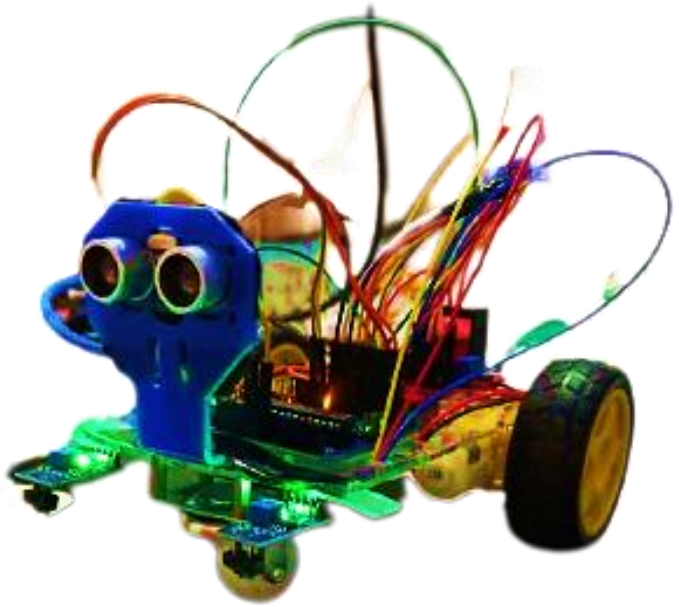
CSE 271S
SYSTEM DYNAMICS AND CONTROL COMPONENTS

LINE FOLLOWER WITH OBSTACLE AVOIDING.

TEAM 31



TEAM MEMBERS

Ahmed Mohammed Bakr Ahmed	2000037
Muhammed ahmed abd-elgawad nassif	2001771
Mahmoud mohamed alsayd soliman	2001278
Yossif Ibrahim Motawea Ahmed	2001218
abdallah zinhom Mahmoud	2000953
Marwan Wael Mahmoud abbas	2001244
Abdelaziz Mohamed Mohamed Ahmed Bekhet	2001028
Omar khaled elsaid	2000307
Ahmed mohamed el sayed mohamed ali khalifa	2000035

TABLE OF CONTENTS

Project Description

Robot car with line following and obstacle avoidance technology which can predict the path drawn in black lines and curves and moves in a straight line if the path is lost, also it can avoid any obstacles it faces by rotating around the obstacle.

Components

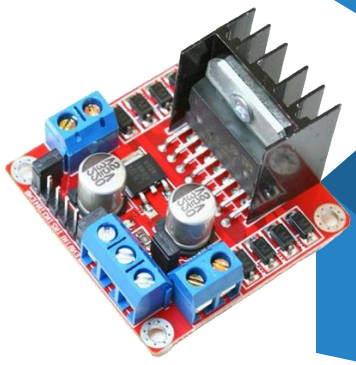
- ## Car Body

This robot features two gear motors with 65mm wheels and a rear caster. The chassis plates are cut from acrylic with a wide variety of mounting holes for sensors, controllers, power, etc. Simply bolt the two pre-cut platforms together, attach the motors and caster and add your favorite robotics controller. This kit includes all the parts needed to assemble the chassis as well as a 4xAA battery holder with barrel jack termination.

- ## Arduino UNO R3

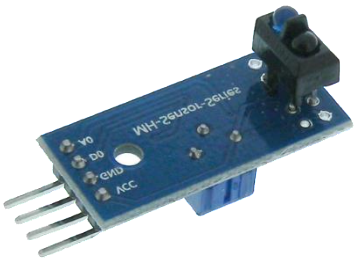
The Arduino UNO Rev.3 board is a microcontroller board based on the ATmega328 (data sheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

- L298 Motor driver



The L298 is an integrated monolithic circuit in a 15-lead Multiwatt 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.

- Line Tracker Sensor



This is high performance line finder that is designed for line following robotic. It consists of two parts – an IR emitting LED and an IR sensitive phototransistor. It can output digital signal to a microcontroller so the robot can reliably follow a black line on a white background, or vice versa. The sensor is Arduino compatible.

- DC Geared Motor with a wheel

This DC geared motor can be connected directly to our robot tires without any couplings. This is an advantage as it reduce assembly complications.

