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SUBJECT CODE – ECE2008
SLOT – G2
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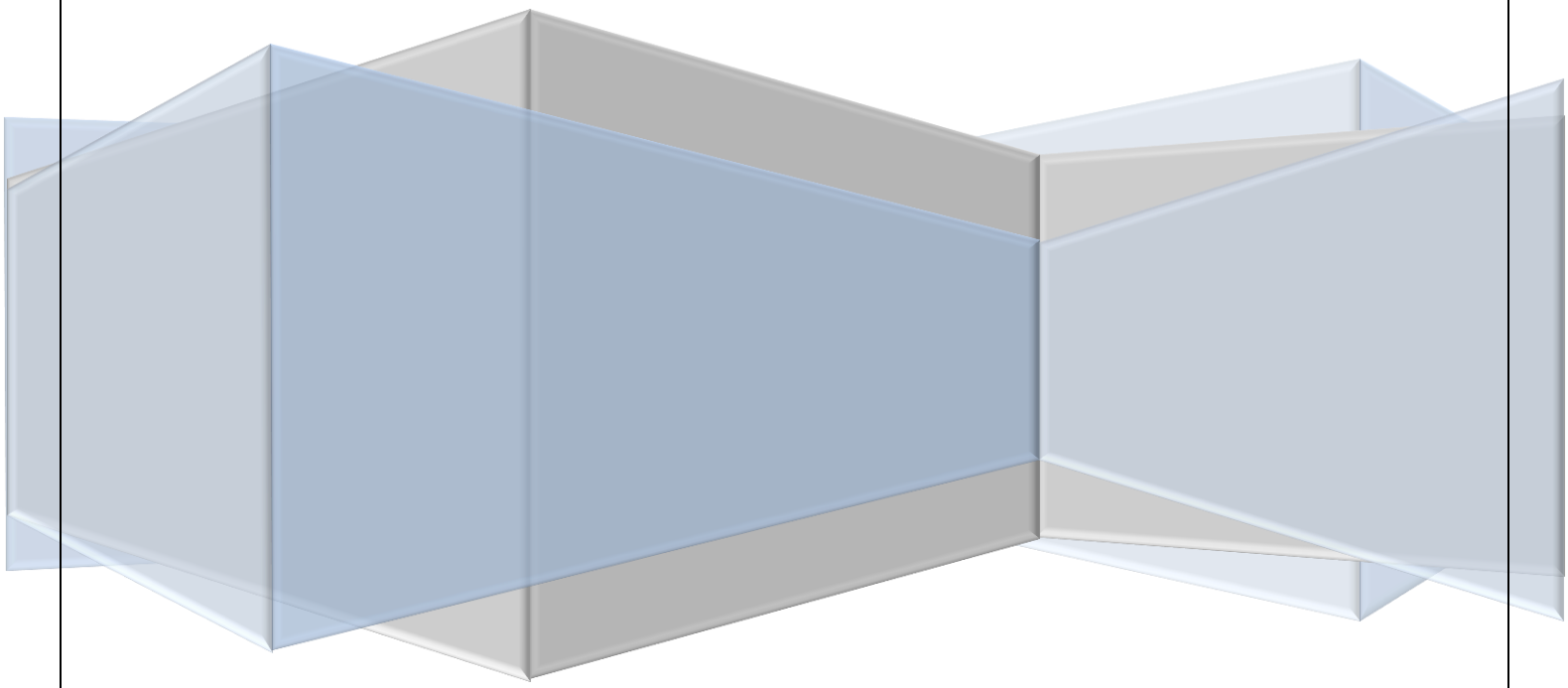
J COMPONENT PROJECT REPORT :

TITLE – ARDUINO BASED HUMAN FOLLOWING ROBOT



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ABSTRACT

For a robot that performs autonomously, the communication between the person and the robot is the most important factor. A significant awareness has been observed regarding the usage of such a technology. This project has a trivial involvement in the development of such robots. A robot that functions fully autonomously should not only complete the jobs that are desired of them but also somehow establish a connection between themselves and the person operating them. A lot of research has been done of these kinds of robot and a lot of work still needs to be done. In order for a robot to communicate and interact with the person, it should also be capable of following that particular person. Keeping this in mind, there should be a capacity in the robot to get information from the surroundings while persuing the required object. The primary goal of my work was to design and fabricate a robot that not only tracks the target but also moves towards it while doing the tracking. So, in this project, I have implemented two IR sensors and one ultrasonic sensor for tracking purposes and I have used 4 TT gear motors with a motor driver module for movement of the robot along the object. In order the track the location of the robot, a GPS tracker is also used in this project. Some of the real world applications of the robot are studied and some of the future improvements related to the robot are also studied.

ACKNOWLEDGEMENT

I am highly indebted to Mr. Sanjay Kumar Singh for his guidance and constant supervision as well as for providing necessary information regarding the project & also for his support in completing the project.

It is my privilege to express my sincerest regards to my project coordinator Mr. Sanjay Kumar Singh for valuable inputs, guidance, encouragement, whole-hearted cooperation and constructive criticism throughout the duration of our project.

I would like to express my gratitude towards my parents & VIT University for their kind co-operationand encouragement which helped me in completion of this project.

AIM

- To define a human following robot.
- To explain the working principle of the robot.
- To implement the robot using arduino as the key component.
- To track the robot's location using a GPS tracker.
- To design the flow chart for the arduino code.
- To design the arduino code as per requirement.
- To explain the applications of the robot.
- To briefly discuss the innovations and improvements related to this robot in the near future.

INTRODUCTION:

Human following robot is very common in this technology era. Human following is a technique used by robot and autonomous vehicles to follow a human within a specific range. In this case, communication between the human and the robot is the most significant factor where sensor is needed to ensure its successfulness.

Humanoid robotics is an emerging research field that has received significant attention during the past years and will continue to play an important role in robotics research and many applications of the 21st century and beyond. In this rapid moving world, there is a need of robot such as "A Human

Following Robot" that can interact and co-exist with them. Because of its human following capability, these robots can work as assistants for humans in various situations and it can also acquire or monitor certain information associated with the human subject. In this project, I am trying to implement a human following robot by using Arduino Uno along with basic sensors such as ultrasonic and IR sensor. All the processing is carried out by the microprocessor while the control of the motors is carried out by the controller. This robot can further be modified by using many technologies such as Bluetooth, PixyCamera etc.

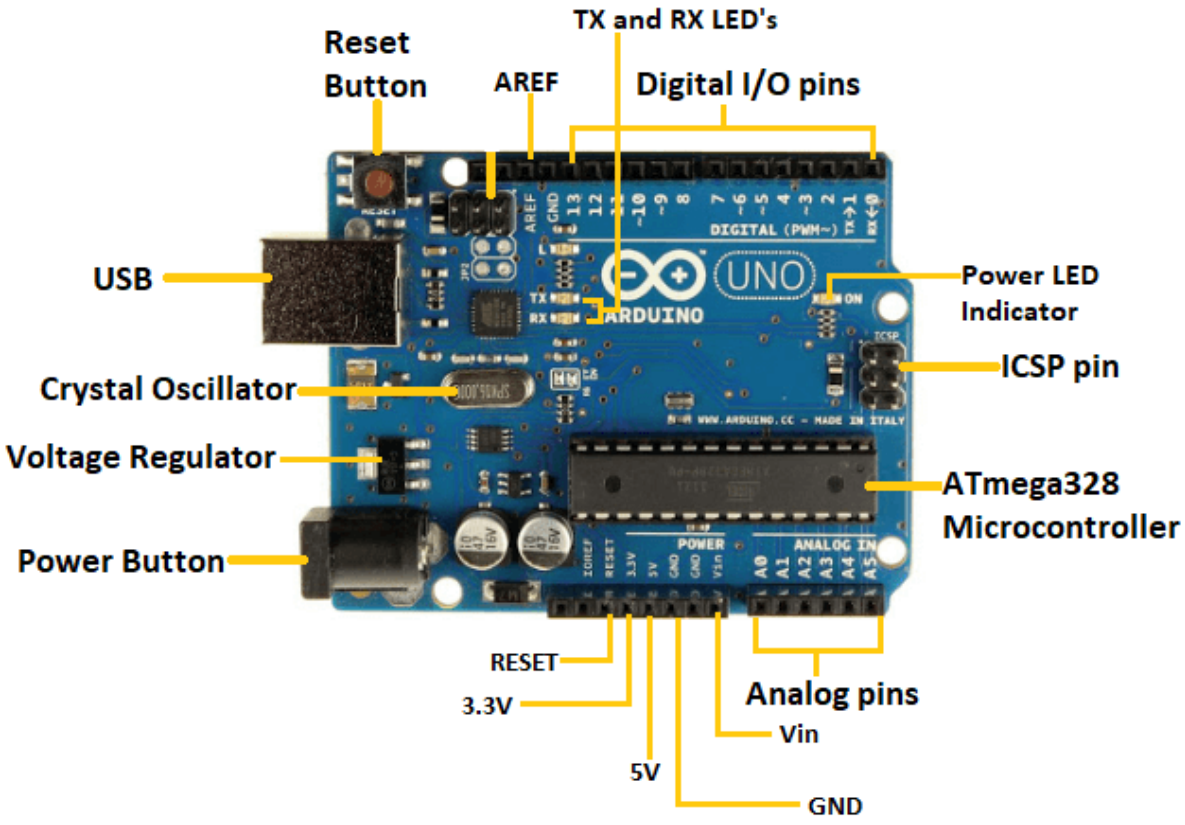
REQUIREMENTS

A.HARDWARE:

1.ARDUINO UNO:

The Arduino Uno is an open source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc . The board is equipped with sets of digital and analog input/output(I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts.

