Robotics II Project 2

Lawan Bachir Djibril Hamidou and Masai Olowokere – UCA Department of Physics & Astronomy

Date: May 04, 2023

Introductions:

For this project, our goal is to build a robot capable of autonomous navigation using an RP Lidar. We started with a previous design for a robot that was functional in our Project 1 and built on that with new parts and programming to attain our goal.

Design:

Part 1: Building

Not much has changed in our robot's design since we built it for our first project of the semester. We have a rectangular aluminum frame with a light and slim wooden base where everything is mounted. Our robot is driven by two wheels taken from a skateboard and for versatility we have two caster wheels. We chose to let the castor wheels be in the back and the driving wheels at the front. The idea behind that choice was to have more stability with traction, however, towards the end of our second project, when tests were being ran on the maneuverability of our robot on the floor of the building it is intended to navigate, we found out that it did not have as much grip as we had hopped. We had some ideas to try and make it more adherent to the ground but unfortunately, we did not have enough time to go through them. Some of those ideas were switching the front of the robot from where the driving wheels are to where the caster wheels are. With that, instead of being a traction it would be a propulsion which would, in theory, give the overall design more stability. Another idea was to add some weight or make the part of the wheels in contact with the floor just more adhesive enough to get it to drive without many issues. Now, when it comes to the modifications we made in order to be able to navigate for our last project's goal, there were not many changes.

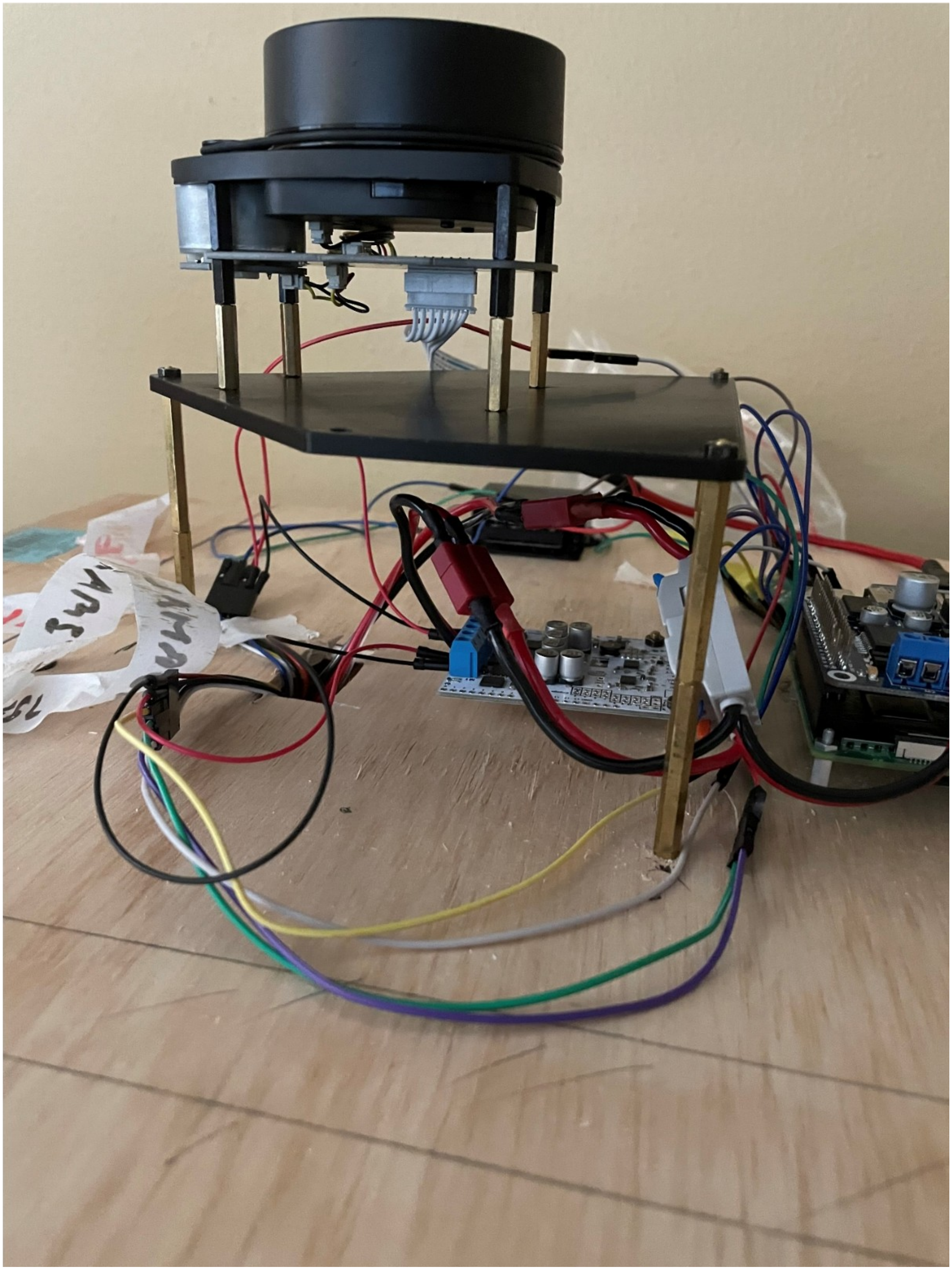
An important part of attaining our objective was being able to map the surroundings of our robot for it to navigate through them. For that purpose, we installed the RP Lidar sensor. The device had to be installed in a way that there would not be many obstacles in its way when it is scanning, so we put it on top of a platform made of a 3D printed plate at about 30 centimeters from the ground.

