

Complete ProtoBot Build Guide

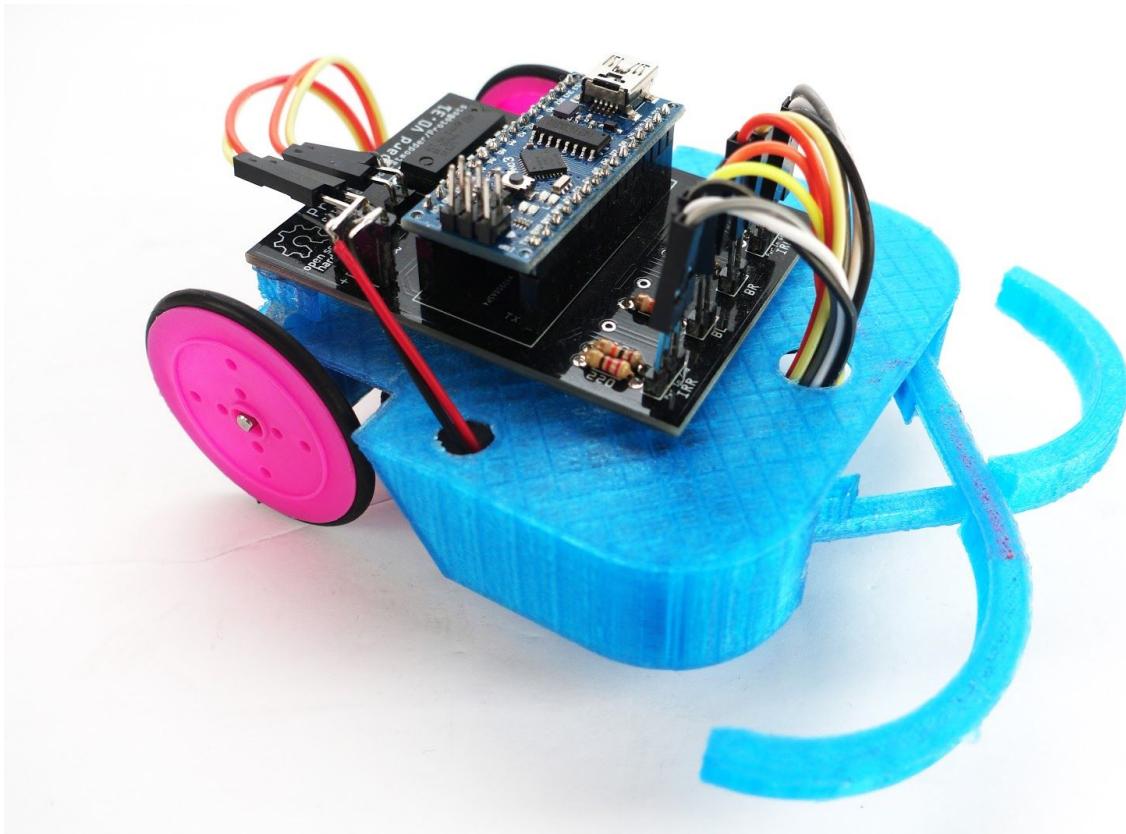


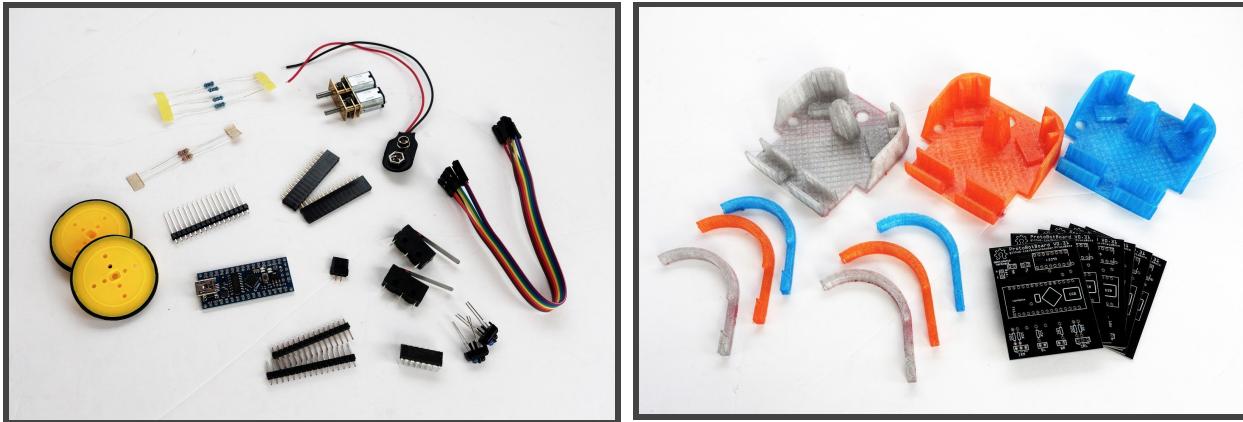
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Parts list:



- 1 x ProtoBotBoard
- 1 x Arduino Nano
- 2 x N20 Gear Motors
- 2 x Plastic Wheels (39MM Diameter, 3MM diameter inner hole)
- 2 x Tactile limit switches (30ish MM levers preferred, to fit Antennas on)
- 2 x TCRT5000L IR Sensors
- 1 x 3D Printed base piece
- 2 x 3D Printed Antenna pieces
- 4 x 3D Printed ProtoBotBoard Supports
- 1 x 9V Battery clip
- 1 x 9V Battery
- 1 x length of "Hook and loop" fastener (Such as Velcro), about as long as the battery
- 7 x DuPont Female-Female 20CM jumper wires
- 2 x 220 Ohm resistors
- 4 x 10K Ohm resistors
- 1 x L293D Motor Driver chip
- 1 x 16-pin length of 10MM male header pins
- 2 x 15-pin length of female header pins
- 1 x 2-pin length of female header pins

The STL Files for the ProtoBotBoard and the PCB Gerber, SVG, and PDF files can be found at the ProtoBots Github:

