Faculty of Engineering - Ain Shams University
Junior Electrical Engineering

Team 37

E l e c t r o B O O M

Line Follower RC Car

System Dynamics and Control Components
(CSE271s)

Table Of Contents

Team Members

Name	ID
Andrew Ayman Samir Zikery (T.L)	*2000003*
Mayar Abdelfattah Ebrahim Abdellatif	*2001405*
Shorouk Tamer Mostafa Mohamed	*2000403*
Bishoy Samir Azmy Astafanous	*2000253*
Raniem Hossam Elden Sobhy Metwaly	*2000012*
Gina Alaa Fathy Sedky	*2001661*
Youssef Saad Gobran Mosaad Gobran	*2001440*
Sara Mohamed Mostafa Ali	*2000331*
Philopateer Sameh Rasmy	*2000955*
Aya Ashraf Abdallah Mahdy	*2001855*

1. *Introduction:*

The line follower robot is an automated vehicle that follows a visual line embedded on the surface. Generally, it uses a black line on a white surface, or you can adjust it as a white line on a black surface.

In industries, giant line follower robots are used for assisting the automated production process. They are also used in military applications, human assistance purposes, delivery services, etc.

2. *Description:*

Line Tracking Object Detection car that tracks a blackline (curved or straight) and turns accordingly the if an object is detected turns around it continuing its way like normal.

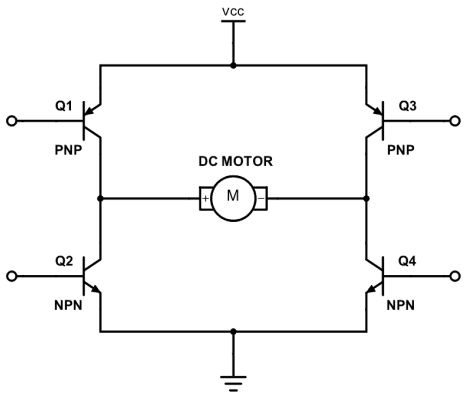
3. *Circuit Design Decisions:*

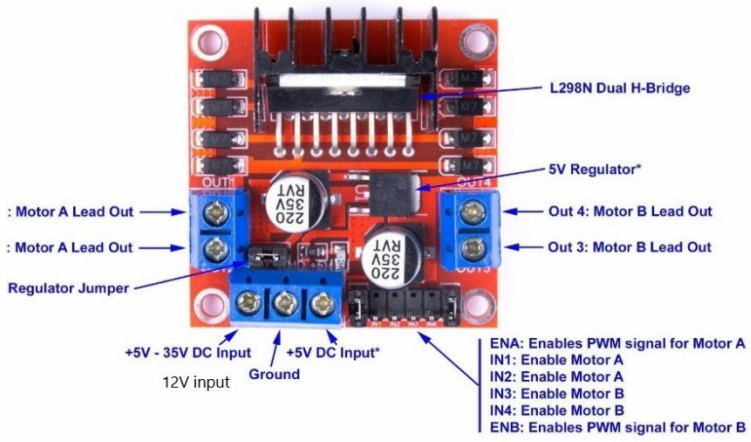
- **Car Structure**

After much consideration, we decided to continue with a laser cut acrylic board (2 WD) to hold the car.

