PUPR- RIOT Robotics
Hato Rey, Puerto Rico
riotroboticspupr@gmail.com

RIOT Robotics Portfolio

Automotive Vehicle Challenge 2021-2022

Polythecnic University of Puerto Rico

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About the Team

RIOT Robotics is a multidisciplinary student chapter that empathizes the robotics field and its different characteristics. Our purpose is to help the members develop their abilities in a way they can later on use in the field. Although we are a newly formed team, we've managed to establish a strong team with skilled leaders that have made our current project come to life. The team is lead by Yanira M. Berríos Díaz (President, Captain and Head of Sensors & Actuators), Nayeli M. Vargas Figueroa (Vice-President and Head of Structure & Materials) and Paola M. Osorio Diodonet (Secretary and Head of Programming).

Our goals for this competition are not far from what everyone might have set theirs too. We would like for our skills to show in the work we have created and have poured our hearts into so far. No matter what the outcomes may be, we are proud in the work we have done and we can't wait for further opportunities.

Mission

Promote the branch of robotics in the student body of the Polytechnic University of Puerto Rico.

Vision

Provide development opportunities in the field of robotics to students where they can gain experience before entering the world of work.

Team Goals

The team's goal is to connect different engineering knowledge to create an autonomous vehicle. Using research methods to be able to design, manufacture and program a vehicle that can complete a predetermined route.

Hypothesis

The Autonomous Vehicle Challenge consists of designing an autonomous vehicle that can complete a predetermined route in less than 5 minutes. The RIOT Robotics team must create through design, manufacturing and programming a fast and agile vehicle, capable of "seeing" obstacles using multiple sensors, impact, and weather resistant and with dimensions no larger than 24 x 24 x 24 inches.

WORK TEAM

Daniel Lozada Pérez

- AVC Team Mentor
- Professor at the Polytechnic University of Puerto Rico

Yanira M. Berrios Diaz

- President RIOT Robotics
- Captain AVC Team
- Mechanical Engineering (Robotics & Industrial Automatization)

Nayeli M. Vargas Figueroa

- Vice-President RIOT Robotics
- Co-Captain AVC Team
- Mechanical Engineering (Robotics & Industrial Automatization)

Paola M. Osorio Diodonet

- Secretary RIOT Robotics
- Head of Programming
- Computer Engineering

WORK TEAM

Alejandro F. González Pacheco

- Member of Programming Team
- Computer Engineering

Iancarlos Rodríguez Ramos

- Member of Structure and Materials Team
- Mechanical Engineering (Aerospace)

Gabriel Muriente Cortes

- Member of Sensors and Actuators Team
- Mechanical Engineering (Aerospace)

Teams Review

Sensors and Actuators Team:

- A search was made for possible sensors and actuators that could be applied to an autonomous vehicle. After doing this, the sensors, and actuators necessary and available in the robotics laboratory were chosen to add to the vehicle.

- Once the sensors were chosen, in this case the LiDAR, tracking camera and GPS. The data that could be captured from the sensors began to be investigated. With the LiDAR camera, the necessary RGB and Depth images, gyroscope, and accelerometer data were captured using an edited developed programmed by the company, intel Real Sense, so that the programming team could use it in their work. The data captured with the tracking camera, is being used to define the position of the vehicle, using the pose data, in relation to the map created with the GPS. The GPS is going to be used to create a map of the course that the vehicle is going to be running.

- A program for all the sensors were designed to capture all the data that the programming team needs to make the autonomous vehicle work. Using MATLAB and the sensors, the code was designed so that the "depth", RGB, accelerometer, gyroscope, pose and GPS map data could be recovered.

Teams Review

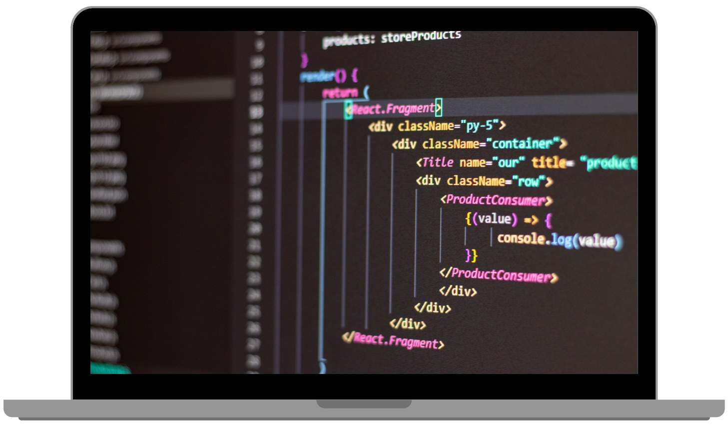
Programming Team:

- The programming team's main goal was to bring all components of our vehicle together so it can complete it's mission. The components we had available were an Intel Real Sense tracking camera and lidar, the car's motors and servos, a GPS, and a raspberry pi 4.