<https://github.com/Bobcatmodder/ProtoBots>

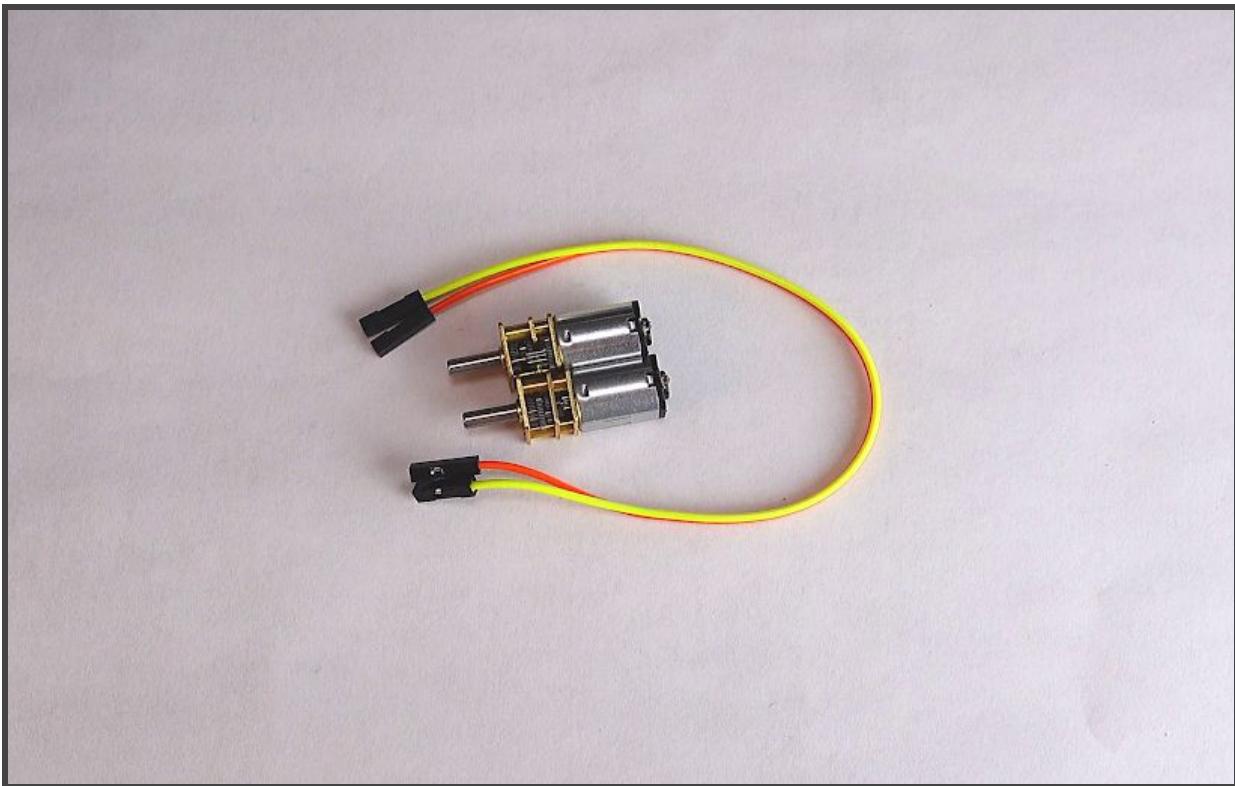
Components can be sourced on eBay, Amazon, or your preferred online retailer. The GitHub also has a parts list with eBay links.

Tools list:



- Fine tip soldering iron
- Solder
- Wire cutters (Not combo strippers)
- Wire strippers
- Pliers
- Brass wool (or sponge, for cleaning soldering iron)
- Solder sucker
- Masking tape
- Hot Glue
- Helping hands (Not necessary, but nice)

Motors:



You will need:

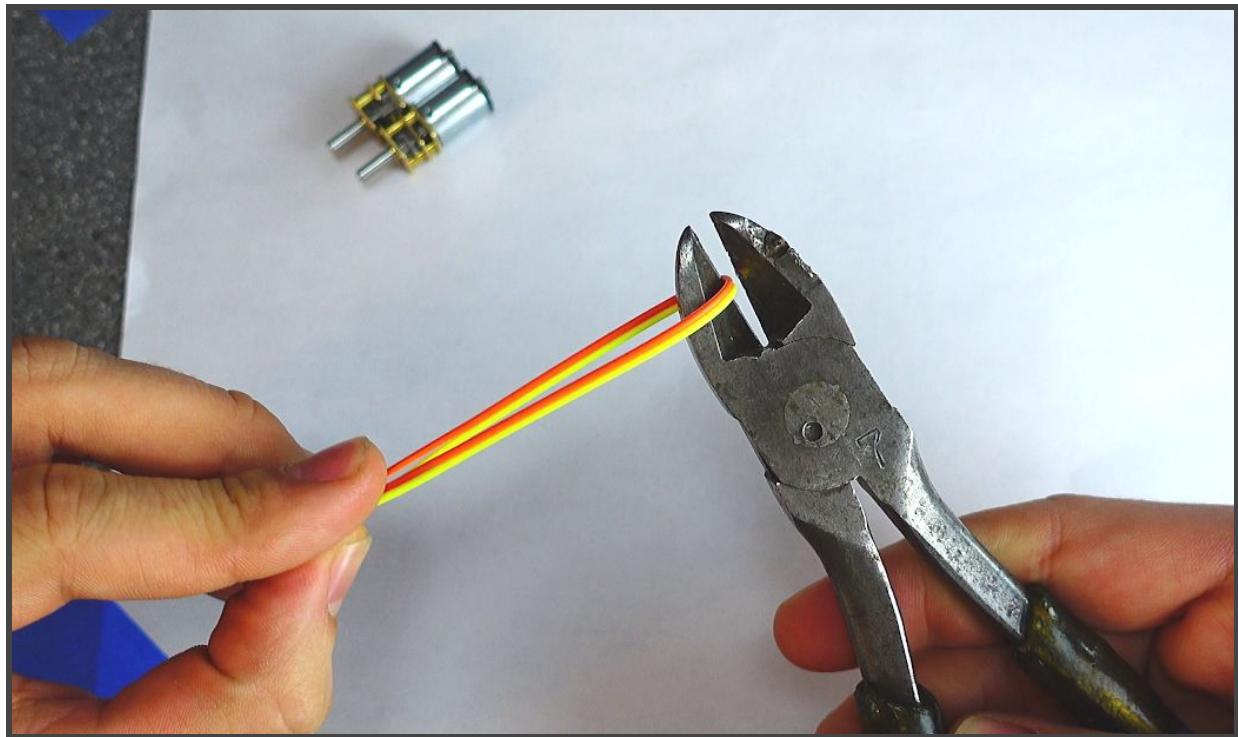
Parts:

- 2 x N20 Gear motors
- 1 set of two DuPont Female-Female jumper wires

Tools to set up:

- Wire cutters/Strippers
- Soldering Iron
- Helping Hands, or something to hold the motors in place. (I used foam and tape)
- Hot Glue gun

