Engineering Magazine

Panama

Centro Cultural Chino Panameño

Instituto Sun Yat Sen

Future Engineers

Team: Brilliant Minds

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WRO 2023

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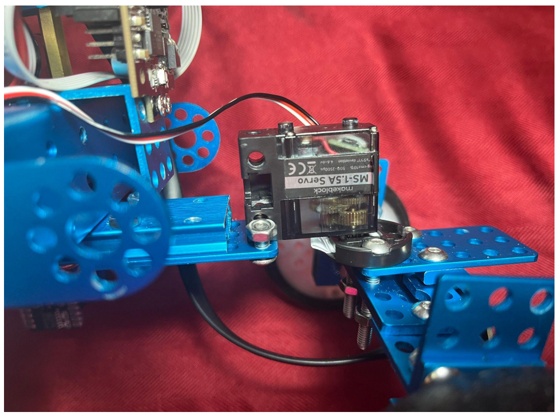
Introduction

In the exciting field of robotics, a remarkable technological breakthrough has led to the creation of robots that use the power of sensors. Sensors are used so the robot can measure everything related to its surroundings. In this case we use the ultrasonics sensors together with the camera. With these components we were able to create a robot that can guide itself through the track by detecting obstacles with its ultrasonic sensor and detecting color with its camera. This will allow it to complete both of the challenges of the competition with precise ease and pressure. Below, we present the entire process we went through to build our robot.

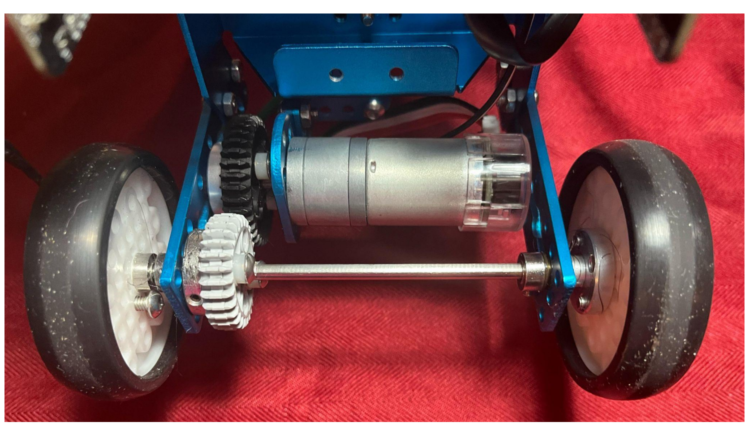
Design Process

<u>Mechanics</u>

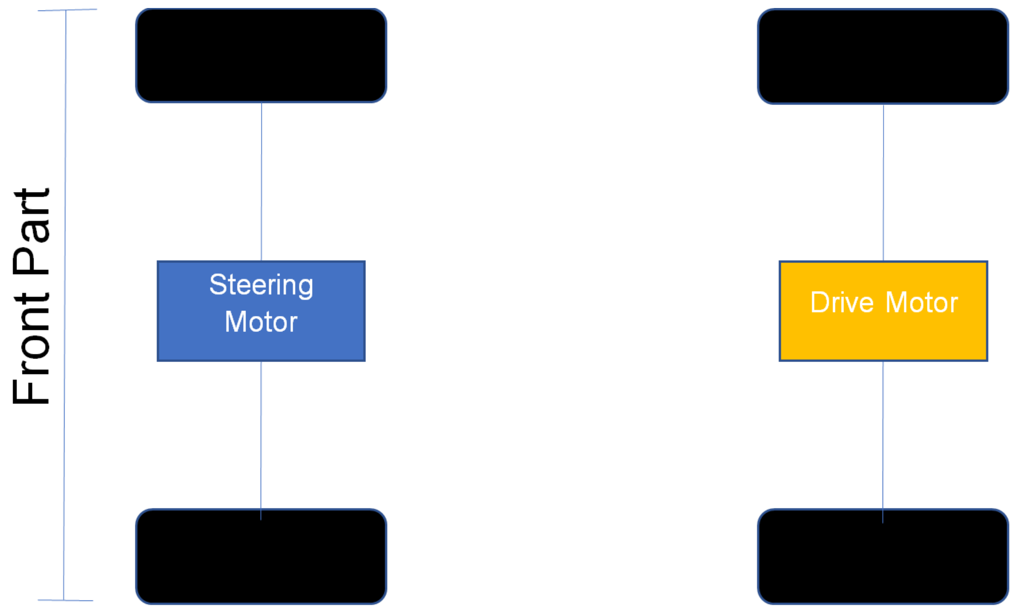
<u>Steering:</u> We use a Makeblock 1,5 servo as a steering motor at the front of the vehicle to control the steering angle. Together with the programming, we can decide the angle it should move depending on the position of the robot and if the track is clockwise or counterclockwise.



<u>Drive:</u> We use a Makeblock Encoder power motor with 1 axle, with this motor and the coding wecan control the speed of our vehicle. We put a gear at the end of the axle so it could get in touch with another gear that had in the middle a metal rod so it can be connected to both wheels.This was made to fulfill the parameters of the competition. Because the gear of the metal rod is smaller than the one in the motor axle this makes the movement of the wheels faster.



Chassis design: We place the steering motor in the front part of the chassis, this makes the turn easier. If the steering motor is at the rear, it would be static. The steering motor works together with the drive motor so that the steering motor guides the robot while the drive motor moves the robot forward.



Electronic

Sensors:

Ultrasonic sensor: We use 3 sensors, one the front and the other two on each side. These sensors are used so that our robot detects when it is approaching an object and does not collide with it.

