Capstone Project: KiwiBot User Guide

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Introduction

During the academic year of 2024-2025, a robot that will be referred to as ‘KiwiBot’ was designed, built, and programmed. The purpose of this robot was to spark interest in engineering for high school students through a technically impressive design and a hands-on interactive controller, that would do what most other hobby robots don’t. This guide entails how to use the robot. For more detailed information refer to the project’s Final Report. For an overview of project’s construction details refer to the project’s Construction Guide.

Step-by-Step Setup Guide for New Users

1. Plug in Robot’s USB and Barrel Jack power cables and turn on the power bank (Refer to Figure 1). The Robot’s MCU (Arduino Mega 2560 Rev3 on second layer) should be preloaded with robot_main.ino sketch.

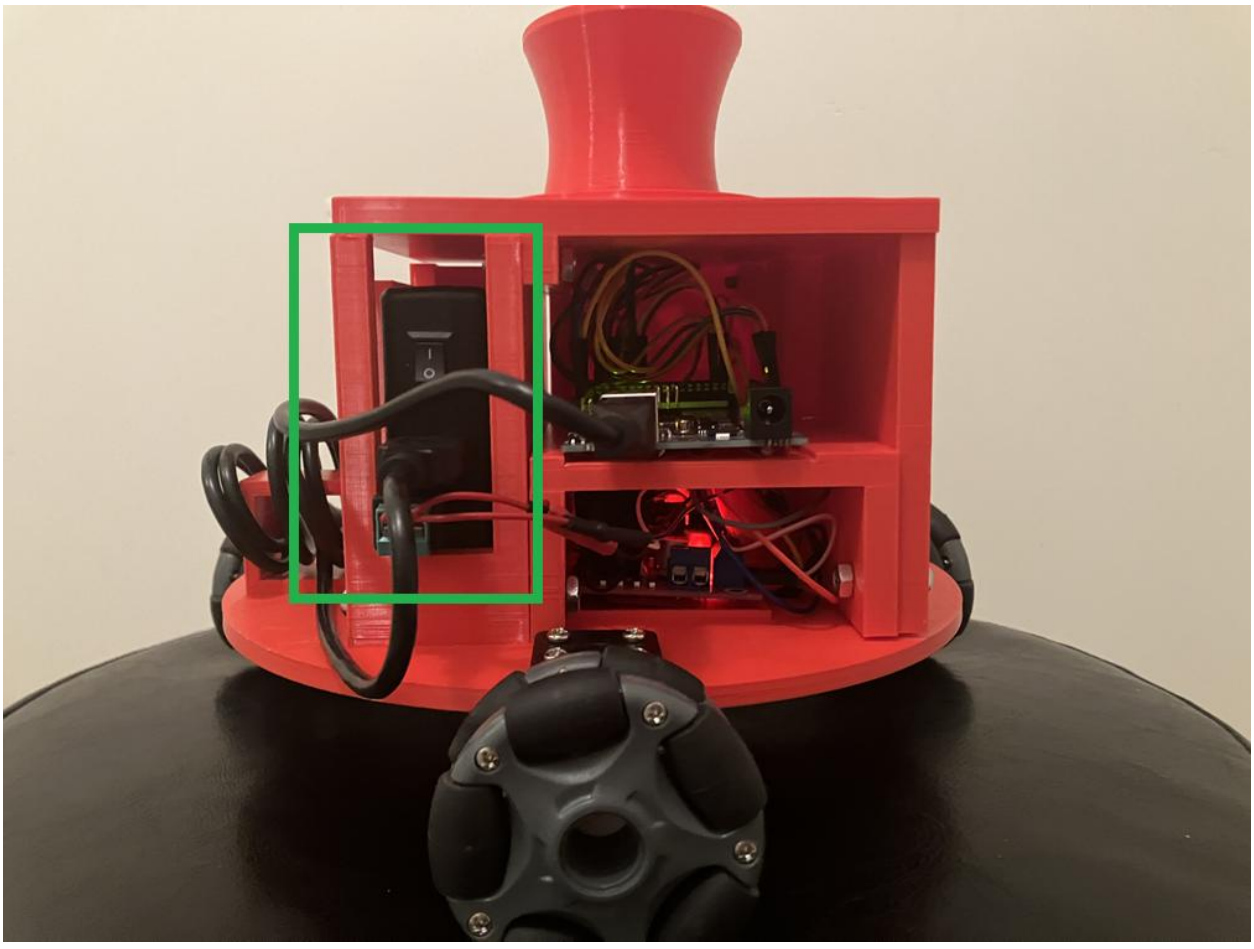

Figure 1: Power Bank Input Locations

2. Plug in Controller's power cable. The Controller should be preloaded with the glove_main_ble.ino sketch. The Controller will enter a startup sequence before the LED displays Red. You will start in Power Off (LED = RED) mode (Refer to Figure 2).