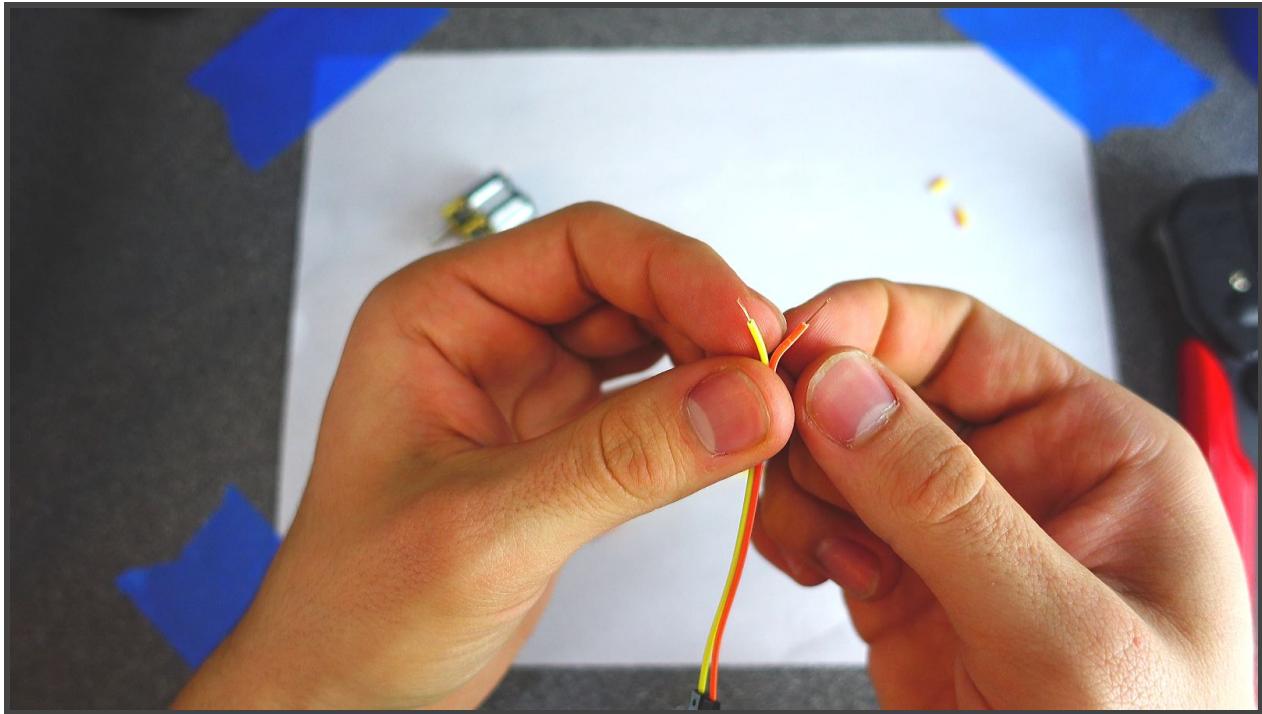
Note: A ventilated workspace is best for soldering. A small fan with a low speed setting works great. As for a worksurface, tin foil taped to a plastic, paper, or cardboard sheet that is attached to your workspace works well.



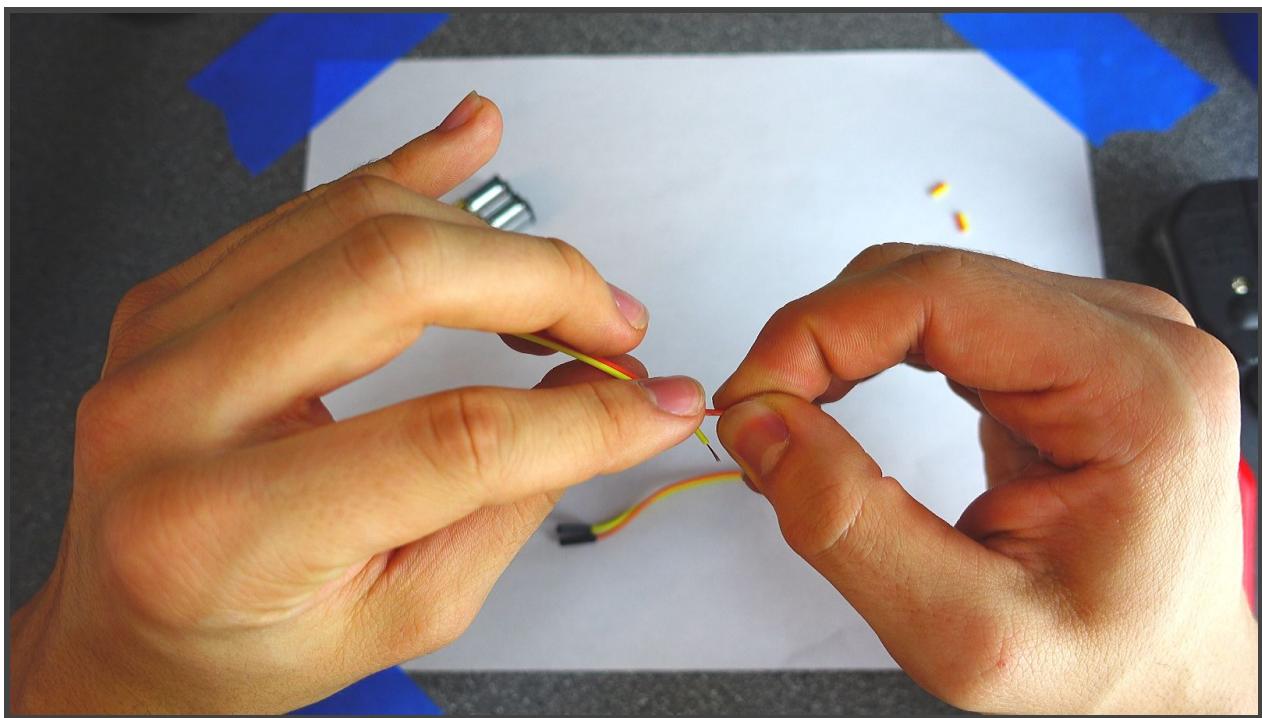
- Take your pair of wires, and cut them in half down the middle



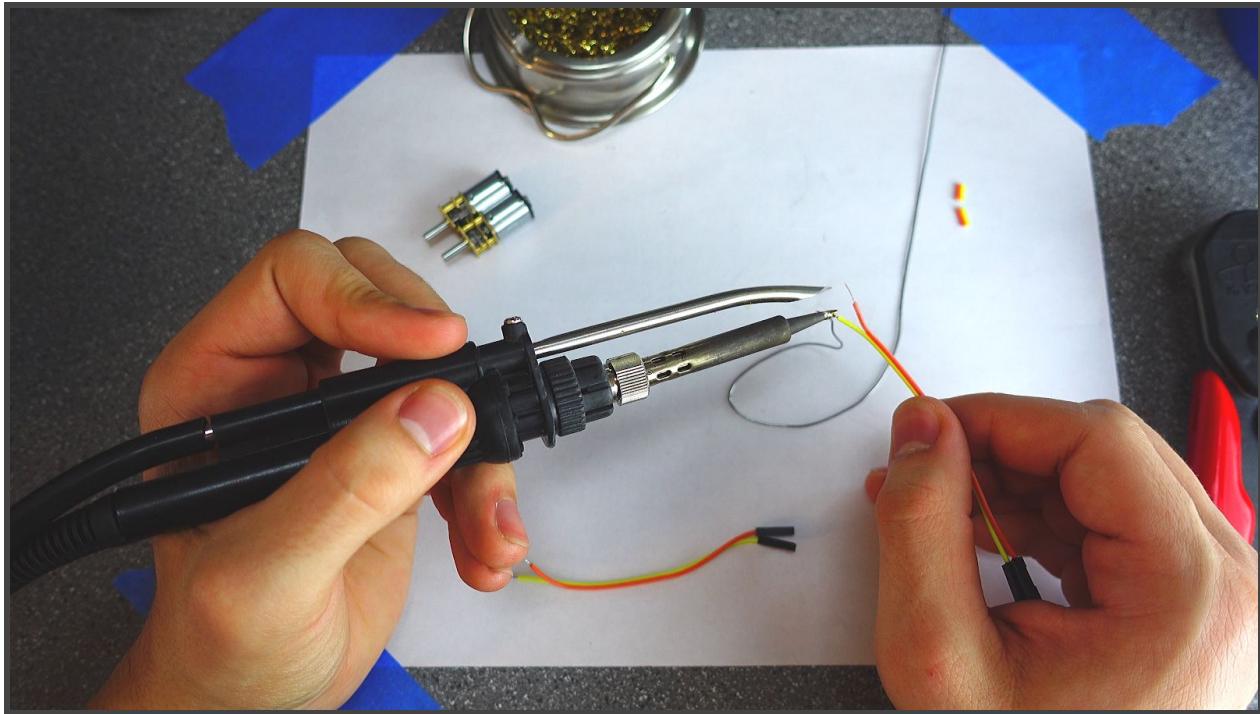
- Use your wire cutters to strip about 5MM or $\frac{1}{4}$ " off the ends of each set



