WPI

NSF Workshop
Assembling your Romi

Last modification: December 6, 2021

1 Introduction

For these activities, you will be using Pololu's Romi robot platform, customized with a lifter assembly and several sensors. We arranged for Pololu to pre-solder headers onto the Romi Control Board, so assembly consists of putting some robot parts together, attaching the lifter arm, and wiring the components. Part of the activities later is to "optimize" the lifter arm to some extent – here we show you a nominal configuration.

2 Assembly

2.1 Materials and tools

- Bill of materials coming soon...
- Small Phillips head screwdriver.
- You might want a small pair of needle-nose pliers to hold the nuts.

2.2 Assembling the Romi

Procedure

1. **Build the basic Romi**. Referring to the Romi User's Guide, build the Romi base. You should browse the first three pages of the User's Guide and then do the build according to Assembling the Romi Chassis. Note that no soldering is necessary, so you can skip steps 1-3 and step 5 of the assembly instructions – we've done that for you!

> **Solution:**
> You will probably want to install a rubber band (not provided) as shown in Step 12 of the Pololu build instructions. We typically leave that step out so that we can later discuss "incidental interactions" when students lift up heavy objects and discover that their line sensor readings change dramatically due to sag in the front end. For the purpose of this workshop, it is more expedient to put it in now, since it will be more difficult to do so after the breadboard has been installed.

2. **Add the line sensor**. Using (2) 3/4" standoffs, attach the line sensor to the front of the robot, as shown in Figure 1. You'll want use screws on the bottom and nuts on top so that the extra screw length doesn't drag on the ground.

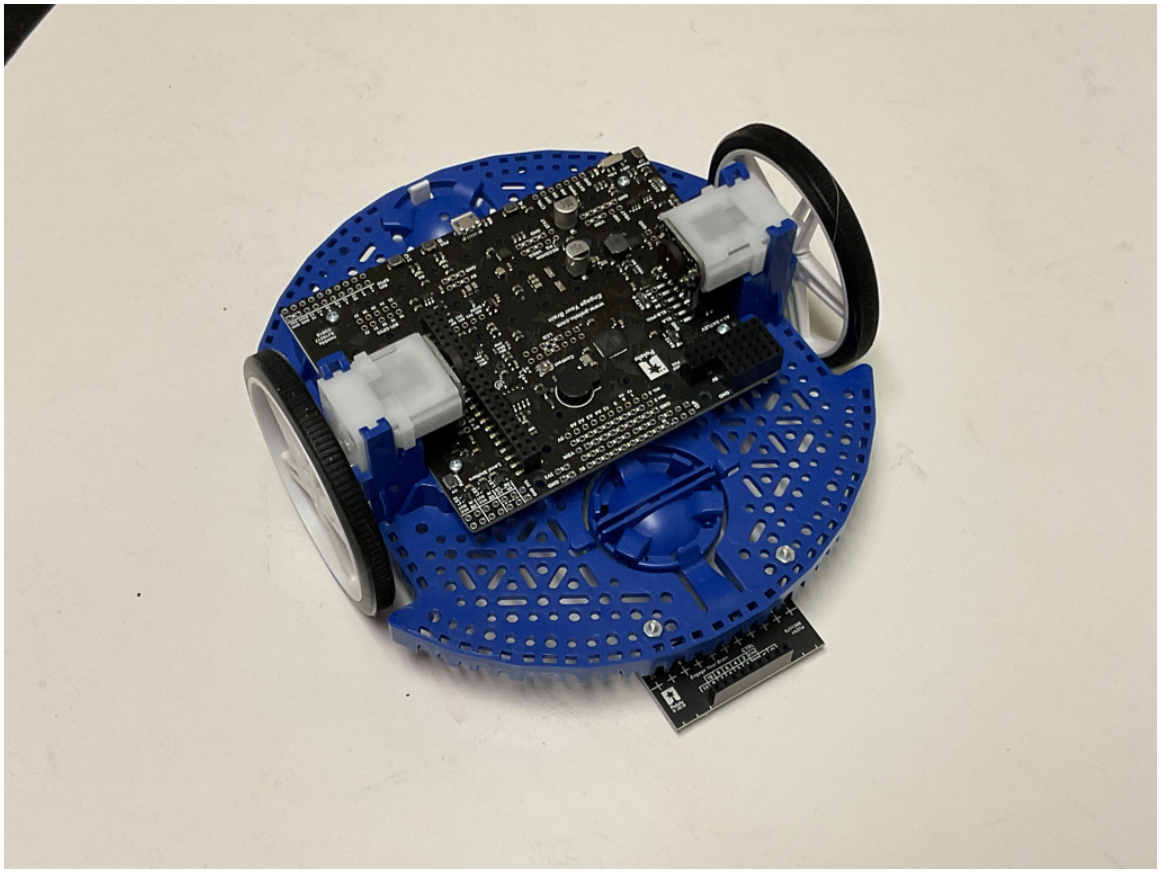

Figure 1: Romi base with line sensor attached.