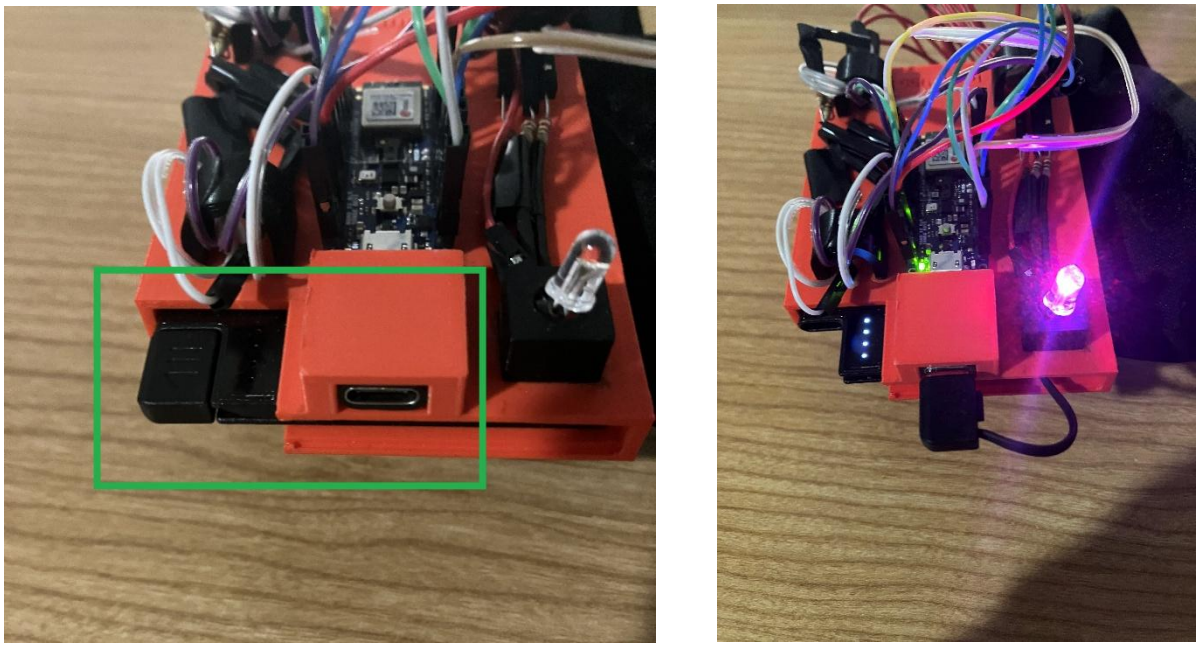

Figure 2: Controller Power Bank Output Location and Start Up Sequence

3. Press the Power Button labelled with a thunderbolt to swap between Power On and Off states (Refer to Figure 3). The Robot will only move when in Power On. When swapping into Power On, the Controller's Home position is set to the orientation your hand currently is in.

