Robotics Project I Report

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

Date: May 05, 2023

Introduction:

For our first project of the semester, we will be building a differential drive mobile robot using materials of our choice found in the lab. We will be designing our robot with the goal in mind of it being able to accomplish navigation purposes and withstand additional parts later. The most important feature we are aiming for with our robot is that it will need to be controlled remotely using the ROS library, and we have the appropriate materials and methods to make that happen.

Design:

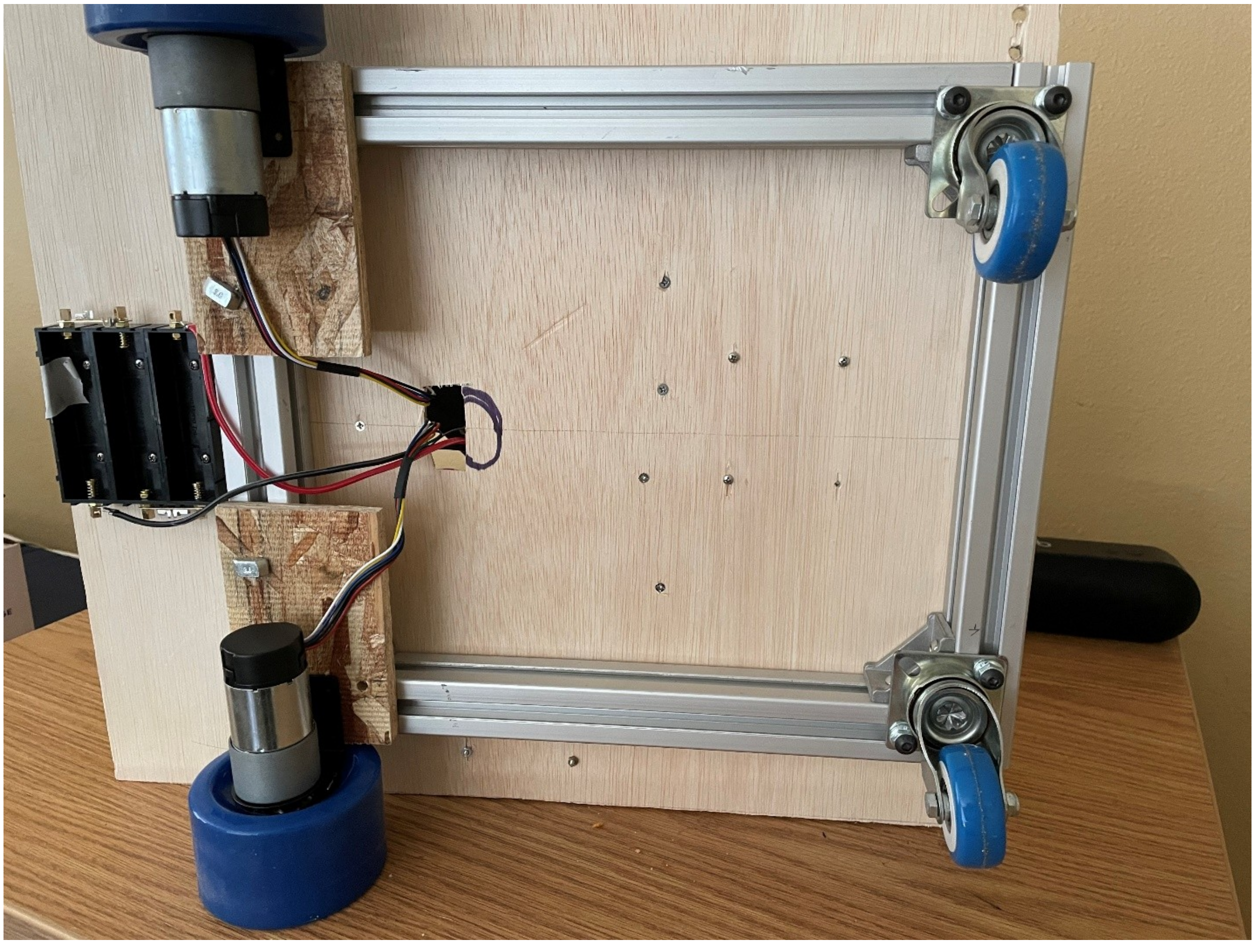
Part 1: Building