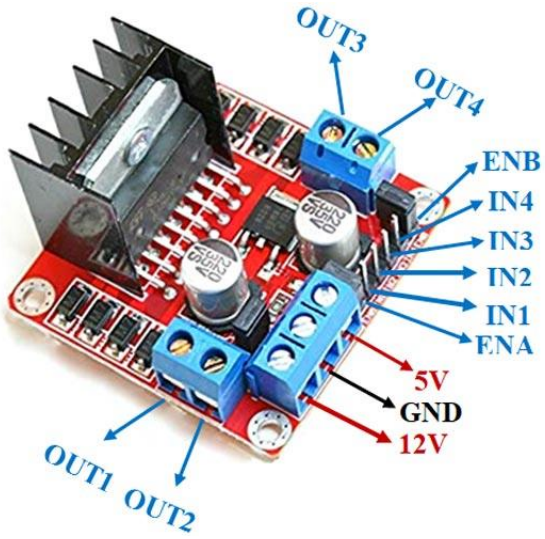
In this robot, 1 arduino uno is required. The arduino code is uploaded in the microcontroller through an USB cable. It serves as the heart of the robot because all the components of the robot are connected to the arduino via jumper wires.



2.L298N motor driver module:

It is a high-power motor driver used in driving stepper motors and DC motors. It can control up to about 4 DC motors and 2 DC motors if they have directional and speed control. The L298N driver module is made of 2 main parts: an L298 IC and a 78M05 5V regulator. Other parts include a heat sink, resistors, capacitors, etc.

In this robot, 1 L298N motor driver module is used to control the movement of 4 TT gear motors.



3. 4 WD car kit: This kit includes 2 car chassis(upper and lower), 4 TT gear motors, 4 wheels, 1battery holder, wires, connectors and screws.

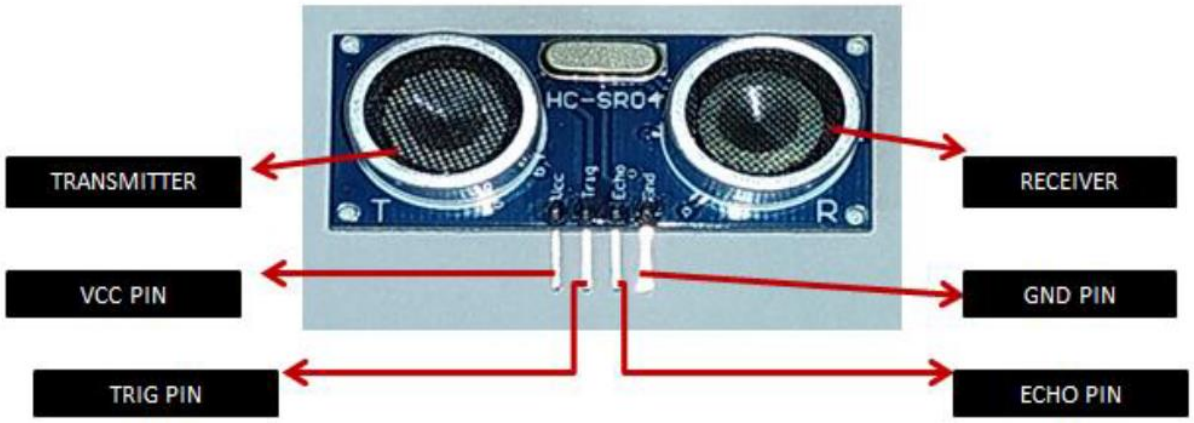
4. Ultrasonic sensor:

In this robot, ultrasonic sensor of model HC-SRO4 is used for forward movement of the robot.

HC-SR-04 has an ultrasonic transmitter, receiver and control circuit.

In ultrasonic module HCSR04, we have to give trigger pulse, so that it will generate ultrasound of frequency 40 kHz. After generating ultrasound i.e. 8 pulses of 40 kHz, it makes echo pin high. Echo pin remains high until it does not get the echo sound back. So the width of echo pin will be the time for sound to travel to the object and return back. Once we get the time we can calculate distance, as we know the speed of sound.

HC-SR04 can measure up to range from 2 cm - 400 cm.



5.IR sensor:

An IR sensor consists of an IR LED and an IR Photodiode, together they are called as PhotoCoupler or OptoCoupler.

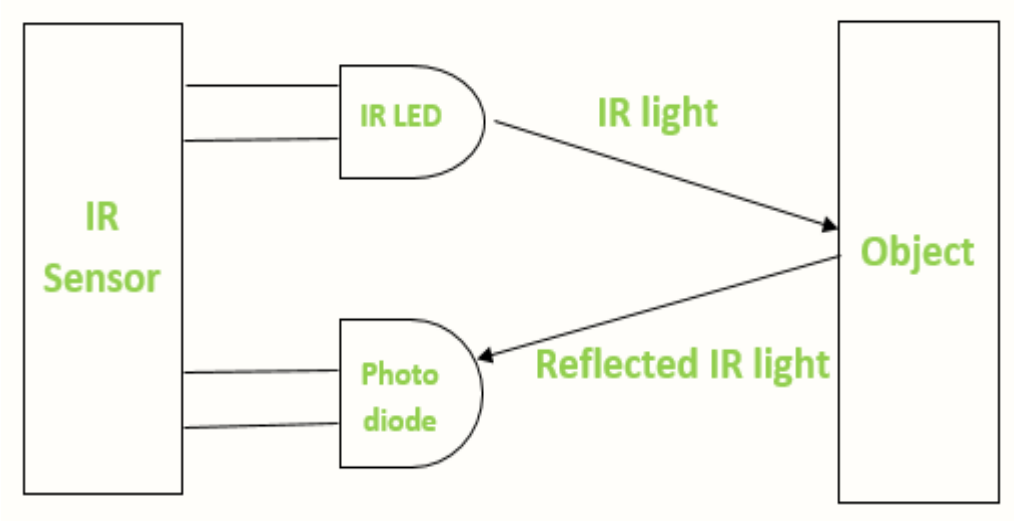
IR Transmitter or IR LED: Infrared Transmitter is a light emitting diode (LED) which emits infrared radiations called as IR LED's. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye.

The picture of an Infrared LED is shown below.

IR Receiver or Photodiode: Infrared receivers or infrared sensors detect the radiation from an IR transmitter. IR receivers come in the form of photodiodes and phototransistors. Infrared Photodiodes are different from normal photo diodes as they detect only infrared radiation.
Below image shows the picture of an IR receiver or a photodiode:

Different types of IR receivers exist based on the wavelength, voltage, package, etc. When used in an infrared transmitter – receiver combination, the wavelength of the receiver should match with that of the transmitter.

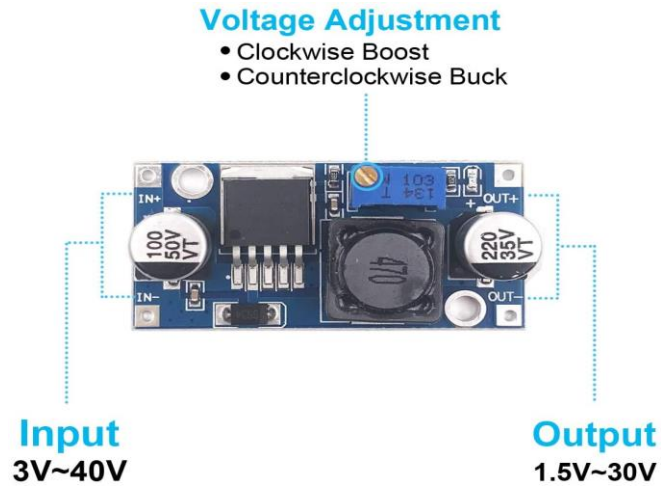
The emitter is an IR LED and the detector is an IR photodiode. The IR photodiode is sensitive to the IR light emitted by an IR LED. The photo-diode's resistance and output voltage change in proportion to the IR light received. This is the underlying working principle of the IR sensor.