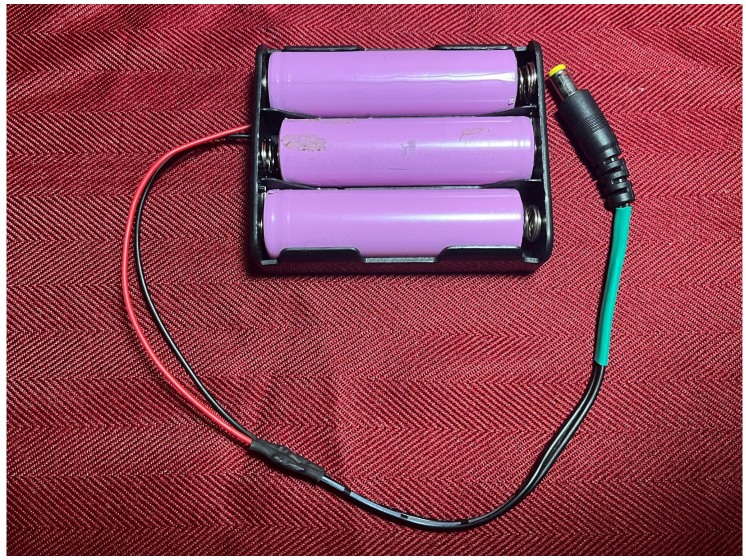
Pixy Camera: This camera is used to calculate distance, and also it identifies objects and colors. Together with the app of the camera, we can determine the color we want the camera to recognize while doing the 2nd challenge.

<u>Speed/steering control:</u>

<u>Servo motor:</u> The makeblock 1,5 a servo motor is used as the steering motor of the robot, which works together with the ultrasonic sensors and the camera to indicate the direction in which the robot should move forward. It follows the instructions we give it through programming. When it approaches an object within 20 cm, it depends on whether it has more space to the right or the left if it is to the right 65 ° and the left 25 °.

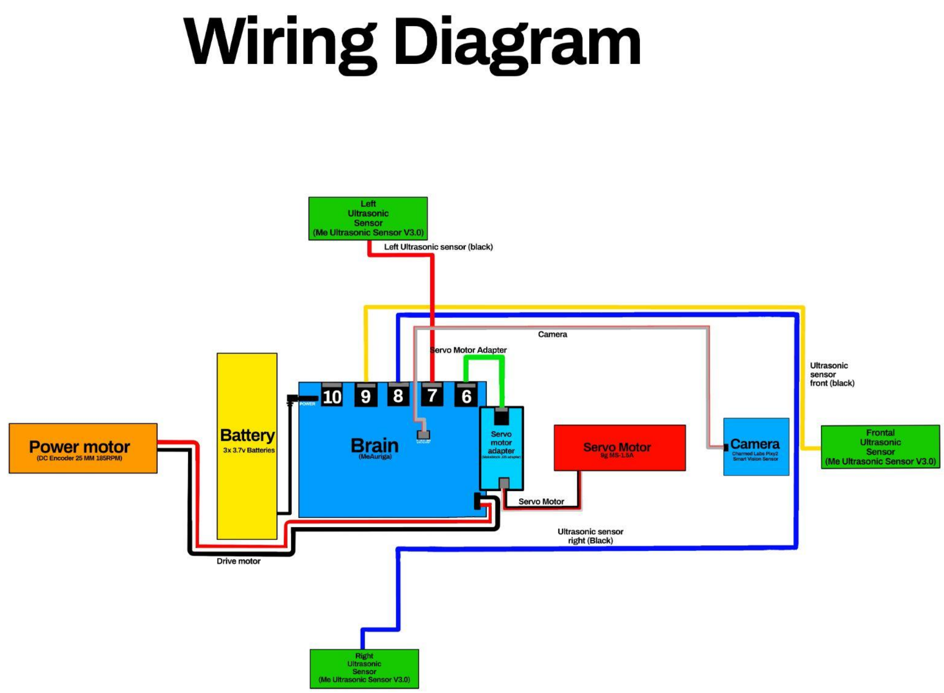
<u>Power motor:</u> We use a makeblock Dc Encoder motor. This motor is the one that helps the robot move backward or forward. Along with the gears and the metal rod it helps the vehicle go faster. With the programming we can decide the speed of this motor.

Power management:



Battery pack: We adapted this battery pack so it could be compatible with the brain we are using, because normally the makeblock brain uses AA batteries. This battery pack uses 3 18650 batteries, each one of them provides us with 3,7 V. We connect the battery pack to the brain. The brain is responsible for the distribution of power between the sensors and motors. Each one of these batteries consumes 2500 mAh.

Wiring Diagram:



In this diagram, we can see all the main components that are connected to the robot's brain. Each cable with a different color to differentiate.

-Rj25 inputs:

- 6th input…………………………………………Servo motor adapter.
- 7th input…………………………………………Left ultrasonic sensor.
- 8th input…………………………………………Right ultrasonic sensor.
- 9th input…………………………………………Front ultrasonic sensor.

