Robot User Manual

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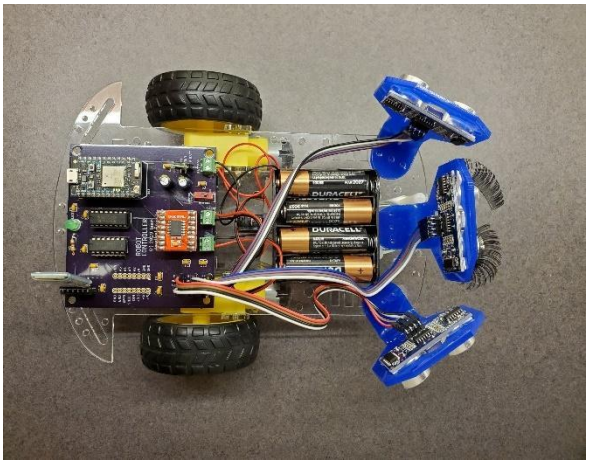
https://github.com/TeamPracticalProjects/Robotics/blob/master/Terms_of_Use_License_and_Disclaimer.pdf



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1. OVERVIEW.

This document describes how to control your Robot. In order to run your Robot, you must have completed all of the steps in the document “Robot_Build_and Installation_Instructions.pdf” that is located in this folder. These steps include:

- Building and testing the Robot PCB.
- Assembling and wiring the Robot.
- Installing the Robot Firmware on the Particle Photon microcontroller module located on the Robot PCB.
- Installing the Robot App on an Android phone or tablet.

The Robot has two switches that the user can control. These are described in section 2 of this document. Once the Robot is turned on and the motors enabled, the Robot is controlled through an Android app. The Robot App is described in section 3 of this document.

2. ROBOT COMPONENTS UNDER USER CONTROL.

The Robot has two switches that the User can access; see figure 2-1.

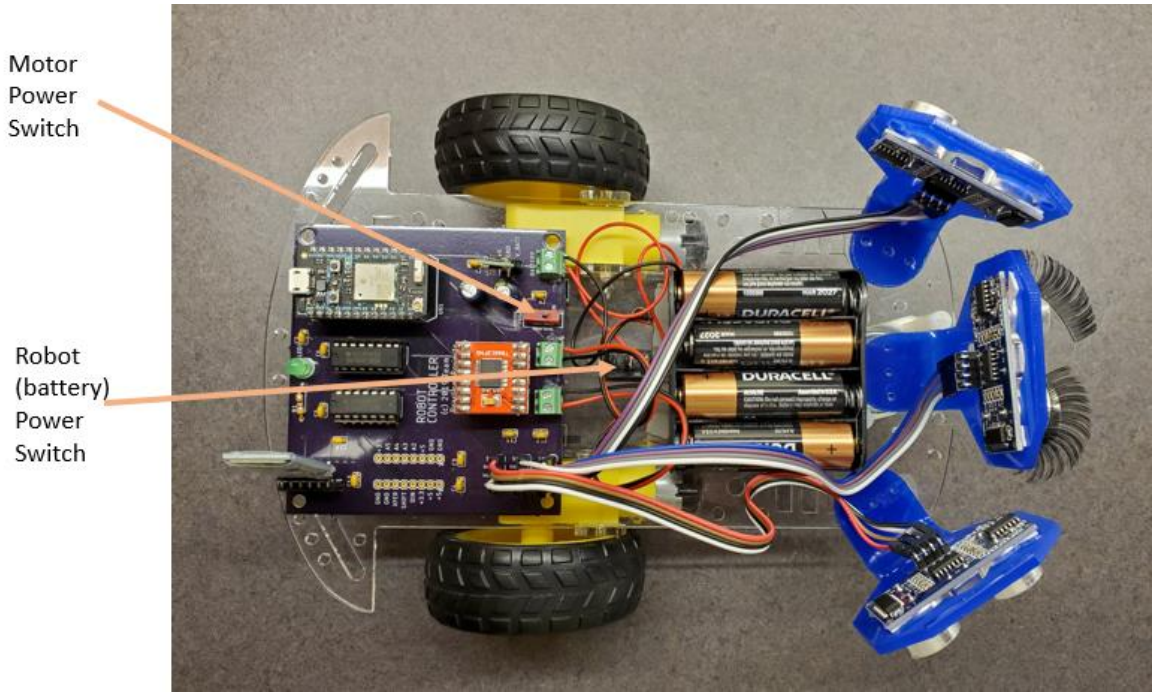

Figure 2-1. Switches on the Robot.