The first step in building the prototype for our robot was putting together a frame to attach all the parts to. We went with aluminum extrusion bars, 30.5 centimeters ones in width and 37 centimeters in length attached together using gusseted corner brackets.

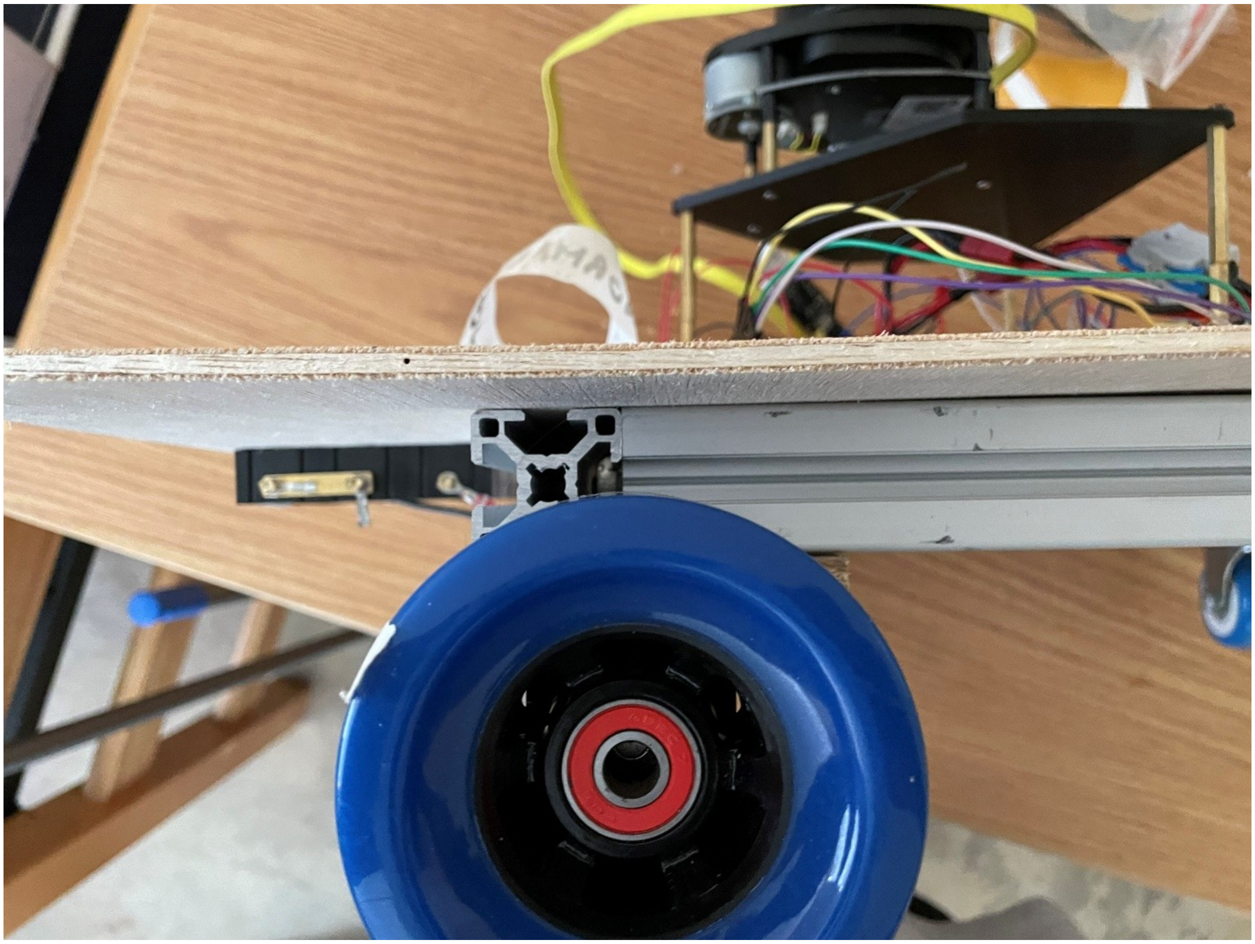
We then chose to make our base for our robot with a wooden board with the purpose of it being light and sturdy enough to contain all the additional parts on it. We chose a board with a length of 46 centimeters and width of 41 centimeters mounted on top of the aluminum frame to have the most space for all the parts we could need to install later on. In order for our robot to be mobile, we need wheels making contact with the ground of course. But primarily, we need motors to drive them which we used two Pololu 12V metal gearmotors for.

