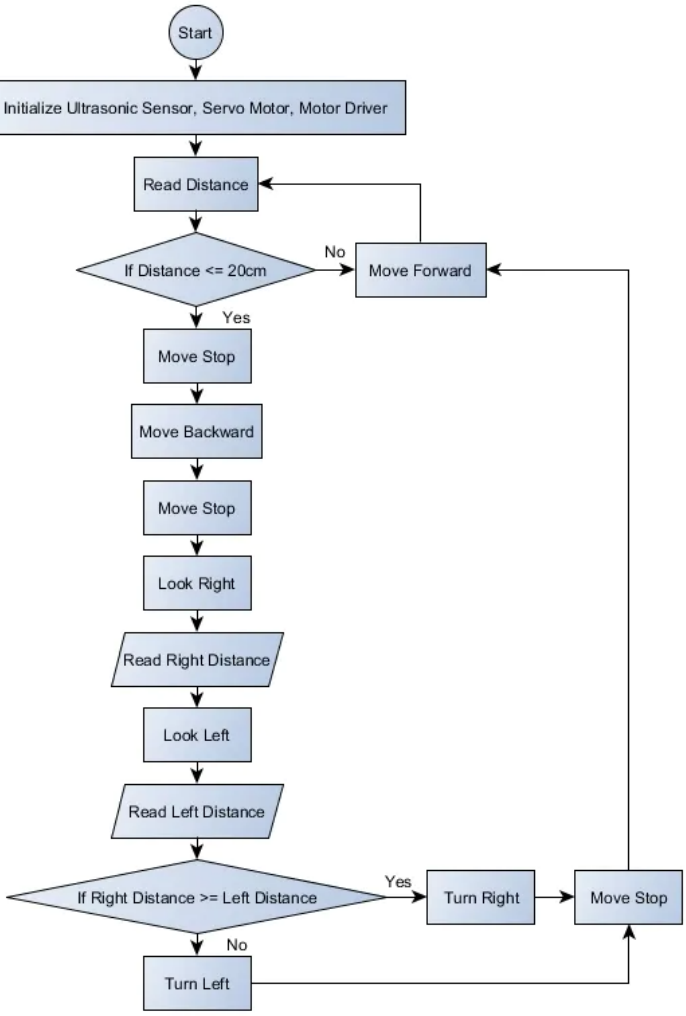

Figure 1.1: Algorithm/Flowchart Diagram

1.3 Block Diagram

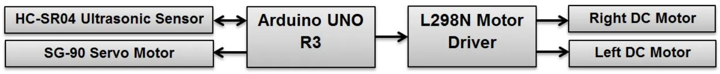

Figure 1.2: Block Diagram

1.4 Components Required for obstacle avoiding robot

- Arduino board.
- HC-SR04 Ultrasonic Sensor.
- LM298N Motor Driver Module.
- 5V DC Motors.
- Battery.
- wheels.
- Jumper Wires.

2 System Characteristics

2.1 ARDUINO NANO

The ATmega328P-based Arduino Nano is a compact, finished, and breadboard-friendly board that was first introduced in 2008. It provides the same connectivity and specifications as the Arduino Uno board in a smaller compact factor. The Arduino Nano has 30 male I/O headers that are arranged in a DIP-30-like configuration. These I/O headers can be used to program the board using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and capable of running two of them simultaneously online and offline. The board may be powered by a 9 V battery or a type B micro USB connection.