- The tracking camera was to be used in conjunction with the GPS. The GPS held the path that the car must follow. Based on this path, the car was given a threshold for its position. This was implemented to account for any insignificant deviation from the path. We then extract the info from the tracking camera to determine whether the vehicle's location is within the path's threshold. If the car were to exceed said threshold, it would activate its kill switch and turn off.

- The lidar's purpose was to validate the vehicle's position based on its distance to the next bucket. To make this possible, we used a combination of 2 types of deep learning neural networks. Our first network was an object detector which identified if there were any buckets in front of the vehicle and, if so, where in the image is it. Using the lidar's depth info., we identified the bucket's distance from the vehicle. Afterwards we cropped the image and, with our second network, classified the bucket as red, blue, or yellow.

- Finally, the last thing we did was implement all our code on the raspberry pi. To do so we had to download the corresponding libraries for each component to make sure it could identify it. Afterwards, we downloaded our code to the pi and finally it was ready to be tested.

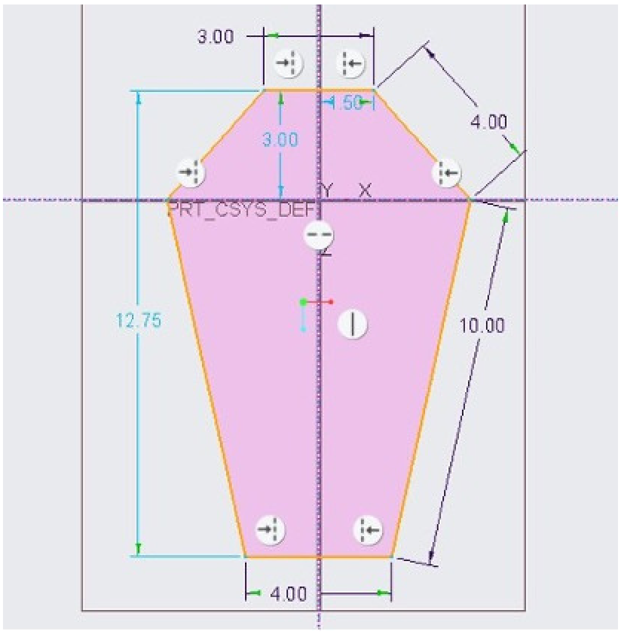


Teams Review

Materials and Manufacturing Team:

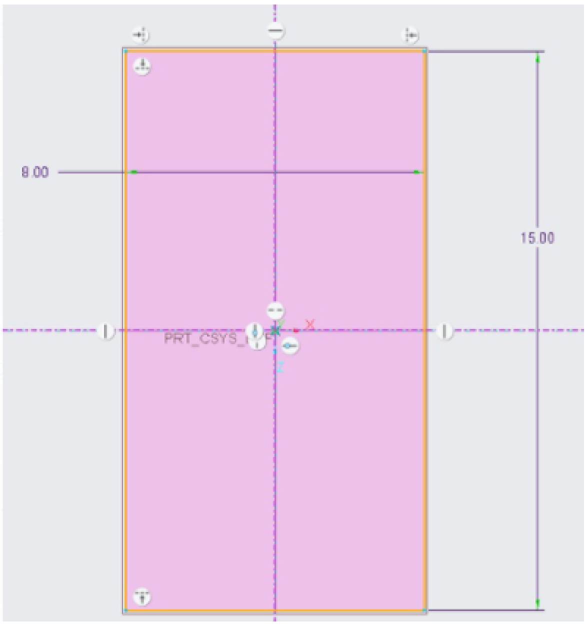
- We designed a model by adapting a Traxxas Slash 4x4 RC car to meet the requirements of the competition. We started by choosing materials, such as acrylic, lexan, and aluminum, to create a design for the second level of the car. This second level is made of lexan with 3D pinted supports, which will have a Tracking Camera, Lidar, Breadboard, Raspberry Pi and Arduino. These components are protected by a cover made of plastic filament. Initially, the cameras had a ramp creating an angle of 15 degrees so that they efficiently capture the road and obstacles, but as the tests were carried out, that measure was discarded since it wasn't necessary.
- For a second battery, a platform was created with acrylic, later replaced with lexan, suspended from the second floor with screws, 0.375-inch aluminum cylinders and reinforced with Velcro.
- To connect all the components to the Raspberry Pi, we drilled the lexan to be able to pass the cables.

Second Floor:



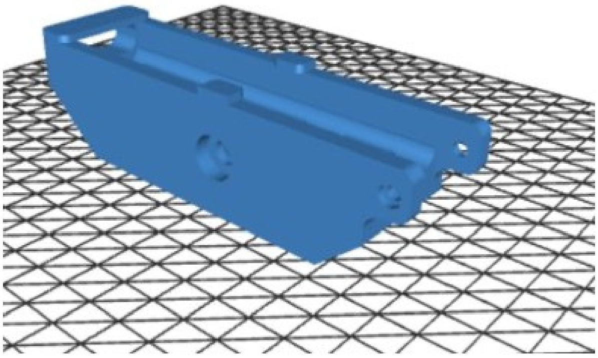
It was the first design created having as supports the body of the same cart. In addition to being versatile, this form is also easy to implement the components.