Optionally, you can pause here, install an integrated development environment, and do the introductory exercises to make sure you can program your robot.

(handouts coming soon)

- Setting up `platformio`
- "Hello, World!"
- "Move it!"

2.3 Assembling the lifter arm

We have provided at least one copy of a lifter assembly for these activities. To do the activities with multiple robots, you will need a lifter assembly for each robot. A good activity is for students to 3d print their own arms, and we provide both SolidWorks files and .stl files for you to print (<link

needed>). If you don't have access to a 3d printer, additional arm assemblies can be sent to you with a few weeks notice.

The instructions below are for a nominal arm configuration. One of the later activities includes determining a better arm configuration and reconfiguring the arm. As such, we do not give specific instructions, as the exact configuration isn't important, though you're encouraged to take some time to plan the assembly.

Note: We have found that motor vibrations and driving tend to cause the nuts to work themselves loose over time. Be sure to tighten screws and nuts well and check/tighten them periodically.

Keep in mind that not every 3d print is the same – you may need to clean out support material or ream out a hole with a small screwdriver. Figure 2 shows the 3d printed parts for the arm assembly. You may have also received a mount for the ultrasonic rangefinder – we find that it is easier to simply mount the rangefinder in a breadboard. If you choose to use the mount, you may have to file out the holes to match your sensor.

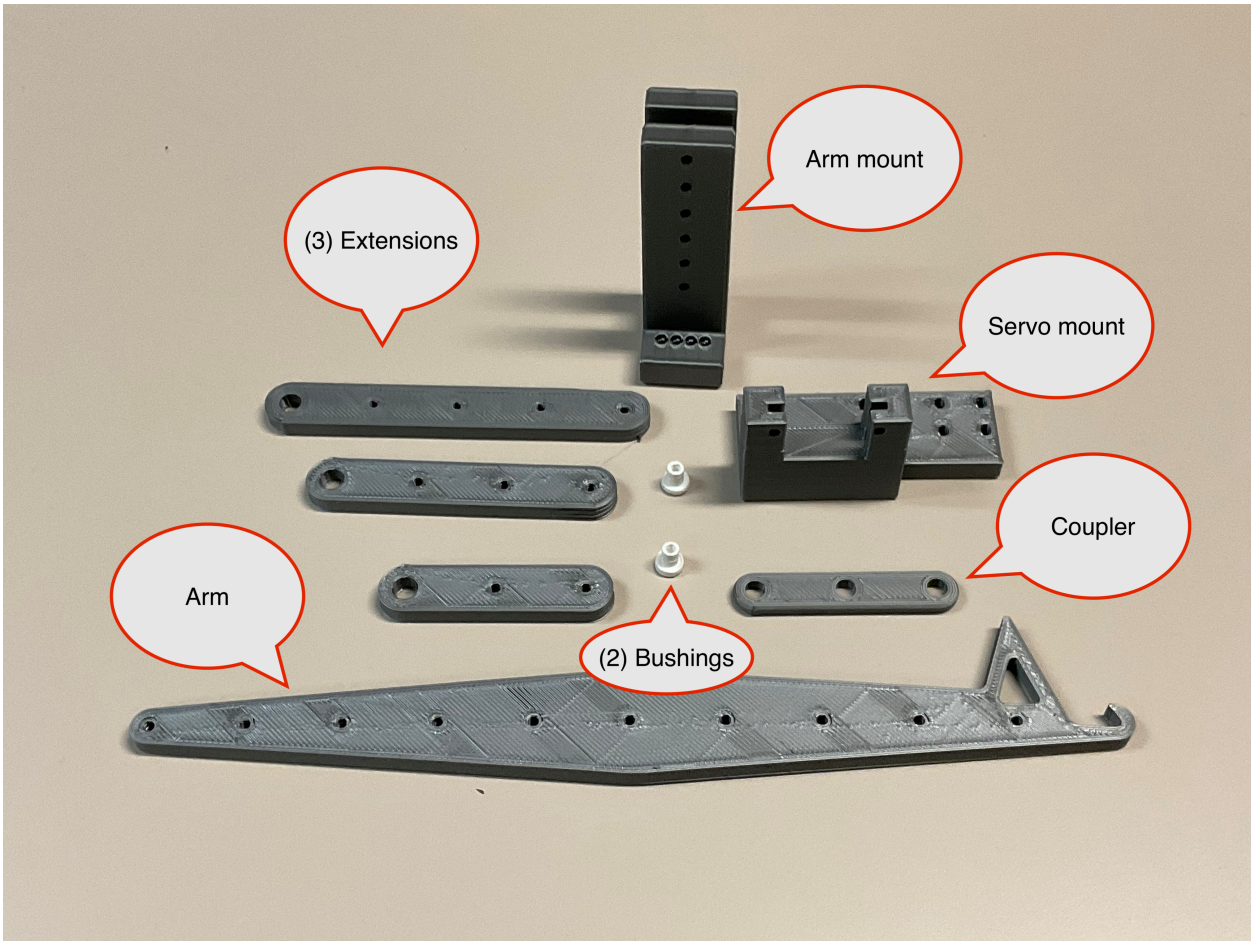

Figure 2: Parts for the arm assembly.