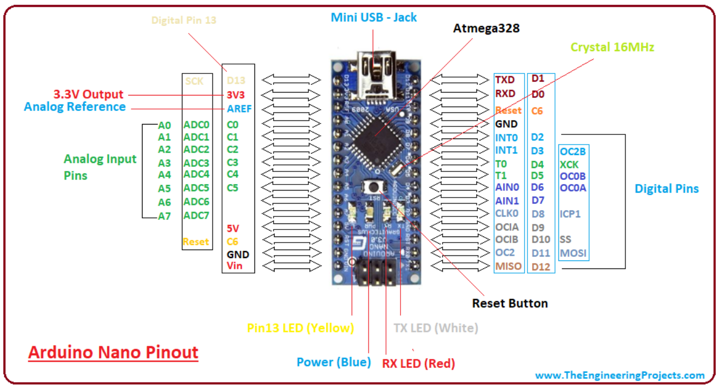

Figure 2.1: Arduino Nano

You may power the Arduino using a battery, an AC-to-DC converter, or by connecting it to a computer through a USB cable. The adapter should have a rating of 9V DC 100-500mA and come with a 2.1mm barrel plug and distinct tip. There is a jumper cord with 3 pins next to the USB jack. If the jumper wires are on the two pins before the USB jack, you are powering through a USB cable; if they are on the two pins before the DC connector, you are powering via a battery or wall adapter. The USB link is used to transport data equally between the Arduino and the PC, and this is authorized. The easy programming of Arduino Uno is one of its advantages. The Integrated Development Environment is used to program the Arduino (IDE). Embedded C language has been chosen as the programming language. It aids in the design of machines and systems that affect the environment by utilizing signals from sensors.

2.2 Ultrasonic Sensor

Understanding how the ultrasonic sensor operates is crucial before beginning the robot's construction since this sensor will be crucial in identifying obstacles. The fundamental idea behind how an ultrasonic sensor operates is to keep track of how long it takes the sensor to broadcast ultrasonic beams and how long it takes to receive them after they have struck a surface. The distance is then determined further using the formula. The HC-SR04 Ultrasonic Sensor, which is generally accessible, is utilized in this project. The same method as previously described will be used to use this sensor.

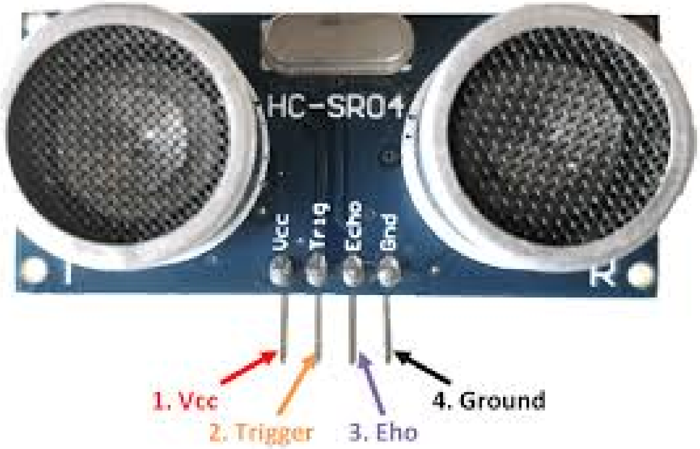

Figure 2.2: Ultra Sonic Sensor

So, the Trig pin of HC-SR04 is made high for at least 10 us. A sonic beam is transmitted with 8 pulses of 40KHz each.