- **Moving Mechanism**

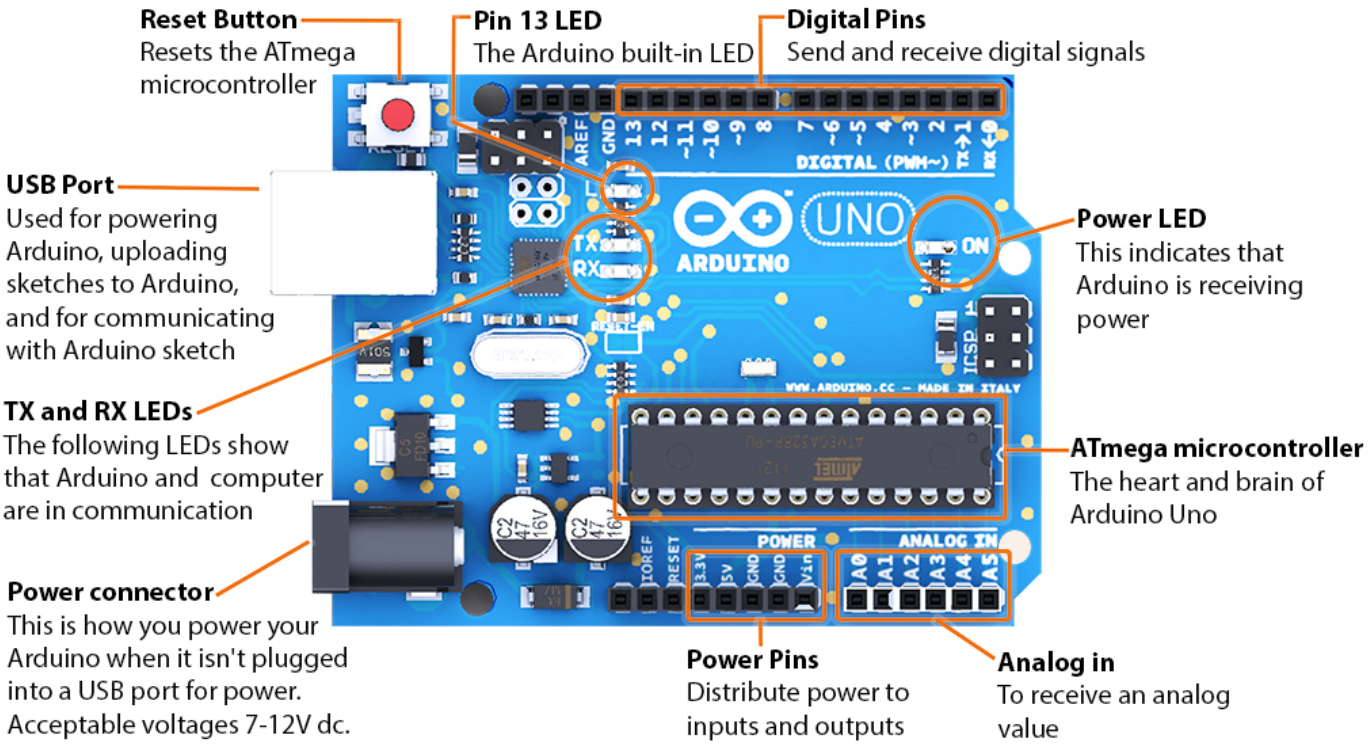
To move the car an H-Bridge (using transistors) is more commonly used for controlling the directions of the motor, L298N Motor Driver is the best for the required task.





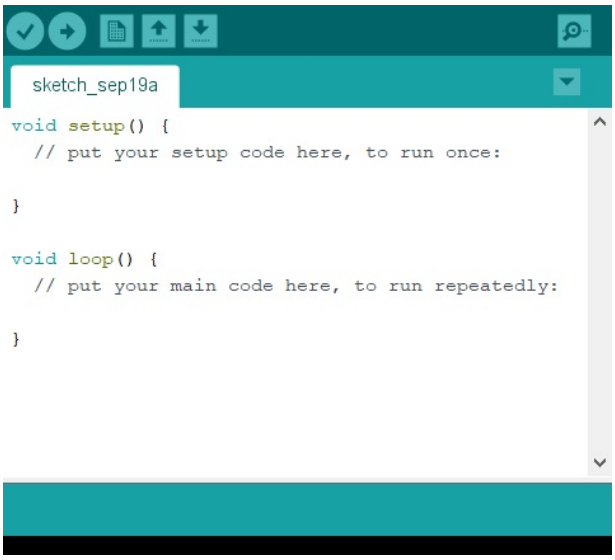
- **Microcontroller type**

After much research, Arduino Uno is the best to use for small projects, easy to repair, simple circuit design and low cost to the number of pins required.