Procedure

1. Install the 1” and 1 1/2” standoffs on the expansion plate, as shown in Figure 3. Not every hole on the expansion plate lines up with a hole on the Romi base, so take care to put the standoffs in the holes shown. Test the alignment with the Romi base, but don’t attach it yet – you’ll want to attach the servo and arm mounts first.

Figure 3: Expansion plate with standoffs installed.

2. Attach the servo and arm mounts to the expansion plate with 3/4” screws. Relative alignment is important so that the coupler can connect the servo horn to the arm. Figure 8 shows what you are working towards. Figure 4 shows a nominal configuration for the mounts. Once the

supports are attached, you can mount the expansion plate to the Romi base with the 1/4" screws. You may want to wait until the assembly is complete, however, as adjusting the locations of the mounts will be easier.

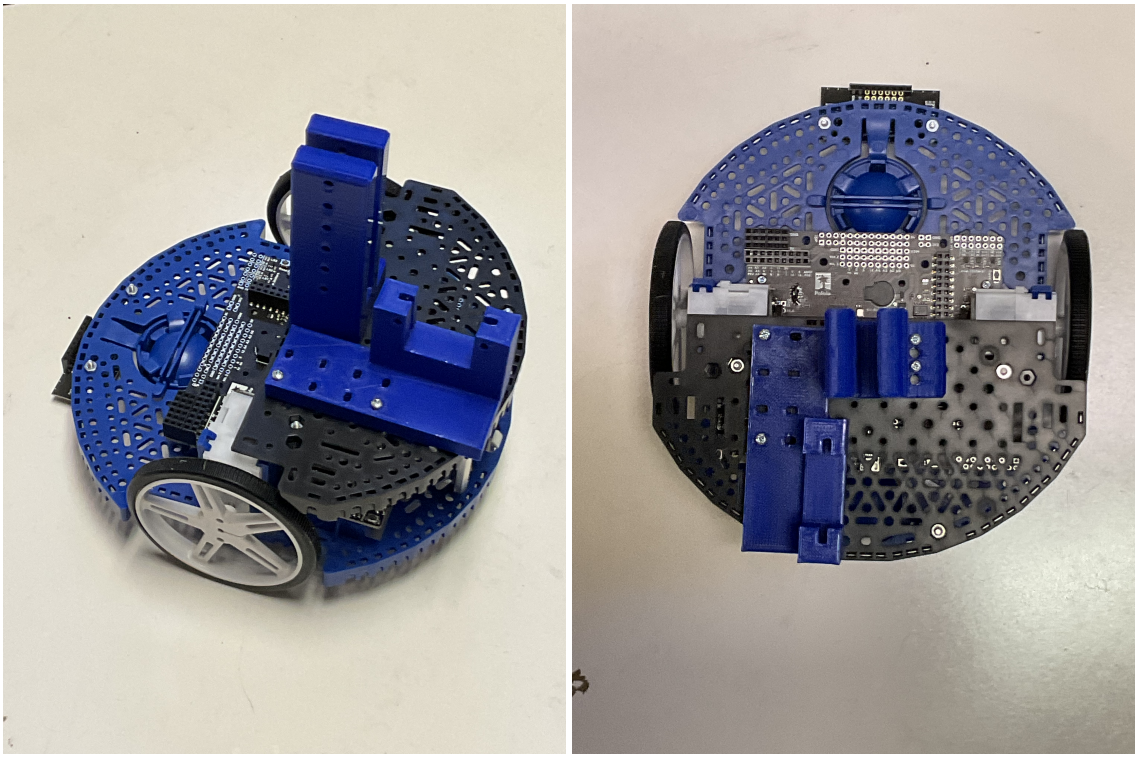

Figure 4: Servo and arm mounts mounted. Once you install the mounts, you can attach the expansion plate to the base, as shown in this figure.

3. Using 3/4" screws, mount the servo in the servo bracket. Mount the horn on the servo using the smallest screw in the package of servo parts. You will want to attach the horn so that it ranges from straight up to straight down. Figure 5 shows the horn at the upward extreme. You can use the horn to *gently* drive the servo to one extreme or the other so you can properly align it.
4. Attach the arm to the arm mount with a 1 1/4"screw as shown in Figure 6.
5. Using 3/4" screws and the provided bushings, attach the coupler to the servo horn and arm, as shown in Figure 7. Use the slightly larger hole near the end of the horn – the screw will be a tight fit, so be gentle when screwing the couple on. You will want to screw from the horn side so that the excess screw length doesn't interfere with the servo motion.
6. If you haven't already done so, attach the expansion plate/arm assembly to the Romi base, as shown in Figure 8.
7. Wire the servo. Unfortunately, the servo cable is not immediately compatible with the arrangement of the sockets on the front, left of the Romi Control Board. That leaves two options for wiring the servo:
    - Wire the servo to the breadboard and then add jumper wires to the correct sockets on the Romi Control Board (see the instructions for mounting the breadboard below).

