

# **E11: Autonomous Vehicles**

**Fall 2010**

**Harris & Lape with Keeter & Ong**

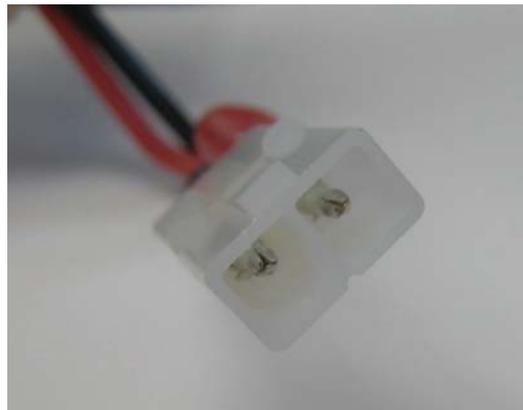
## **Lab 5: Robot Assembly**

### **Introduction**

In this lab, you'll make your very own robot! You should have a Mudduino and a chassis, as well as your kit of parts. Now it's time to put them all together.

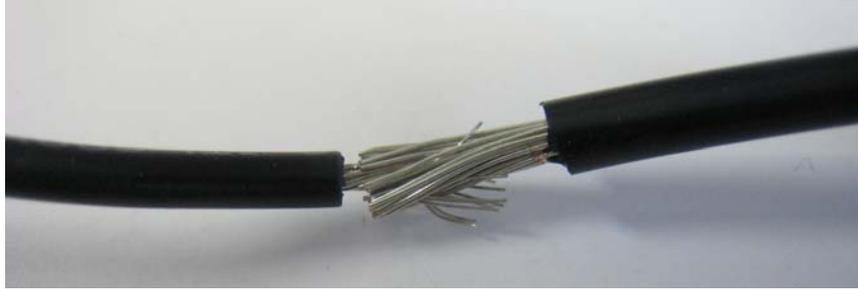
### **Preparing the battery**

The robot is powered by a 7.2V RC car battery. Before it can be used, you need to solder a male Tamiya connector to the battery wires. The male connector has metal prongs inside plastic sheathes:



**WARNING: The battery is designed for high current output. If you accidentally create a direct path between power and ground, the battery will start smoking in about four seconds. There is also the possibility of sparking between power and ground, which can cause small burns. If you take care to keep power and ground separated, you won't have any problems.**

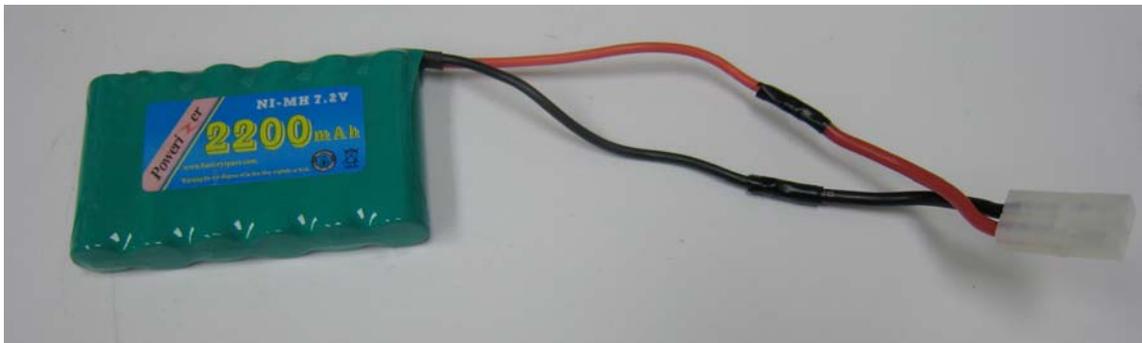
Now that we've gotten the scary warnings out of the way, here's how to attach the connector. Cut the wires so that about 4" emerge from the battery, and 2.5" emerge from the connector. Strip about 1/3" off of the black wires. Intertwine the wires, like so. Make sure you have a good mechanical connection before you solder.



Heat the junction, and apply copious amounts of solder. Make sure that the solder is actually soaking into the connection, rather than just wetting the surface (if this isn't happening, keep heating the wires). You should also flip over the wires and solder the other side. You want to make a very strong electrical and mechanical connection.



Once you're satisfied, clean up any stray wires with the cutters and wrap electrical tape around the junction. Then, do the same thing with the red wires. You should end up with the following:

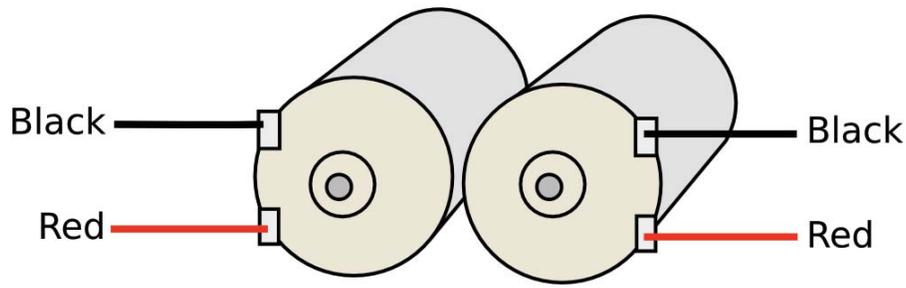


Write your initials on your battery pack.

Plug your battery pack into the charger and the charger into the wall. You should see a red light on the charger indicating that the battery pack is charging. It is a good idea to recharge your battery before each of the future labs so that it remains at full strength.

