Internals/Wiring

Purpose

The goal of this section is to explain the wiring between the electrical components that comprise the standard base of the robots of one of the linemen used in Notre Dame's team, and the controller stack used to control the lineman. The drive and controller stacks are composed of Arduino and XBee shields, and either a screw shield or USB host shield between them, depending on if it is for the drive or controller stack, respectively. After reading this document, the reader should know how to replicate the wiring used and should have a basic structure to work off should they decide to deviate from the standard base. It should be noted that all the wires going between internal components use 14 AWG, save for the smaller wires that connect to and from the drive stack, which use 22 AWG due to the smaller size of the screw shield.

Overall Pictures

Below in Figure 1 of this document is a picture of the internal wiring of one of our linemen "Irish Chocolate."

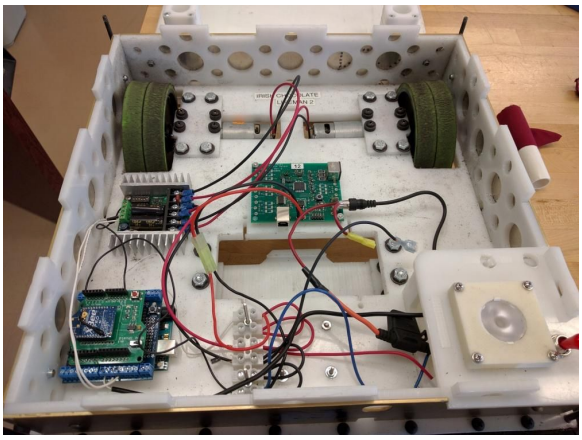

Figure 1: Picture of Standard Base internals

While this lineman is a good example of the wiring used for the robots standard base, the extra length of the wiring makes it difficult to understand what is wired to what. Figure 2 below is a labeled, simplified schematic.

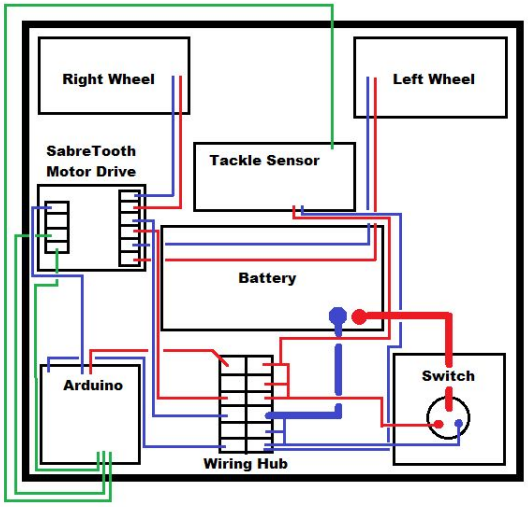

Figure 2: Simplified wiring diagram

In this schematic, green wires notate wires that send data from one component to another. Red wires represent voltage and blue represents grounding wires.

Detailed Walkthrough

The first component investigated is the connection between the battery and the switch. Below in Figure 3 is a picture of the wiring involved with the switch.

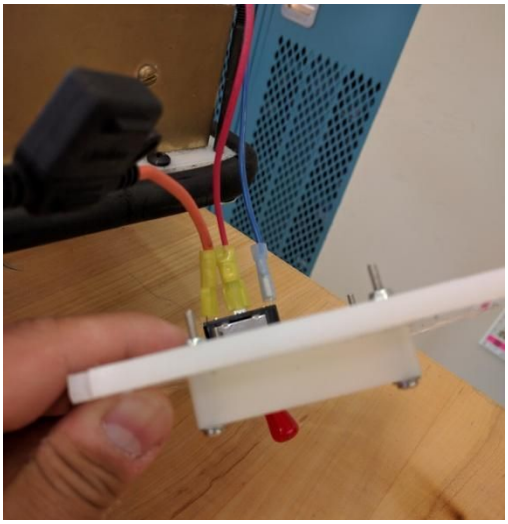

Figure 3: Switch

The orange wire attached to the SPST 12VDC/30A Illuminated Toggle Switch connects to the black Littelfuse fuse box. From there the wire extends to connect to the positive terminal of the battery. The blue wire is a grounding wire and the red is power. The leads connecting to both the switch and the battery use disconnect terminals.