We used motor mounting brackets to attach those to the bottom of the aluminum frame. An addition that was made along the way while installing those motors was screwing 1cm wide wooden boards to the aluminum bars to allow for easier mounting of the motors to them.

Fundamentally, our robot will be driven using traction with two driving wheels at the front and two caster wheels at the back. Our driving wheels were regular skateboard wheels of 4.15 cm radius and 5cm length. These are attached to our motors. The caster wheels we use are 2.3 cm in radius and 1.8 cm in length. However, they are attached to a backet giving them a combined length of 6.9 cm.



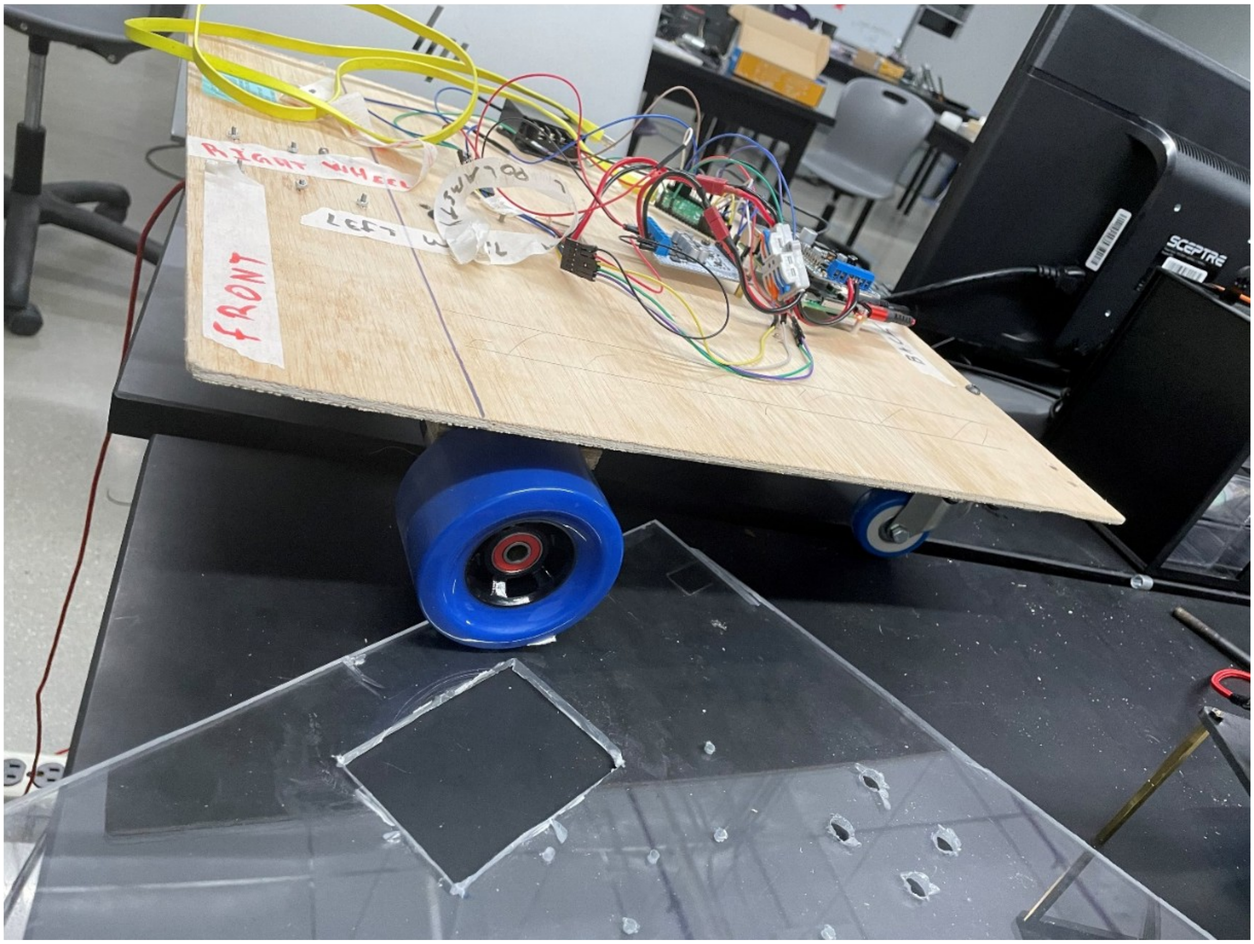
The driving wheels are attached to the motors in such a way that there is a 1.9 cm gap between them and our wooden base.