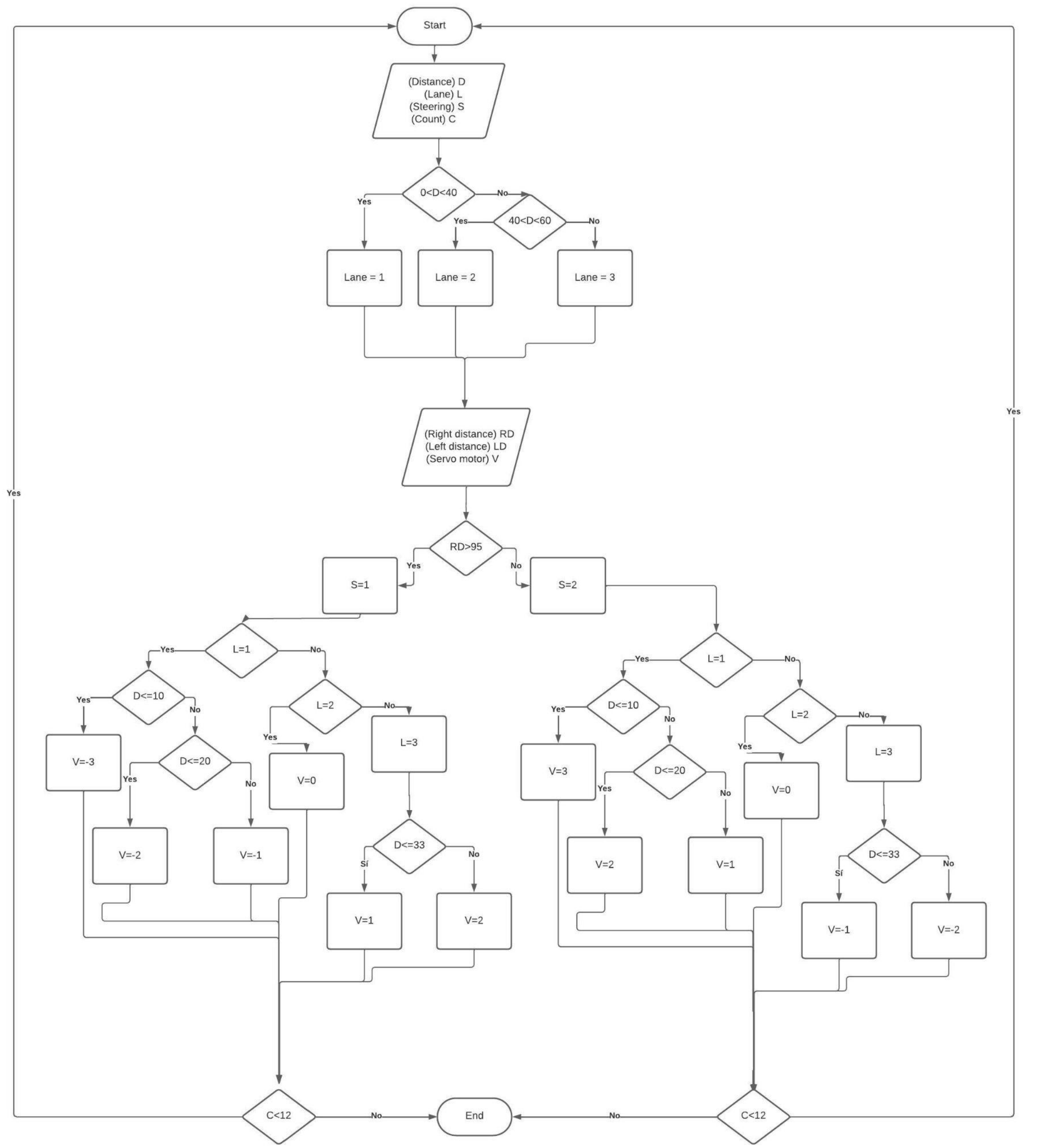
-ICSP input………………………………………… Pixy camera.

-Encoder motor port………………………………..Encoder power motor.

-Power jack…………………………………………Battery pack.

Programing:

Flowchart:



Pseudo code:

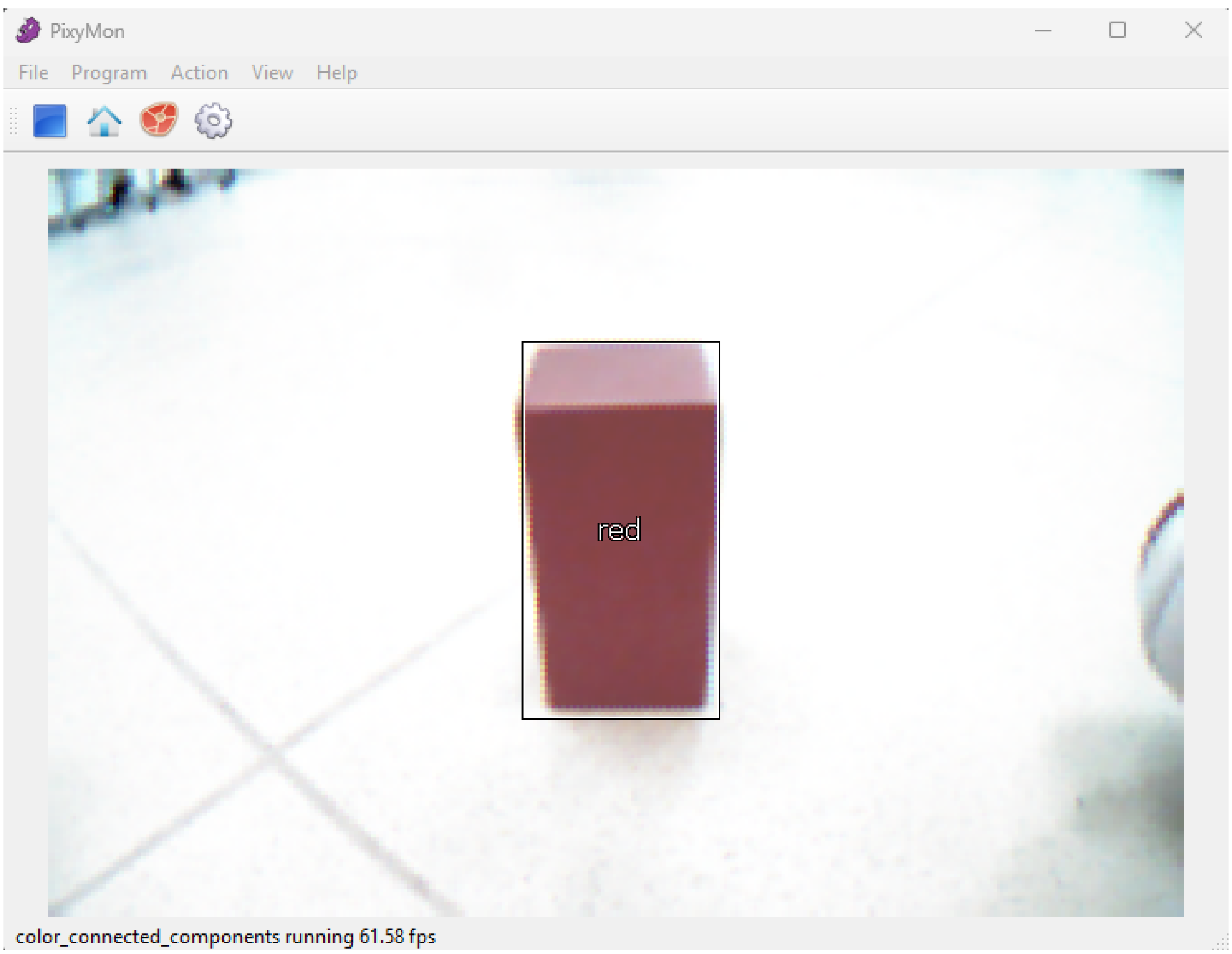
```
Start
Introduce D, L, S, C
If 0<D<40
Yes lane = 1
No If 40<D<60
      Yes lane = 2
      No lane = 3
Introduce RD,LD,V
If RD>95
Yes  S=1
       If L=1
Yes  if D<=10
        Yes V=-3
                If C<12
                   Yes return to start
                    No end
        No if D<=20
              Yes V=-2
                      If C<12
                     Yes return to start
                       No end
               No V=-1
                      If C<12
                     Yes return to start
                       No end

No S = 2
     If L=1
Yes  if D<=10
        Yes V=3
                If C<12
                   Yes return to start
                    No end
        No if D<=20
              Yes V=2
                      If C<12
                     Yes return to start
                       No end
               No V=1
                      If C<12
                     Yes return to start
                       No end
```