- Voltage: 4– 9 V DC
- No Load Speed: 90 +/– 10rpm
- No Load Current: 190mA (max.250mA)
- Minimum Torque: 800 gm.cm

- Ultrasonic Sensor Module

Distance measurement sensor is a low-cost full functionality solution for distance measurement applications. The module is based on the measurement of time flight of ultrasonic pulse, which is reflected by an object.
Resolution = 1 cm

- ## Ultrasonic Sensor Mount

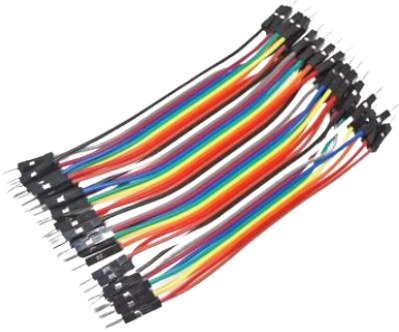
  Suitable for ultrasonic sensor fixation, compatible with servo motor to allow rotational movement for the ultrasonic sensor.
  easy solution for multi-directional sensation of ultrasonic sensor.

- ## Lithium Rechargeable Battery 18650 / 3.7V

  3.7V 18650 22000mAh (Actual ~ 1500mAh) Li-ion Rechargeable Battery.

- ## Male-Male Jumper Wire- 200 mm

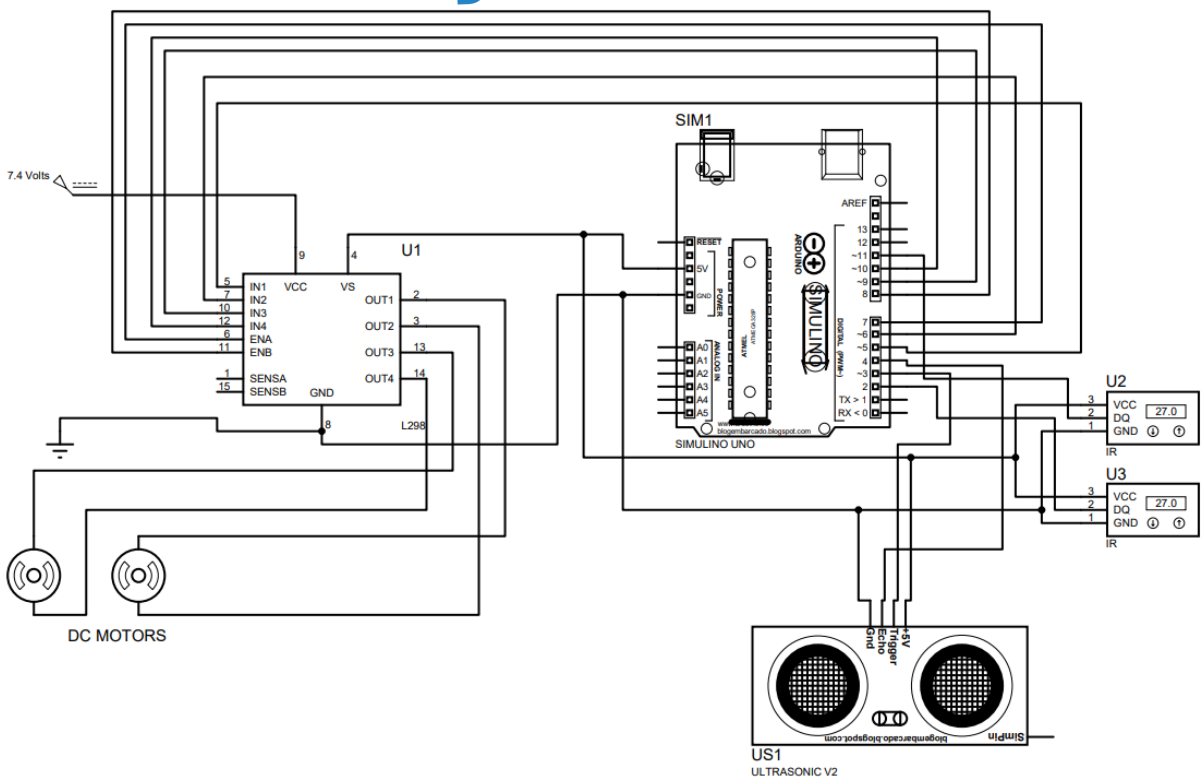
  These are 200 mm long jumpers with male connectors on both ends. Use these to jumper from any female header on any board, to any other female header.
  - Single Port male to male Jumper Wire.
  - Greatly used for breadboard and Arduino.



- ## Male-Female Jumper Wire- 200 mm

  Male-Female Jumper Wire 120 mm Very useful wires, saves you from crimping custom cables, if you need several pins at once, you can just connect a few of these wires together.