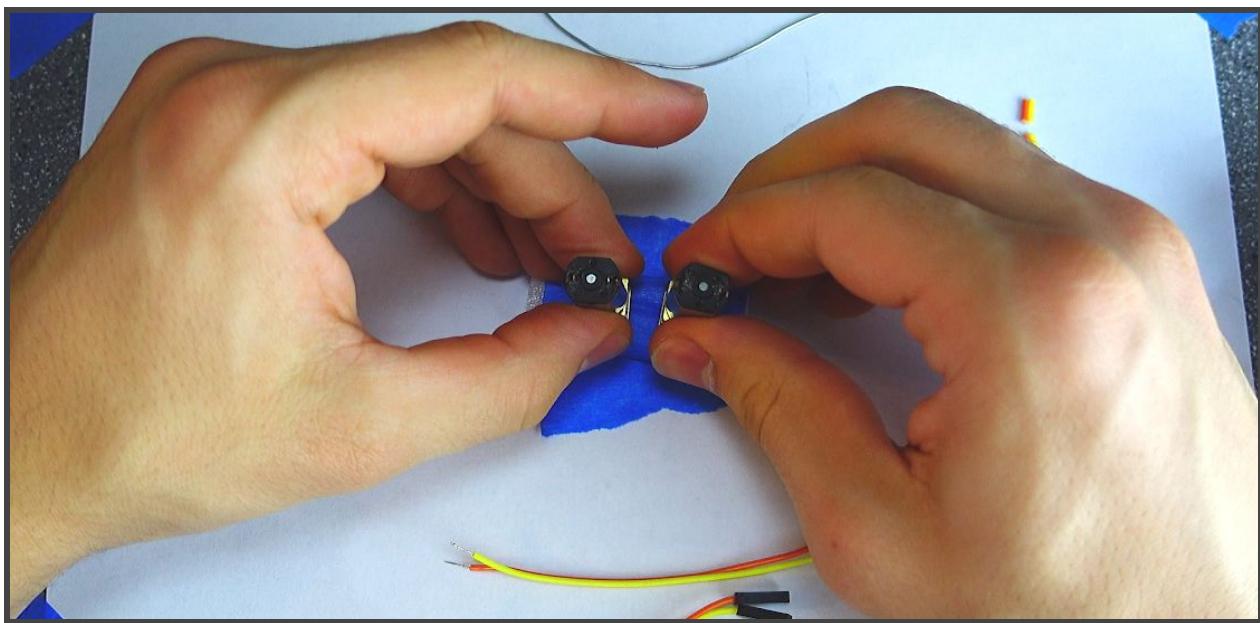
- Split the ends apart



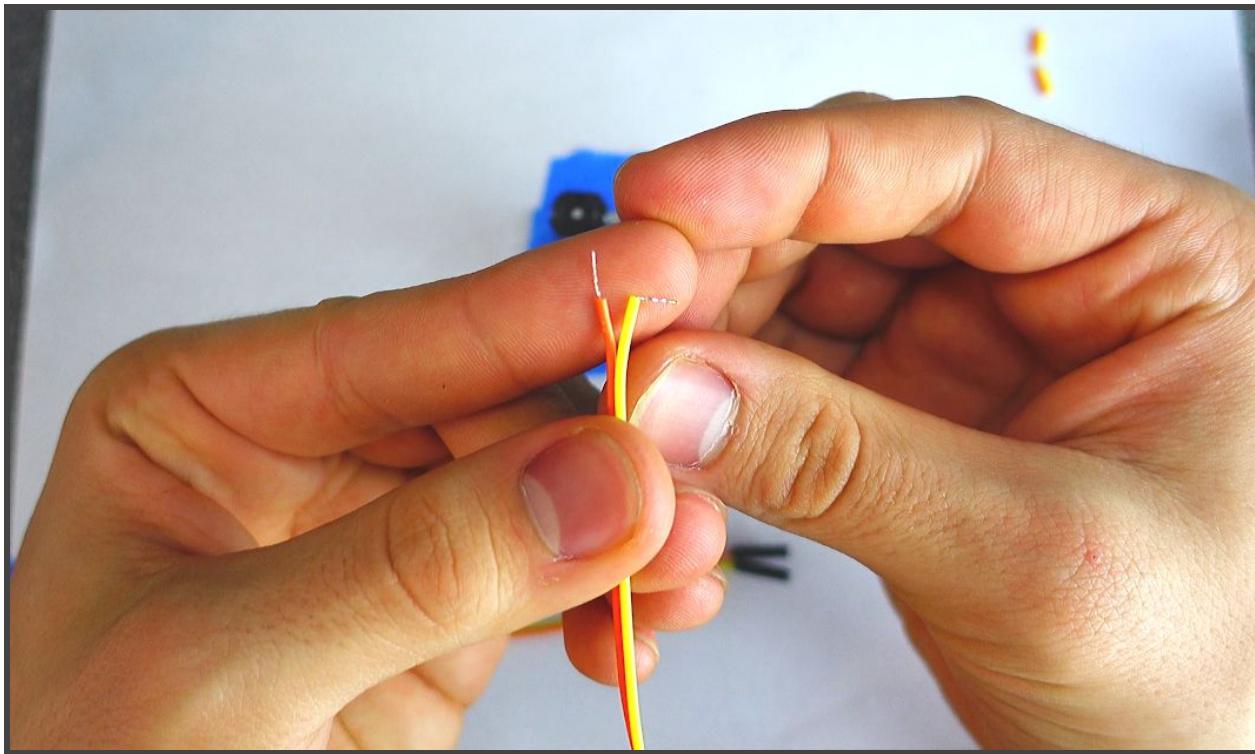
- Twist the strands of each wire end together, so that they stay tidy