No if L= 2
Yes V=0
No L=3
If D<=33
Si V=-1
If C<12
Yes return to start
No end
No V=-2
If C<12
Yes return to start
No end

Strategy:

Camera: The camera has a special app for its use that serves as an interface to visualize what the camera is observing. This app allows us to put a “signature”, the signature is like a label that we put on the object that we want, and this one is saved in the camera's memory. To save it we first need to have the color of the obstacle. All images that come out of the camera are made up of pixels so we can take a pixel to select the color we want. We decided to save as a signature the colors red and green which are the colors of the objects in the second challenge.



<u>Discussion of the Code:</u>

For the code we use Arduino since the board we use is based on an Arduino one, along with the C language.

For the first challenge, we had to get the robot to make 3 laps around the track. For this, we needed to set two variables first: in which lane and in which direction it will advance. To define the lane, the robot uses ultrasonic sensors to measure the range of distances that represent each lane with respect to the center. For example lane 1, the one closest to the center is in a range between 0 and 40 cm, so if the robot is located between that range, the lane variable is equal to 1; likewise it would do with the other ranges equaling them to the corresponding number, 2 for the middle one and 3 for the outside one. Having this we move on the second variable, the direction. We have two possibilities, clockwise and counterclockwise, so we determine this when the robot leaves the range of the inner wall, then if it finds more distance to the right side means that it must turn to the right, that is to say it goes clockwise; on the contrary if it has more distance to the left is that it must turn there, it goes counterclockwise. Having these two variables defined, the robot has everything it needs to go autonomously. If the robot is on lane 2 (center lane) or lane 3 (outer lane), the vehicle will make an adjustment so in both cases it could move to lane 1 (inner lane). This was made so our robot could complete the challenge faster. We also added the variable count, this one helps the vehicle to count how many times it turns and the define when it has to stop. Because our robot has to complete 3 laps and on each laps it turns 4 times then we put or robot to count 12 times it turns to then stop.

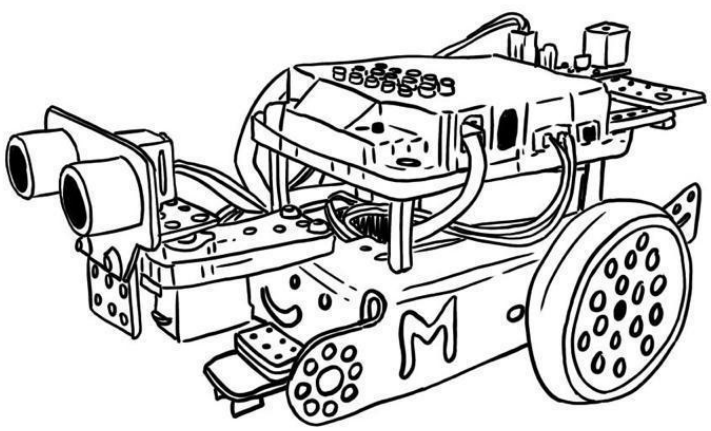
For the second challenge, the robot must dodge objects. For this we use the pixycam2 camera that allows us to save “signatures” of different colors so that the robot does something in particular when it detects them. In this case avoid them. First we save the signatures of the green and red color, in addition to the color of the walls. This code keeps looking for these three signatures to evade them. The camera distinguishes how close they are thanks to the perspective of the camera, the bigger the wall is, the closer it is. In addition, the colored obstacles, depending on their color, will turn in a certain way: if it is green to the left and if it is red to the right.