When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor defines.

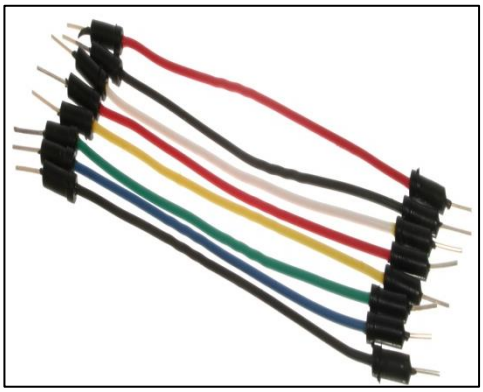
6.Li-ion battery: I have used 4 lithium batteries in in series combination. Each battery supplies 3.7 V when fully charged. Each battery produces a current of 3A. So, total voltage of the combination is 14.8V and total current remains 3A.

7.LM2596 DC-DC buck convertor: This is used to tune the o/p voltage from the 4S battery combination to 12 V, which is the required voltage needed to be supplied to the motor driver module.

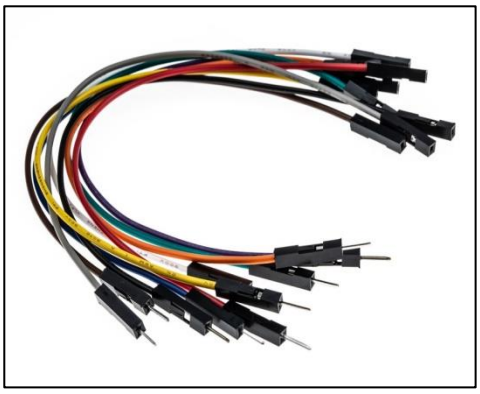


8. SPST switch: 1 SPST switch is used for switching the battery supply on/off.

9. Jumper wires: These are used for making the connections between the components of the robot. I have used both male-male and female-male jumper wires.



MALE – MALE JUMP WIRE



FEMALE – MALE JUMP WIRE

10. Odestro GPS tracker:

- The tracker can chain your easy-lost & valuable belongings together and work with smart phone to prevent loss. The tracker is also a remote control of your smart phone camera for self-portrait
- The tracker is a kind of Bluetooth 4.0 Low Energy product which works through iTracing app.
- In addition, the tracker can also provide a last seen pin-drop on map to help you recover your items and search your cars in parking site
- It's size is compact and it is a lightweight design and it has low energy consumption.
- It supports Bluetooth 4.0 and the effective range is up to 25m.
- So, it will be attached with the robot to track it's location.

11. Double sided tape: This is used for attaching various components of the robot with the car chassis.

12.DC Multimeter: This is used to check the o/p voltage of the buck converter.

13. Soldering iron kit: This kit is used to solder wires to various components of the robot.

14. Arduino cable: This is used for connecting the arduino with the laptop.

B.SOFTWARE:

1. codebender.cc (For doing arduino code)
2. iSearching(For connecting the GPS tracker with the mobile phone)

WORKING PRINCIPLE

When someone come near to the robot, it starts to follow that person. There are 4 wheels in the robot and 4 motors attached to the chassis. Now there are three sensors on the robot, one is an ultrasonic sensor and two IR sensors, which are arranged left and right to the ultrasonic sensor. When you put your hand near to the ultrasonic sensor the robot will start forward and if you turn your hand to the left side the Arduino robot moves on the left side, and if you put your hand in the right the robot will move in the right direction.

When you put your hand in from of the ultrasonic sensor then the sensor detects you and sends this information to the Arduino. There is some distance prefix in the Arduino, so if your hand is away from the sensor it will not read that and if your hand is near to the sensor it will read it. Now Arduino knows that there is something in front of the sensor and Arduino send some instruction to the motor driver and motor driver trigger the motors and the Arduino robot starts to move forward we need to run all motor forward.

IR sensor works on infrared light which can also detect the object near to it. So, there are two IR sensors, one is at the left side of ultrasonic sensor and other is at the right side of the ultrasonic sensor. When anything comes near to the left sensor, Arduino got the information that there is something is near to the left sensors and according to the code,

the robot will turn to the left. and the same process for the right sensor. So this is how the human following robot works.

A GPS tracker is fitted to the robot to track it's location. The tracker is a kind of Bluetooth 4.0 Low Energy product which works through iTracing app.

EXPECTED OUTCOMES

The Robot must follow the following objectives:

- The robot must be capable of accurately following a person.
- It should be capable of taking various degrees of turns.
- The robot must be insensitive to environmental factors such as noise.
- The robot must be capable to avoid collision.

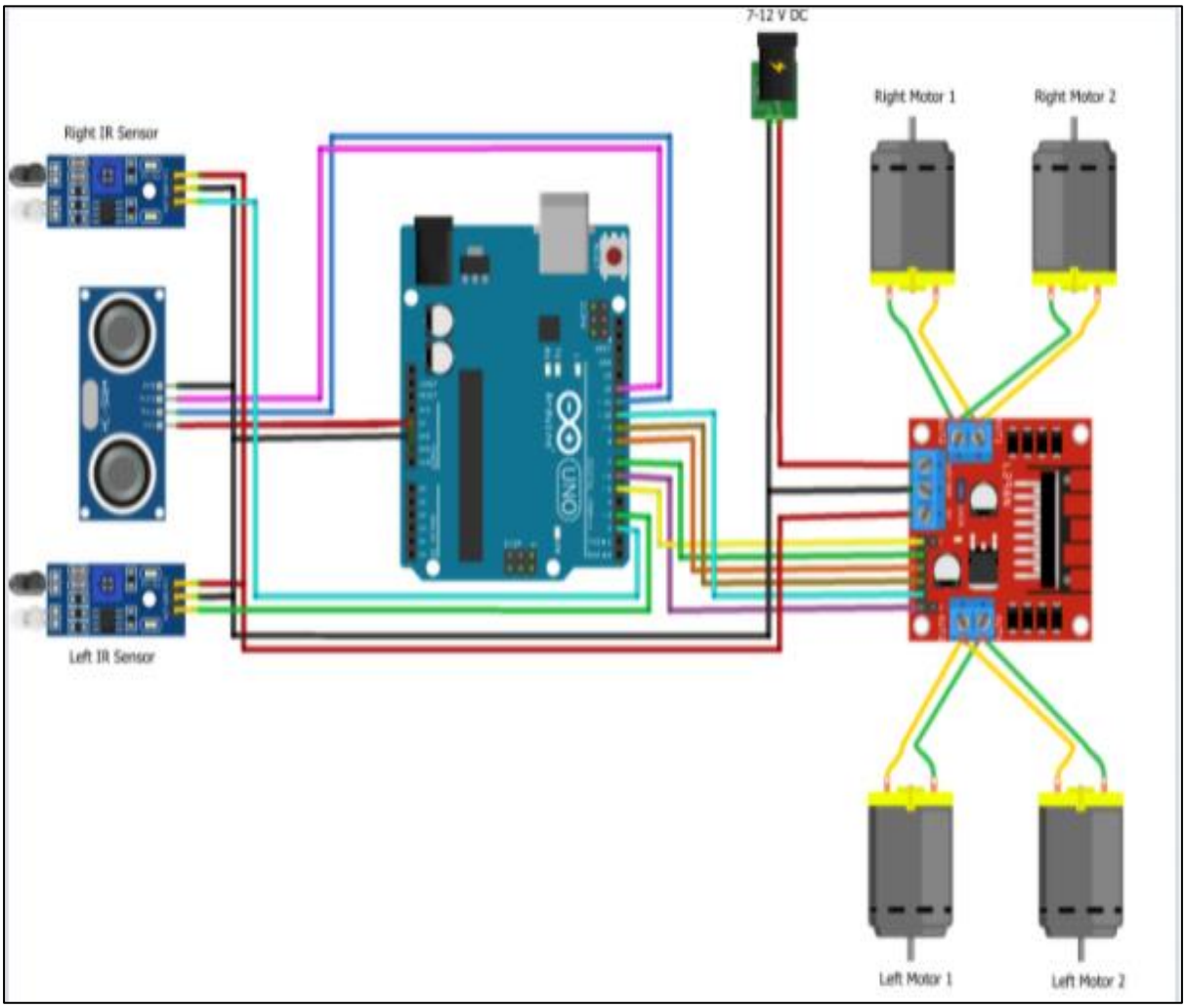
PROCEDURE TO ASSEMBLE THE ROBOT

- Solder wires to gear motors.
- Mount all four motors on the car chassis using connectors and screws.
- Attach both the car chassis plates using screws and make sure that it is tightened properly so that we don't have any loose parts.
- Join red to red and black to black wires of dc motors on each side.
- Attach L298N motor driver module on car chassis.
- Connect right side motors to out 1 and out 2 pins of the L298N motor driver.
- Connect left side motors to out 3 and out 4 pins of the L298N motor driver.
- Connect 4 li-ion rechargeable batteries in series and supply it to the i/p poet of the dc-dc buck converter. Now tune the buck converter to get the o/p voltage from the buck converter as 12 V. Check the o/p voltage using a dc multimeter. Attach the o/p wires of the buck converter supplying 12 V DC power to +12V pin and ground pin of the motor driver module.
- Place arduino uno on the car chassis using double sided tape.
- Connect L298N motor driver module pins to arduino uno pins as per table below:

L298N Driver Pins	Arduino pins
ENA	D5
IN1	D7
IN2	D8
IN3	D9
IN4	D10
ENB	D6

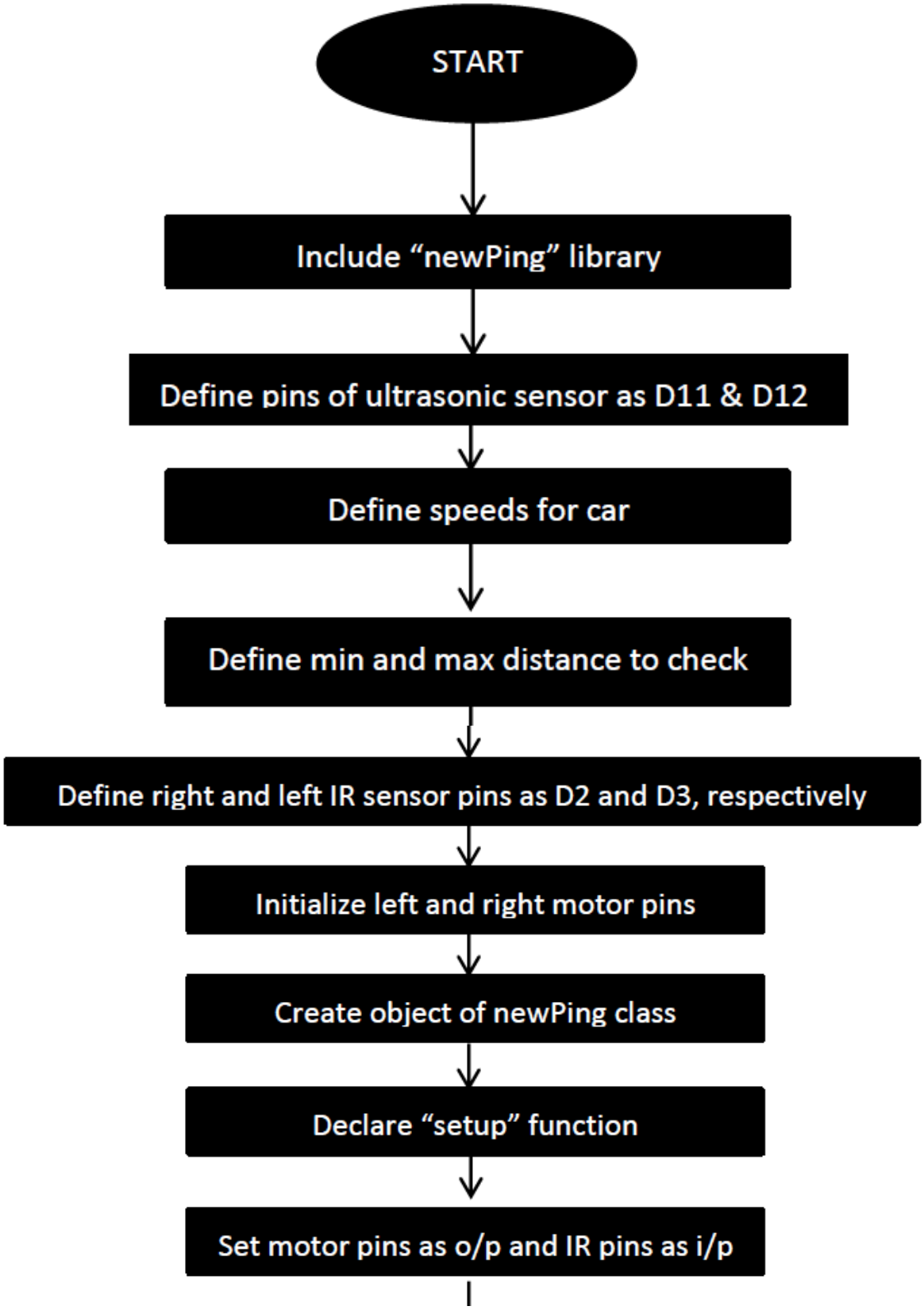
- Attach wires to +5V pin and ground pins of the motor driver module.
- Take +5V and ground from motor driver module and provide to the 2 IR sensors.
- Also provide +5V and ground to ultrasonic sensor and arduino uno.
- Connect right and left IR sensors' out pins to D2 and D3 pins of arduino uno, respectively.
- Connect ultrasonic sensor to arduino uno pins.
- Make ultrasonic sensor frame using foam board or any plastic material.
- Attach 2 IR sensors and the ultrasonic sensor to the frame and fix this frame on the car chassis using double sided tape.
- Attach wheels to car now.
- Finally, attach the GPS tracker on the car chassis and turn it on, and connect with your mobile phone by using the "iSearching" app.