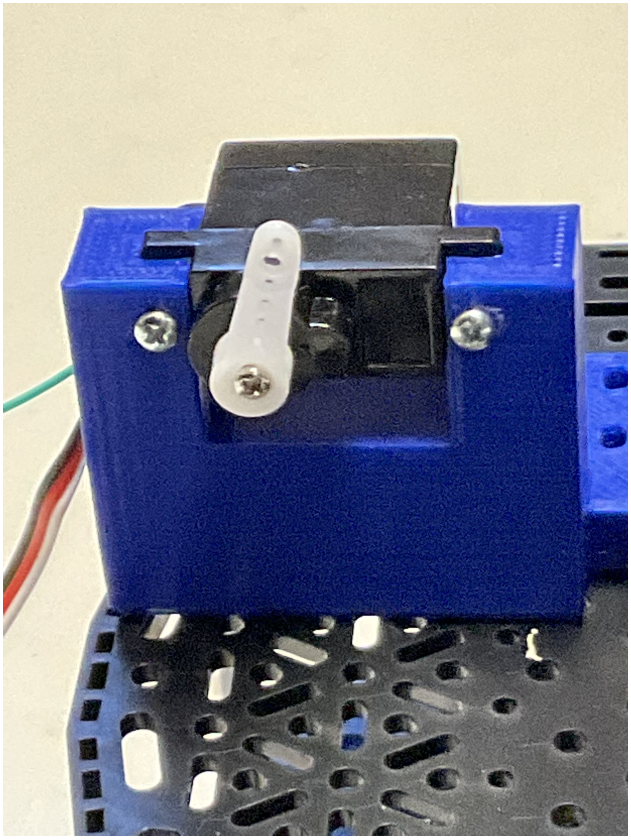

Figure 5: Servo with horn mounted.

- Rearrange the wires on the servo. (this is probably not worth it – remove from the instructions?)

2.4 Attaching the breadboard and wiring.

To simplify the wiring of components, we have pre-soldered headers on the front left corner of the Romi Control Board. For some components (e.g., the line sensor), it may be easiest to wire them directly to the sockets, for others, it may be easiest to use a breadboard (the servo motor, ultrasonic rangefinder).

Solution: Note that there are several options for mounting the breadboard, and each location has advantages and disadvantages. We show the breadboard mounted to the front of the Romi, which makes mounting the ultrasonic rangefinder easy, since it fits directly in the breadboard. Note, however, that this position interferes with the nominal motion of the lifter arm. While not originally intended, we have left the design as-is to give students a chance to discuss pros and cons of various positions for the arm and breadboard. "Reaching over" reduces the range of the arm. Positioning the arm off the rear of the chassis requires a 180 degree turn before picking up a container. Moving the breadboard requires re-thinking how to mount the ultrasonic rangefinder. Other options have advantages and disadvantages.