The “motor power switch” is a slide switch that is mounted on the Robot PCB. This is a 2 position slide switch. Normally, this switch is set forward, i.e. toward the batteries, as shown in the closeup view of figure 2-2. In this position, the Robot electronics can control the drive wheel motors. If the “motor power switch” is set to the rear of the Robot, the Robot electronics will perform normally but the motors will be de-energized. This latter position of the “motor power switch” is available for testing and debugging purposes only. In normal use, this switch should be set in the forward position (per figure 2-2) so that the motors are energized.

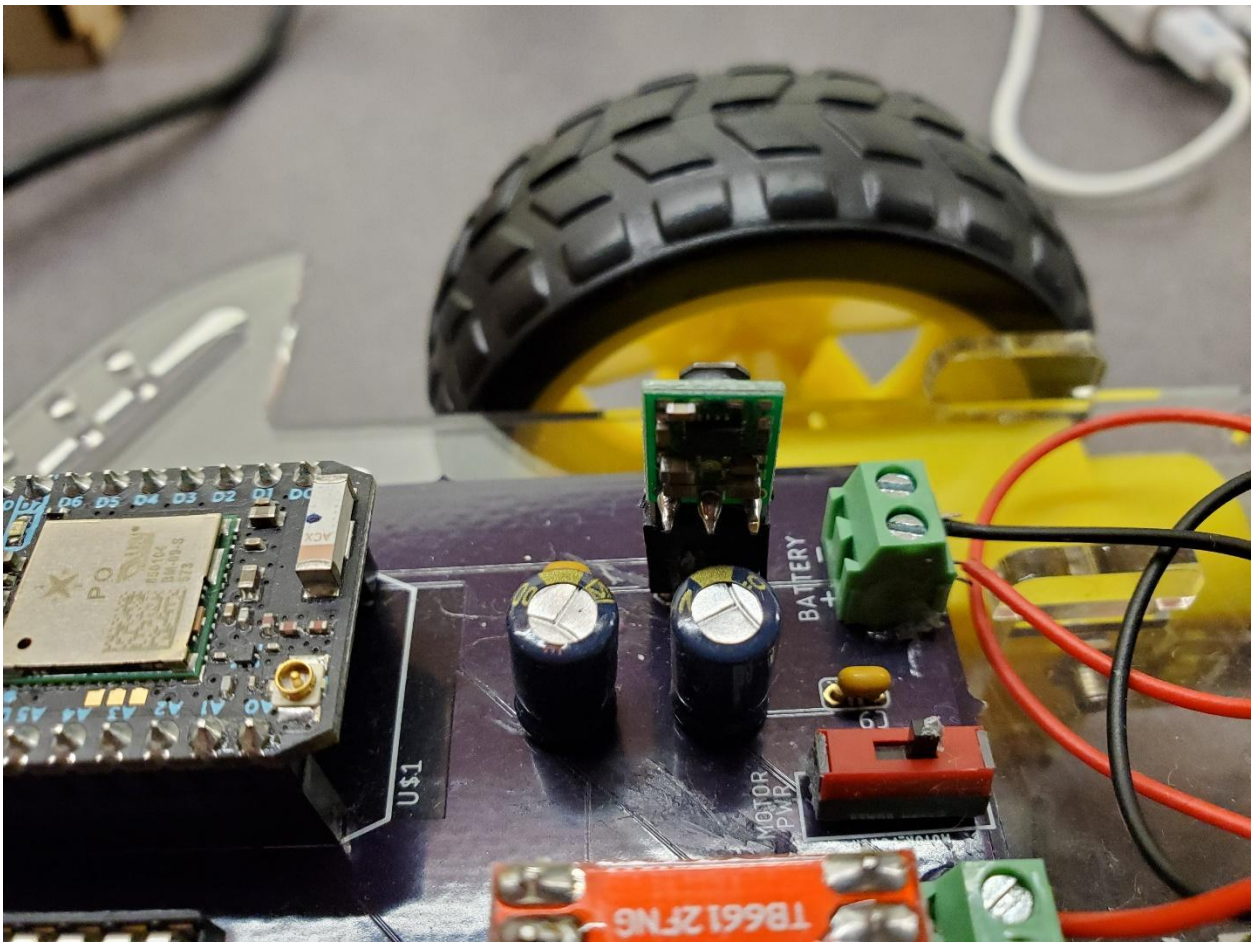

Figure 2-2. Motor Power Switch Closeup (normal position).

The “battery power switch” is located between the PCB and the batteries. This is a rocker switch and the switch control is on the underside of the Robot, as shown in figure 2-3. In the “0” position, the batteries are disconnected and the Robot is completely powered off. In the “1” position, the batteries are connected to the electronics and the Robot can function. We suggest that you turn this switch off whenever you are not actively using the Robot, in order to conserve the batteries. Turn this switch ON (to “1”) whenever you want to use your Robot.