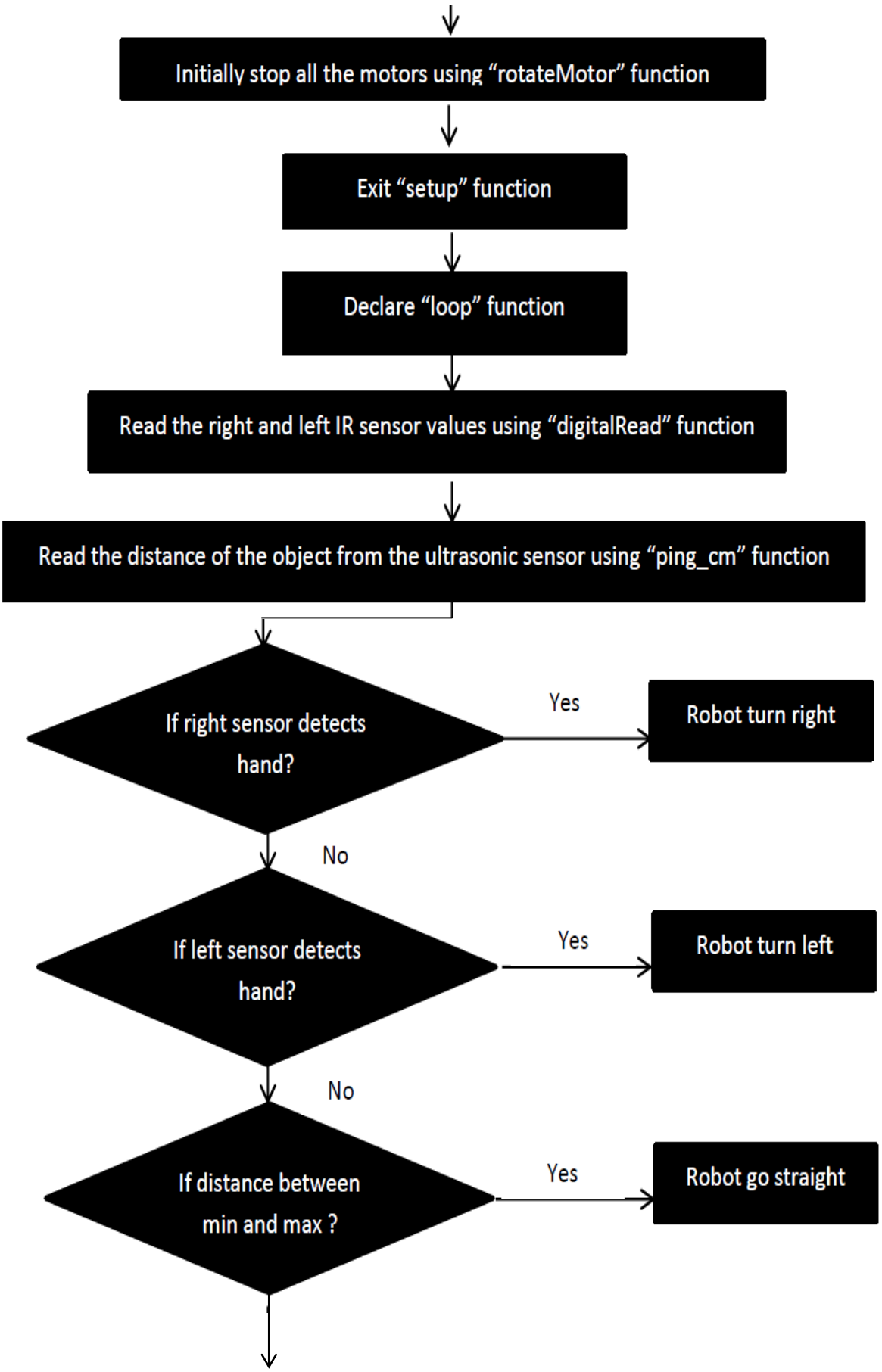
CIRCUIT DIAGRAM

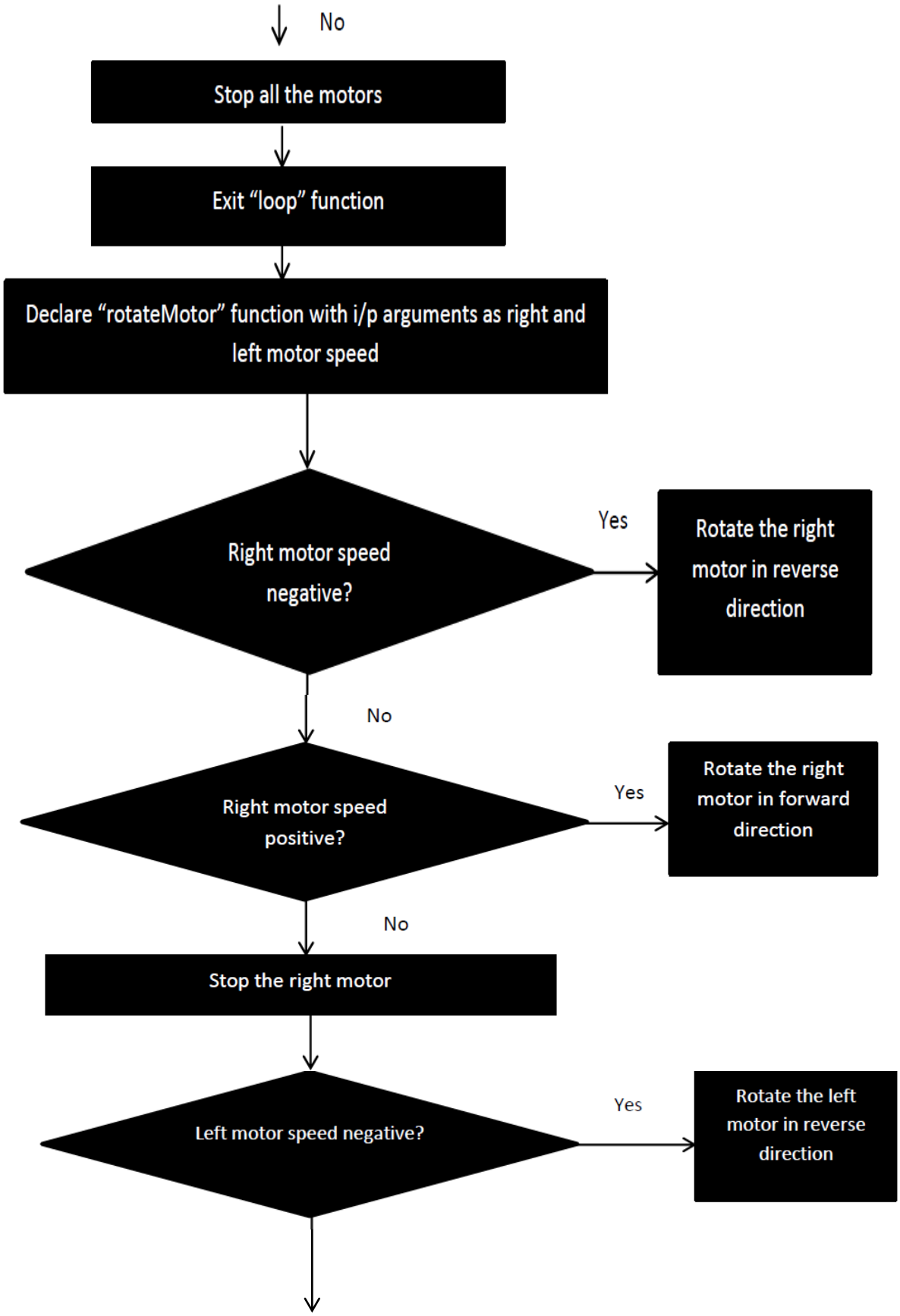


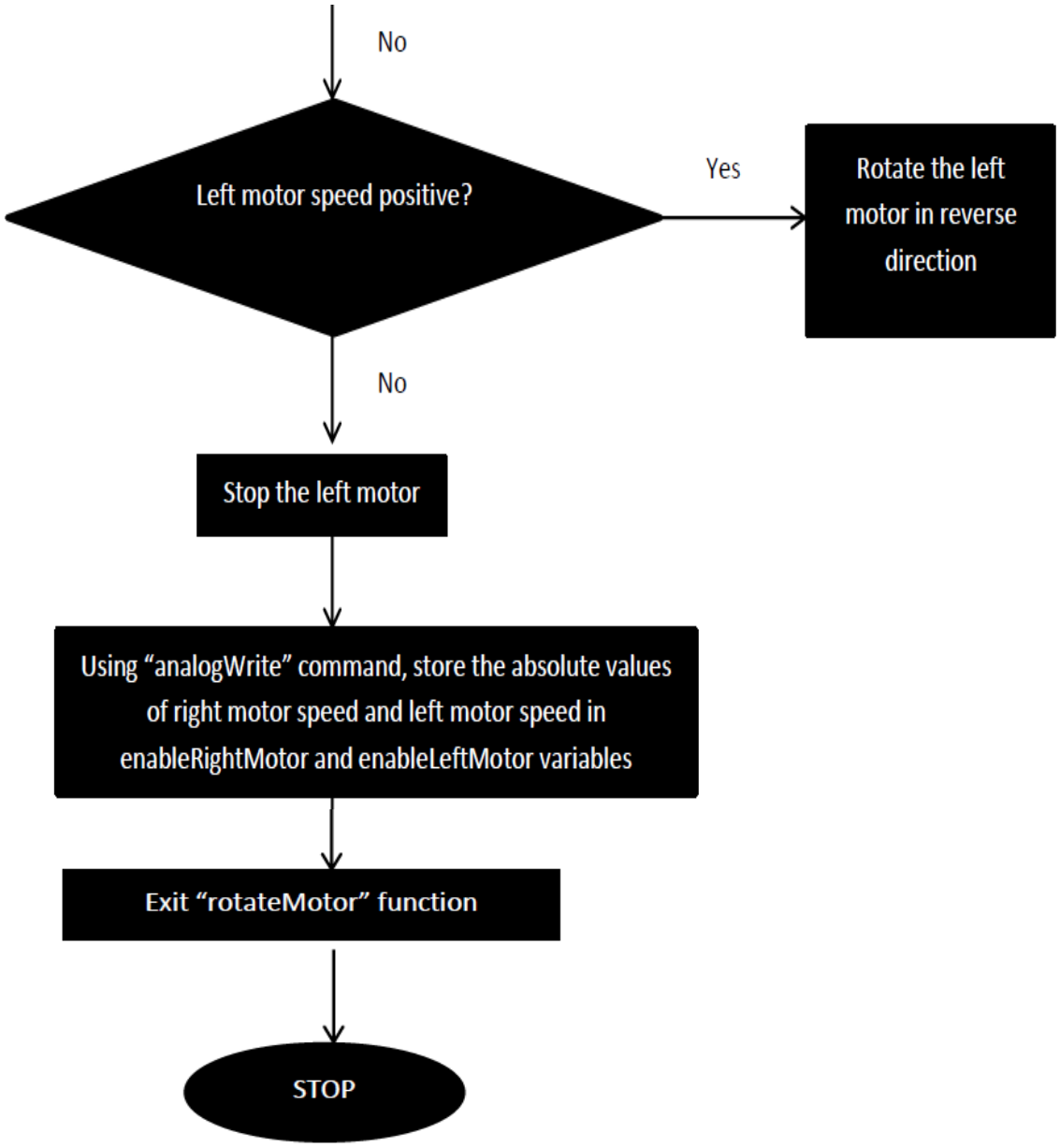
This schematic diagram is followed to make the connections of the robot.