Circuit Design



Circuit Explanation

- First, we connected the battery to the motor driver l298D and connected the motors to it then we powered the Arduino Uno and the sensors by the 5V and ground pins.
- Then we started to connect the signal pins to the Arduino Uno board and started coding it.
- For the ultrasonic the trig and echo pins were connected to Arduino where trig is used to send a signal and echo to give a signal on receiving the sound again.
- For the IR the signal pin was connected to give a signal on detecting the line.
- There are four signals to control the motors from IN1 to IN4 and two enable pins are always set HIGH.

Working streams

We divided the team into 3 groups working in parallel on the project.
Team I: worked on the circuit design. (The first 3 in the table names)
Team II: worked on the code. (The second 3 in the table names)
Team III: worked on testing, measurement and adjusting the car to the track. (The last 3 in the table names)
We chose a day in which 2 or 3 of us connected the parts together and started working on different tracks.

Project foundation

The project aims to make a RC Car that follows a line and avoids obstacles.
The workload was divided on different times and equally among us as demonstrated before.
Then we tried to improve our work step by step through coding and adjusting sensitivity of sensors.

Problems and solutions

Problem: on setting the motors speed to maximum speed the car deviated from the track

Solution: the IR sensors were not able to follow up with the motors high speed, so we reduced it.

- There were no other problems that faced us.

Programming language

Arduino can be programmed using C++.

Moving mechanism

First, priority moves are given for obstacle avoidance to be executed first then line following mechanism follows.

Obstacle avoidance is done by turning to the left then right then forward then right and left to return again to the track.

Line following is done on to stages: overlapped & non-overlapped.

For non-overlapped it moves forward until it read a right or a left signal then it turns

For overlapped it moves forward if it read two signals to cross the cross.

Q & A

1. How many motors did you use in your car?
    - Two motors for two wheels and a third free moving wheel with no motor driving it.

2. How many batteries did you use? And how much voltage did they produce as an overall voltage?
    - Two lithium-ion batteries.
    - Total 7.4 Volt (each 3.7V and connected in series).

3. Are all the batteries connected together and supplying the same output? Or there is a battery distribution schema that you used?
    - Yes, all batteries were connected together as shown in circuit diagram i.e., there was no battery distribution schema.

4. How many sensors did you use in your car? And where did you place them?
    - Three sensors (2 IR sensors to follow the line and one ultrasonic sensor to avoid obstacles)
    - We placed them at the car front to get the signal and process it before controlling the motors.

5. What should your car do if it faces an obstacle?
    - The ultrasonic sensor will read the distance and if it is less than or equal 9 cm it will follow a constant behavior by ignoring the signals coming from the IR sensors and turn for 800 milliseconds to the left then same time to the right then moving forward for 700 milliseconds then it will turn right for 800 milliseconds and to the left for another 800 ,so cancelling the right-left behavior with left-right returning to the track and the 700 milliseconds forward was to pass the obstacle.

6. Explain the obstacle dimensions you used in your trial/experiment. And why exactly did these dimensions worked with your car?
    - We used a Pepsi can with a diameter of 6.6 cm.
    - It worked because we adjusted the time for each move to fit with the obstacle dimensions.