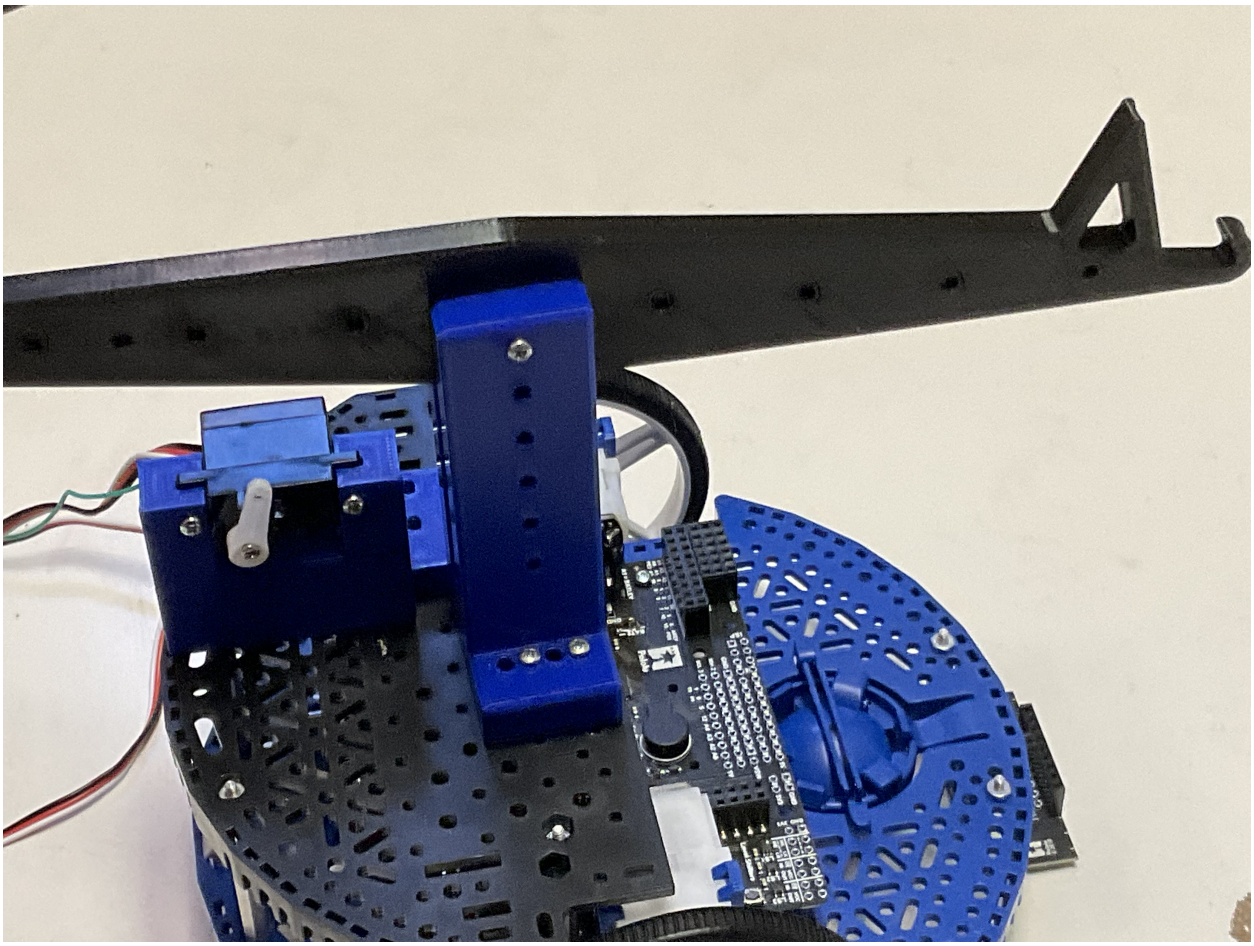

Figure 6: Arm attachment.

We show the breadboard mounted on the front, which is good for getting started.

Procedure

1. Attach your breadboard to the Romi.

   (a) Cut two short spacers – 1/4" is good – from the plastic tubing supplied in your kit. Using 3/4" screws, mount the breadboard to the base with the spacer between the breadboard and the chassis, as shown in Figure 9. Alternatively, you can just use tape or a rubber band to hold the breadboard to the Romi, but do not remove the backing paper on the breadboard – you'll never get it off if you want to move it later.

   > **Solution:** Unfortunately, we didn't realize until too late that the short standoffs that come with the Romi Control Board have a different threading than the screws. Ignore them.

   (b) Using the provided wires, connect the 5V socket on the Romi Control Board to the '+'

power rail on the breadboard. Connect `GND` to the '`-`' rail. Refer to the pin diagram for the Romi for which pins are where.

2. Connect the ultrasonic rangefinder.
   (a) Insert the ultrasonic rangefinder such that it is pointing forward. Connect `Vcc` on the rangefinder to the '`+`' rail and `Gnd` to the '`-`' rail. Connect the `Echo` pin to pin `11` on the Romi. Connect the `Trig` pin to pin `4`.
3. Connect the servo.
   (a) Break off four of the breakaway pins and connect the servo wires to the breadboard. Use a wire to connect the red wire of the servo to the '`+`' rail and the black wire to the '`-`' rail.
   (b) Use a wire to connect the white servo wire to pin `6`. You can leave the green wire on the servo disconnected.
4. Connect the line sensor array. Though the line sensor array has six sensing elements, we will only use two of them for now (you may use a third later).
   (a) Wire the `Vcc` and `Gnd` to the '`+`' and '`-`' rails. Connect any two sensor elements to `A3` and `A4` on the Romi Control Board. It's probably easiest to just connect them directly, though you can go through the breadboard, if you wish.

Figure 10 shows the complete robot, with wiring.