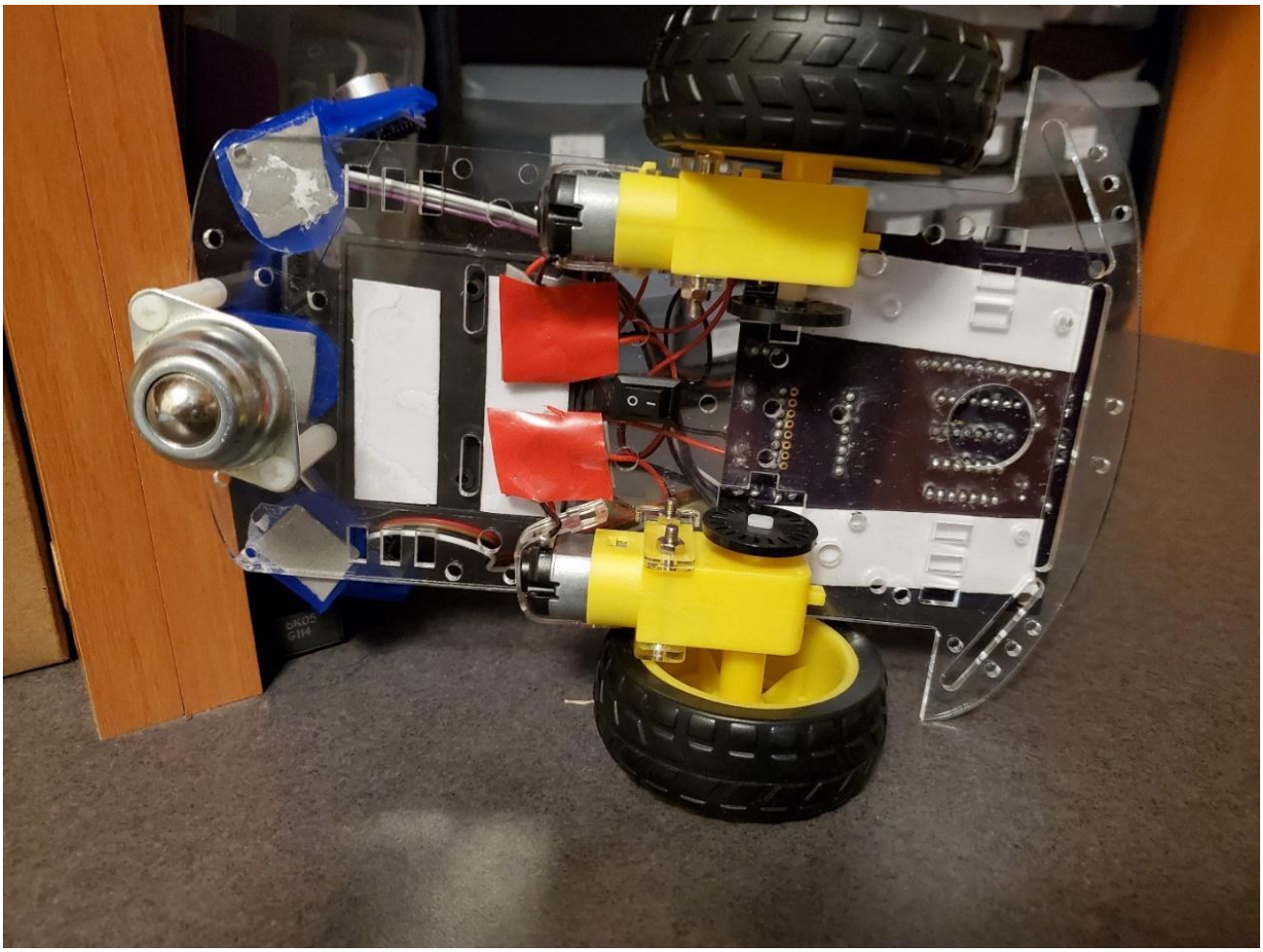

Figure 2-3. Battery Power Switch.

3. ROBOT APP USER INSTRUCTIONS.

When you open the Robot App on your Android device, you should see a screen similar to figure 3-1, below. Note the word “Disconnected” in red at the top right of the screen. This indicates that you must first create a Bluetooth connection between the App and your Robot. If you look at the Bluetooth module on your Robot, you will see a flashing red LED. This also indicates that the Robot’s Bluetooth module is not connected to any device at this time.