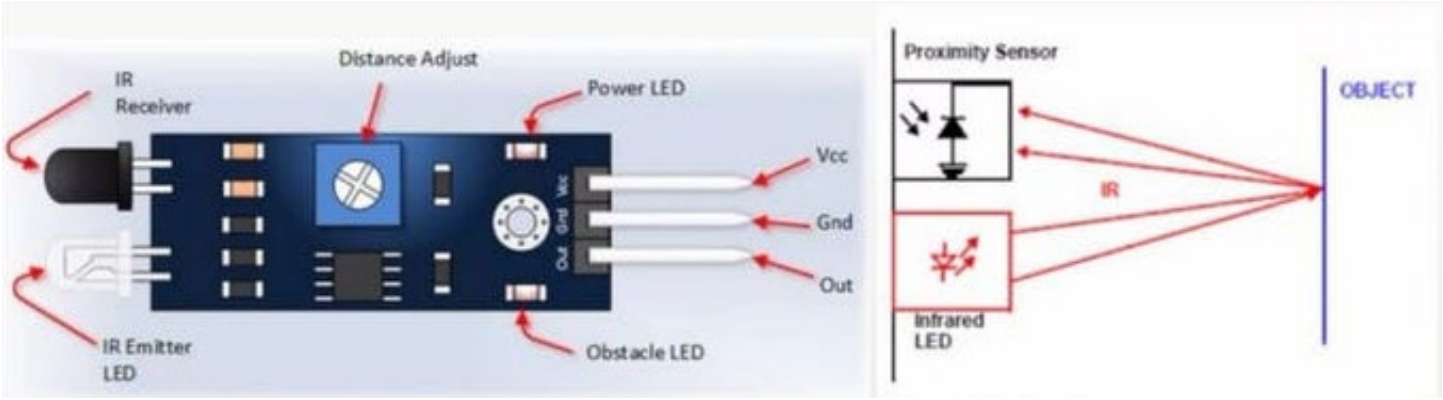
- **Programming language**

Arduino C is the best suitable for Arduino Uno, furthermore; OOP (Object Oriented Programming) will be used to divide the project to more simpler tasks easily divided between the team.

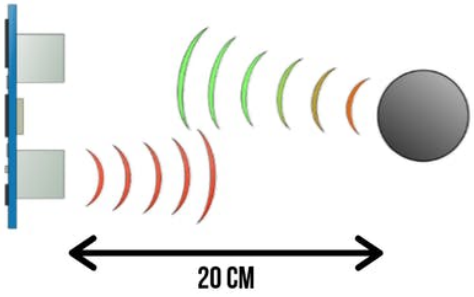


- **Sensors**

1. **Infrared (IR) sensor:** emits the light to detect some surroundings. When IR rays fall on a black surface, it is absorbed by the black surface, and no rays are reflected; thus, the IR receiver doesn't receive any rays, and the reverse happens with white surface; thus, we use two to know when the car is not on the line.

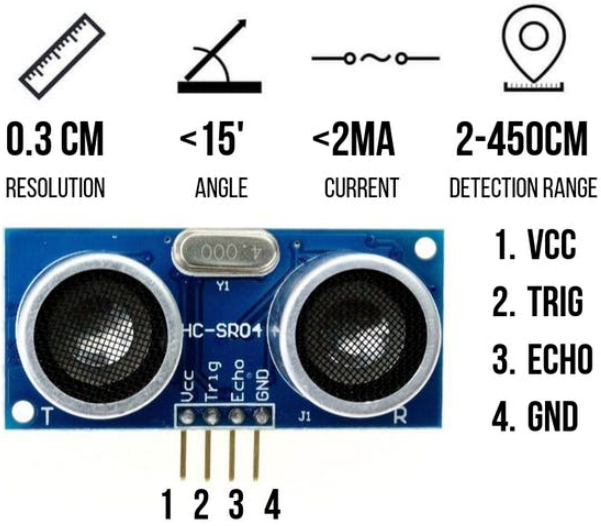


2. **Ultrasonic (HC-SR04) sensor:** emits sound wave that travels through the air and if there is an object or obstacle on its path It will bounce back to the module.



SPEED OF SOUND:
v = 340 m/s
v = 0.034 m/s

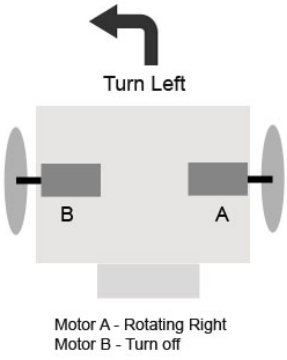
TIME = DISTANCE/SPEED
t = s/v = 20/0.034
= 588 us
s = t x 0.034/2

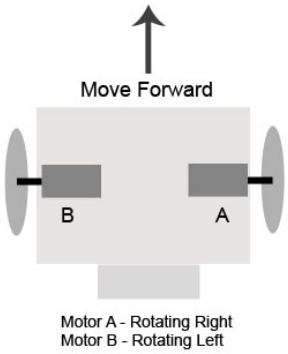


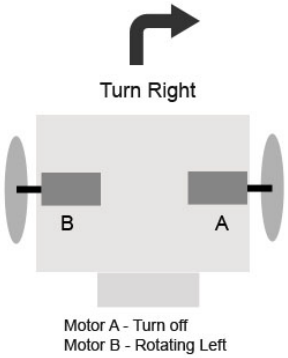
4. *Circuit Explanation:*

- ***Steering***

Motor driver enables us to control each motor rotation and speed individually, so different combinations can do different things.