FLOW CHART OF ARNUINO CODE




Initially stop all the motors using “rotateMotor” function
Exit “setup” function
Declare “loop” function
Read the right and left IR sensor values using “digitalRead” function
Read the distance of the object from the ultrasonic sensor using “ping_cm” function
If right sensor detects hand?
Yes
Robot turn right
No
If left sensor detects hand?
Yes
Robot turn left
No
If distance between min and max ?
Yes
Robot go straight


No
Stop all the motors
Exit "loop" function
Declare "rotateMotor" function with i/p arguments as right and left motor speed
Right motor speed negative?
Yes
Rotate the right motor in reverse direction
No
Right motor speed positive?
Yes
Rotate the right motor in forward direction
No
Stop the right motor
Left motor speed negative?
Yes
Rotate the left motor in reverse direction



#Note: This flow chart is used to design the arduino code.

ALGORITHM OF ARDUINO CODE

- Start the process.
- Include “NewPing” library to handle the ultrasonic sensor.
- Define pins for the ultrasonic sensor as D11 and D12.
- Define speeds for car.
- Define min. and max. distance to check.
- Define right and left IR sensor pins as D2 and D3.
- Declare right and left motor pins for L298N motor driver module.

- Create object of NewPing class to handle ultrasonic sensor.
- Declare a setup function with return type void.
- Inside the setup function, set the motor pins as output and then setup IR pins as input.
- Initially, stop all the motors using “rotateMotor” function which takes right and left motor speed as argument.
- Exit the setup function.
- Declare a function with name as “loop” and return type as “void”.
- Inside loop function, read the right and left IR sensor values using “digitalRead” function.
- Also read the distance of the object from the ultrasonic sensor using “ping_cm” function.
- If IR sensor detects the hand then its value will be LOW else the value will be HIGH. If right sensor detects hand, then turn right. We increase left motor speed and decrease the right motor speed to turn towards right using “rotateMotor” function.
- If left sensor detects hand, then turn left. We increase right motor speed and decrease the left motor speed to turn towards left using “rotateMotor” function.
- If distance is between min and max then go straight by applying same speed to the right and left motors using “rotateMotor” function.
- Else stop all the motors.
- Exit the loop function.
- Declare “rotateMotor” function which take right and left motor speed as arguments.
- If right motor speed is negative, then it rotates right motor in reverse direction.
- If right motor speed is positive, then it rotates right motor in forward direction.
- Else it stops the right motor.
- If left motor speed is negative, then it rotates left motor in reverse direction.
- If left motor speed is positive, then it rotates left motor in forward direction.
- Else it stops the left motor.
- Using “analogWrite” command, store the absolute values of right motor speed and left motor speed in enableRightMotor and enableLeftMotor variables.
- Exit the “rotateMotor” function.
- Stop the process.

ARDUINO CODE

```
#include <NewPing.h>
#define ULTRASONIC_SENSOR_TRIG 11
#define ULTRASONIC_SENSOR_ECHO 12
#define MAX_FORWARD_MOTOR_SPEED 75
#define MAX_MOTOR_TURN_SPEED_ADJUSTMENT 50
#define MIN_DISTANCE 10
#define MAX_DISTANCE 30
#define IR_SENSOR_RIGHT 2
#define IR_SENSOR_LEFT 3
//Right motor
int enableRightMotor = 5;
int rightMotorPin1 = 7;
int rightMotorPin2 = 8;
//Left motor
int enableLeftMotor = 6;
int leftMotorPin1 = 9;
int leftMotorPin2 = 10;
NewPing mySensor(ULTRASONIC_SENSOR_TRIG, ULTRASONIC_SENSOR_ECHO, 300);
void setup()
{
  pinMode(enableRightMotor, OUTPUT);
  pinMode(rightMotorPin1, OUTPUT);
  pinMode(rightMotorPin2, OUTPUT);
  pinMode(enableLeftMotor, OUTPUT);
  pinMode(leftMotorPin1, OUTPUT);
  pinMode(leftMotorPin2, OUTPUT);
  pinMode(IR_SENSOR_RIGHT, INPUT);
  pinMode(IR_SENSOR_LEFT, INPUT);
  rotateMotor(0, 0);
}
void loop()
```

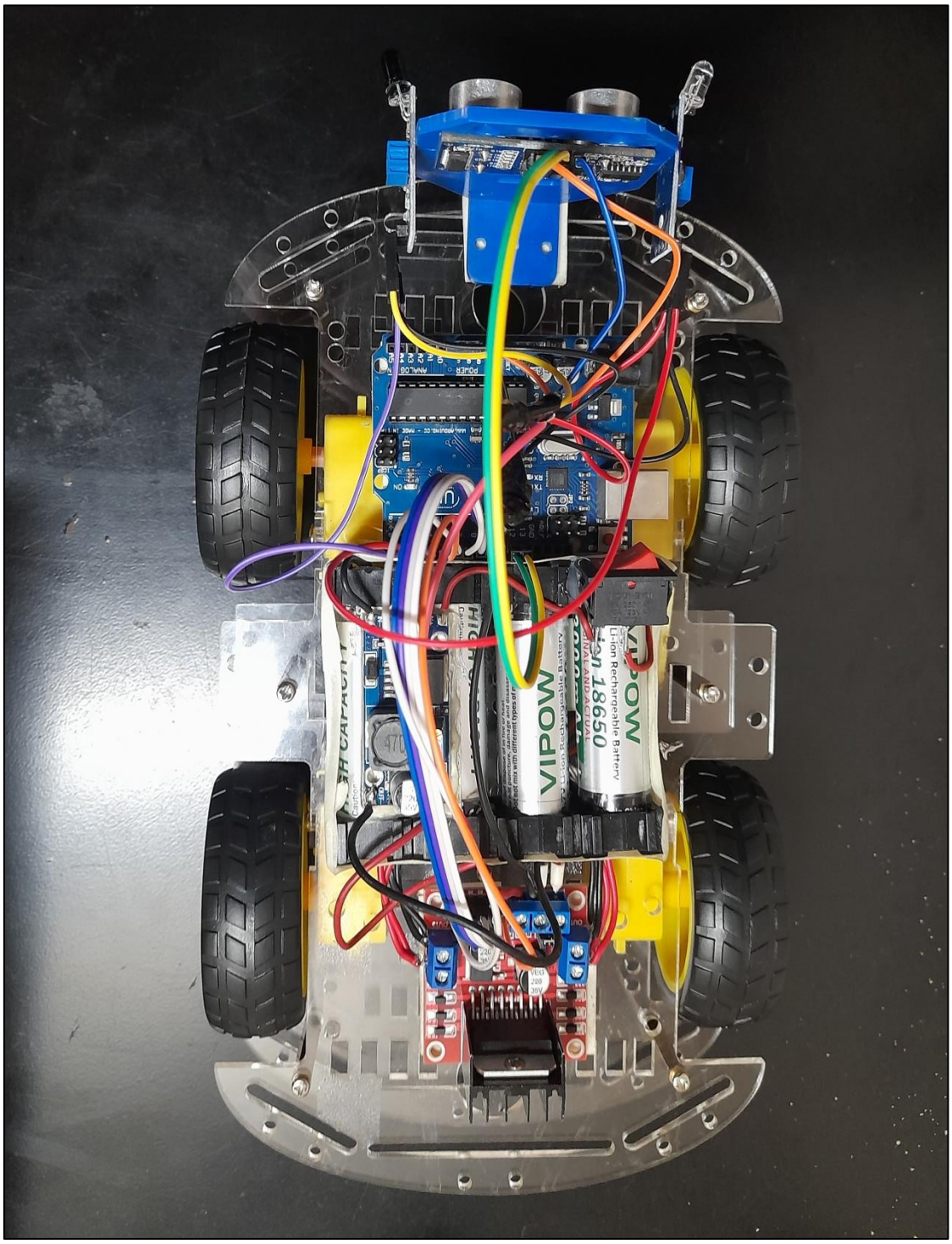
```
{
  int distance = mySensor.ping_cm();
  int rightIRSensorValue = digitalRead(IR_SENSOR_RIGHT);
  int leftIRSensorValue = digitalRead(IR_SENSOR_LEFT);
  //NOTE: If IR sensor detects the hand then its value will be LOW else the value will be HIGH
  /*If right sensor detects hand, then turn right. We increase left motor speed and decrease the right motor speed to turn towards right*/
  if (rightIRSensorValue == LOW && leftIRSensorValue == HIGH )
  {
    rotateMotor(MAX_FORWARD_MOTOR_SPEED - MAX_MOTOR_TURN_SPEED_ADJUSTMENT, MAX_FORWARD_MOTOR_SPEED + MAX_MOTOR_TURN_SPEED_ADJUSTMENT );
  }
  /*If left sensor detects hand, then turn left. We increase right motor speed and decrease the left motor speed to turn towards left*/
  else if (rightIRSensorValue == HIGH && leftIRSensorValue == LOW )
  {
    rotateMotor(MAX_FORWARD_MOTOR_SPEED + MAX_MOTOR_TURN_SPEED_ADJUSTMENT, MAX_FORWARD_MOTOR_SPEED - MAX_MOTOR_TURN_SPEED_ADJUSTMENT);
  }
  //If distance is between min and max then go straight
  else if (distance >= MIN_DISTANCE && distance <= MAX_DISTANCE)
  {
    rotateMotor(MAX_FORWARD_MOTOR_SPEED, MAX_FORWARD_MOTOR_SPEED);
  }
  //stop the motors
  else
  {
    rotateMotor(0, 0);
  }
}
```

```
void rotateMotor(int rightMotorSpeed, int leftMotorSpeed)
{
 if (rightMotorSpeed < 0)
 {
  digitalWrite(rightMotorPin1, LOW);
  digitalWrite(rightMotorPin2, HIGH);
 }
 else if (rightMotorSpeed > 0)
 {
  digitalWrite(rightMotorPin1, HIGH);
  digitalWrite(rightMotorPin2, LOW);
 }
 else
 {
  digitalWrite(rightMotorPin1, LOW);
  digitalWrite(rightMotorPin2, LOW);
 }
 if (leftMotorSpeed < 0)
 {
  digitalWrite(leftMotorPin1, LOW);
  digitalWrite(leftMotorPin2, HIGH);
 }
 else if (leftMotorSpeed > 0)
 {
  digitalWrite(leftMotorPin1, HIGH);
  digitalWrite(leftMotorPin2, LOW);
 }
 else
 {
  digitalWrite(leftMotorPin1, LOW);
  digitalWrite(leftMotorPin2, LOW);
 }
```