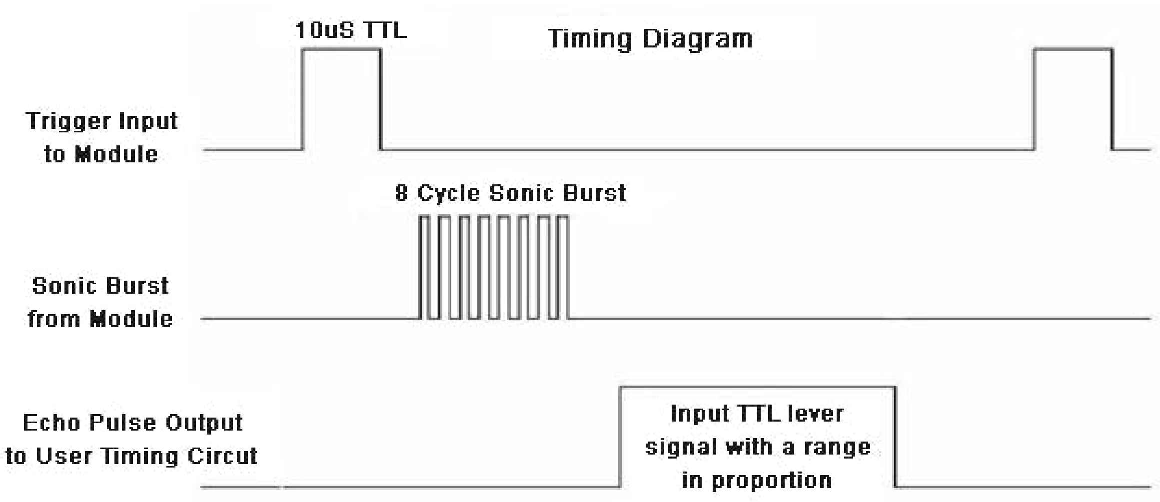

Figure 2.3: Ultrasonic Timing Diagram

The signal then strikes the surface, bounces back, and is picked up by the HC-SR04 receiver's Echo pin. When the pin was sent high, it had already reached its highest point.

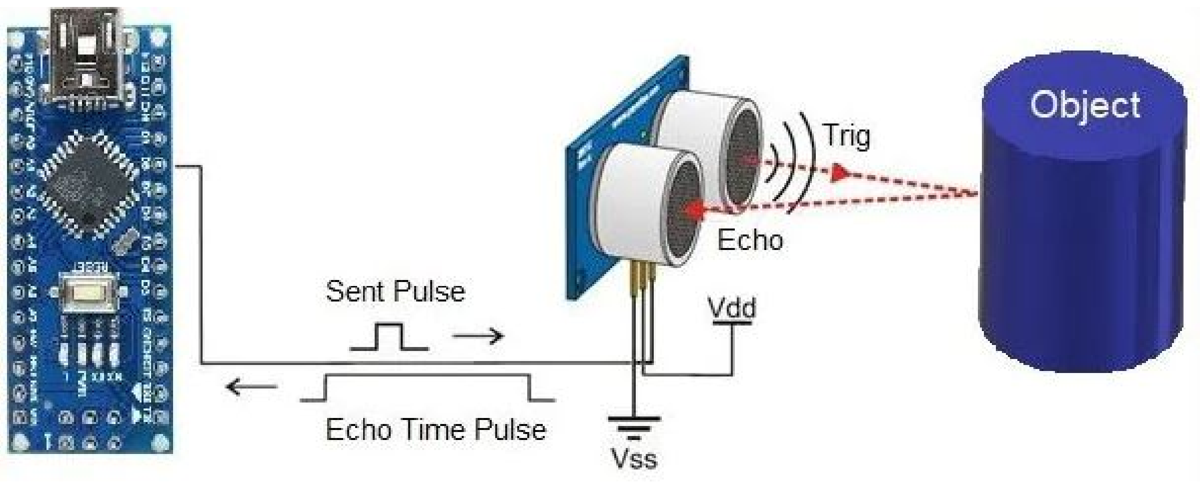

Figure 2.4: Simulated Ultra Sonic Sensor

The length of time that the beam takes to return is recorded in a variable and converted to distance using the following calculations:

$$Distance = Time \cdot \frac{SpeedofSoundinAir(343\frac{m}{s})}{2} \tag{1}$$

The next figure shows the calibration curve of HC-SR04 Ultrasonic Sensor:

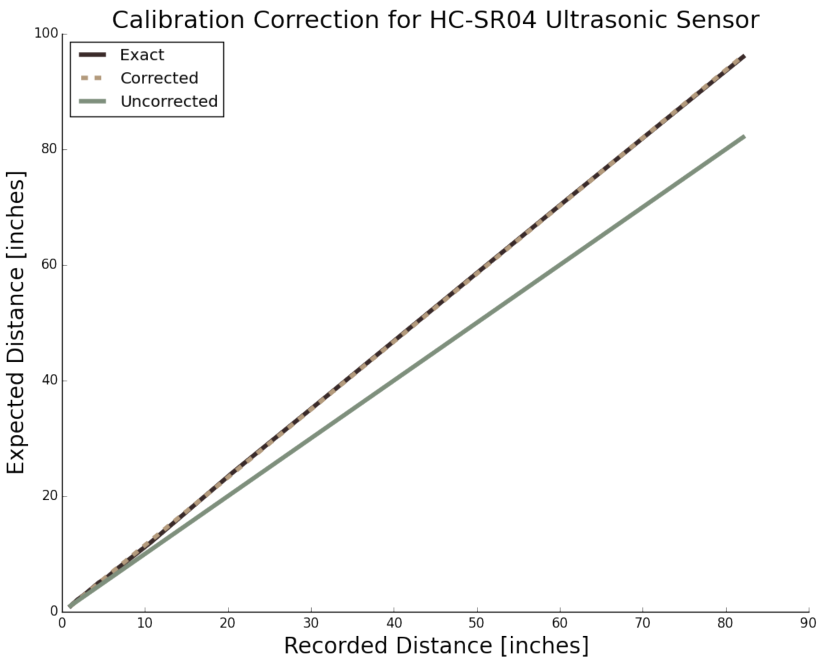

Figure 2.5: Ultra Sonic Sensor Calibration Curve

2.3 LM298N Motor Driver Module

This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

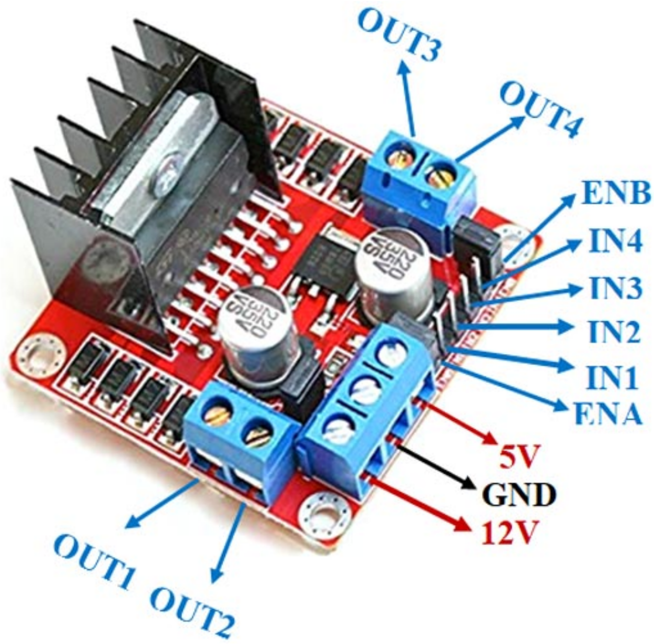

Figure 2.6: LM298N Motor Driver Module

2.3.1 PWM – to control speed

A DC motor's speed may be altered by altering the input voltage. Pulse width modulation is an approach that is frequently used to achieve this (PWM).

PWM is a method that involves transmitting a sequence of ON-OFF pulses to change the average value of the input voltage. The Duty Cycle, often known as the average voltage, is a function of the pulse width.

The average voltage delivered to the DC motor increases with increasing duty cycle, increasing motor speed. The average voltage provided to the DC motor decreases as the duty cycle gets shorter, which slows down the motor speed.