The switch wires proceed to connect to the terminal block, which is shown in Figure 4. Alongside Figure 4 is a diagram that will be used to reference and label the terminals.

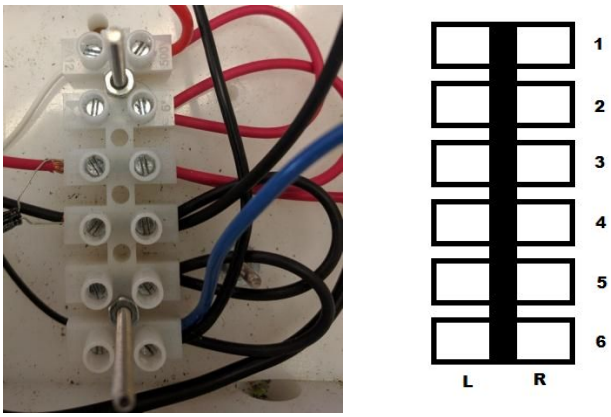

Figure 4: Terminal block image and labeling diagram.

The power from the switch goes into 3R, and the ground from the switch connects to 6R. There are many small red wires that connect 1R to 2R and 2R to 3R and sets all of them at the same voltage. A similar structure has been done for the 4R, 5R and 6R and the grounding wires.

One power cord leaves from 3L and connects the Sabertooth motor driver, and a grounding wire from 4L follows it. Between 3L and 4L, there is a 2.2 microFarad, 50V capacitor. A power wire from 1L leads to the drive stack, and its paired grounding wire connects to 6L. From 1R and 6R, a power and grounding wire makes its way to the tackle sensor. Finally, the grounding lead that goes back
to the battery exits from 4R. **(For ease of assembly, it is suggested that the wiring for the terminal block be completed before attaching it to the base plate.)**

Figure 5 below shows the wiring for the drive stack's screw shield. For ease of visibility, the XBee and the XBee shield have been removed. This way, the screw shield is visible for identifying the wiring.

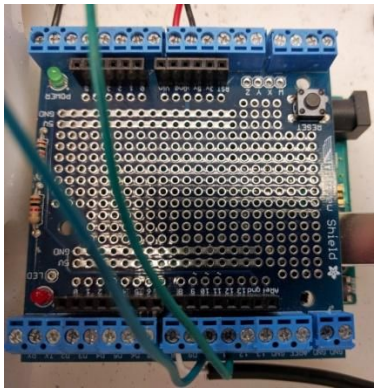

Figure 5: Arduino wiring

Green data wiring extends out of pins 11 and 10, and connect to Sabertooth, which we will see in Figure 6 below. The white/black wire that connects to D8 comes from the tackle sensor. The grounding wire coming out of the terminal block connects to the ground pin on the top left of the

image. Another grounding wire extends from the top of the screw shield to the Sabertooth, and the power from the terminal block goes to the Voltage In pin at the top of the screw shield.

Figure 6 shows both a unwired and wired Sabertooth motor controller. Notice that there are two "terminals" associated with this. The green screw terminals will be connected to the drive stack, and the black terminal drives the wheels and is attached to the primary terminal block.