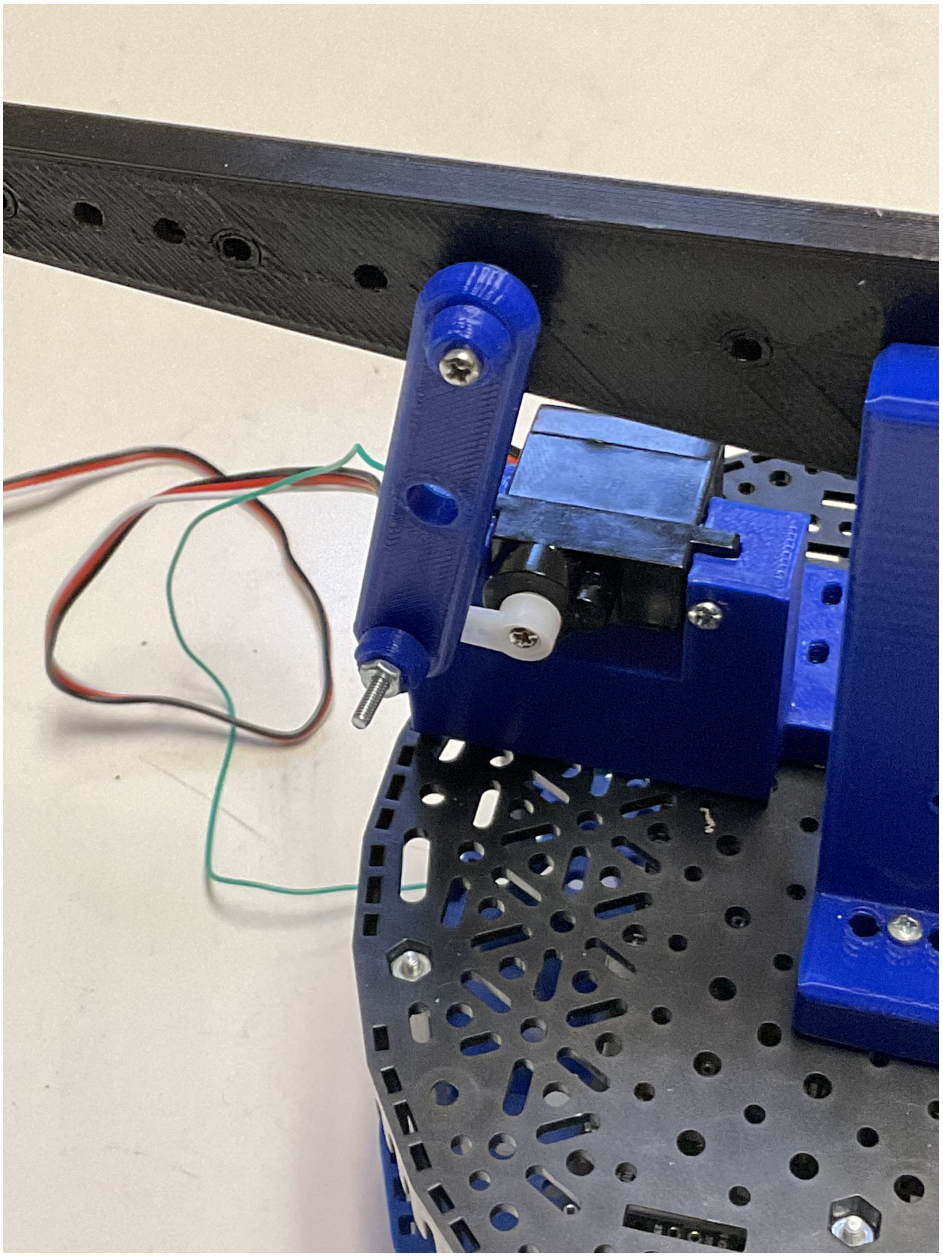

Figure 7: Coupler attachment.