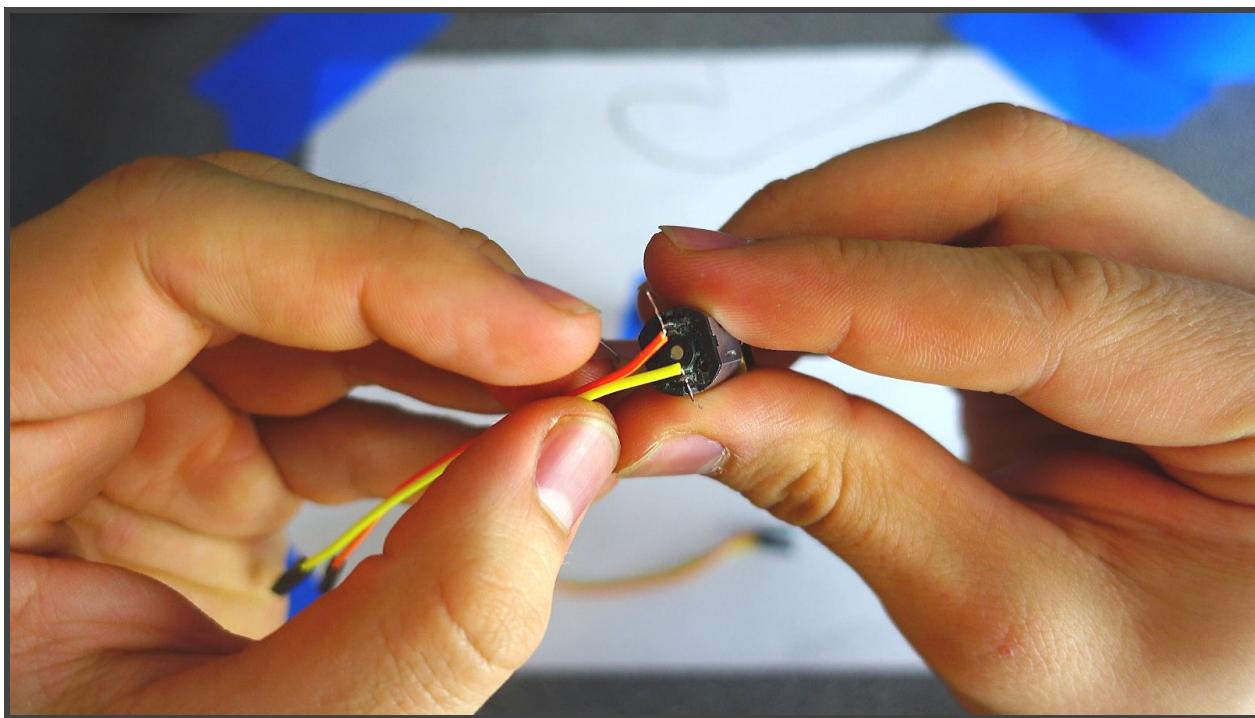
- Tin each wire end, by holding them on top of the solder, then applying your iron's tip



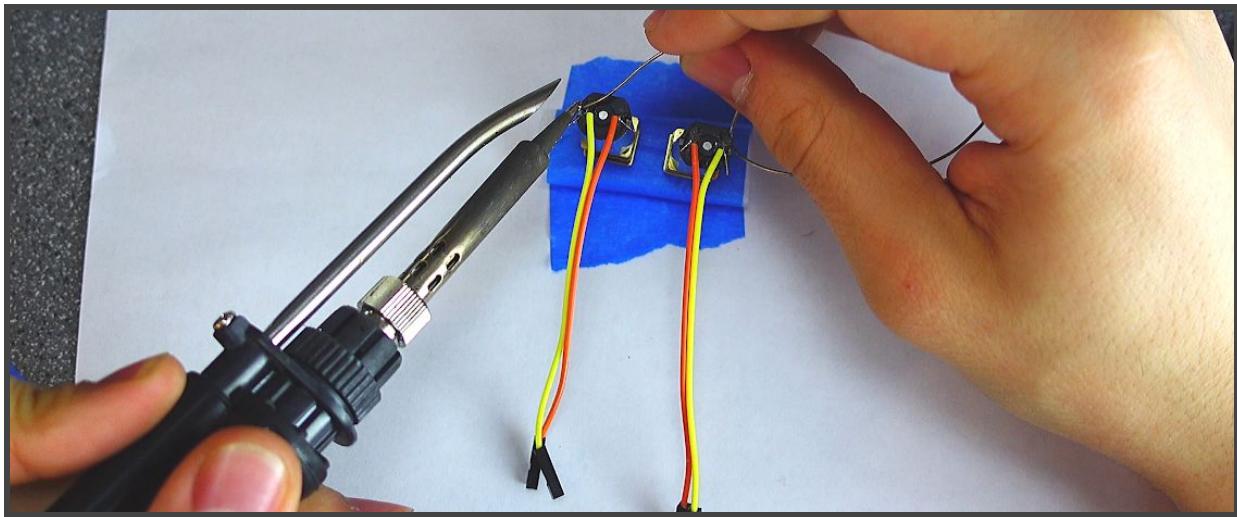
- Secure the motors somehow. I used a piece of foam with tape to hold it in place.



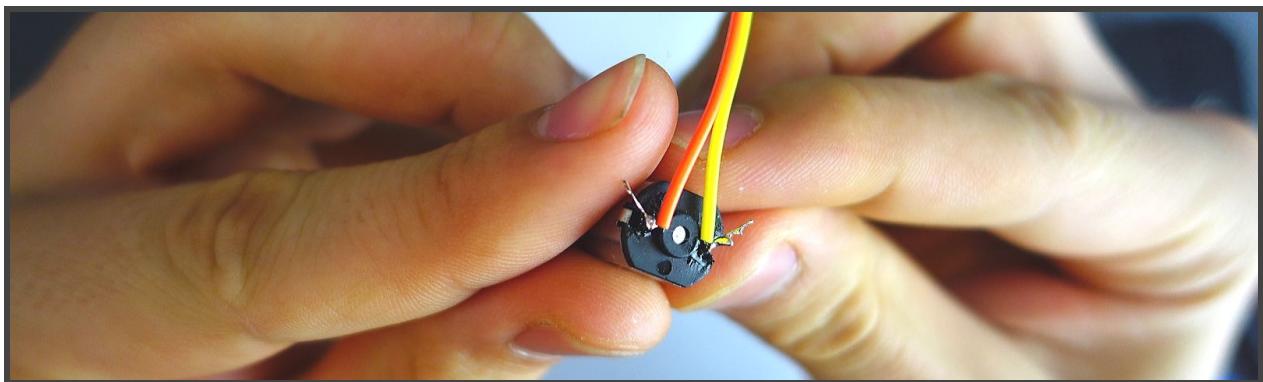
- Bend the wire ends at a 90 degree angle, so that they're 180 degrees apart