Teams Review



This design was created as a backup of not being able to create the first model due to material, machine and time problems.

Castings :

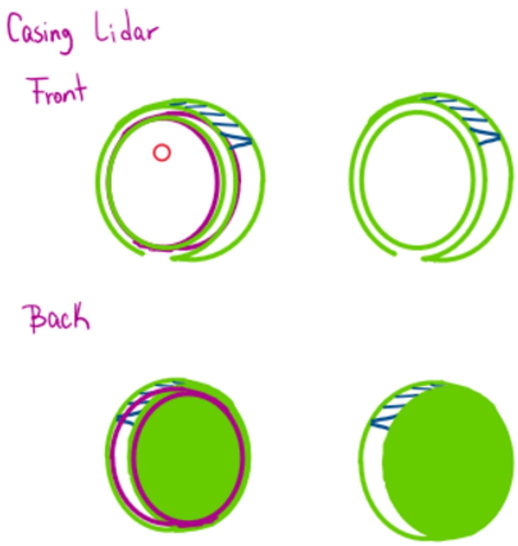


Model found with the measurements of the camera and printed with plastic using the facilities of the university. This frame is attached to the front of the second floor using a ¼-20 screw.

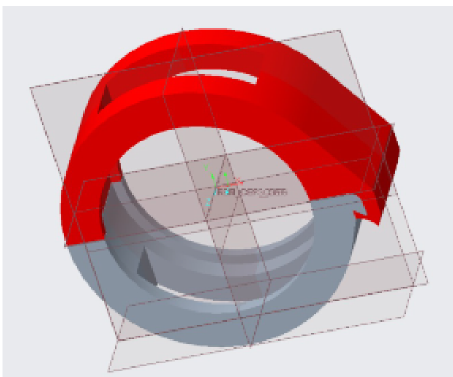
Teams Review

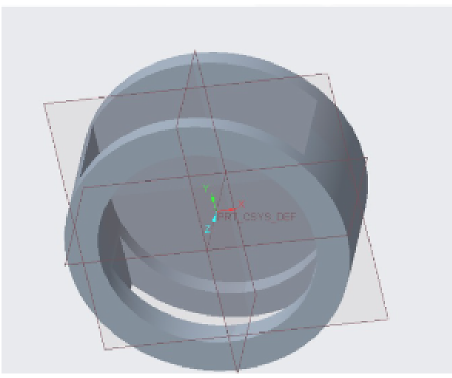
LiDar:

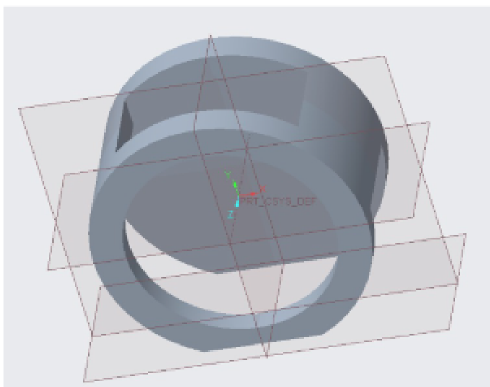
Various versions of the LiDar casing were created using a drawn structure as a reference.



The versions in order, the last one being the one chosen to use.