Figure 3-1. App Opening Screen.

Make sure that the Robot is powered on and is nearby to you. Now, tap in the “Choose BT device” button at the top left side of the App screen. You will now see a screen similar to figure 3-2. Note that there will be some long coded numbers (MAC Addresses) in the fields that are blanked out in red in figure 3-2.

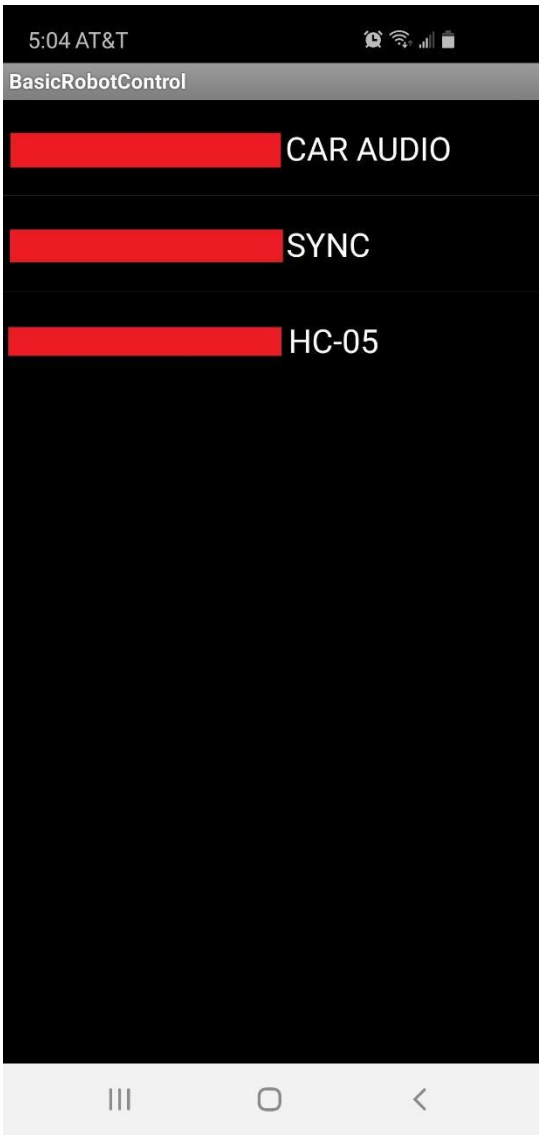

Figure 3-2. Bluetooth Connection Selector Screen.