Journal entries

Chronology

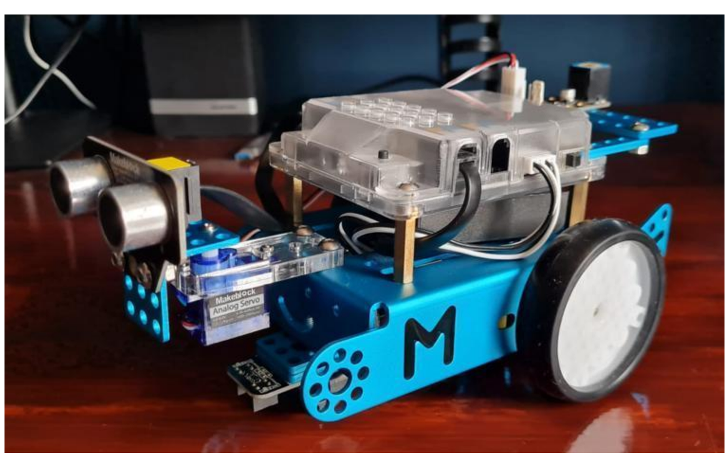
Week 1: Presentation of Preliminary Project.

After registering to participate in the 1st internal round and choosing the category in which we wanted to participate, we presented our preliminary project, which included: the parts we needed for our robot and their budget; the environment in which our robot would operate and the sketch or design of the robot.



Week 2: Prototyping

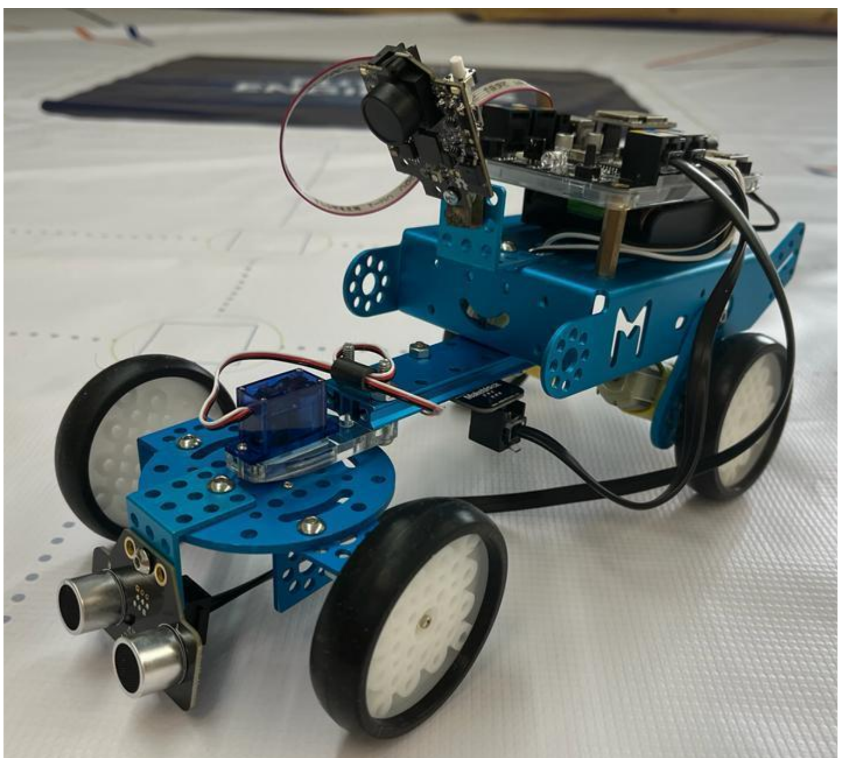
A member of our team already had most of the parts we needed, so with a little research and the manufacturer´s program we achieved our goal: to create an autonomous vehicle that avoided obstacles.



Week 3: Adapting our initial prototype to the challenges of the Olympiad

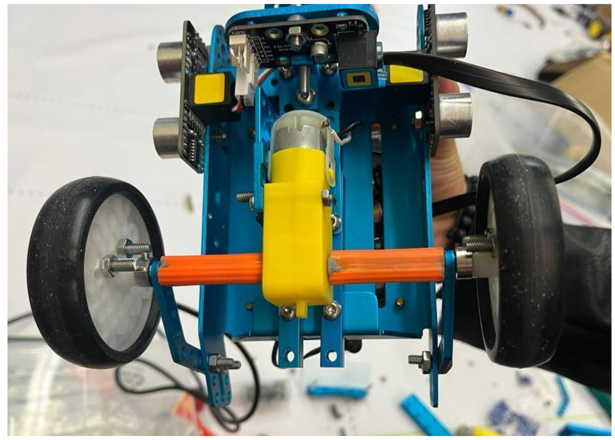
As we studied the challenges and rules of the competition in more depth, we adapted our initial prototype:

- We initially proposed our prototype with a single omnidirectional rim at the front.
- Then we put on the two tires to go with the two rear tires.
- Up to that point it was equipped with only an ultrasonic sensor mounted on a servo motor, giving it 180° mobility with which it scanned its surroundings to avoid obstacles.
- We have now fixed the drive so that it meets the requirements of a single propulsion motor and steering motor. In addition, we added a camera so that it can differentiate colors.



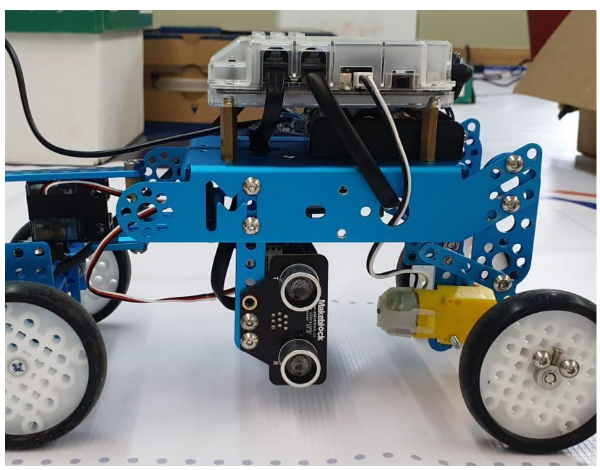
Week 4: Fixing of the driving system

In the beginning, we had 2 motors connected to the rear and they moved independently of each other, which is not allowed by the olympiad rules, so we adapted a single motor to drive the two rear tires. We used wall plugs and epoxy to make an extension to connect the motor shafts. We replaced the servo motor with a more powerful one.