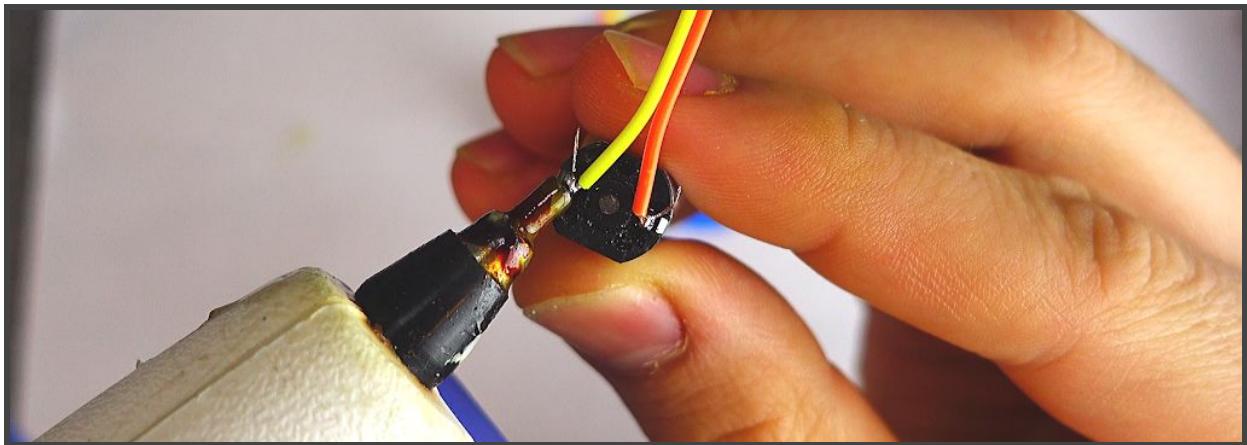
- Insert the wire ends into the holes in the metal connection tabs on the motors



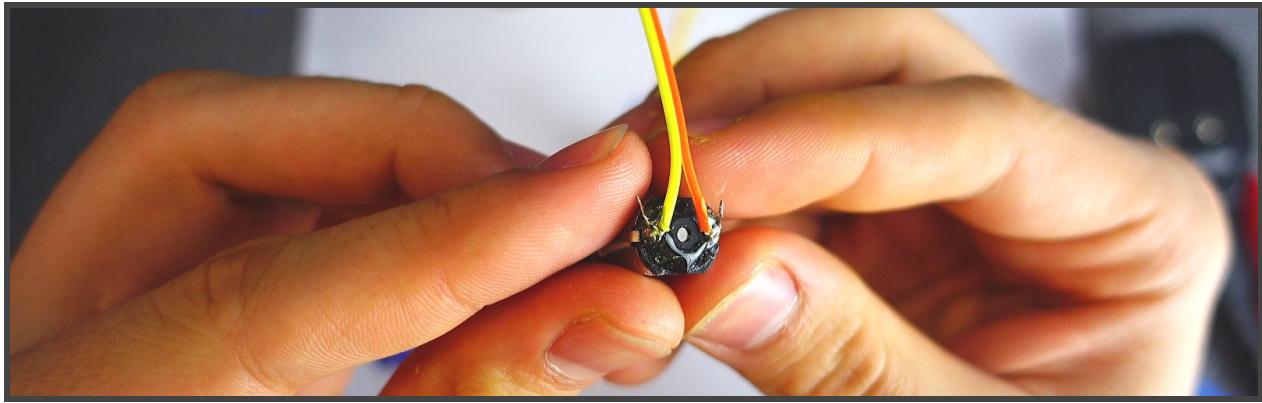
- Solder the wires to the motors



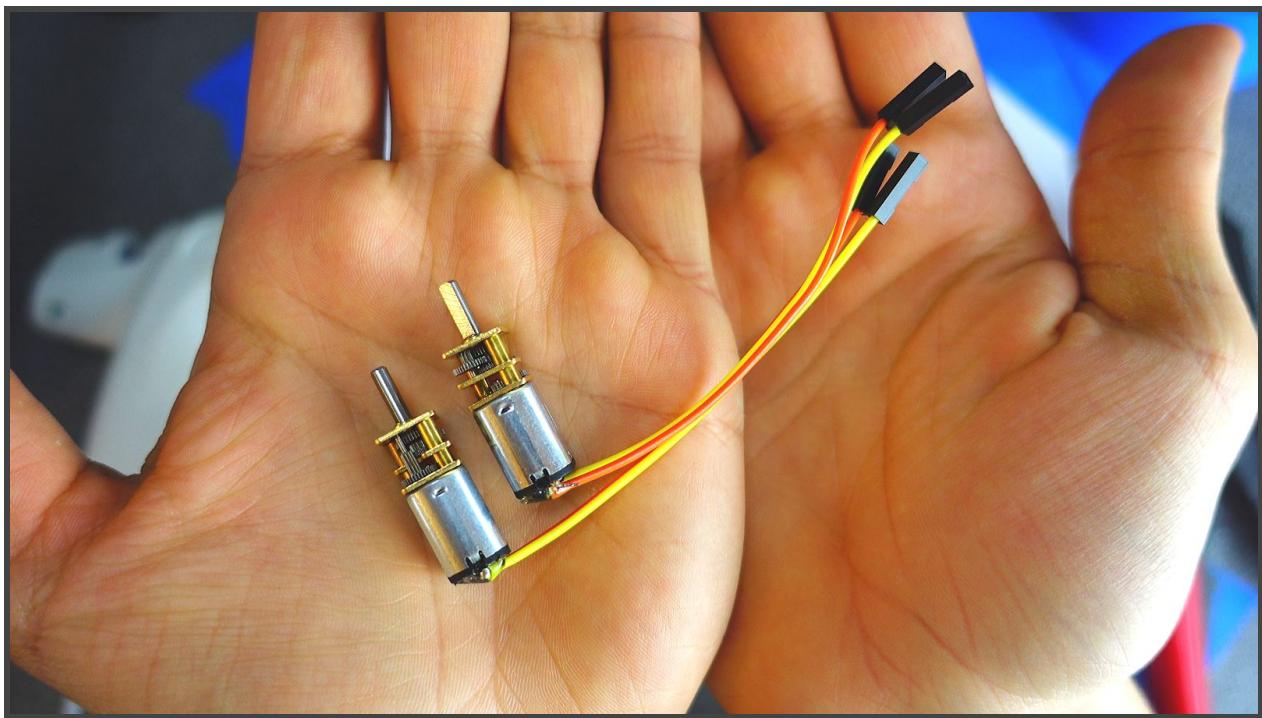
- When you're done, each motor should look like this