The Code

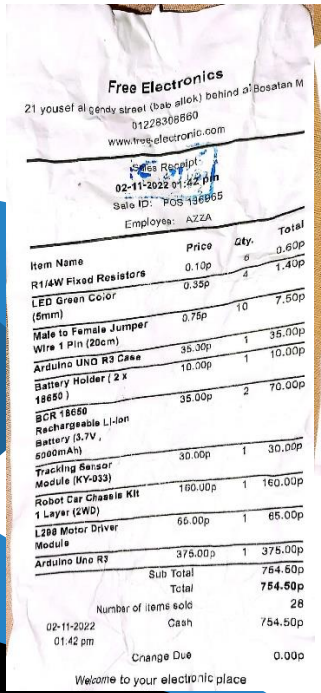
```
int enLeft = 7;
int enRight = 8;
int right_motor1 = 5;
int right_motor2 = 6;
int left_motor1 = 9;
int left_motor2 = 10;
int right_signal = 11;
int left_signal = 2;
int trig = 3;
int echo = 4;
int duration;
int distance;
void setup() {
//define motors
pinMode(right_motor1, OUTPUT);
pinMode(left_motor1, OUTPUT);
pinMode(right_motor2, OUTPUT);
pinMode(left_motor2, OUTPUT);
pinMode(enLeft, OUTPUT);
pinMode(enRight, OUTPUT);
//define IR sensors
pinMode(right_signal, INPUT);
pinMode(left_signal, INPUT);
//define Ultrasonic sensors
pinMode(trig, OUTPUT);
pinMode(echo, INPUT);
Serial.begin(9600);
}

void loop()
{
  //Enable Motors
  digitalWrite(enLeft, HIGH);
  digitalWrite(enRight, HIGH);
  //Measuring distance
  // Clears the trigPin
  digitalWrite(trig, LOW);
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10 ms
  digitalWrite(trig, HIGH);
  delayMicroseconds(10);
  digitalWrite(trig, LOW);
  // Reads the echoPin, returns the sound wave travel time in ms
  duration = pulseIn(echo, HIGH);
  // Calculating the distance
  distance = duration * 0.034 / 2;
  // Prints the distance on the Serial Monitor
  Serial.print("Distance: ");
  Serial.println(distance);

  // Priority given to ultrasonic
  if (distance <= 9)
  {
    //turn left for 1 sec
    analogWrite (right_motor1, 100);
    digitalWrite (left_motor1, LOW);
    digitalWrite (right_motor2, LOW);
    digitalWrite (left_motor2, LOW);
    delay(800);

    //turn right for 1 sec
    digitalWrite (right_motor1, LOW);
    analogWrite (left_motor1, 100);
    digitalWrite (right_motor2, LOW);
    digitalWrite (left_motor2, LOW);
    delay(800);
```

```
//move in a line for 1 sec
    analogWrite (right_motor1, 100);
    analogWrite (left_motor1, 100);
    digitalWrite (right_motor2, LOW);
    digitalWrite (left_motor2, LOW);
    delay(700);

  //turn right for 1 sec
    digitalWrite (right_motor1, LOW);
    analogWrite (left_motor1, 100);
    digitalWrite (right_motor2, LOW);
    digitalWrite (left_motor2, LOW);
    delay(800);
//turn left for 1 sec
    analogWrite (right_motor1, 100);
    digitalWrite (left_motor1, LOW);
    digitalWrite (right_motor2, LOW);
    digitalWrite (left_motor2, LOW);
    delay(800);

  }
  else {
  // IR line follower


  // if right sensor detects && left doesn't turn right

  if (digitalRead(right_signal) == HIGH && digitalRead(left_signal) == LOW)
  {
    analogWrite (left_motor1, 0);
    analogWrite (right_motor1, 80);
    digitalWrite (right_motor2, LOW);
    digitalWrite (left_motor2, LOW);
    Serial.println("Right");

  }

  // if left sensor detects && right doesn't turn left
  else if (digitalRead(left_signal) == HIGH && digitalRead(right_signal) == LOW )
  {
    analogWrite (left_motor1, 80);
    analogWrite (right_motor1, 0);
    digitalWrite (right_motor2, LOW);
    digitalWrite (left_motor2, LOW);
    Serial.println("Left");

  }

  //else ==> move in a line
  else
  {
    analogWrite (right_motor1, 100);
    analogWrite (left_motor1, 100);
    digitalWrite (right_motor2, LOW);
    digitalWrite (left_motor2, LOW);
    Serial.println("forward");

  }

}
}
```

Total Cost Calculations

#	Component type	model	quantity	Price in Egypt (LE)
1	Car body	Robot platform	1	230.00
2	Microcontroller	Arduino UNO R3	1	390.00
3	Motor driver	L298	1	65.00
4	Infrared sensor	Line tracker sensor	2	80.00 (40.00 for each)
5	Ultrasonic sensor	Ultrasonic sensor module	1	60.00
6	Battery	Lithium rechargeable battery	2	70.00 (35.00 for each)
7	Mount	Ultrasonic mount	1	15.00
8	Wires	Male to Male and Male to Female Jumpers	30	22.50 (0.75 for each)

TOTAL COST = 932.5 LE

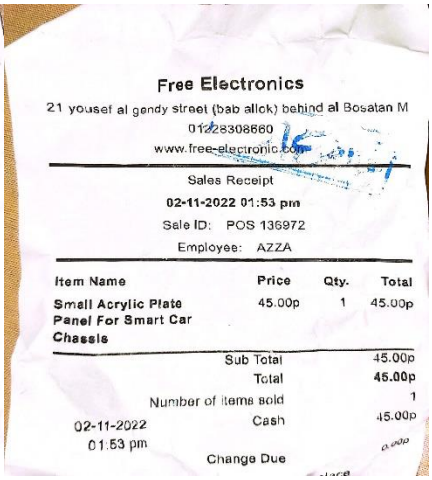


Free Electronics
21 yousef al gendy street (bab allok) behind al Bosatan M
01228308660
www.free-electronic.com