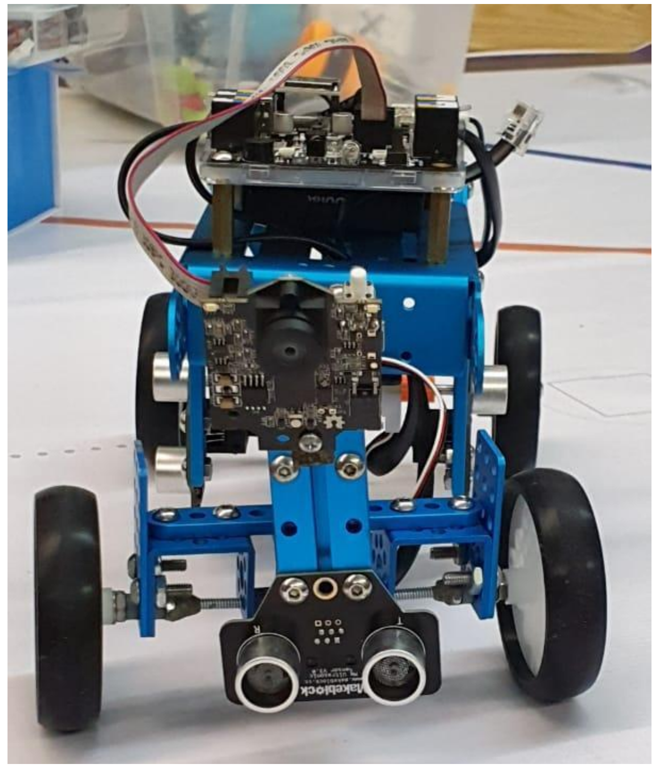


Week 5: Adjustments to the robot structure

We changed the position of the ultrasonic sensors, moved them back a bit, and also placed them vertically so that they would not interfere with the movement of the front tires. We also added new L-shaped supports to stabilize the rear tires and the propulsion motor.

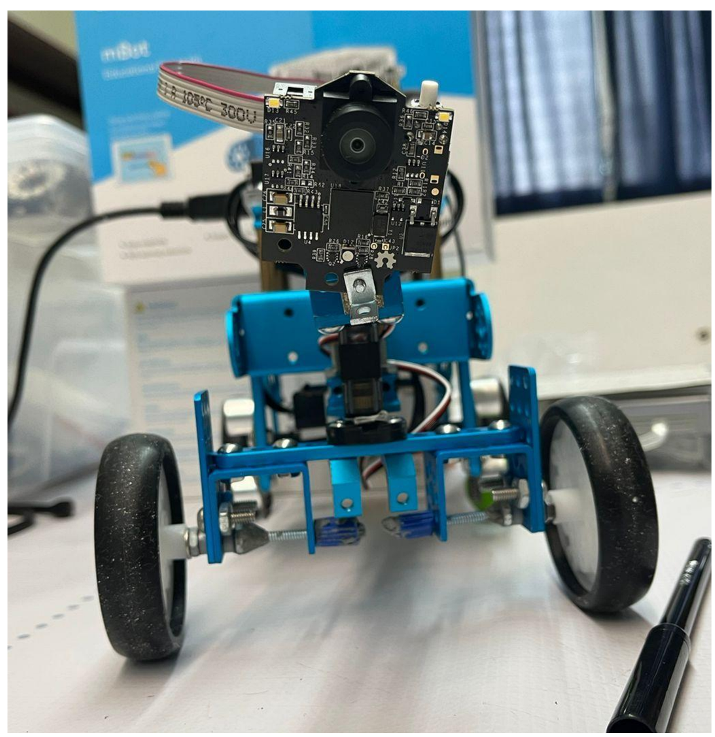


Week 6: Testing for camera programming



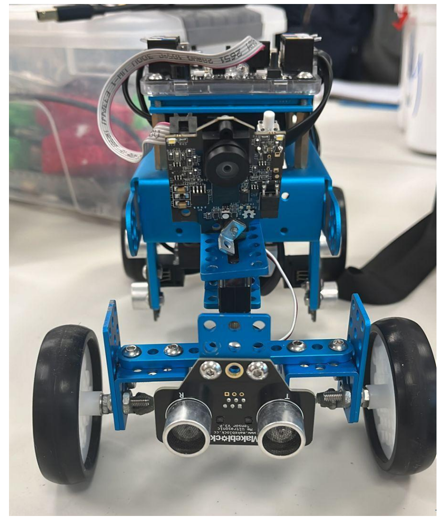
We started to work on adapting the camera to the Makeblock system since it works with programming blocks, but the camera needs a separate code so we are going to decide whether to translate all the code so we are going to decide whether to translate all the code to C++ in order to be able to work in the same programming language.

Week 7: Change of front ultrasonic sensor for Camera



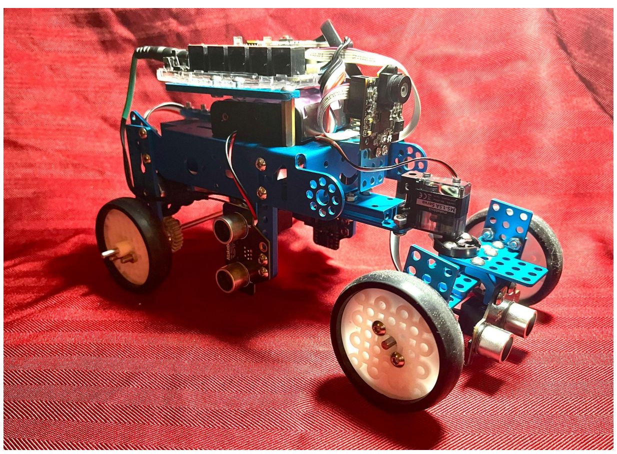
With the help of the camera, we were able to remove the front ultrasonic sensor, because the ultrasonic sensor had errors when it had a specific angle. Apart from that the robot had no physical changes, we only adapted the programming to the change made.