Locate your device on the screen in figure 3-2. It should say "HC-05"[1]. Tap on this device to make the Bluetooth connection between your App and the Robot. At this time, you should see two things change:

- The App should return to the main screen with the top right message now saying "Connected" in a gray field; see figure 3-3.

[1] If you do not see your Robot's HC-05 module on this list, then you need to "pair" your Android device with the HC-05 module. Go to your Android device's "Settings" and find the Bluetooth settings. Use this screen to find all Bluetooth devices in range and then select the HC-05 device and follow the instructions on your Android device to "pair" with it. Once your Robot's HC-05 is paired with your Android device, you should be able to use these instructions to connect with it without having the pair again.

- The red LED on the Bluetooth module on the Robot should now just occasionally flash red, as opposed to flashing red continuously. This verifies that the App is now communicating with the Robot.

Figure 3-3. Robot Bluetooth Connected.

At this point, you are ready to use the App to control your Robot. There are two modes of Robot control: *manual* and *automatic*. In "manual" mode, you can use the green buttons on the App to manually control the Robot, as follows:

- **STOP button**: tapping this button brakes the Robot to stop it. The Robot remains stopped until you tap another button. The green LED on the back of the Robot PCB is off when the Robot is stopped.

- **FORWARD button**: tapping this button moves the Robot forward at high speed. The Robot continues until you tap STOP or any other of the buttons. The green LED on the back of the Robot PCB is on when the Robot is moving.

- **BACK button**: tapping this button moves the Robot backward at high speed. The Robot continues until you tap STOP or any other of the buttons. The green LED on the back of the Robot PCB is on when the Robot is moving.

- **LEFT button**: tapping this button causes the Robot to pivot to the left. The Robot continues pivoting until you tap STOP or any other of the buttons. The green LED on the back of the Robot PCB is on when the Robot is moving.

- **RIGHT button**: tapping this button causes the Robot to pivot to the right. The Robot continues pivoting until you tap STOP or any other of the buttons. The green LED on the back of the Robot PCB is on when the Robot is moving.

- **FWD_LEFT button**: tapping this button causes the Robot to move forward while turning left, at medium speed. The green LED on the back of the Robot PCB is on when the Robot is moving.

- **FWD_RIGHT button**: tapping this button causes the Robot to move forward while turning right, at medium speed. The green LED on the back of the Robot PCB is on when the Robot is moving.

- **AUTO**: this button places the Robot into *automatic navigation* mode, which is described further below. The Robot remains in automatic mode until some other button is tapped. The green LED on the back of the Robot PCB is on when the Robot is moving.

Note that after tapping any button, the button color turns to yellow and remains so until some other button is tapped. A yellow button indicates the active control on the Robot.

Figure 3-4 is a photo of the App after placing the Robot into *automatic navigation* (AUTO) mode. When the Robot is in AUTO mode, it uses the three ultrasonic sensors to navigate automatically, avoiding collisions with obstacles in its path.

When the Robot is in AUTO mode, the App displays some additional information below the buttons, as illustrated in figure 3-4. This additional information indicates the Robot's current action. The following is brief description of how the Robot navigates when in AUTO mode.