## Preparing the motors

Cut off two 6" pieces each of red and black wire to connect the motors to the Mudduino board. Strip 1/3" of insulation off the ends and solder a red and black wire to each of the motors. Twist the wires together to keep them neat. Note that since the motors are driving wheels on opposite sides of the bot, you will want the wire colors to be mirror images:



This will make programming the robot's driving more intuitive.

Be careful with your wires; if they bend too much, they may snap off.

## Assembling the gearbox

The robot's gearbox can be assembled in different ways depending on the desired speed and torque. For the purposes of this lab, we will assemble it in the lowest-speed configuration with a 344.2:1 gear ratio. Follow the directions in the gearbox kit.

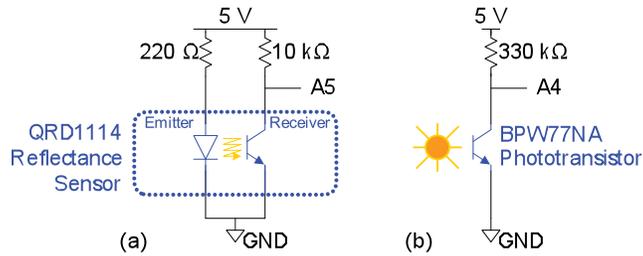
The directions contain a scale that will help you place the parts at the right position on the shaft. Be sure to tighten down the grub screw forcefully against a flat edge of the hex shaft so that the gear hub does not slip when the motors apply full torque. If the hub does slip later, you'll have to disassemble your gear box and rebuild it.

Plug the motors into the gearbox. For the sake of consistency between robots, put the red wires on the bottom. Bolt the gear box to the chassis using the nuts and bolts from the gear kit.

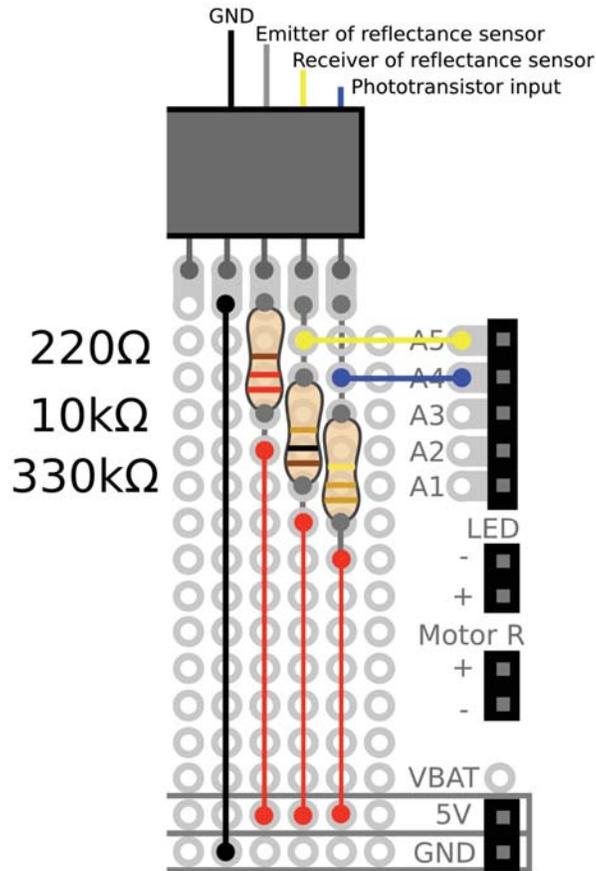
Put tires on your two wheels and mount them to the gear box.

## Wiring up the sensors

The standard robot is equipped with two different sensors: a phototransistor, and a reflectance sensor. The sensors require supporting circuitry to operate. The circuit diagrams of the phototransistor and reflectance sensor are shown below:

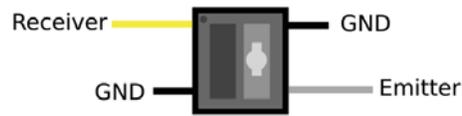


The required resistors will be soldered onto the perfboard on the top half of the robot. We recommend the following wiring strategy. You can use the leads of the resistors on the underside of the board to make some of the short connections. Take your time and get it right the first time; it's easy to goof up and fairly time consuming to redo if you make the wrong connections.

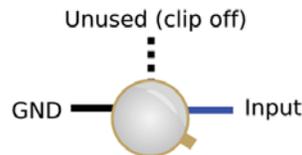


You will need to make a 4-wire cable with four male header pins at one end that connects to the female sockets at the front of the robot. The following diagram shows which pins on the sensors connect to the slots on the Mudduino. The short pins on the reflectance sensor are GND.

## Reflectance sensor



## Phototransistor



It's up to you to decide how to arrange these wires. You may wish to use some electrical tape to prevent pins from shorting. Again, it is much better to get this right on the first try. Talk to your instructor if you have any questions.

Write a short Arduino program to read the reflectance sensor on A5 and the phototransistor on A4. Look at the results and convince yourself that the sensors are wired correctly. If you have trouble, check the voltages with a voltmeter and look for shorts between pins.

## Robot assembly

You can think of the robot as a delicious sandwich: crunchy gearboxes and tangy batteries squished in between the chassis and the Mudduino. The entire thing is held together by 4 bolts, one on each corner.

Attach the ball caster to the front of the robot. Place the thicker black plastic standoff between the caster and the chassis to level the robot. The holes are slightly too small for the screws, so the process of screwing them in will cut threads in the chassis.

Finally, add the battery and Mudduino. Make sure that the battery cable is coming out in a convenient location. Tighten the back two screws to hold everything together. Tighten the front screws as well, but not too much - if they are too tight, the front of the chassis will bend upwards.