Week 8: use of the frontal ultrasonic sensor for turning correction.



For the second challenge, we had problems when a green object was on the outside because there was a point where the ultrasonic sensors on the sides did not detect the walls, for this reason, we decided to place the ultrasonic sensor again.

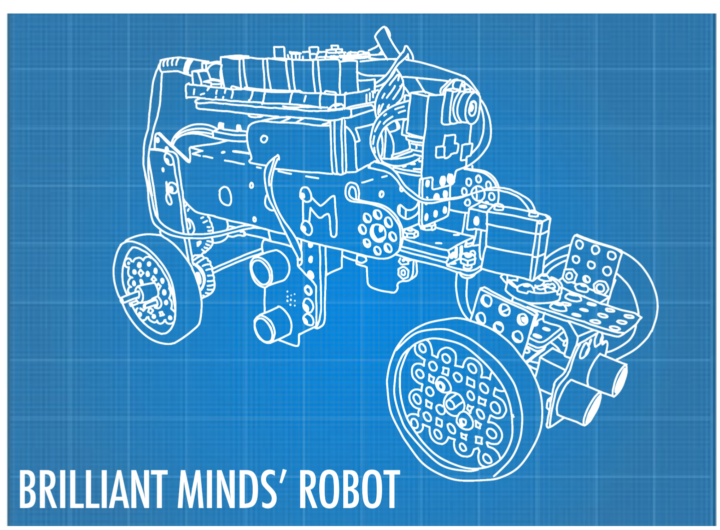
Week 9: Change of parts



As we were looking for a way to make our vehicle faster, we changed some parts to more powerful ones. Such as: the brain, the power motor and replacing the AA batteries for a 3,7 V lithium battery pack. We also added a RGB led to help us with the programming process and also for aesthetic purposes .

Week 10: The robot chassis is finalized

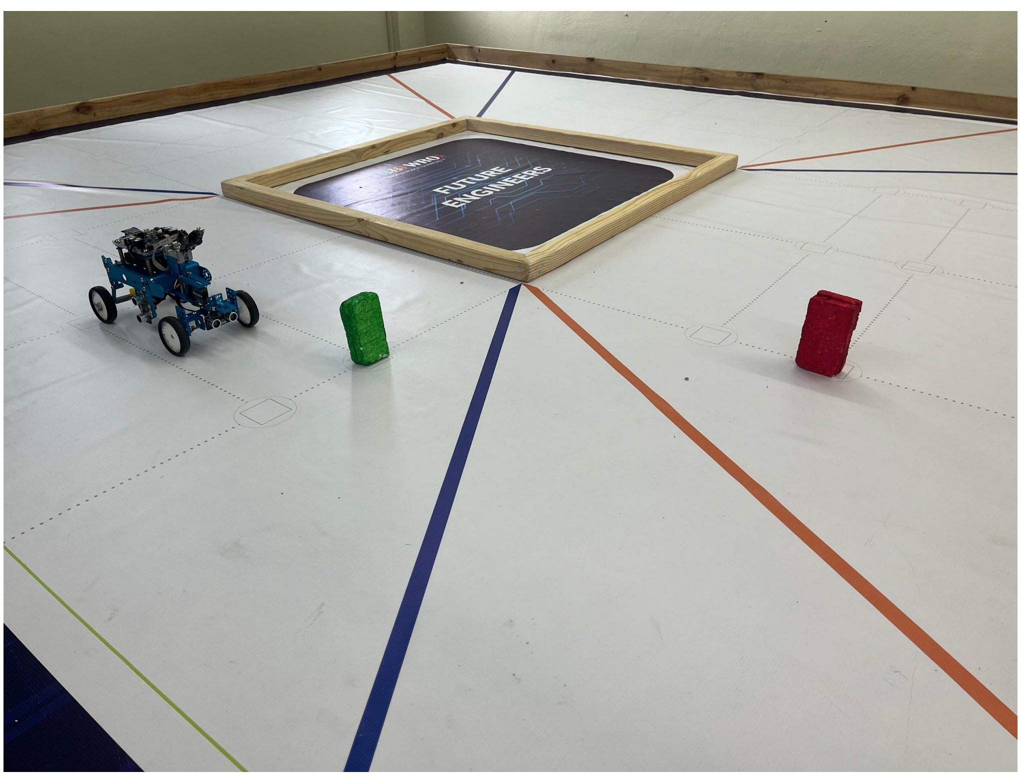
The robot is physically finished with small adjustments to the code to make it more accurate, aside, from any necessary or practical changes like moving the camera backward, shortening the length of the robot, and other adjustments, such as screwing the nuts better so that there would not be vibrations or loss of bolts during the round.



Challenges

1st Challenge: To meet the first challenge we use 2 ultrasonic sensors. These are the ones that tell the robot on which side there is more room to turn. In the programming, we added the variable lane. Depending on how much space the robot has on each side it will determine which lane is. After this, the vehicle moves forward and in the turn depending on how much space it has on each side it identifies if the track is clockwise or counterclockwise. If the robot is on lane 2 (center lane) or lane 3 (outer lane), the vehicle will make an adjustment so in both cases it could move to lane 1 (inner lane). This was made so our robot could complete the challenge faster. We also added the variable count, this one helps the vehicle to count how many times it turns and the define when it has to stop.

2nd Challenge: To fulfill the second challenge we use the camera, which helps us to identify the colors of the objects of the second challenge to then give the signal if it should turn to the right or left. In this challenge we also use the front ultrasonic so there wouldn't be errors when the vehicle makes a turn.