Parts	**Quantity**	**Purpose**
Raspberry Pi 3	1	Store and drive the system
Pololu Dual G2 motor driver board	1	Drive the motors
30×30 Aluminum Extrusion Bar	4	Provide a rigid frame
46×41 Wooden Plate	1	Offer a base for mounting devices
Pololu 12V DC Gearmotor	2	Drive the robot
Motor mounting bracket	2	Attach motors to the base
11.8×7.5 Wooden plate	2	Attach the motors to the aluminum bars
2.3 cm radius Caster Wheels	2	Provide versatility of movement to the robot
4.15 cm radius skateboard wheel	2	Tract the robot
21700 Lithium-ion Battery	3	Power up the system

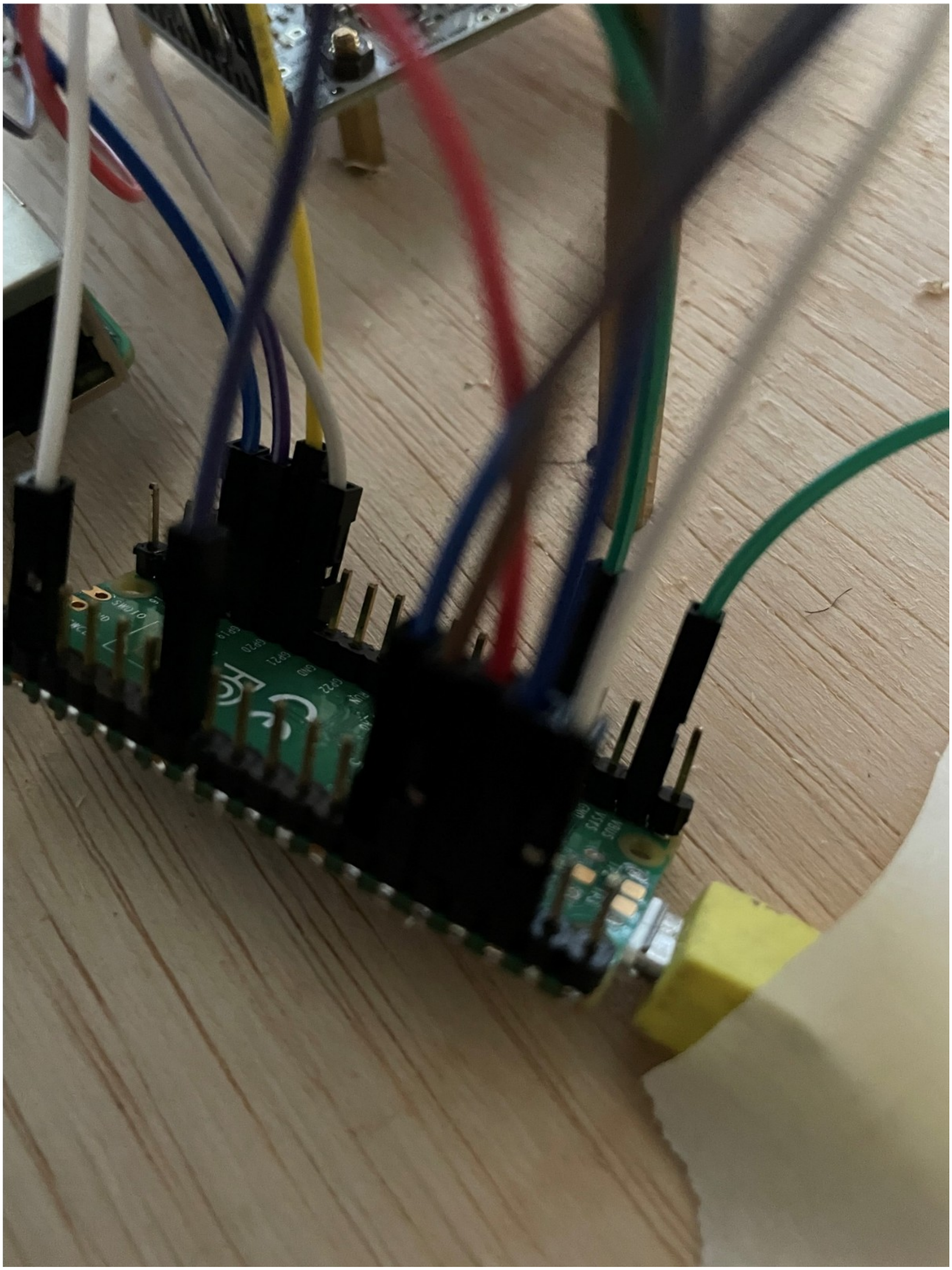
Raspberry Pi motor driver board	1	Provide power Raspberry Pi
Raspberry Pi Pico	1	Store data from motors
RP Lidar	1	Scan for objects surrounding the robot

Part 2: Navigation

In the navigation section of this project, there were several steps that needed to be accomplished in order to get to our goal of autonomous driving. The first step was to be able to drive our robot in a simulation using RVIZ and Gazebo. The ROS graphical interface RVIZ allowed us to build a robot model similar to our real one on the computer and using the gazebo simulator we were able to run it and see how it performed.



Since we need to be able to control two DC motors, we have also installed a Raspberry Pi Pico microcontroller connected to our Raspberry Pi that will allow us to specifically control the driving wheels for their different properties during navigation such as motor speed and direction. The connections between the Raspberry Pi Pico and the motor driver board go as follows: M2PWM pin to GP21, M2DIR pin to GP20, M1PWM pin to GP19, M1DIR pin to GP18, ground pin to GND. The connections between the Raspberry Pi Pico pins GND, 3V3, GP3, GP2 connect to the left motor's follwing this pattern: green, blue, yellow, white cable. Motors. On the right motor it goes as follows, white cable to GP4, yellow cable to GP5, blue cable to VBUS. Of course, the postive and Ground pins on the motors connect to the same pins on the motor driver board as in the previous project.



During our tests, the converter we used during the design of our robot to distribute power to the Raspberry Pi and the motor driver board experienced an overload and became unusable. We put a Raspberry pi driver board connected to the Raspberry Pi and the power supply to replace it into giving power to the microcontroller.