The image below shows PWM technique with various duty cycles and average voltages:

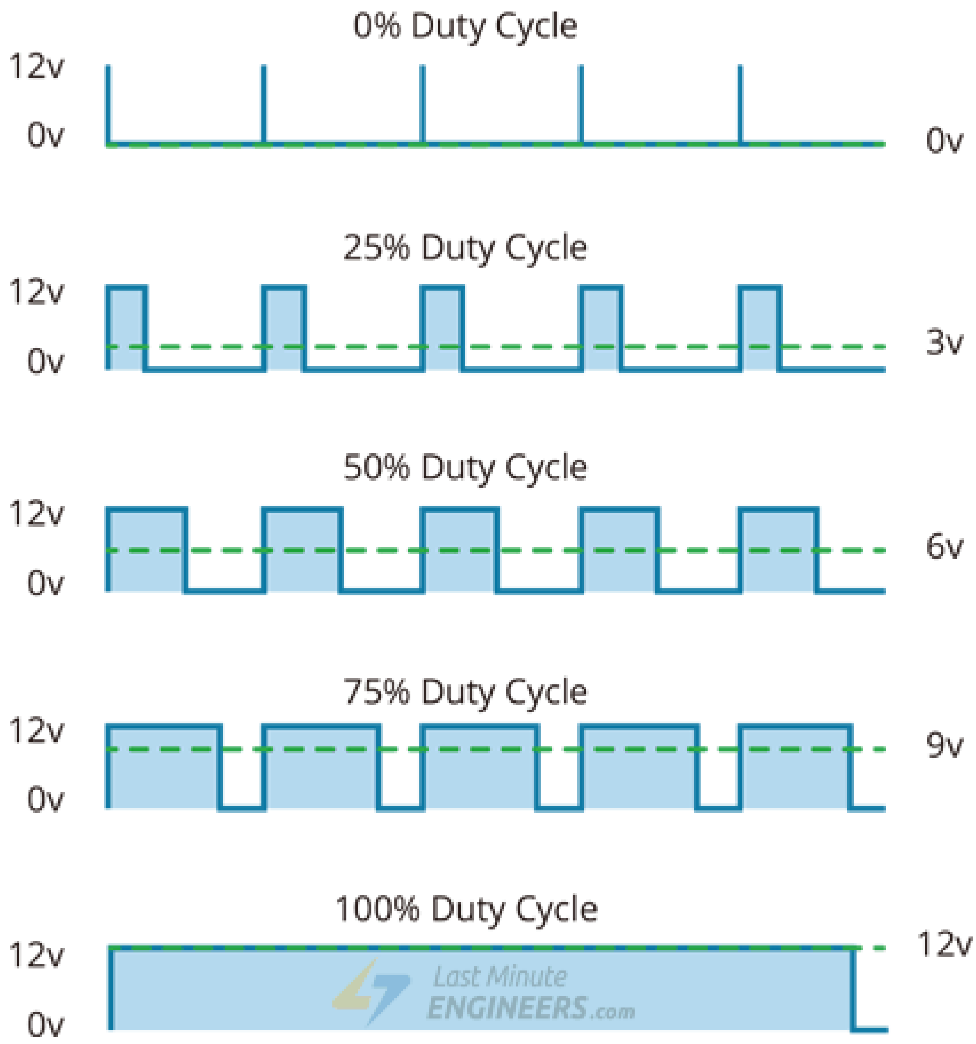

Figure 2.7: Pulse Width Modulation(PWM) Technique

2.4 5 DC motors

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 magnetic fields.

Figure 2.8: 5 DC motor

2.4.1 DC Motor Performance Curves

The DC motor's usual speed-torque curve is seen below. If we look attentively, the hot motor curve exhibits an intriguing behavior. The no-load speed grows together with the motor temperature. This is a result of how heat affects magnets. The speed will return to normal once the motor begins to cool. The opposite end of the curve, when stall torque is decreased for a "hot" motor, follows the same reasoning. Observe the efficiency curve, and how the motor's peak efficiency should occur close to its working torque under ideal conditions.