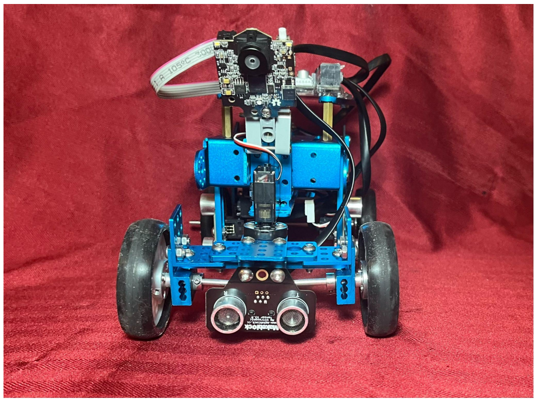


Conclusion

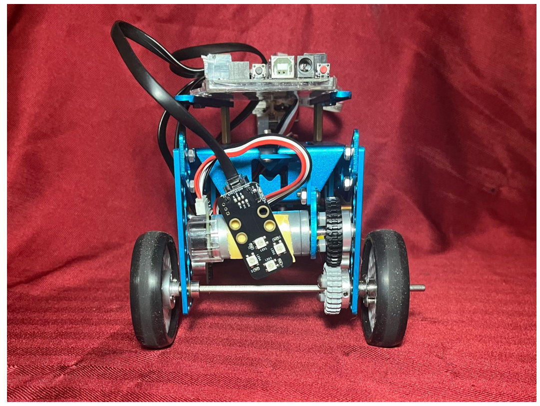
The combination of the ultrasonic sensors, camera and programming has allowed us to develop a robot capable of detecting obstacles and dodging them in its environment and recognizing colors to overcome the challenges of the track effectively. Through the process of documenting, prototyping, and adapting to the challenges of the competition, our team has shown dedication, research and creativity in building this autonomous vehicle. With our project we have learned everything that involves the engineering process and how our solution can be shown to a community and go way further than just a vehicle that dodges obstacles. We are happy to represent Panama and be part of the team of the host country in the World Robot Olympiad. We are confident that our robot will be prepared to meet the challenges of the Olympiad and excel in its performance.

Appendix

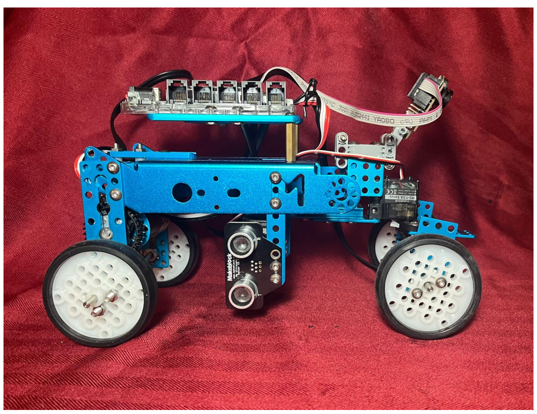
Front View



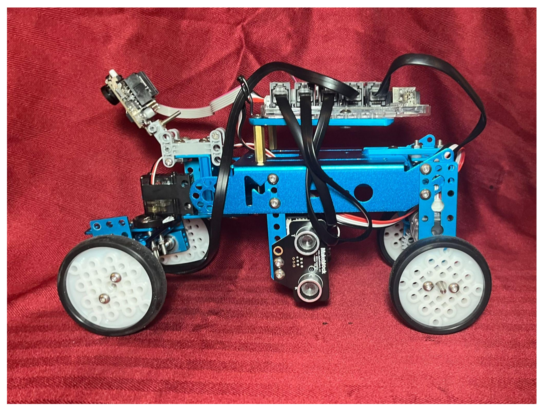
Back View



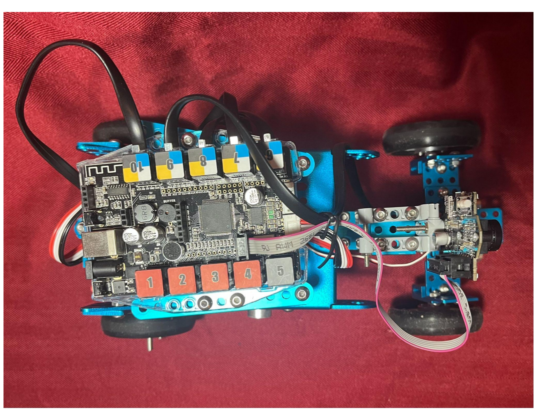
Right Profile



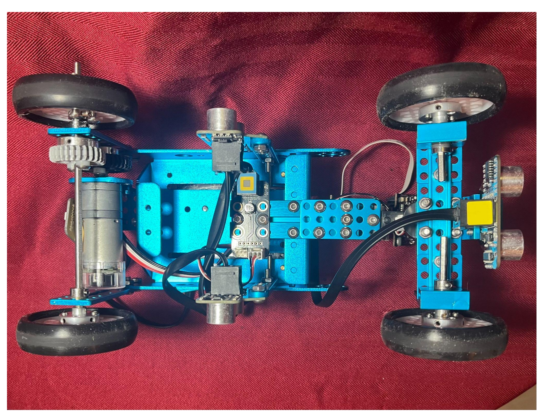
Left Profile



Top View



Bottom View



Team´s photos:

Brian Lee Ivanna Díaz Ricardo Chong

<u>Videos´ Links :</u>

-1st Challenge

Brilliant Minds-Future Engineers-WRO 2023 First Track. Instituto Sut Yat Sen

-2nd Challenge

Brilliant Minds-Future Engineers-WRO 2023. Second Challenge. Instituto Sun Yat Sen

<u>Github repository link:</u>

https://github.com/BrlntMinds/1st-repository