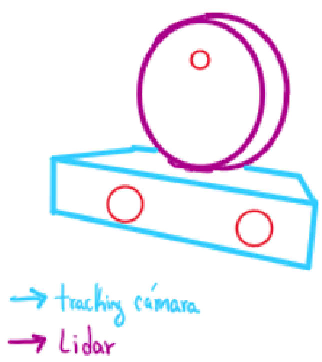




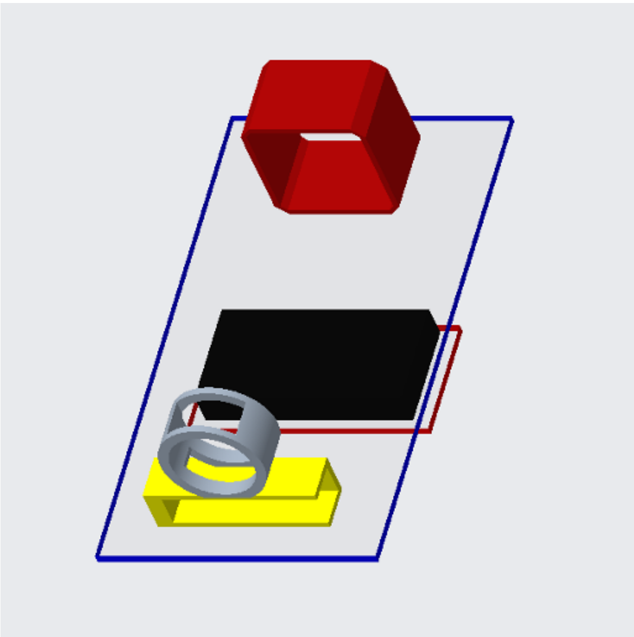
Teams Review

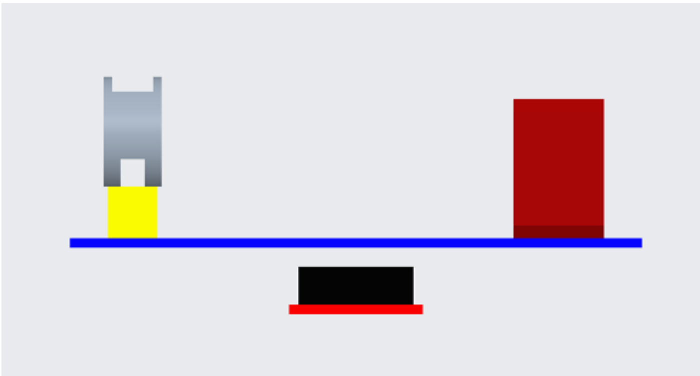
Camera Assembly:

The lidar camera is fixed together with the tracking camera casing with a ¼-20 screw.

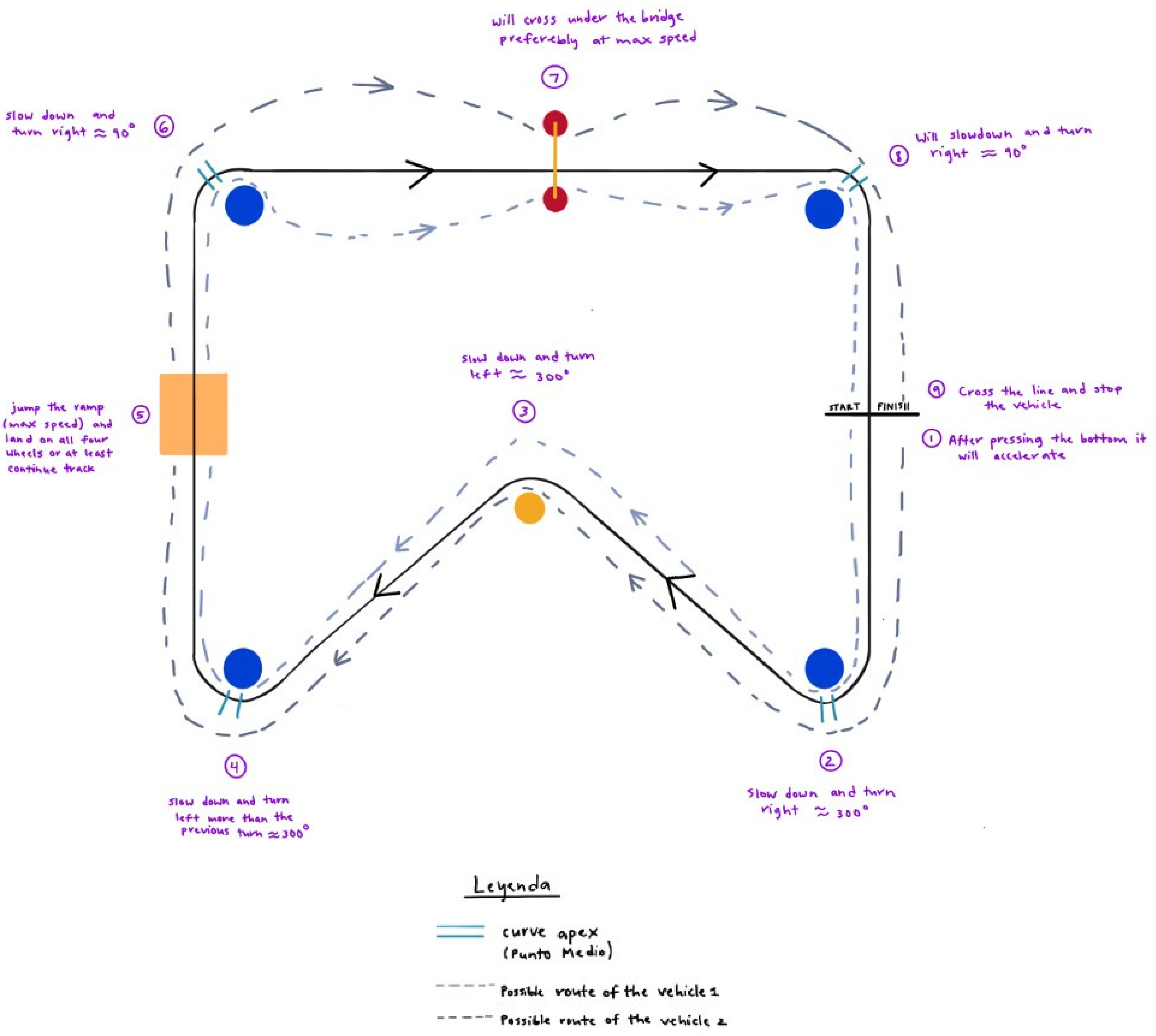


Assembly Completed:

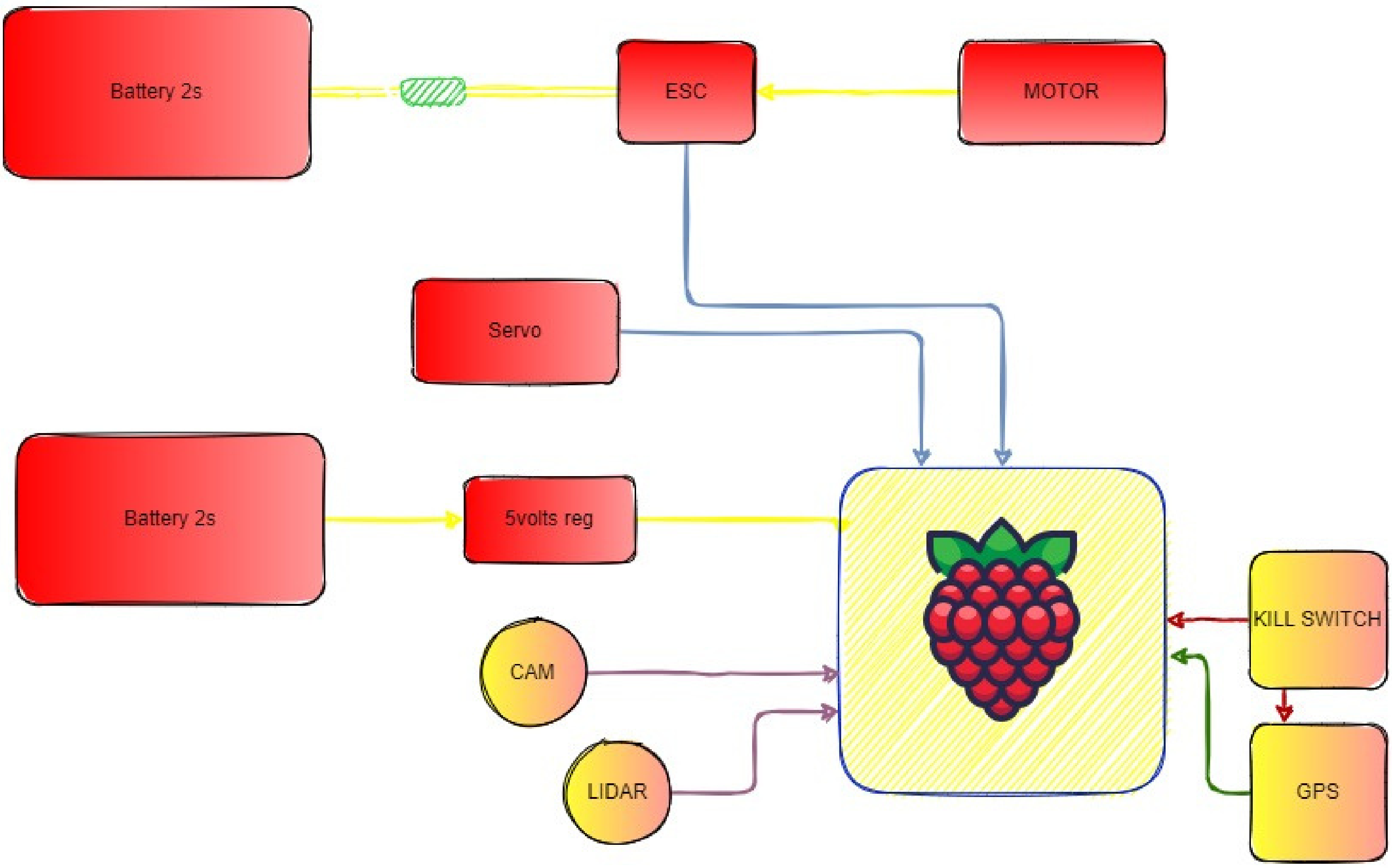




Concept of Operation



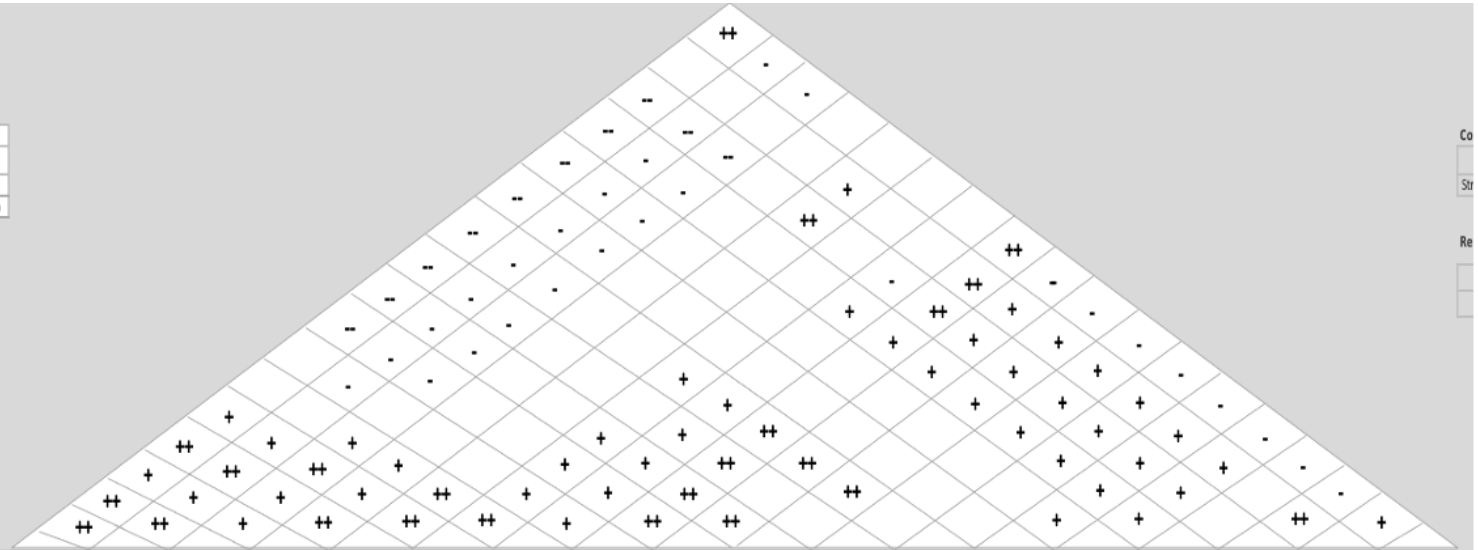
Electrical Connections



Quality Function Diagram

Function Deployment

le:	Autonomous Vehicle Challenge
er:	Yanira M. Berrios Diaz
te:	17 de diciembre de 2021
rs:	Nayeli, Iancarlos, Paola, Gabriel, Alejandro, Juan



MOP's → / MOE's ↓	Dimensions of 24" x 24" x 24" or smaller	Weight should be around 15 lbs	Low center of gravity	6" tires	Motor	Reach a speed of 4.0 ft/s or more	Complete track in 5 minutes or less	High Sensitivity Sensors	Radar	LiDar	Gyroscope	Camara	Speaker	RGB Lights	Button or Switch	LiPo Batteries; 1 for sensors & 1 for vehicle	Should be able to whitstand low temperature (30°F)	Sensor housing
The design must be small	9	1	1	1	3	1		1	1	1	1	3	3	1	3	3		3
Modular construction for easy assembly and diassembly	9		3	1	3			3	1	1	1	1	1	9	3	3		9
Weight should be proportional to car size	1	9	9		3			3	3	3	3	3	3	3	3	3	3	3
Withstand collisions	3	1	3		1			3	3	3	3	3	3	3	3	3		9
Weatherproof		3			3			9	9	9	9	9	9	9	9	9	9	9
R/C Car Base	9	9	3	3	9	3		1						3	9	1		3
R/C high power motor for speed		9		3	9	9	9									9		
R/C All terrain tires	1	9	1	9	9	3	3											
Traction control system			3			9	3	9									9	3
Stability control system			3			3	3	9									9	3
Sensor platform	3	9	9			1	1	9	9	9	9	9	9	9		3	9	9
Secondary battery for sensros		1	3			1		3	9	9	9	9	9	9		9	9	3
Able to detect distance							1	9	9	9		3						
Able to detect obstacles							1	9	3	9		9						
Able to detect colors							1	9				9						
Able to self-orient							1	9			9							
Physical Input and Output	1	1	3					3										3
Not be controlled by external connections							9	9	9	9	9	9	9	9	9			
Back up batteries																9	9	
Needs to be extra													9	9				9
Target or Limit Value	36	52	41	17	40	30	32	98	56	62	53	67	55	64	39	52	57	66