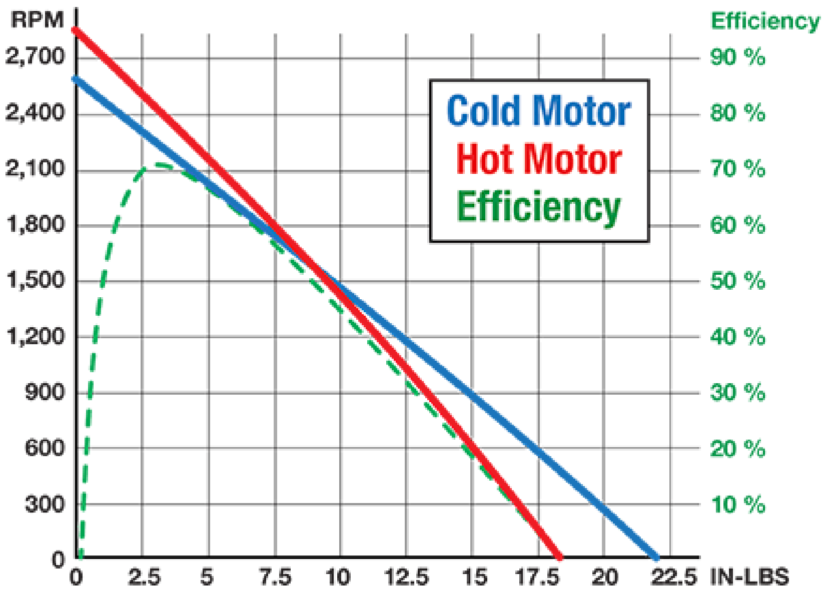

Figure 2.9: DC motor curve

3 Design of The System

Robot movement is guided by sensors in the directions of forward, backward, left, and right. When a barrier that ultrasonic sensors can identify is in its path, the robot's progress will halt.

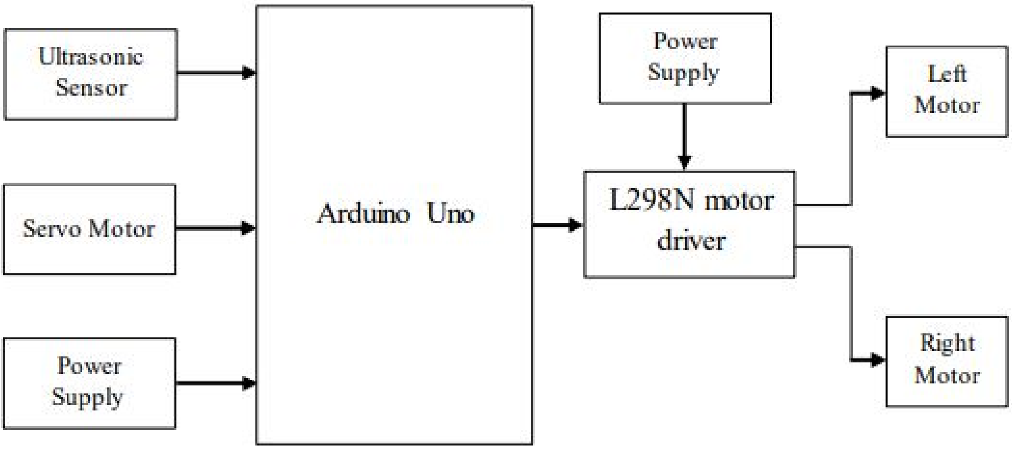

Figure 3.1: Structure of obstacle avoiding Robot

3.1 Circuit Diagram

The system employed two distinct power sources: a 9V battery to power the microcontroller module and a 12V source that was regulated to 5V to power the ultrasonic sensor. Two servo motors were installed to both of the rear wheels of the three-wheel obstacle-avoiding robot and placed side by side to provide a stable and smooth performance.