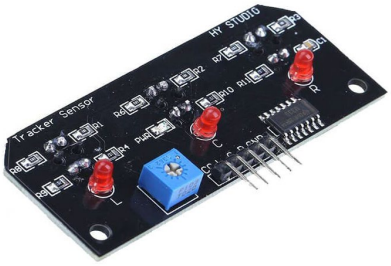


- **Power Supply**

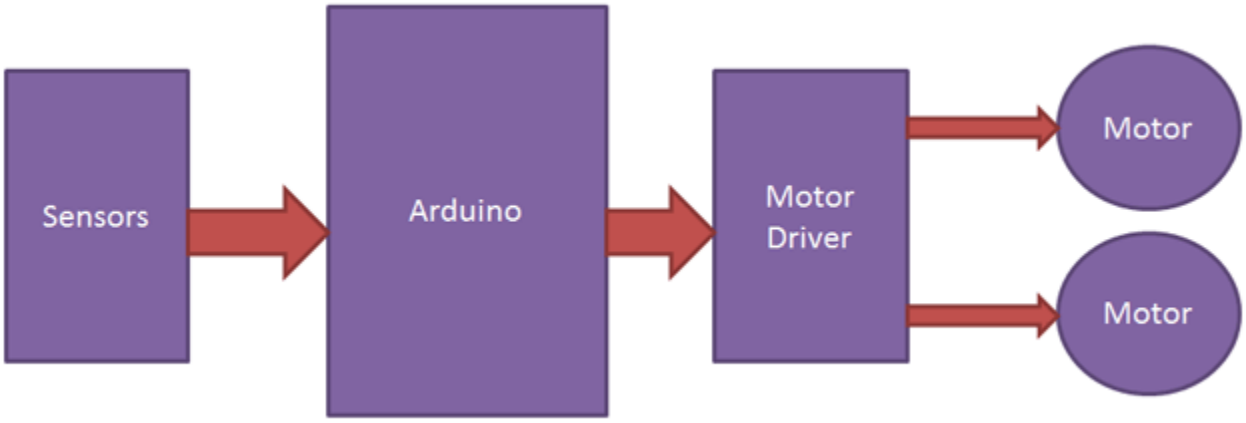
(3.7 * 3 ≈ 12v) Lithium Battery Pack is used to supply the voltage to the circuit (connect to +12 pin on the motor driver) with a switch to control whether the motors are forward or reverse.

- ***Line Tracking***

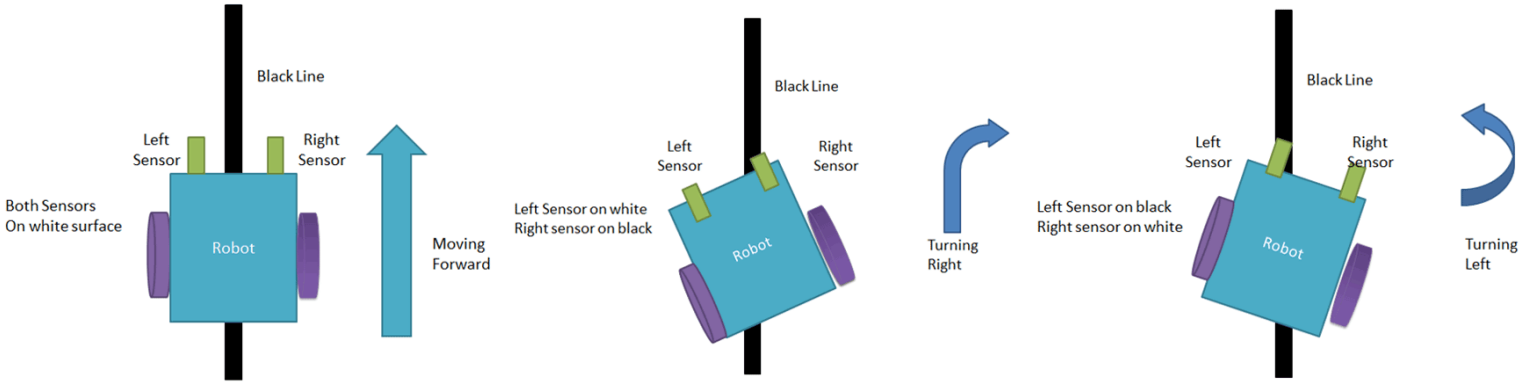
We used the IR sensor as we mentioned but the version with the 3-chaneel array to detect if the car is on the line and if the line going to the right or to the left to make the car turn respectively.