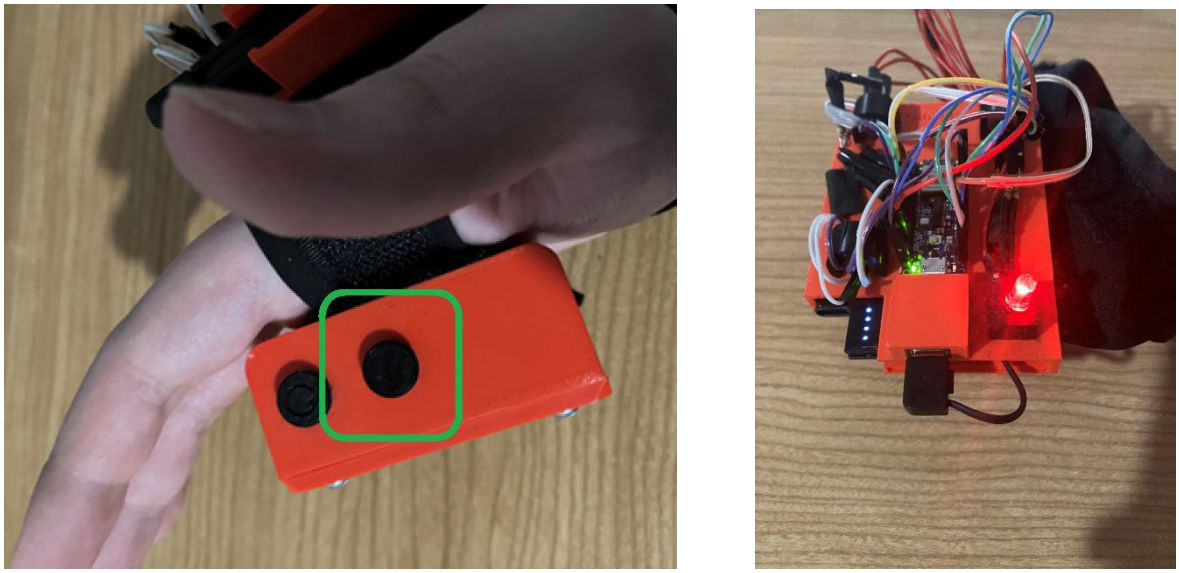

Figure 3: Power Button Location with LED Red

4. Press the Rotate Button labelled with an arrow to swap between Rotate Off and On states (Refer to Figure 4). In Rotate Off (LED = GREEN), only planar movement will be allowed in X and Y. In Rotate On (LED = YELLOW), both planar and rotation movement will be allowed in X, Y, and W.

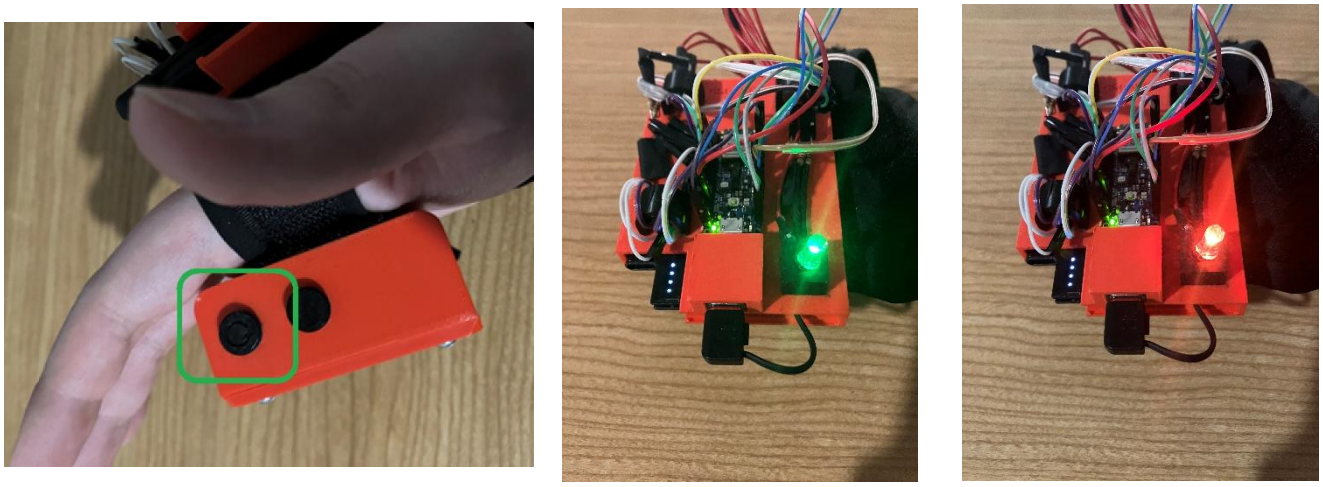

Figure 4: Rotate Button Location with LED Green and Yellow

5. To move the Robot, all tilt motions of the hand are confined between 45 degrees of the Home position. It is HIGHLY recommended to not tilt your hand 90 degrees or upside down, as this makes it very difficult for the IMU to get accurate pitch, roll and yaw measurements. To move the Robot left, ease your hand in the roll direction left. To move the Robot forward, ease your hand down in the pitch direction. To rotate the Robot, turn your hand like turning a knob (Refer to Figure 5). It is HIGHLY recommended to have the glove comfortably tight to reduce wobble during tilt motions and to take movement slowly.