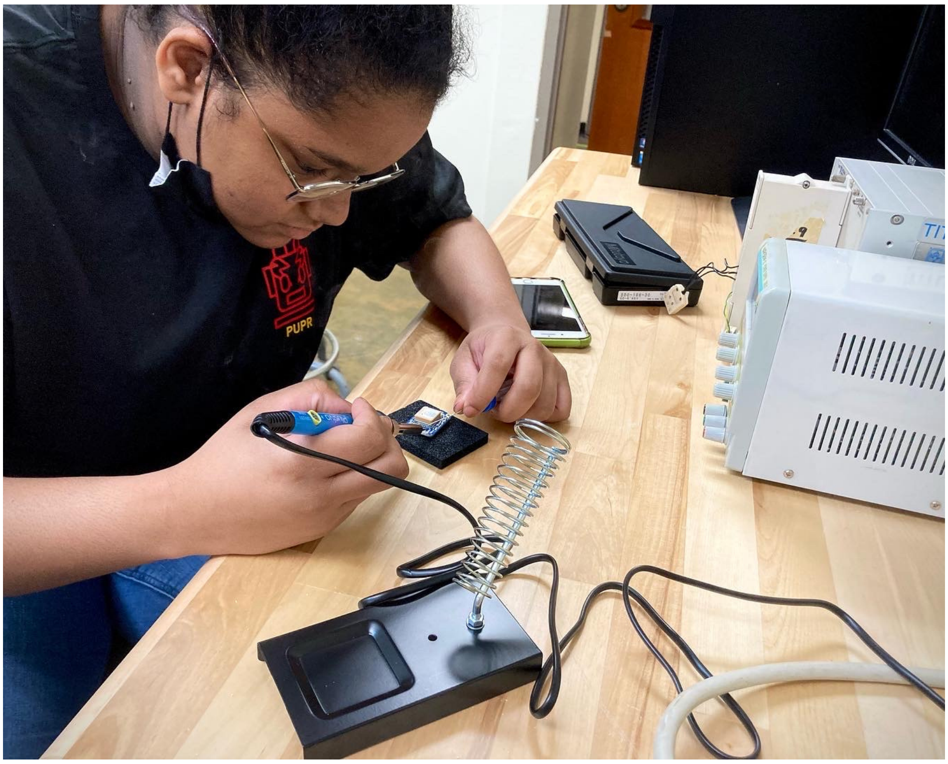
Materials Cost

Product	Quantity	Price
GREEN/BLUE Slash 4X4: 1/10 Scale 4WD Electric Short Course Truck with TQ 2.4GHz Radio System	1	$334.58
Adafruit Ultimate GPS Breakout - 66 channel w/10 Hz updates - Version 3	1	$35.40
120 cables multicolor Elegoo Dupont de 40 pines de macho a hembra de alambre, 40 pines macho a macho, 40 pines hembra a hembra tableros de cables de puente de cinta,. kit para arruinar	1	$7.78
Kit de 4 placas experimentales de circuito, incluye 2 piezas de 830 puntos y 2 piezas de 400 puntos, placas de circuito sin soldadura para bloques de conexión de distribución Proto Shield	1	$13.36
Juego con 32 placas de circuito impreso (PCB) Elegoo, prototipo, de doble cara, para que usted mismo pueda soldarlas, con 5 caras compatibles con los juegos Arduino	1	$13.37

Materials Cost

Product	Quantity	Price
Kit de soldador – Soldador de 60 W de temperatura ajustable, alambre de soldadura, pinzas, soporte de soldador, juego de puntas de soldador, bomba de desoldar, mechas de soldadura, tubos termorretráctiles [110 V, enchufe de EE. UU.]	1	$20.06
Arduino Nano	2	$45.96
LEXAN- 24 in. x 18 in. x 0.093 in. Polycarbonate Sheet	1	$29.88
8 FT Micro HDMI Cable	1	$32.99
VGA to HDMI Adapter with AUDI	1	$24.99
Power Hobby, LiPo, 5200 mAh, 50C ,2S, 7.4 V	2	$119.98
Insignia, 20,00 mAh Portable Battery, USB-C Port, 2 USB ports	2	$89.98
Velcro Package	1	$4.35
TOTAL	**16**	**$772.68**

Work in Process Images



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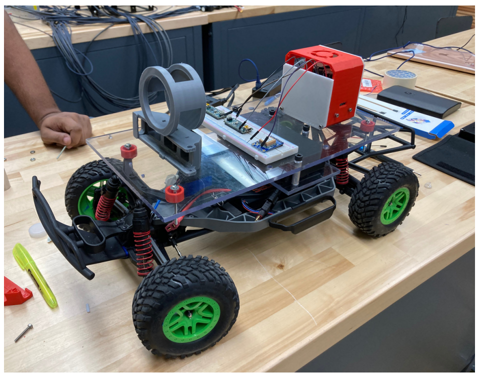
ROBOTICS