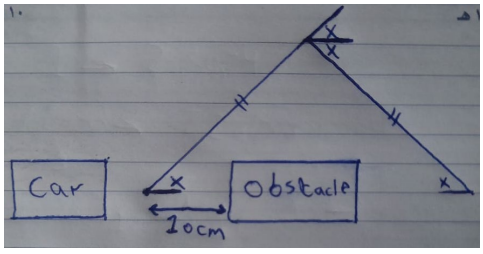
- **Path Prediction**



There are 4 states available (4th one which is the two IR are on black will keep the car continue forward):



- ***Obstacle Avoidance***



We use the ultrasonic to check if there is an object less than 10cm then the car rotates until the object is no longer visible then continue forward for a certain period then rotate the other way around with rotation of double the initial rotation then continue forward until it finds the line again making an isosceles triangle around the obstacle which results in a dynamic code useful for a range of obstacle dimensions.

5. *Questions & Answers:*

1. ***How many motors did you use in your car?***
   2 Motors used (Reason explained below in problems section).

2. ***How many batteries did you use? And how much voltage did they produce as an overall voltage?***
   3 Lithium Batteries(3.7v) used in series to produce an overall voltage of (3.7 * 3 = 11.1 ≈ 12v).

3. ***Are all the batteries connected and supplying the same output? Or there is a battery distribution schema that you used?***
   They are connected in series to supply the motor driver with power then the driver supplies 5v to the Arduino and sensors.

4. ***How many sensors did you use in your car? And where did you place them?***
   2 sensors used(ultrasonic and IR 3-channel array). Ultrasonic on the front on the top of the car. IR Sensor on the front on the bottom half of the car with screws to adjust the height between the sensor and the ground.

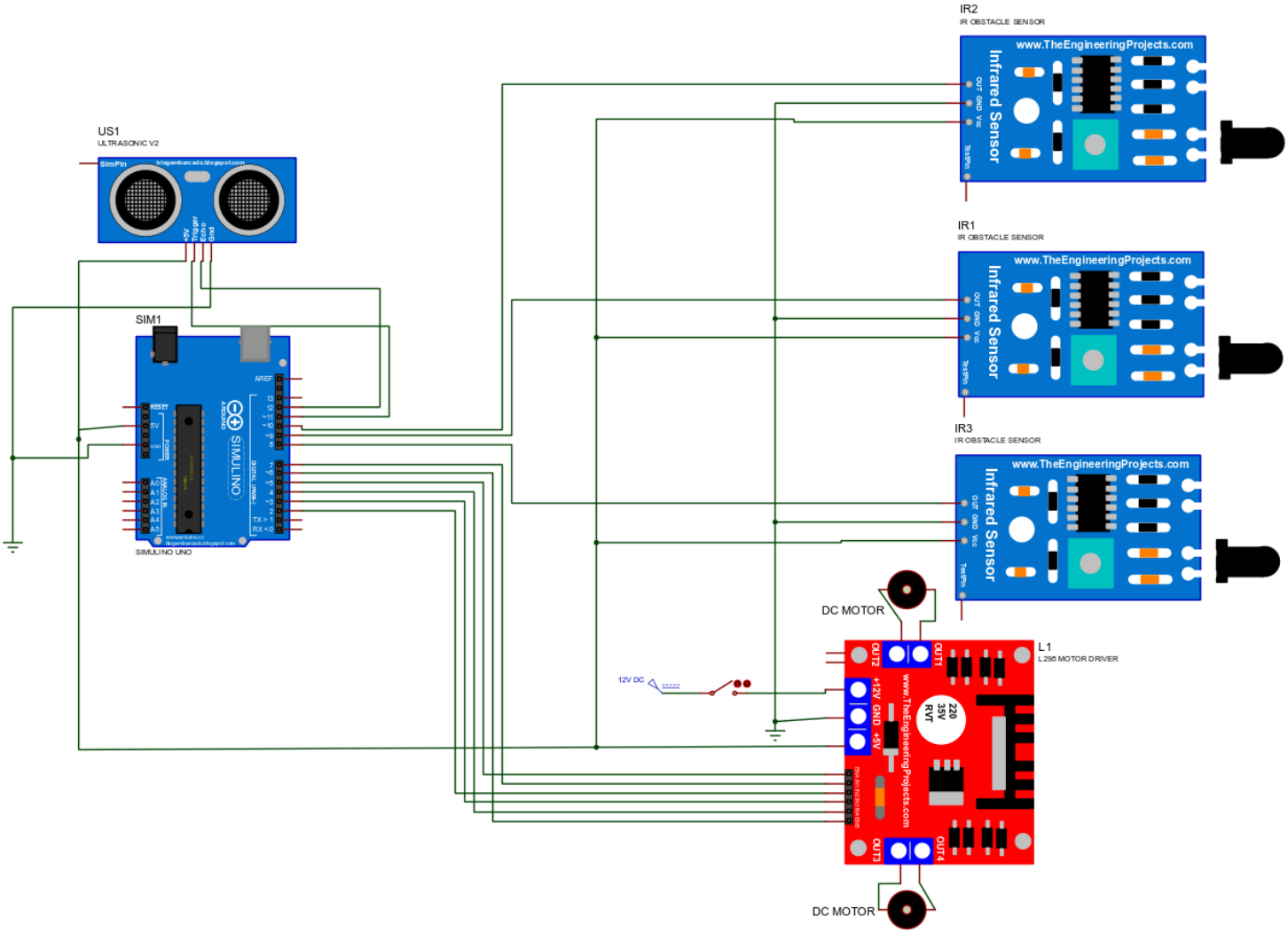
5. ***What should your car do if it faces an obstacle?***
   The car should make an isosceles triangle around the obstacle as shown before in the obstacle avoidance (Explanation section).