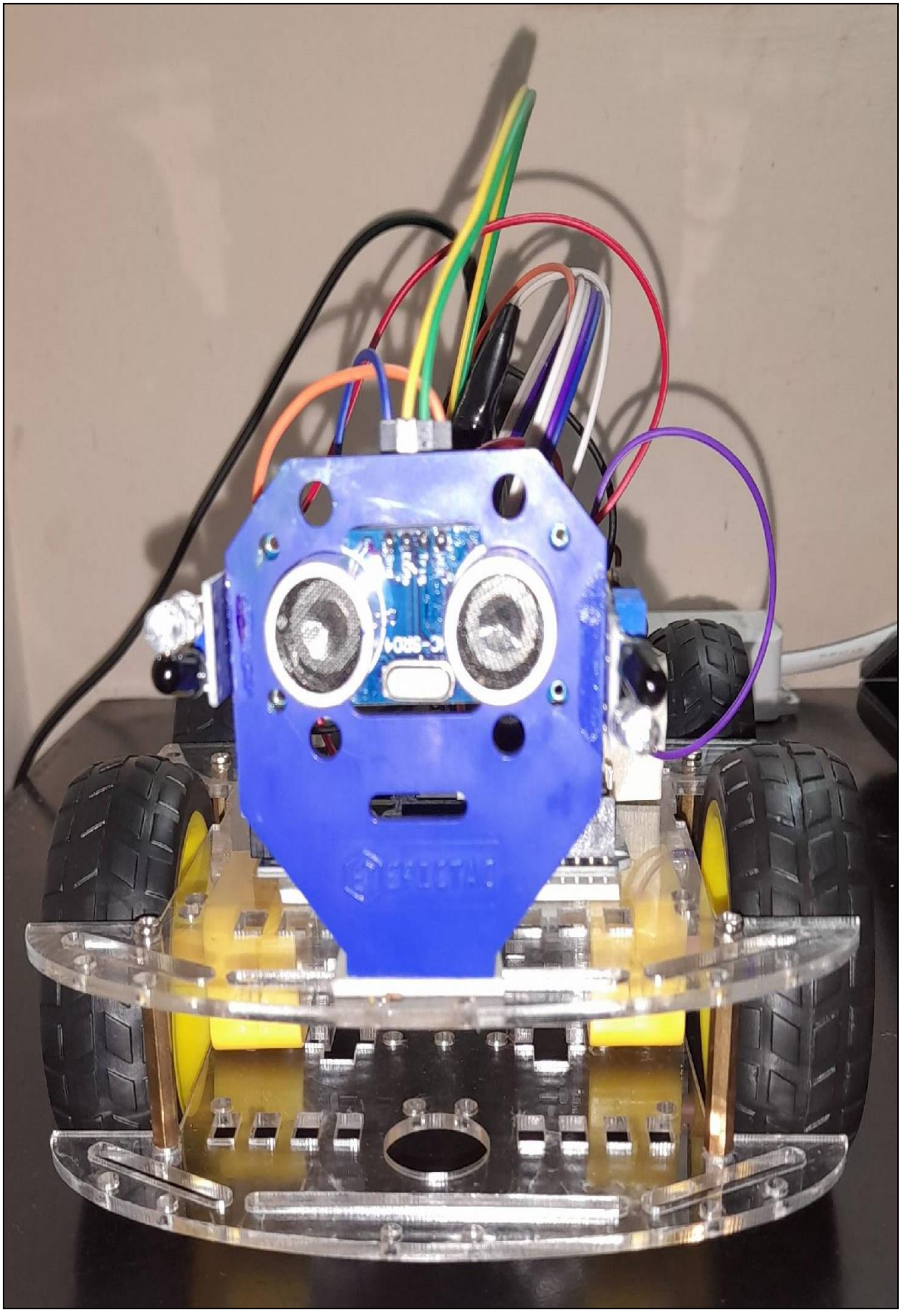
```
  analogWrite(enableRightMotor, abs(rightMotorSpeed));
  analogWrite(enableLeftMotor, abs(leftMotorSpeed));
}
```

EXPERIMENTAL SETUP

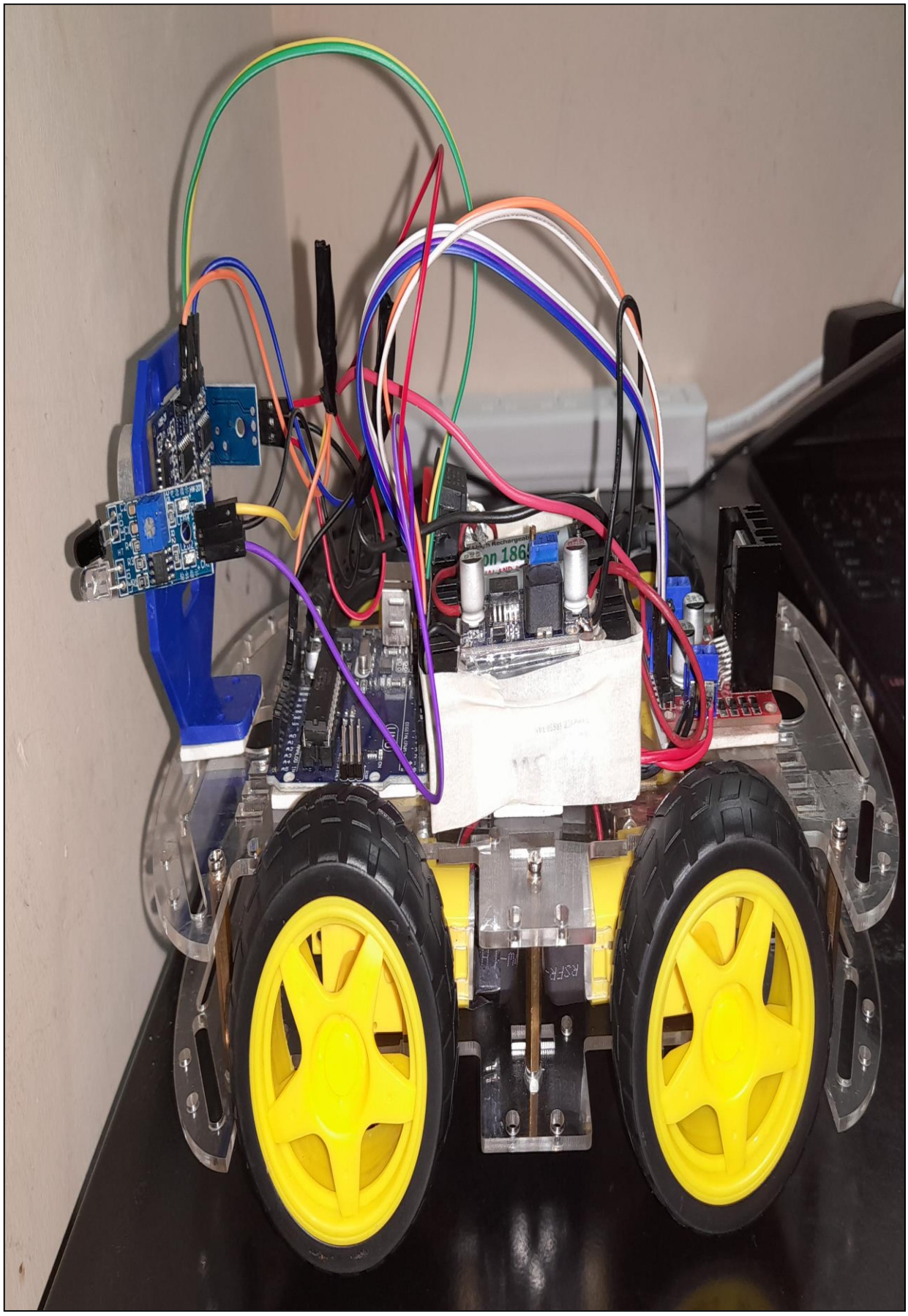
1.It represents the top view of the robot. All the components are already described under "COMPONENTS" section.