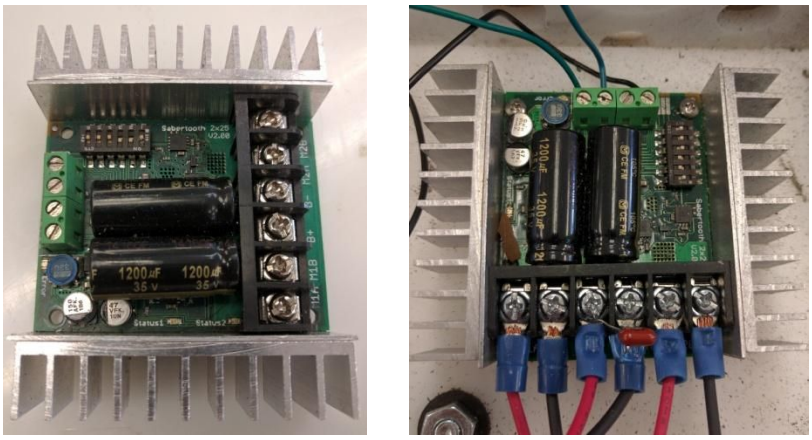

Figure 6: Sabertooth, wired and unwired

On the green terminal, wires from Arduino pin 11 and 10 should connect to pins S2 and S1 respectively, and the ground coming from the drive stack should connect to the 0V pin. For the black terminal, power from the terminal block should attach to the B+ pin, and ground to B-. The pins for the motors are labeled M1A, M1B, M2A, and M2B, where A pins bring power to the motor and B pins are grounds. M1 corresponds to the motor on the left, and M2 to the motor on the right. All the leads connecting to the black terminal use spade terminals.

The final electrical component of the robot is the tackle sensor. In Figure 7 below you can see the power and ground connections coming from the terminal block. The wire on the far lower right sends data back to the Arduino via pin D8, and the silver box at the top right connects to the LED's mounted around the top plate.

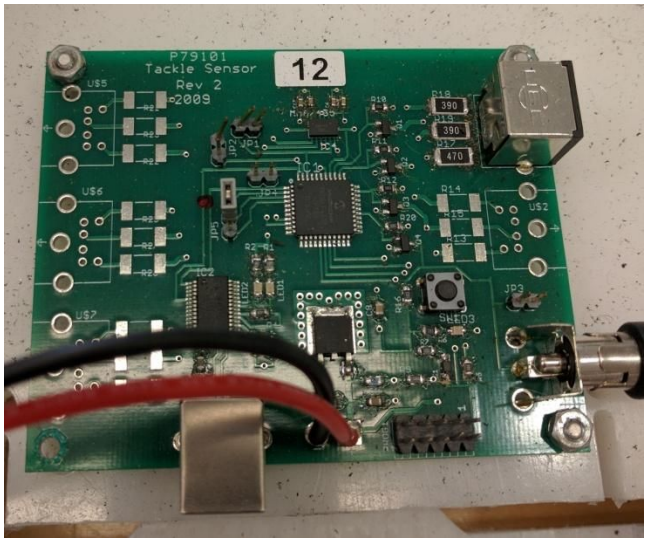

Figure 7: Picture of tackle sensor wiring.

LED Lighting

The tackle sensor is in control and has pre-programmed sequences for the multi colored LEDs that should show the status of the robot. Note that the LEDs should be visible from all sides of the robot. In Notre Dame's current iterations, the LED lights are attached to the top plate, but they can be attached on the bottom or side-plate if one chose to do so.

Xbox Controller Wiring

The ND Xbox controllers have USB extensions that plug into the controller stack's USB host shield, which is the shield between the Arduino and XBee shields. A closeup view of the controller stack is shown in Figure 8 below.