6. ***Explain the obstacle dimensions you used in your trial/experiment. And why exactly did these dimensions worked with your car?***
   We used a water bottle with a diameter of about 6cm and height of about 25cm. the height is important to make sure that the obstacle can detect it and the width is not important (relatively small) because the code is dynamic to the object width.

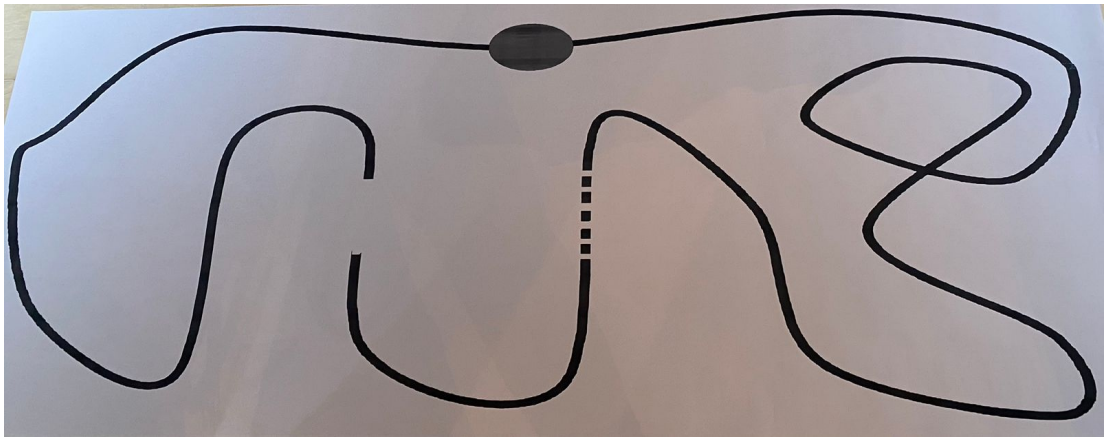
6.*Problems & Solutions:*

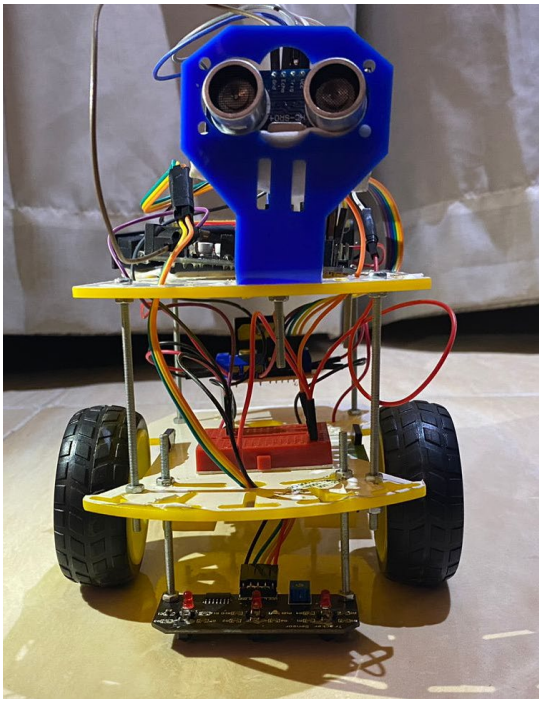
Problem	Solution
Used Heavy Acrylic Board which made the Car so heavy on the motors.	Used 2 WD acrylic plates with 2 motors instead of four.
Used 4 Motors which consumed more power resulting in shorter lifetime for batteries before recharging	
Used 3 separate IR sensors which resulted in too much testing and calibration for each sensor consuming a lot of time	Used 3-Channel IR Tracking sensor as shown previously.
With testing; We discovered that the right motor pin received less voltage than the left although the code is the same for both.	We tested the voltage of the positive and negative for the two motors and through the code, we multiplied the right voltage with a suitable ratio.
IR sensor wasn't working as expected even with changing the sensitivity	We showed our problem to the vendor which then, He agreed to replace it resulting it to work as expected.
The thickness of the line wasn't suitable for the 3 sensors to correctly read.	Changing the line width to correctly suit the sensor.
Track Dimension required was too large to print by any machine in the market.	Scaled Down the track to print the track at the largest machine we found at width of 90cm.