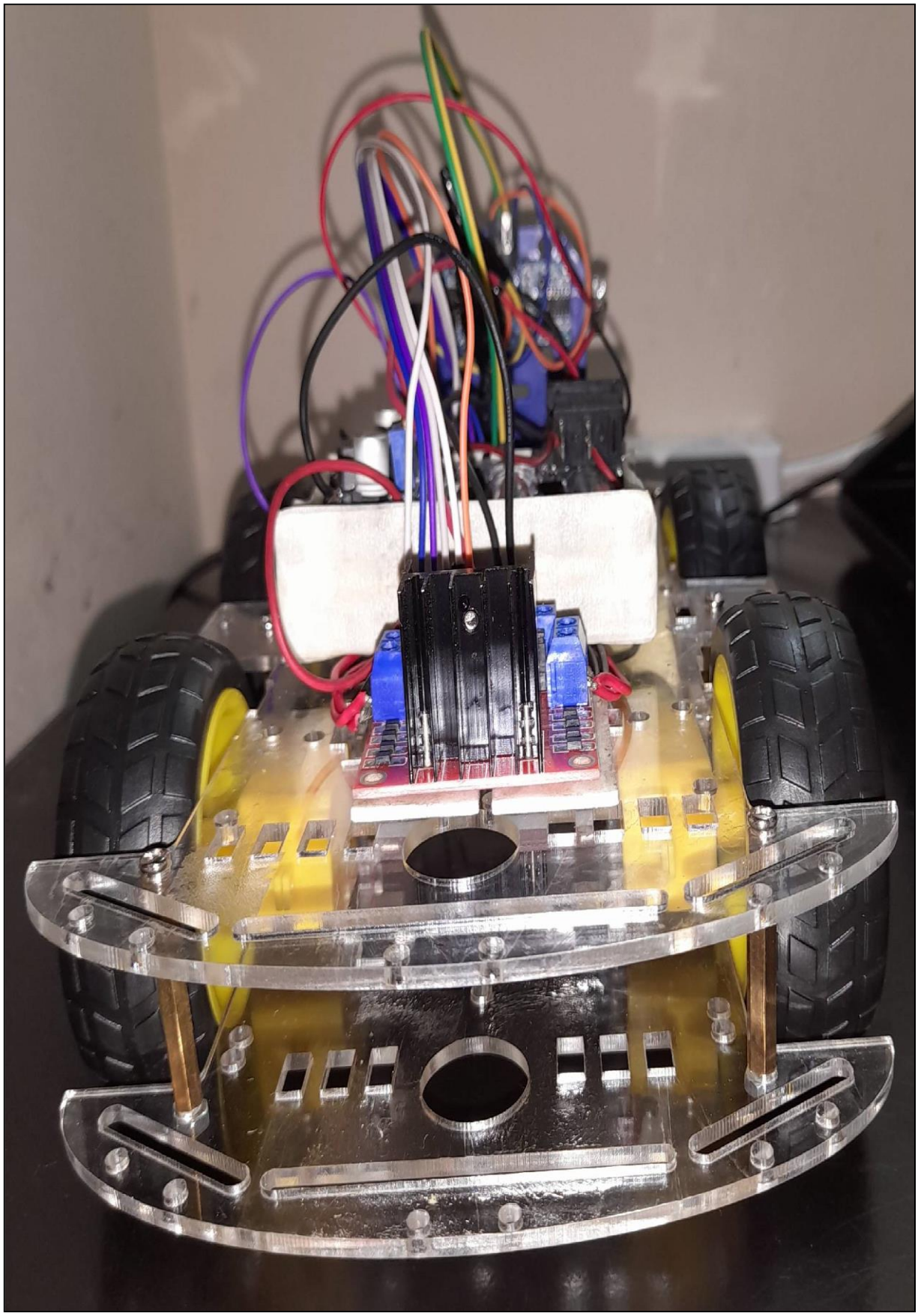
2. It represents the front view of the robot.



3.It represents the side view of the robot.



4. It represents the back/rear side of the robot.



OBSERVATIONS

- When an object comes closer to robot in forward direction, and the distance between the object and the robot is between 10 cm(min. distance) and 30 cm(max. distance), the ultrasonic sensor get's activated, and all motors rotate with same speed in forward direction, thereby following the object.
- When an object comes towards left of the robot near the left IR sensor, the left IR sensor get's activated, and the robot turns left.
- When an object comes towards right of the robot near the right IR sensor, the right IR sensor get's activated, and the robot turns right.
- The speed of rotation of the motors can be adjusted using the arduino code.
- The minimum and maximum distance between the object and the ultrasonic sensor can also be adjusted within a range of approximately 4 m.
- The sensitivity of the two IR sensors are also tunable.
- The o/p voltage from the dc-dc buck converter can also be tuned to get the desired o/p voltage.
- The robot's location is also tracked using the GPS tracker within a range of approximately 10 m.
- When the robot got deviated from it's path and the distance between me and the robot exceeded the threshold distance of the GPS tracker, I got a warning alarm and message in my mobile phone which is connected to the GPS tracker via Bluetooth, and as a result, I got to know that the robot is not following me.
- From my mobile phone, I can see the robot's location in the google map under the "iSearching" app.
- I was also able to find the robot using my mobile phone through the "iSearching" app, by clicking the "Alert" option which was present next to the tag of the GPS tracker, and as a result, the GPS tracker produced beep sound as an output and hence, I was able to find the robot.
- When the GPS tracker was turned off, I got a warning message and alarm in my phone, which indicated that the GPS tracker was disconnected.

RESULTS

- The working principle of the robot is properly explained.
- The components used in the robot are properly explained.
- The robot is properly implemented using arduino as the key component.
- The robot's location is properly tracked using the GPS tracker.
- The flow chart of the arduino code is properly designed.
- The algorithm of the arduino code is properly explained.
- The arduino code is properly designed.

APPLICATIONS OF HUMAN FOLLOWING ROBOT

Looking deeply into environment or our surroundings, we will be able interpret that "YES" there is a need of such robot that can assist humans and can serve them. Such a robot can be used for many purposes. With a few changings, the robot can act as a human companion as well.

Some other applications of this robot are as follows:

- It can assist in carrying loads for people working in hospitals, libraries, airports, etc.
- It can provide service to people at shopping centers or public areas.
- It can assist elderly people, special children and babies.
- It can follow a particular Vehicle.

FUTURE IMPROVEMENTS

There are many interesting applications of this research in different fields whether military or medical. A wireless communication functionality can be added in the robot to make it more versatile and control it from a large distance. This capability of a robot could also be used for military purposes. By mounting a real time video recorder on top of the camera, we can monitor the surroundings by just sitting in our rooms. We can also add some modifications in the arduino code and the structure as well to fit it for any other purpose, for example in a vehicle follower.

Similarly it can assist the public in shopping malls. So there it can act as a luggage carrier, hence no need to carry up the weights or to pull that. Using this code the robot will automatically follow that person.

CONCLUSION

A successful implementation of a human following robot is illustrated in this project. This robot does not only have the detection capability but also the tracking and following ability as well. The tracking is basically performed using the IR sensors and a ultrasonic sensor and the human is followed on the basis of that detection. It was also kept in mind that the "following" capability of the robot should be as efficient as possible. The tests were performed on the different conditions to pin point the mistakes in the algorithm and correct them. The GPS tracker that was attached with the robot, worked successfully and the robot's location was tracked. This added an additional security of the robot from being lost.

I have learnt to tune the sensitivity of the IR sensor. I have also learnt to tune the o/p voltage of a dc-dc buck converter.

I have learnt to design the arduino code for the robot based on our requirement.

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