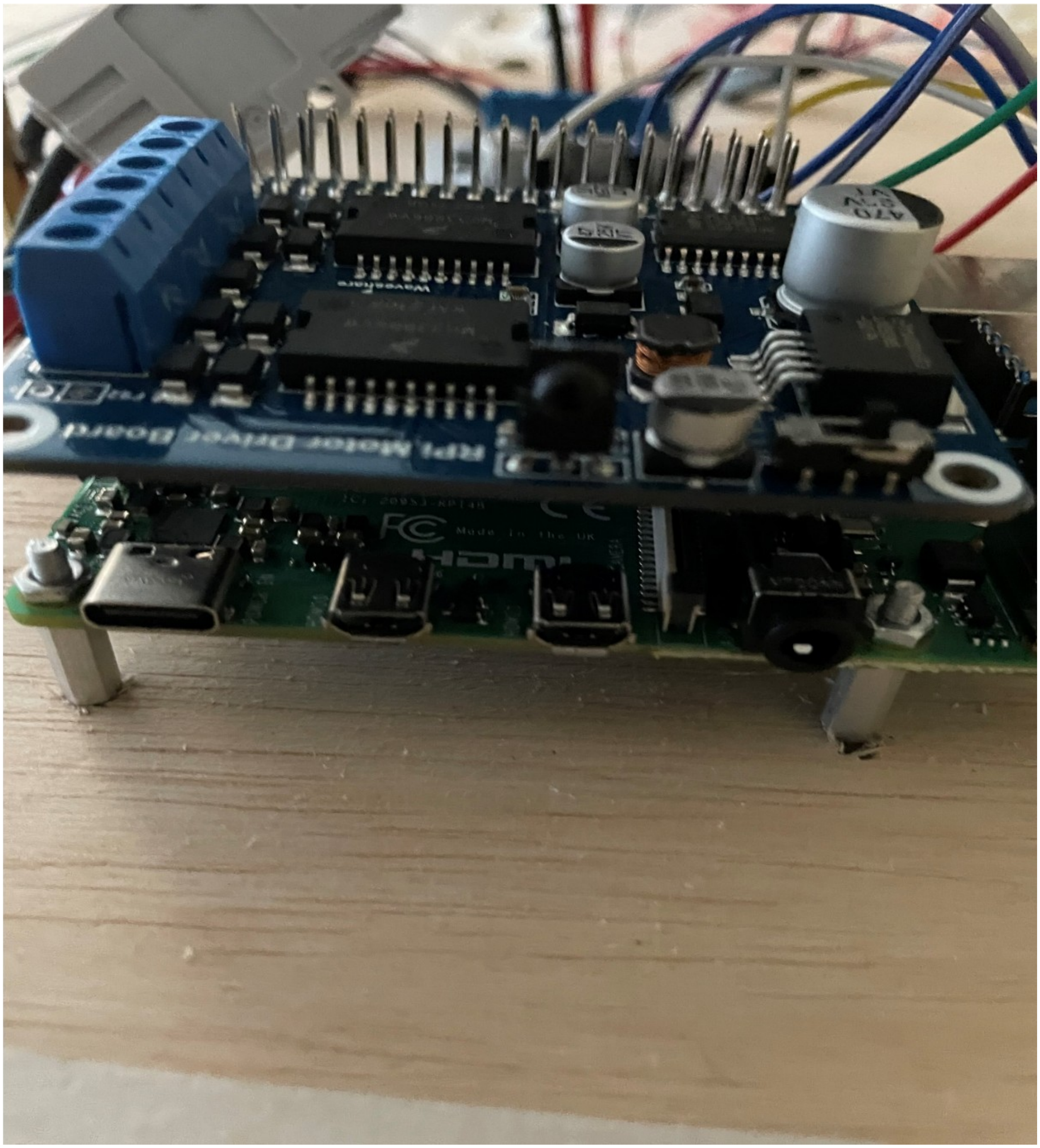
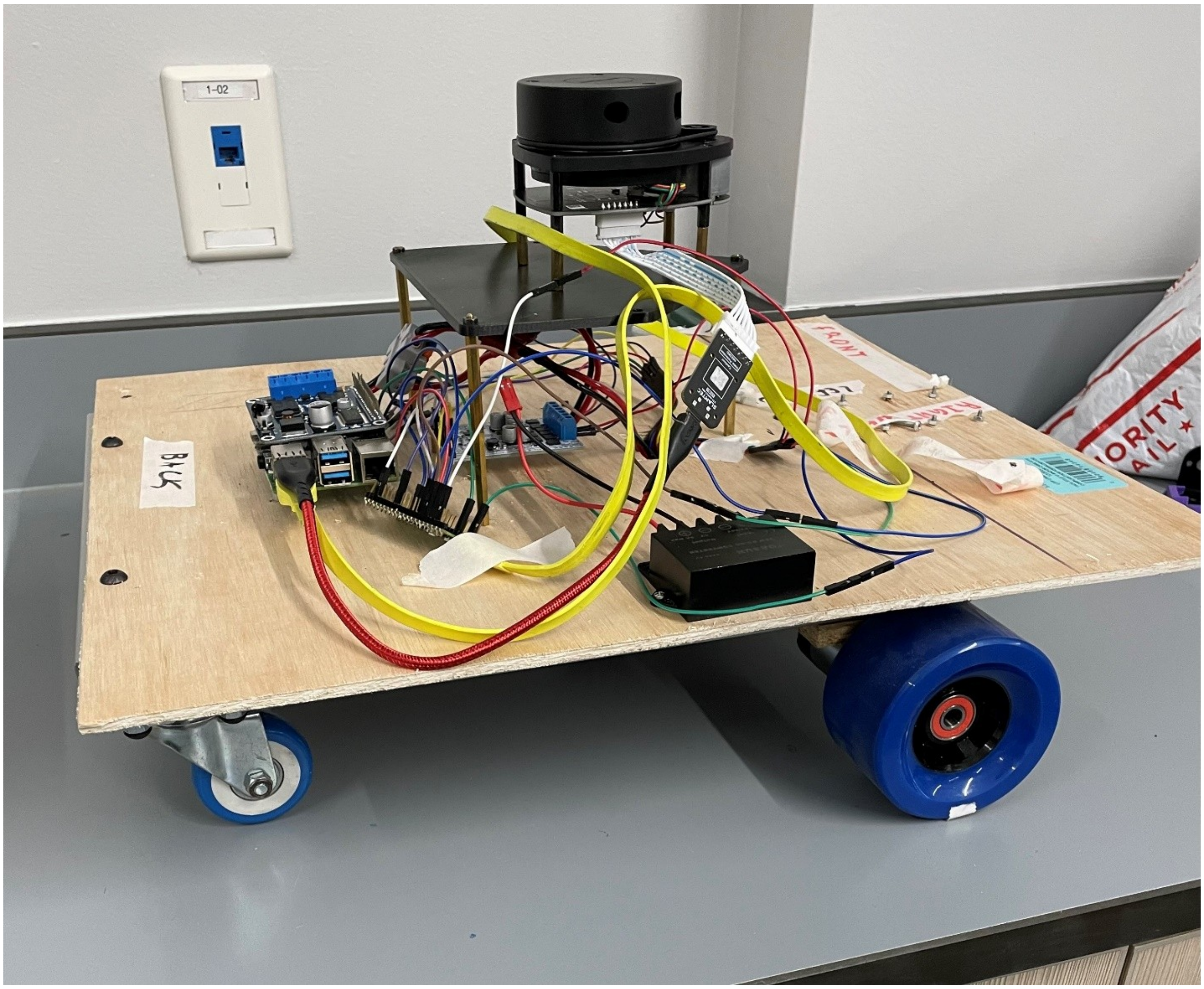


Figure 1 illustrates the final design of our robot for this project.



Conclusion:

In Conclusion, we had a lot of success overall in this project. Even though there were some mishaps along the way, we were able to build on top of our previous model and we implemented the different libraries and protocols we needed to be able to map out the targeted area and make the robot run inside of it while avoiding obstacles. At the end, we had to redraw a map from the previous one we had during our tests, but the issue was resolved rather easily.