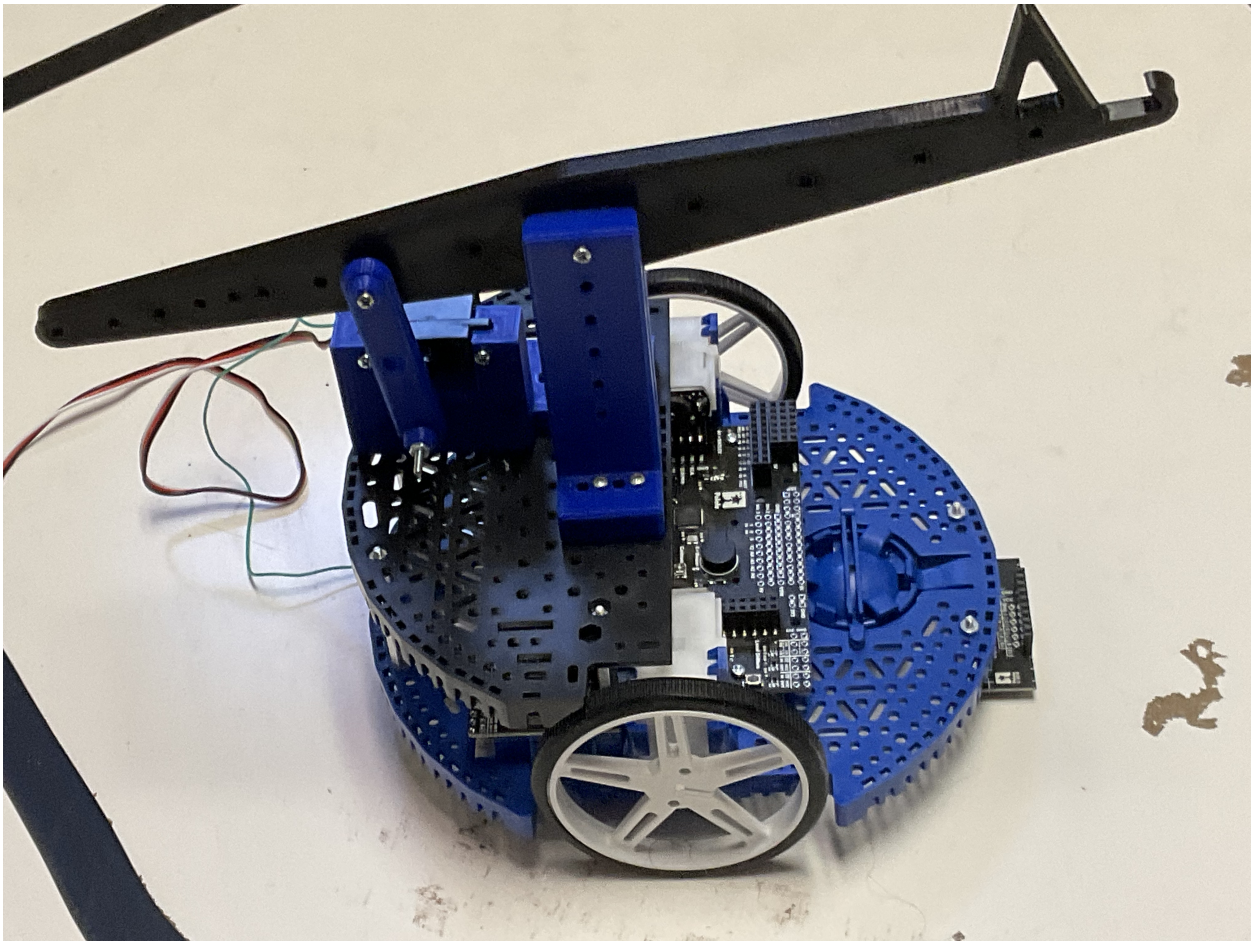

Figure 8: Romi with arm assembly complete.