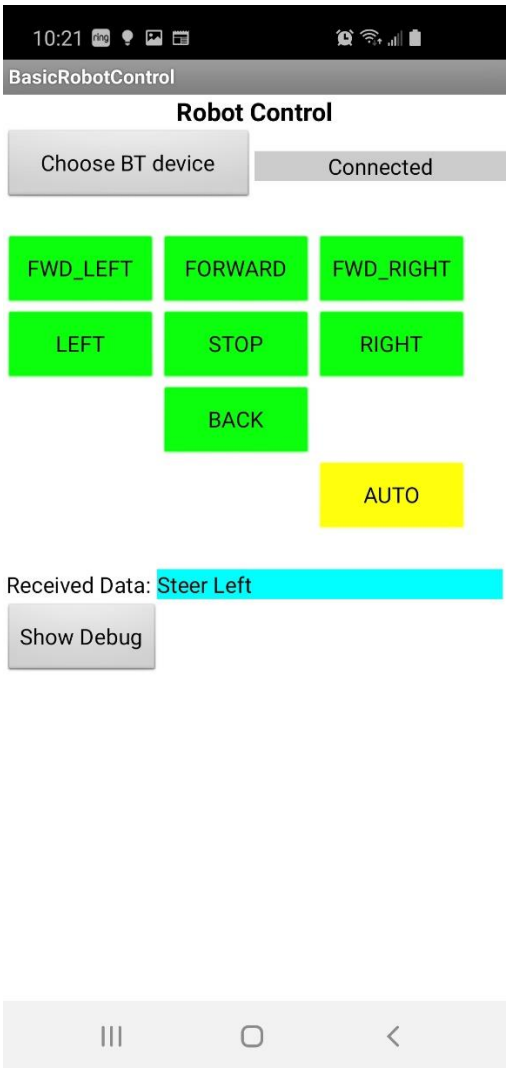

Figure 3-4. Robot Automatic Navigation Mode.

When the Robot is in AUTO mode, it primarily uses the front ultrasonic sensor to detect obstacles. If the front ultrasonic sensor detects an obstacle ahead, it randomly selects a direction to pivot (left or right) and it pivots in that direction until it finds an open space ahead. The Robot should always find an open space ahead; at the very least, it pivots 180 degrees so that "ahead" is now the path that the robot came in on. If this path is blocked and the Robot can't find an open space anywhere, it automatically exits the AUTO mode and stops.

The two side sensors are needed for the Robot to detect that it is angling toward a wall or other obstacle; i.e. the obstacle is not directly ahead but the Robot is approaching it at an oblique angle. When one of these sensors detects that the Robot is too close to a side obstacle, the Robot pivots away from it until it is clear on the sides. If the Robot detects that it is too close to both sides (i.e. the corridor narrows, the Robot backs up until it is clear enough on one side to pivot around and exit the way it came in.

The App has an additional button – a gray button that says “Show Debug”. Tapping this button causes the App to display a history of the Robot’s decision messages, along with the distance readings that caused the Robot to make an AUTO mode decision. See figure 3-5, below.

Figure 3-5. Auto Mode with Debug Log.

This extra information is normally not used but it can be useful in understanding how the Robot got into some situation and how it responded to that situation. The Robot firmware publishes an entry for this log display every time that it makes a new AUTO mode decision, e.g. stop going forward and steer to the left. Each log entry contains the Robot’s new decision and, just below this decision, displays the three distance measurements that drove the decision. For example, the entry:

Steer Left

Dist 35.05 8.78 3.85
.

Means the following:

- The Robot decided that it needs to steer to the left (turn left while moving forward at low speed)
- The basis for this decision was:
    - Ultrasonic left side measurement is 35.05 inches, which is clear to the left.
    - Ultrasonic front measurement is 8.78 inches, which still has room to move forward.
    - Ultrasonic right side measurement is 3.85 inches, which is too close on the right.

Since the Robot must get clear of the right side and it has room to move forward, the decision is to “steer left” (as opposed to “swivel left”, where the Robot pivots and does not move forward while doing so).

The log is read from the top down, where the most recent entry is at the top, the next entry down is the Robot’s previous decision, etc.

When you are through using your Robot, you may close the App on your Android device. We recommend that you turn off the Robot power using the *battery power switch* on the underside of the Robot when it is not in use. This will extend the life of the batteries that power the Robot.