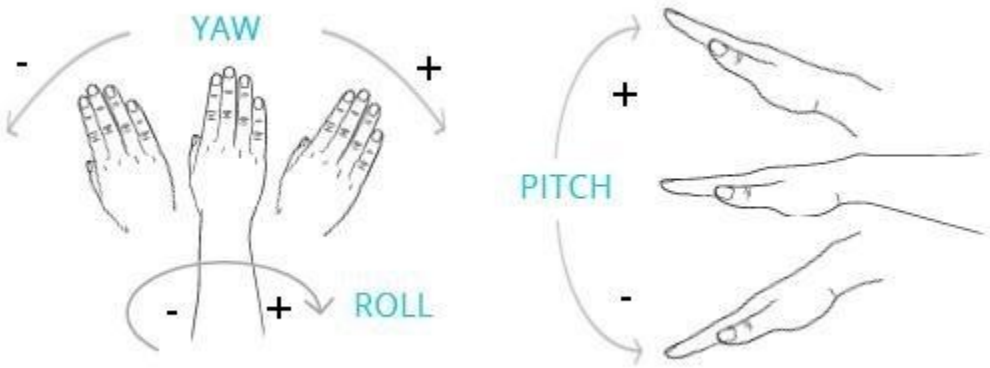

Figure 5: Visual Mock-Up of Pitch, Roll and Yaw of Hand from Home Position

6. (Optional) Run the accompanying BLE python script (sim_ble.py) when the Controller is on. The program should be compatible with any device on Linux, MacOS or Windows, provided the device can support BLE connections and has both python and the python "Bleak" library installed (type pip install bleak in a terminal to do so). When the program is running, enter 0 into the terminal to exit. While running it will display the information the Controller is sending to the Robot in real time (refer to Figure 6).