Work in Process Images



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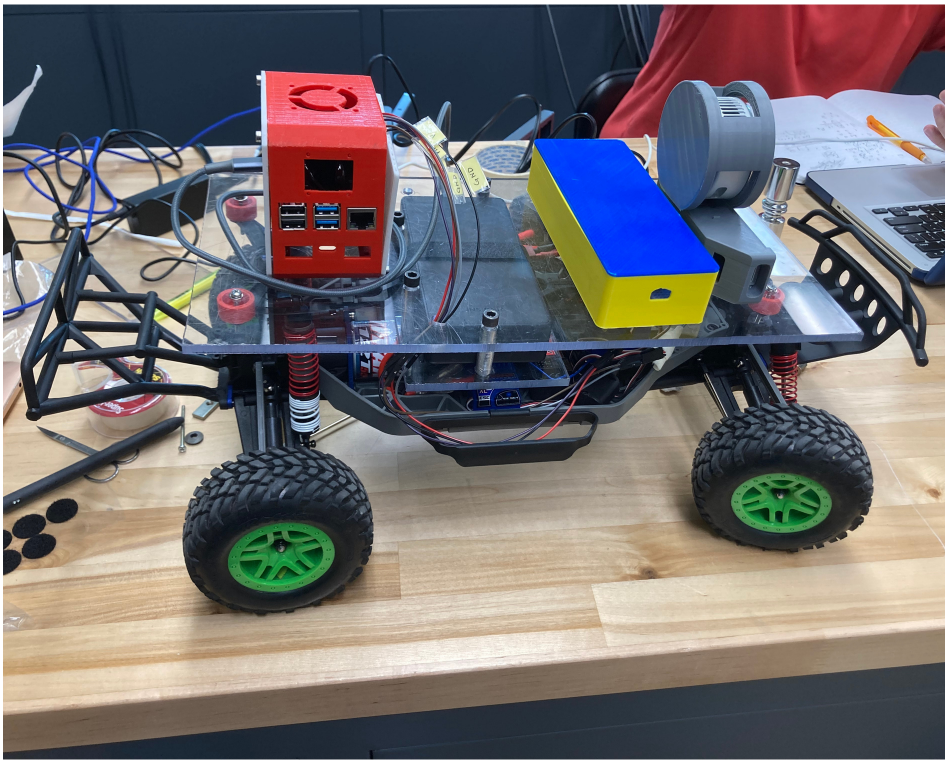
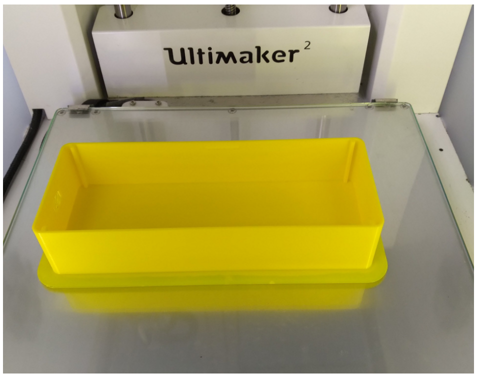
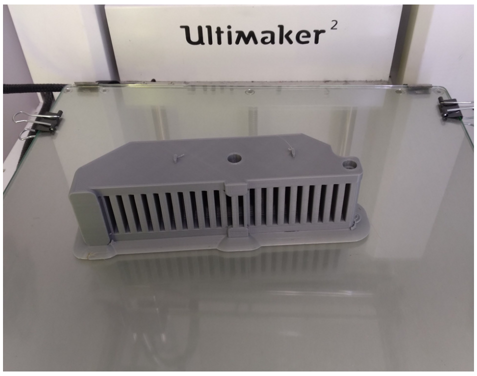
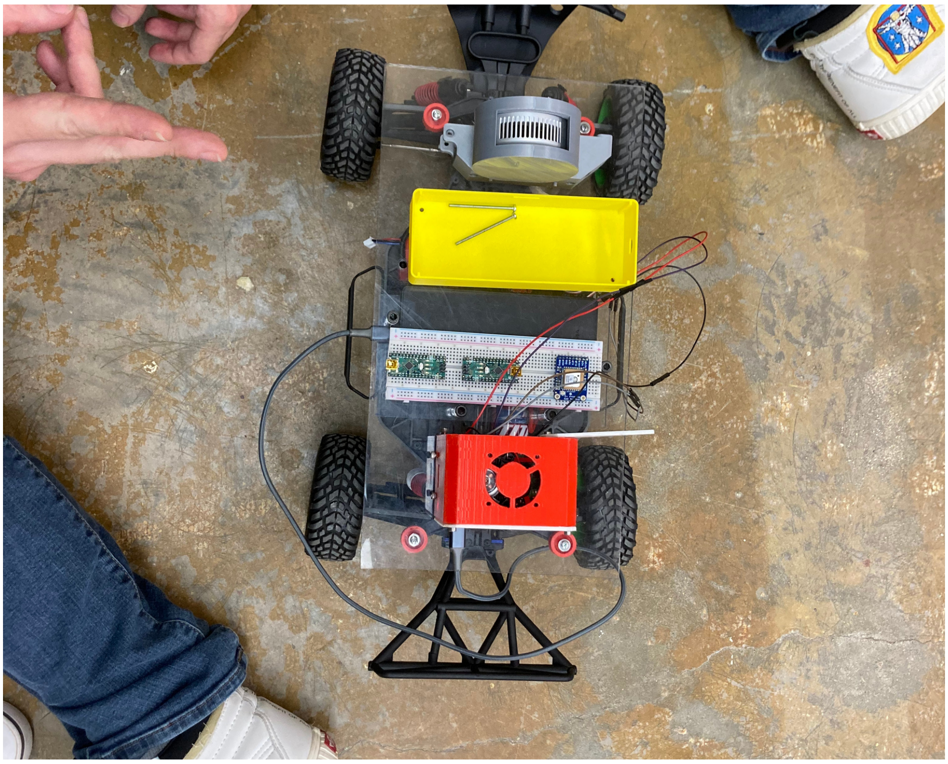
ROBOTICS

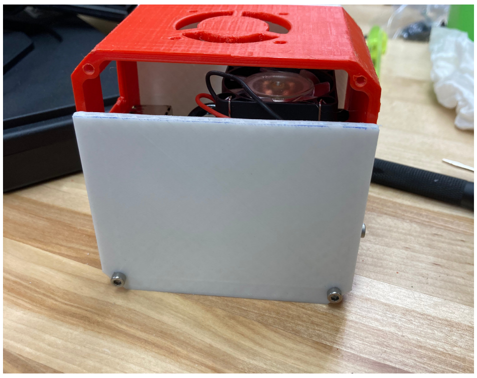
Work in Process Images











Work in Process Images