On top of our base, for this project, we have attached the basic devices that will allow us to control our robot remotely using ROS. The first thing we needed was a Raspberry Pi microcontroller which is mounted 1.3 cm above the base and 10 cm below the center. In order to be able to control the motors we also need a driver board, and we installed the Pololu Dual G2 High-Power motor driver board. It was attached on top, the same height above the base as the Raspberry Pi, and 2.5 cm below the center. In order to power all of this, we are using three Samsung 50E 21700 Lithium-Ion batteries. We attached the battery box at the front underneath the base to allow for more room at the top and saw a 1.9 cm width and 4.5 cm length hole, 2.5 cm above the center of the base to get the cables for power through to the other components on top. We finally attached a converter to be able to power to the motor driver board and the raspberry pi at the same time from the batteries. A list of the different used in the building of this prototype can be found in the following document:

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
25W DC-DC converter regulator	1	Provide power to both the Raspberry Pi and the motor controller



When we finished building our robot, we weighed it and found it to be 3.6 kg on the scale. The final dimensions were 46 cm in length, 41 cm in width, and 10.2 cm in height. After running some tests by placing more and more weight on top of the robot while running it, we found it to have a payload maximum capacity of about 20 kg added weight, above which it does not run straight anymore.

Part 2: Circuit and Navigation

On the motor driver board, using solderless cables, we plugged the positive end of the power to the VIN pin and the ground pin to ground. Pins M1A and M1B went to the left motor and pins M2A and M2B went to the right motor with the left motor having an inverted polarity so both wheels can turn in the same direction. The connections from the motor driver board to the Raspberry Pi go as follows: ground to the ground pin of the Pi, M1DIR pin of the driver board to a GPIO pin on the Pi, the M1PWM controlling speed of the motor is connected to another GPIO pin. The same goes for the M2PWM and M1DIR pins. After we connect our robot to a computer using VNC Viewer, we run our event listener program and launch our keyboard to control the robot's motion using keyboard commands.

Conclusion:

In conclusion, this project was a success. We were able to build a stable and rigid robot using our materials available to us in the lab and after some experiments and tests, we were able to get it to understand commands remotely and drive using our keyboard. This project, with it being more design oriented, was a great base for what is to come for the rest of the semester.