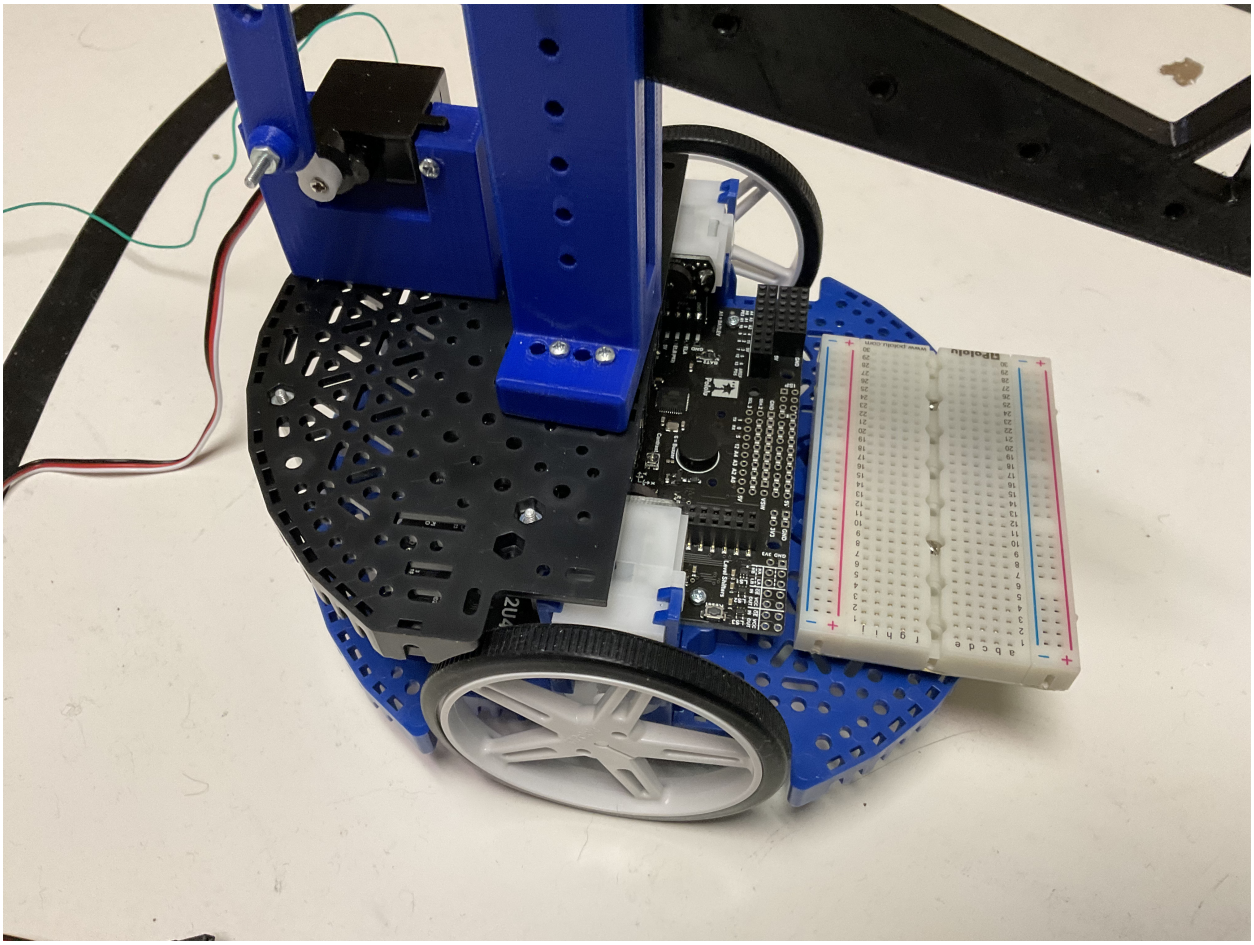

Figure 9: Romi with breadboard mounted.

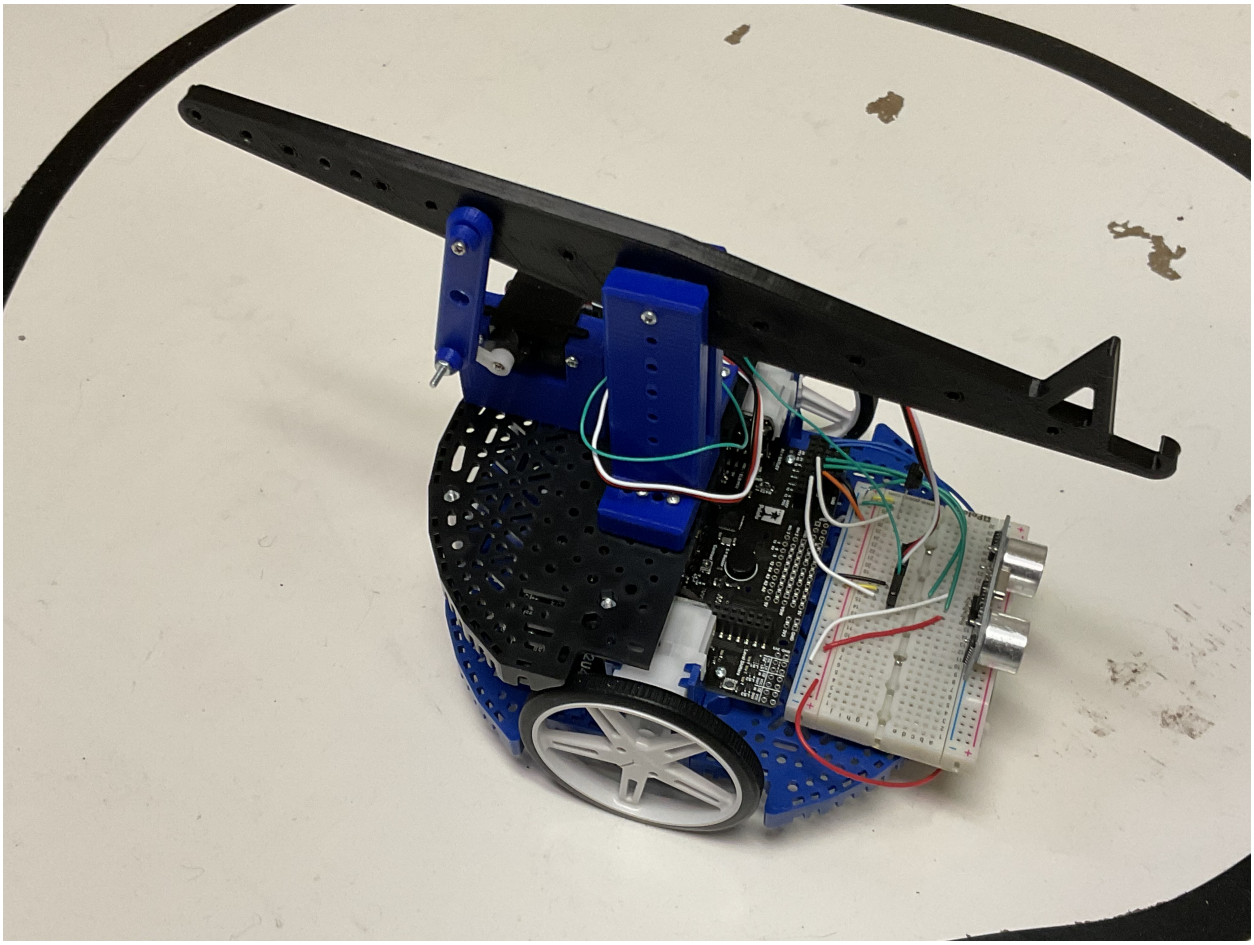

Figure 10: Romi built and wired.