Sales Receipt
02-11-2022 01:42 pm
Sale ID: POS 136965
Employee: AZZA

Item Name	Price	Qty.	Total
R1/4W Fixed Resistors	0.10p	6	0.60p
LED Green Color (5mm)	0.35p	4	1.40p
Male to Female Jumper Wire 1 Pin (20cm)	0.75p	10	7.50p
Arduino UNO R3 Case	35.00p	1	35.00p
Battery Holder (2 x 18650)	10.00p	1	10.00p
BCR 18650 Rechargeable Li-Ion Battery (3.7V , 5000mAh)	35.00p	2	70.00p
Tracking Sensor Module (KY-033)	30.00p	1	30.00p
Robot Car Chassis Kit 1 Layer (2WD)	160.00p	1	160.00p
L298 Motor Driver Module	65.00p	1	65.00p
Arduino Uno R3	375.00p	1	375.00p
Sub Total			754.50p
Total			754.50p
Number of items sold			28
Cash			754.50p
Change Due			0.00p

Welcome to your electronic place



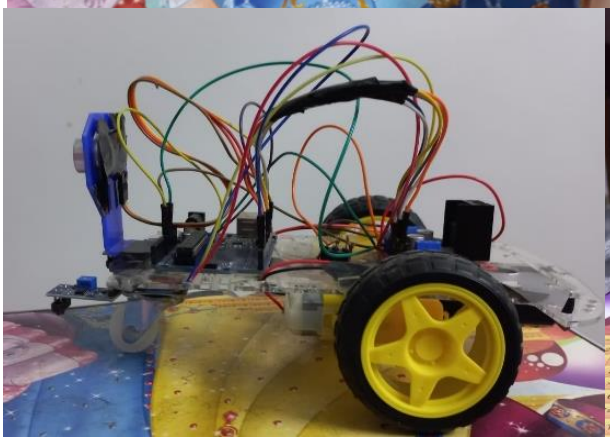
Free Electronics
21 yousef al gendy street (bab allok) behind al Bosatan M
01228308660
www.free-electronic.com

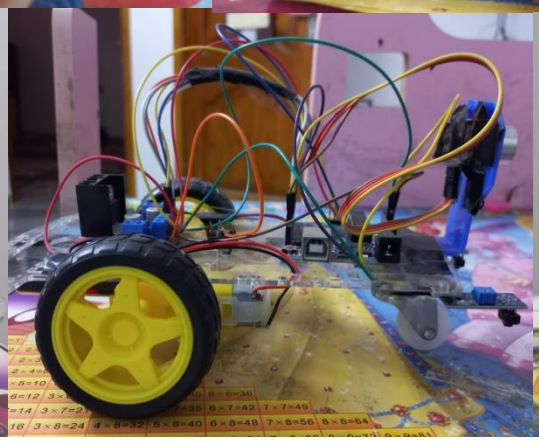
Sales Receipt
02-11-2022 01:53 pm
Sale ID: POS 136972
Employee: AZZA

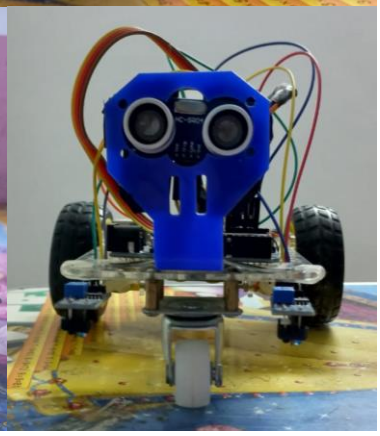
Item Name	Price	Qty.	Total
Small Acrylic Plate Panel For Smart Car Chassis	45.00p	1	45.00p
Sub Total			45.00p
Total			45.00p
Number of items sold			1
Cash			45.00p
Change Due			0.00p

02-11-2022
01:53 pm

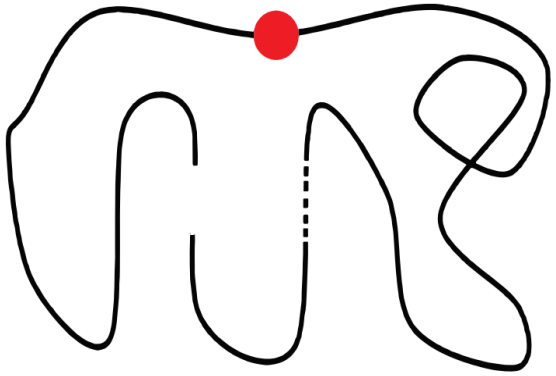
CAR PHOTOS







TRACK USED



THE END