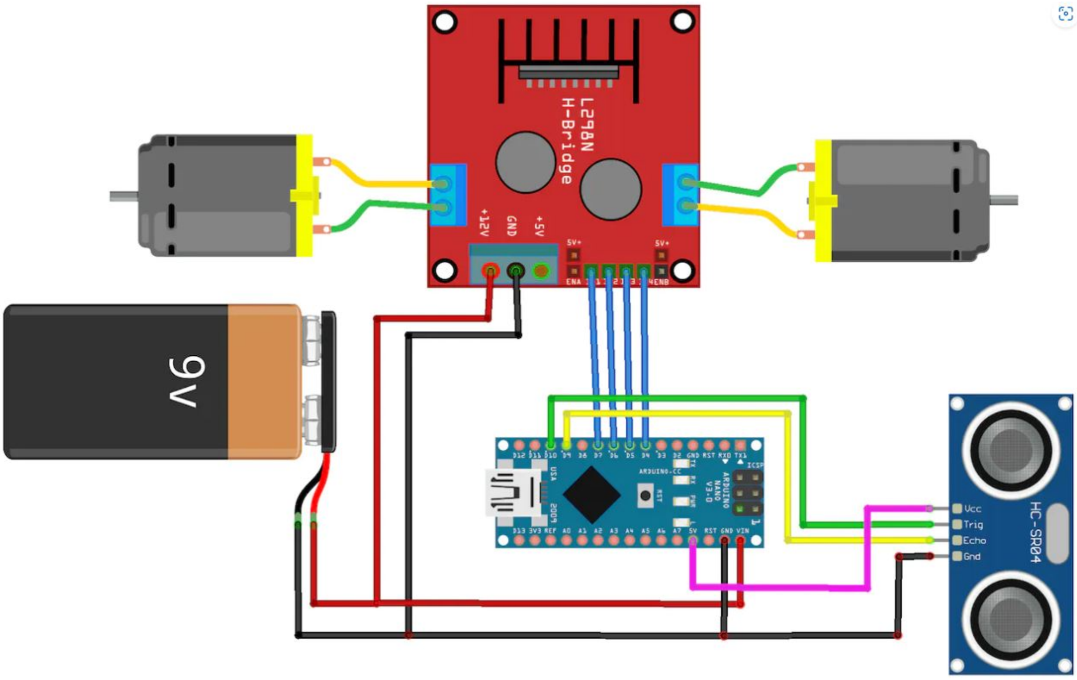

Figure 3.2: Obstacle Avoiding Robot Circuit Diagram

3.2 Chassis and prototype design

This 5mm thick robot chassis is divided into two portions, with the center portion hiding the wiring and parts. to sustain the whole robot as well as to accommodate the numerous components employed. The two chassis plates are created with a maximum width and height of 170mm 285mm. Six 30mm-long pillars divide and support the plates.The plates have holes where the bolt and nut will go. Figure 3.4 depicts the three-wheeled robotic structure with two rear wheels and a front wheel. Plastic wheels that are directly connected to the servo motor make up the rear wheels. Due of its modest weight, a caster wheel is employed to prevent the robot from being overloaded. The four-wheeled robot structure is installed with two rear wheels and two front wheels, respectively, as shown in Figure 3.4. The ultrasonic sensor is positioned just high enough on the robot's top to follow the lawn's pavement without touching it. All of the necessary system components are able to fit inside the robot's bodywork.