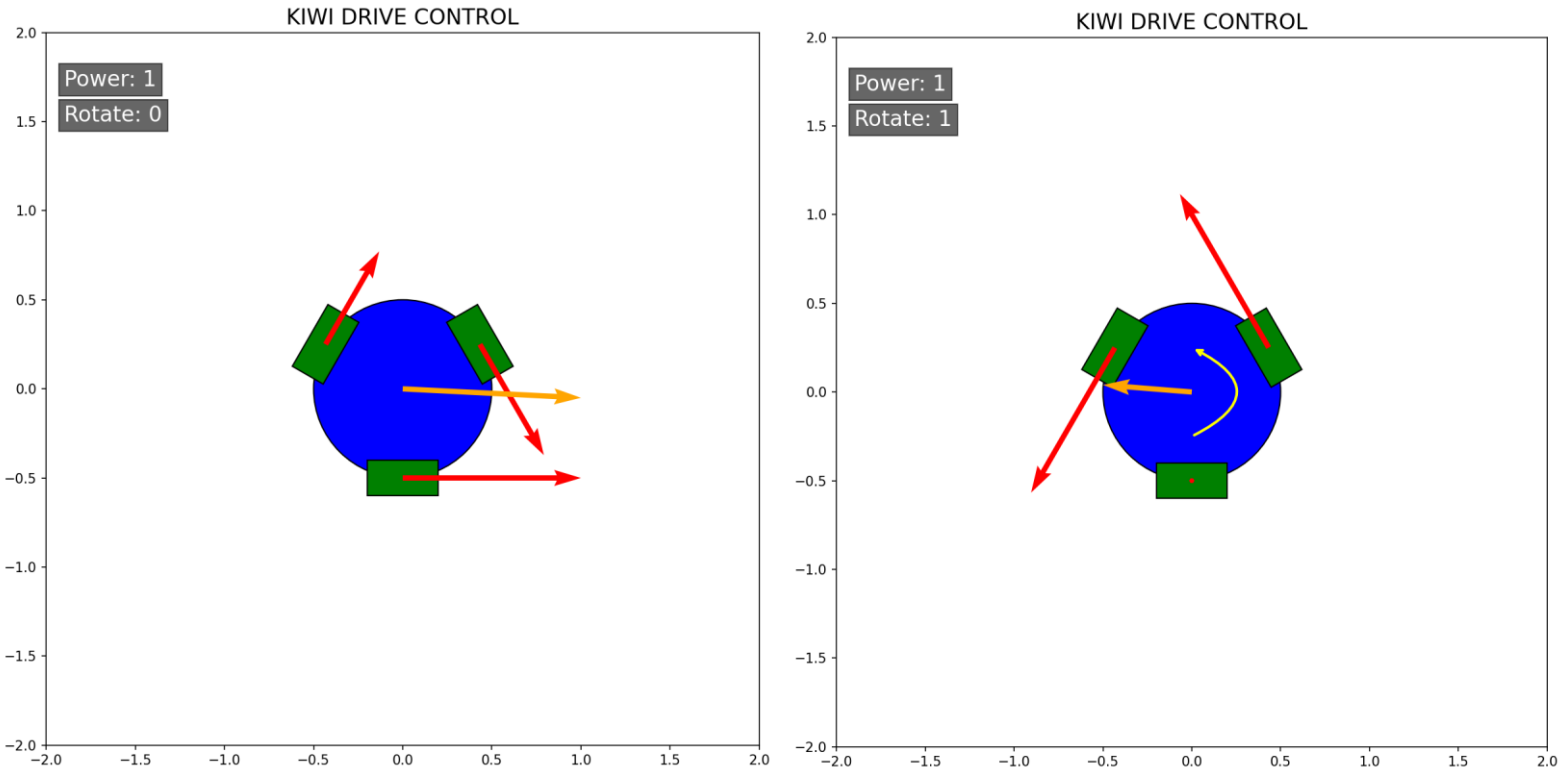

Figure 6: Two Examples of Complementary UI Program During Runtime

Recharging the KiwiBot

To recharge the Robot, use the provided charger, ensure the power bank is unplugged and off and plug the charger into the barrel jack of the Robot's power bank. Wait for the charger's LED indicator to turn Green. Refer to Figure 7.

Figure 7: Recharging Robot

To recharge the Controller, use the provided charger and plug into the side port of the Controller's power bank. Wait for the power bank's 4 LEDs to be all lit up and not blinking. Refer to Figure 8.

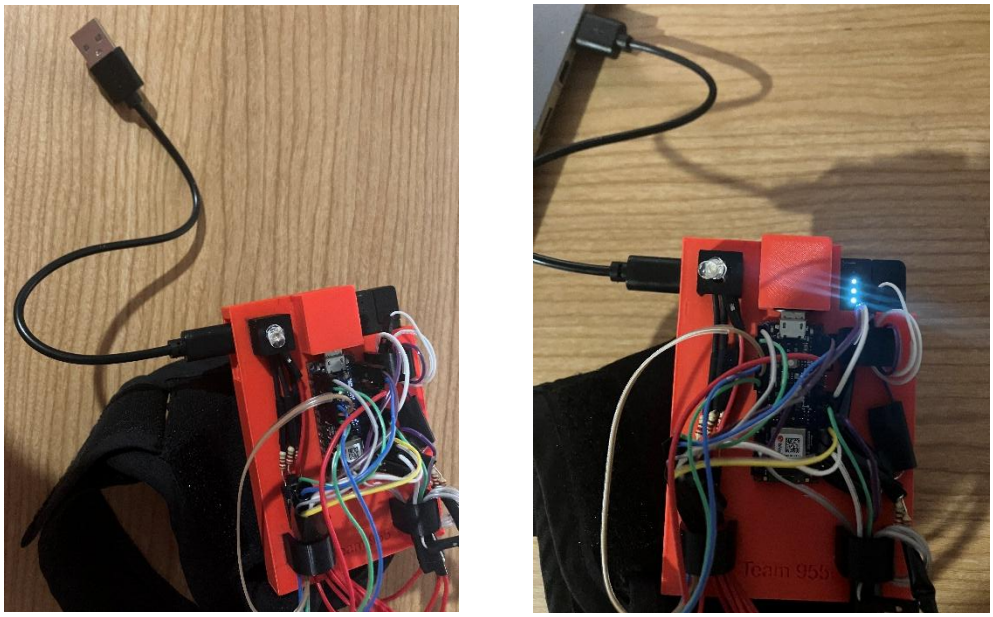

Figure 8: Recharging Controller

Known Issues and Troubleshooting Tips

- DO NOT leave the Robot unattended to charge over a long period of time. Although the battery likely has built-in protections, overcharging the Robot can damage the battery.
- DO NOT expose the Robot or any components to water / weather conditions.
- DO NOT hold the Robot on its side. The D-shaft adapters connecting the omni-wheels to the motor shafts are 3D printed and can allow the omni-wheels to slide off. During standard operation this is not an issue, although superglue can be recommended as more permanent solution.
- DO be gentle with the devices during transport and operation. Measures were taken to bolster their sturdiness and wire connections, however they are not infallible.
- The Robot will drift imperfectly in X, Y planar movement. You can account for this rather easily with manual nature of adjusting tilt controls. An alternative fix to this, would be to implement PID control using the encoders built into the motors. The encoder wires are currently unused and taped to the bottom of the Robot.
- If one of the wheels isn't working (stops rotating or rotates only in one direction) it's likely because of a loose wire connection on the Arduino Mega 2560 on the second layer of the Robot. Electrical tape has been used to mitigate this issue, but the effectiveness of this solution is untested.
- Sometimes the buttons will stick or double press, often confusing first time users when they accidentally cycle between Power ON / OFF. This is an issue with the design involving supergluing the keycaps comparatively small push buttons. Potential fixes would involve using entirely different push buttons that can better accommodate a keycap.