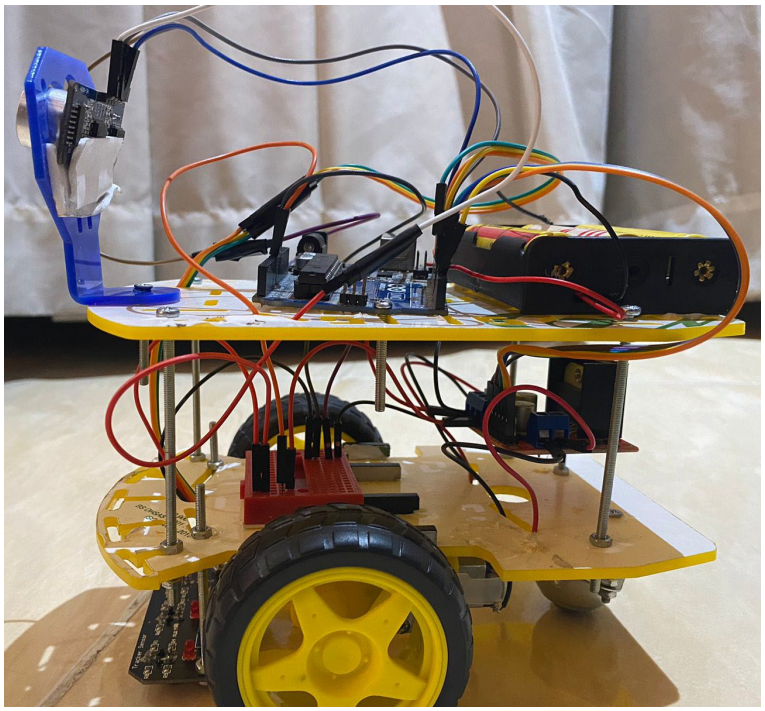
7. Circuit Diagram

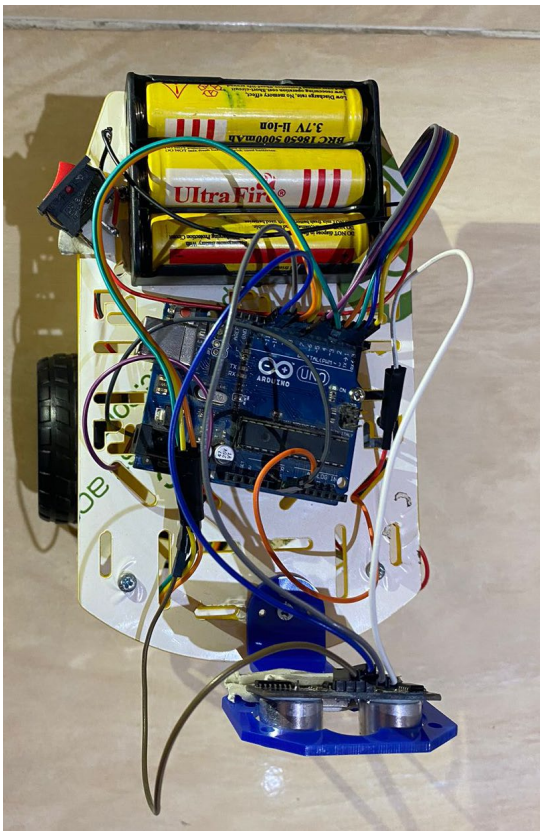


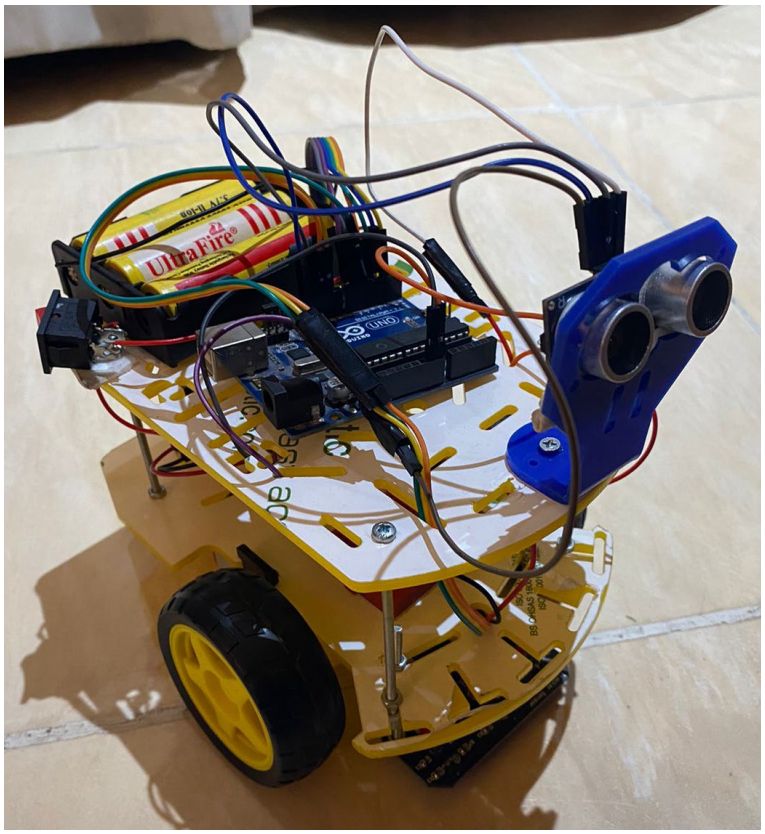
8. *Car & Track Photos:*








UltraFire
ARDUINO
UNO


UltraFire
UNO

9. Work Distribution:

- **Andrew Ayman Samir:**
  Project Management, Arduino Programming and Testing.
- **Bishoy Samir Azmy Astafanous:**
  Arduino Programming and Software Testing.
- **Philopateer Sameh Rasmy:**
  Arduino Programming and Software Testing.
- **Youssef Saad Gobran Mosaad Gobran:**
  Hardware Testing and resources supplier.
- **Gina Alaa Fathy Sedky:**
- Hardware Testing and resources supplier.
- **Mayar Abdelfattah Ebrahim Abdellatif:**
  Car Design and Positioning.
- **Sara Mohamed Mostafa Ali:**
  Car Design and Positioning.
- **Shorouk Tamer Mostafa Mohamed:**
  Car Design and Positioning.
- **Raniem Hossam Elden Sobhy Metwaly:**
  Track Printing and Report Maker.
- **Aya Ashraf Abdallah Mahdy:**
  Track Printing and Report Maker.

10. Bill Of Material:

We have most of the materials already available due to a previous project, but the project cost as of today is estimated (1115 EG)

Source: Free Electronics

	Product name	Unit price	Stock status
	Battery Holder (3 x 18650)	15.00 EGP	In Stock
	BCR 18650 Rechargeable Li-ion Battery (3.7V , 5000mAh)	35.00 EGP ~~50.00 EGP~~	In Stock
	EU Universal 18650 Lithium Battery Charger 2 Cell	85.00 EGP	In Stock
	65pcs Flexible Breadboard Jumper Wires	45.00 EGP	In Stock
	L298 Motor Driver Module	65.00 EGP	In Stock
	Ultrasonic Sensor HC-SR04 Holder	15.00 EGP	In Stock
	Ultrasonic Sensor (HC-SR04)	45.00 EGP	In Stock
	Robot Car Chassis Kit 2 Layer (2WD)	275.00 EGP	In Stock
	Arduino Uno R3	375.00 EGP	In Stock
	Line Tracker Module (3 Channels)	90.00 EGP	In Stock