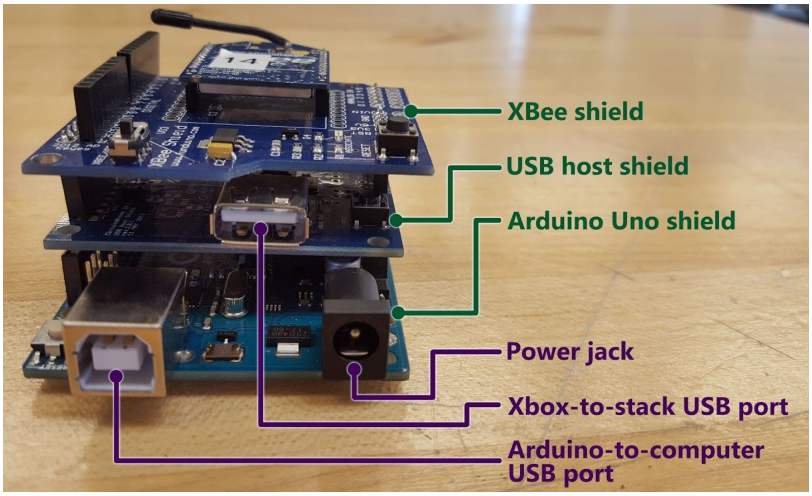

Figure 8: View of controller stack, with labeled shields and ports.

The controller stack can be powered either by a battery through the power jack, or by a computer or laptop through the Arduino-to-computer port. The battery used by the Notre Dame Robotic Football Club is a 7.2V rechargeable battery, and its connection is shown in Figure 9 below.

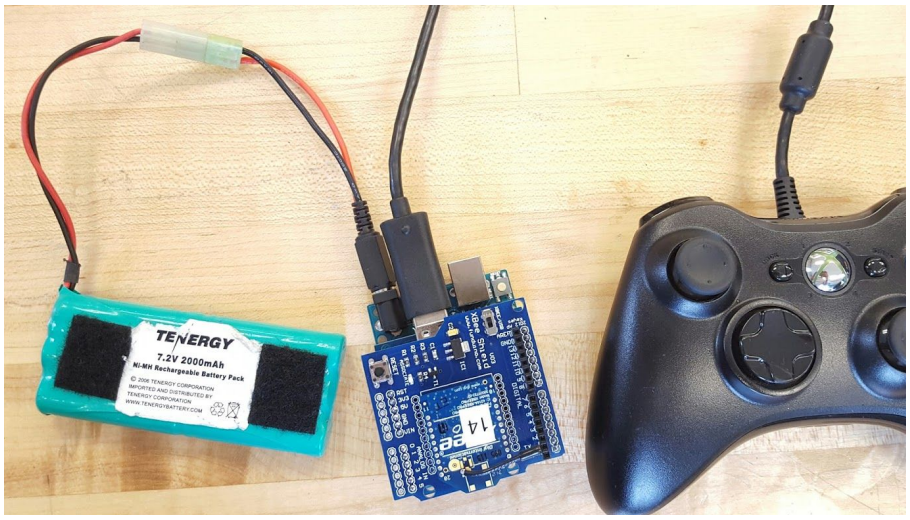

Figure 9: View of controller stack connected to Xbox controller and battery.

Common Errors

If a robot is malfunctioning, there are several possible causes in the wiring. The most common fixes are discussed below.

1. If a robot seems to start and stop often, check the connection of the leads to the battery. Poor leads will often lead to random shut downs or frequent brownouts that will decrease the robot's performance. This is also true for the connections to and from the switch.
2. Check to see that the wire connections are firm. Especially check the screw pins for loose connections. Be sure that all connections are tight and resist pulling on the wires.
3. If a wire has been overly twisted, and kinks are visible in the wire, consider replacing the wire with a new one as the bent wire usually is an indication of tearing in the wire.
4. **IMPORTANT NOTE**: there are tiny switches on both the drive stack and controller stack that will say either 'USB' and 'XBEE', or 'DLINE' and 'UART'. When you want to drive the robot, make sure both switches are on 'XBEE' or 'UART'. When you want to upload code onto the robot, make sure both switches are on 'USB' or 'DLINE'. If this is not followed properly, the controller won't be able to connect to the robot, and you will receive errors when trying to upload code.

This concludes the wiring guide for the standard base of the lineman. If followed correctly, the robot should function once the supplied codes are uploaded to their respective Arduinos.