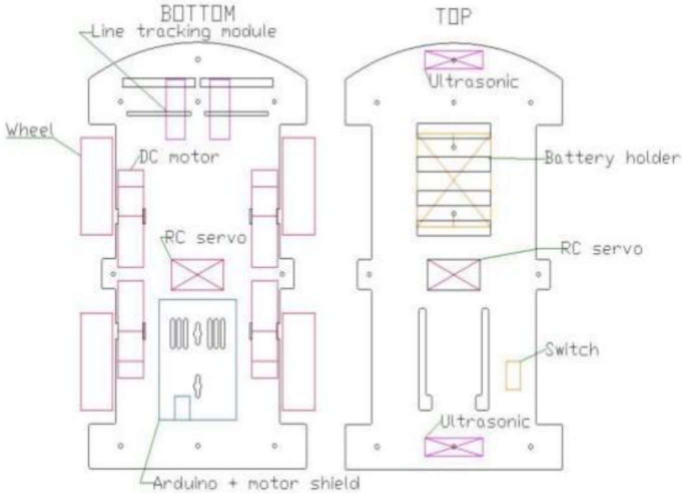

Figure 3.3: Robotic vehicle chassis design

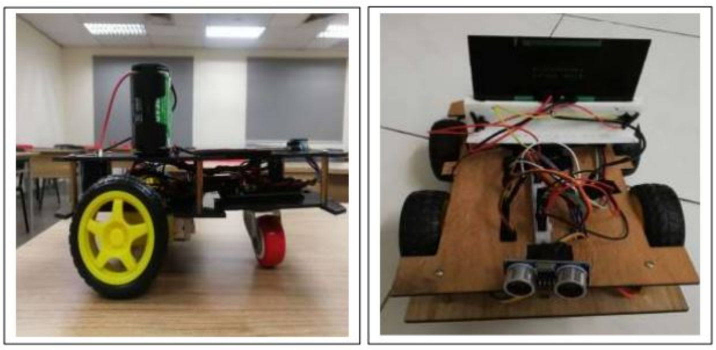

Figure 3.4: Three and Four wheeled robot

3.3 Software implementation

The system is developed using the Arduino software and C and C++. the information transmitted by the Arduino program to the Arduino Uno. The driver is informed which signals should be delivered by the Arduino Uno, which keeps track of incoming signals. As a result, based on the inputs entered, the robot moves in a specific order. The way to move the robot ahead is shown in the flow chart in Figure 6. The Arduino instructs the motor to turn right and go forward if the ultrasonic sensor detects an obstruction less than 40 meters away. The ultrasonic sensor sends a sound signal at a frequency of 37 KHz and then waits for the signal to return with an echo. You can access the code here.

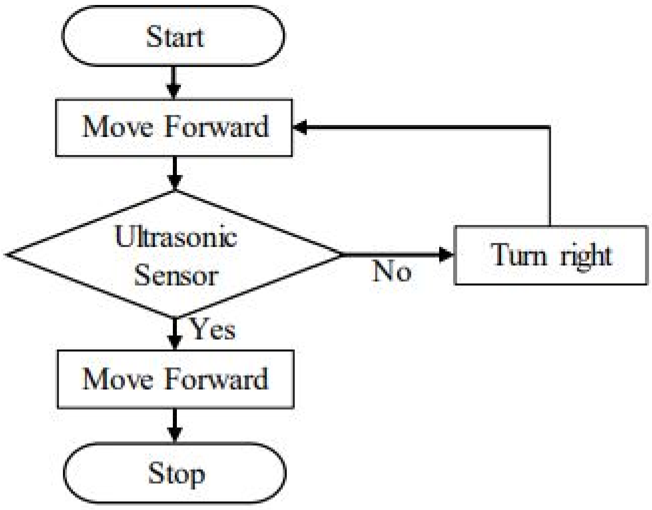

Figure 3.5: Proposed Design flow Chart

4 Conclusion

Numerous publications on obstacle-avoiding robots have been developed using the Arduino Uno, Raspberry Pi, and Android platforms. In these experiments, an obstacle-avoiding robot is created utilizing the Arduino platform, an Android implementation, and an ultrasonic sensor. The robot's brain is an Arduino Uno board. It also involves the software's portable application component. The Android application receives input that determines the robot's basic movements. A level of precision and a low likelihood of failure are attained. The commissioning of such a robot can increase its efficiency and enable remote and wireless job control. As a result, the assessment of the three-wheel obstacle-avoiding robot system demonstrates that it has the capacity to avoid obstacles, avoid collisions, and adjust its position.

References

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