- Use your hot glue gun to put a generous dab of hot glue on each joint

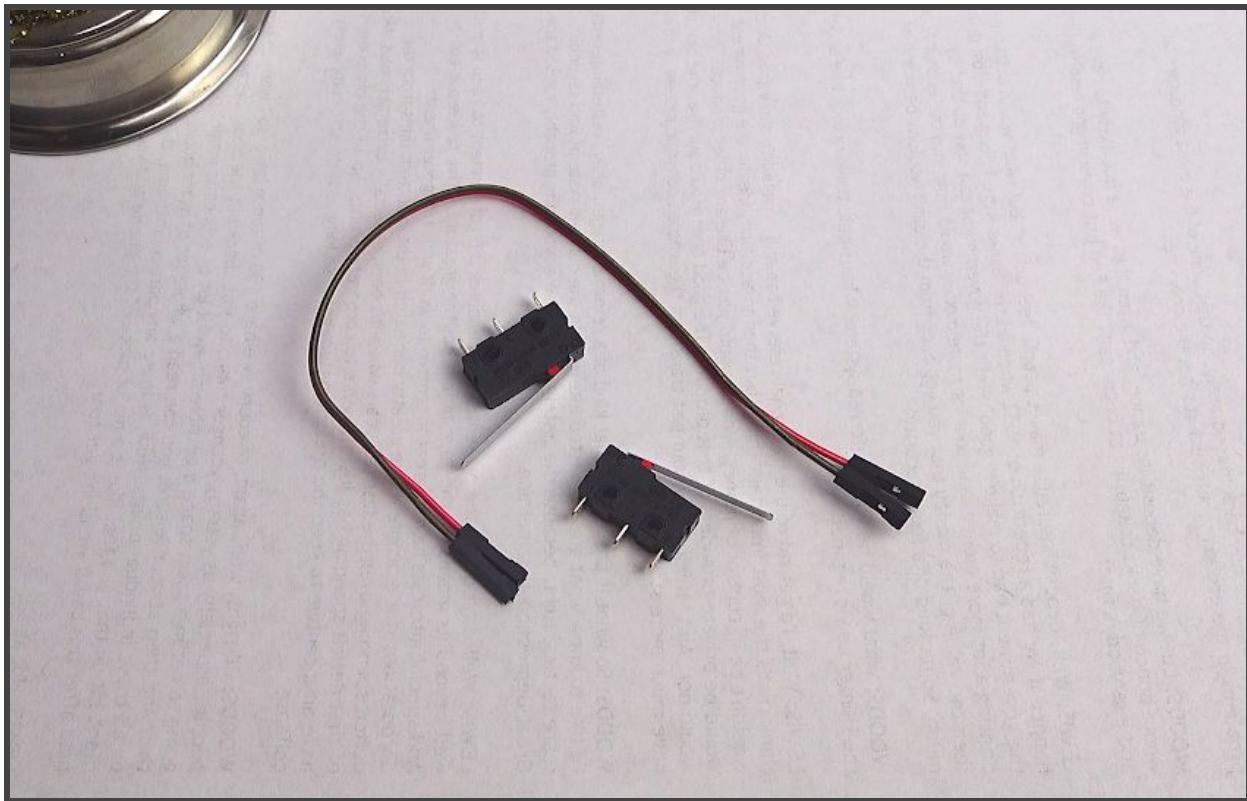


- When you're done, each motor should look like this



Your motors are now ready to be used on a Probot!

Bump Sensors:



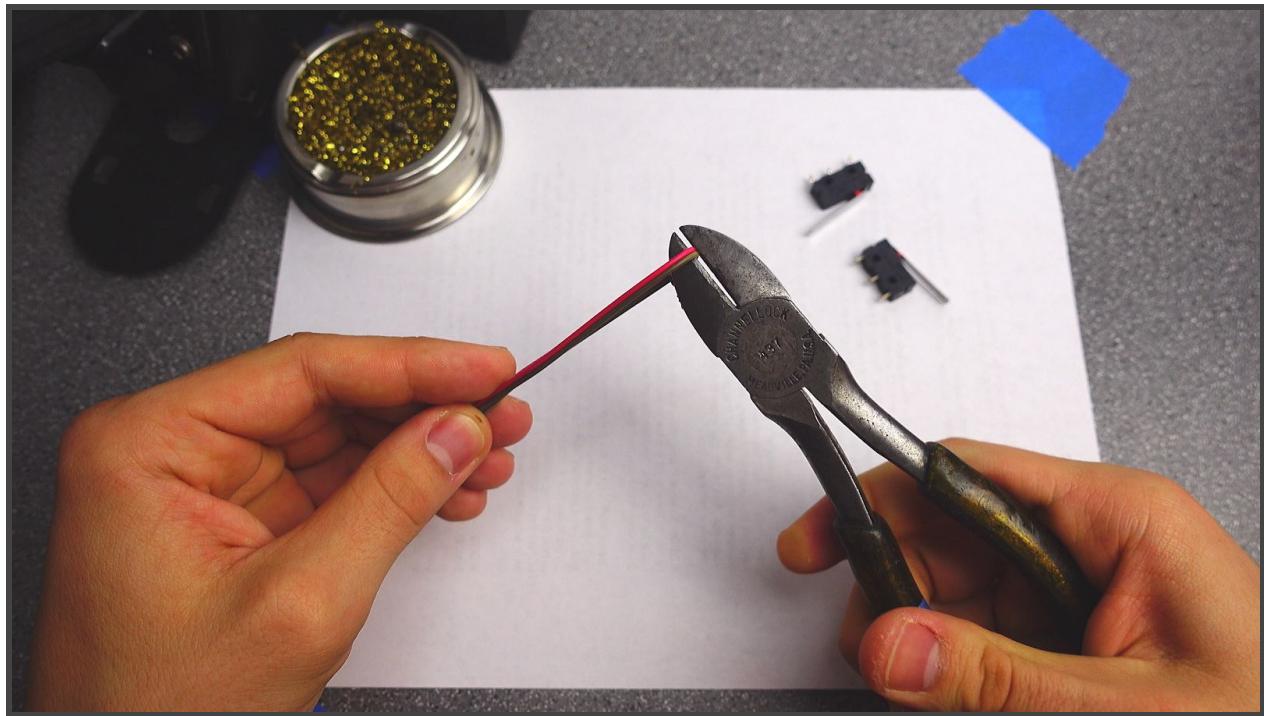
You will need:

Parts:

- 2 x Limit Switches
- 1 set of two DuPont Female-Female jumper wires

Tools to prepare:

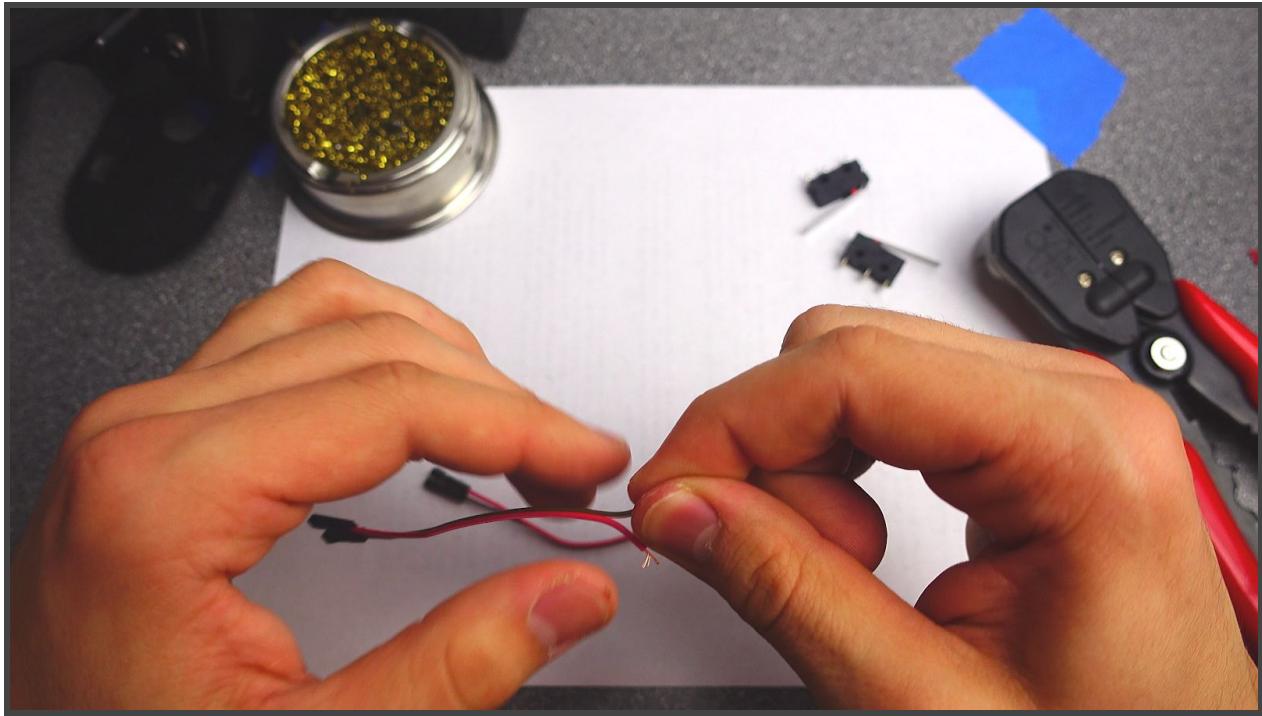
- Wire cutters
- Wire strippers
- Soldering Iron
- Helping Hands, or something to hold the bump sensors in place (I used tape)



- Cut your pair of wires in half



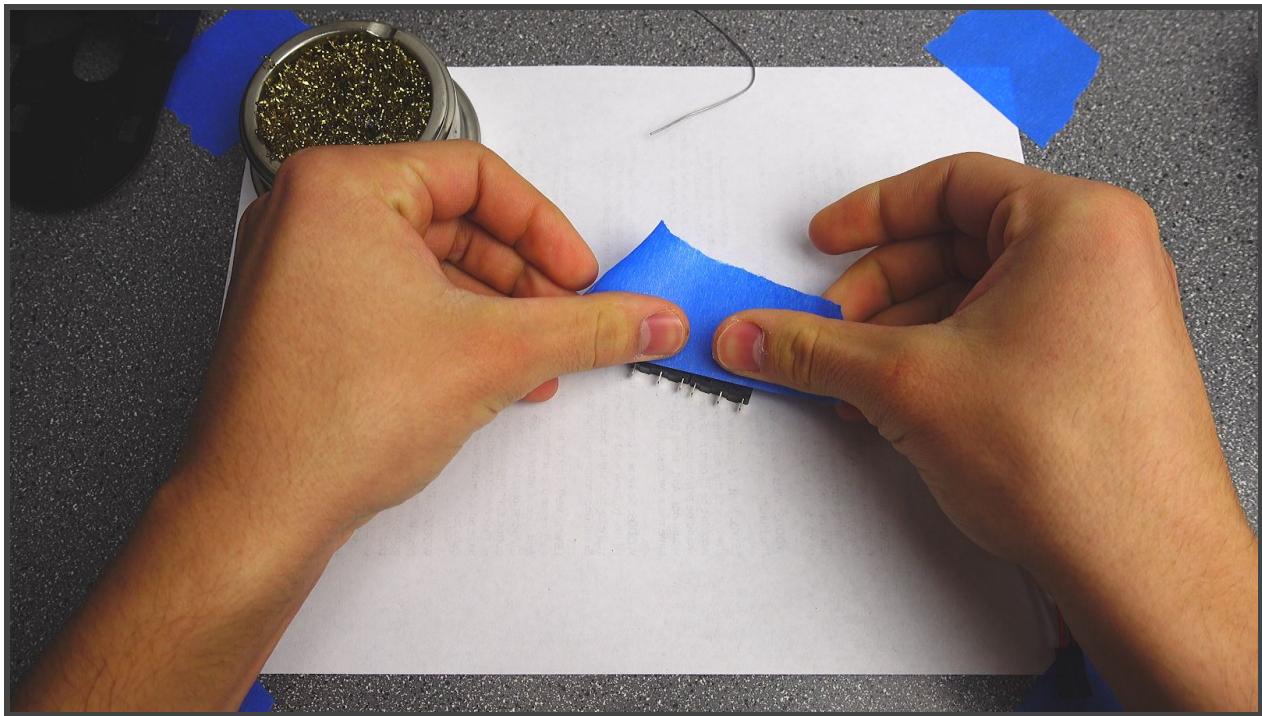
- Use your wire strippers to strip about 5MM or $\frac{1}{4}$ " insulation off the ends



- Split the ends apart, then twist the loose strands on each wire end together



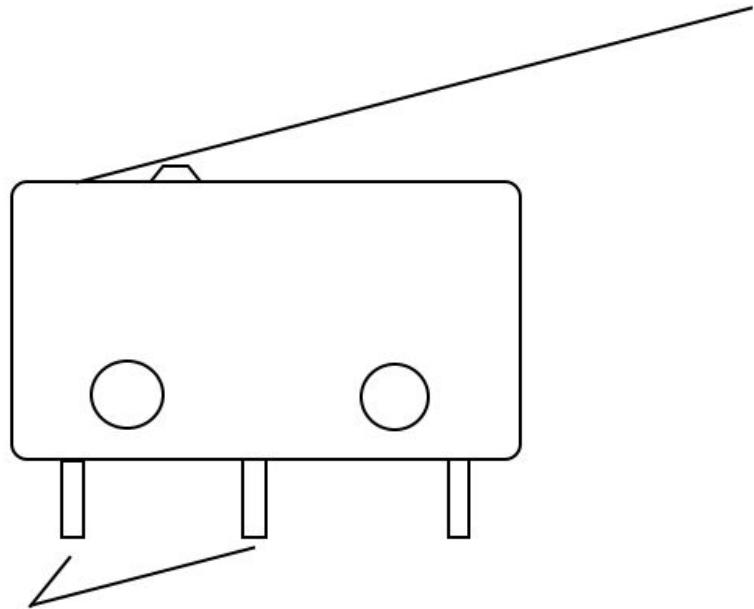
- Tin the wire ends, by holding them over the solder, then applying your tinned iron tip



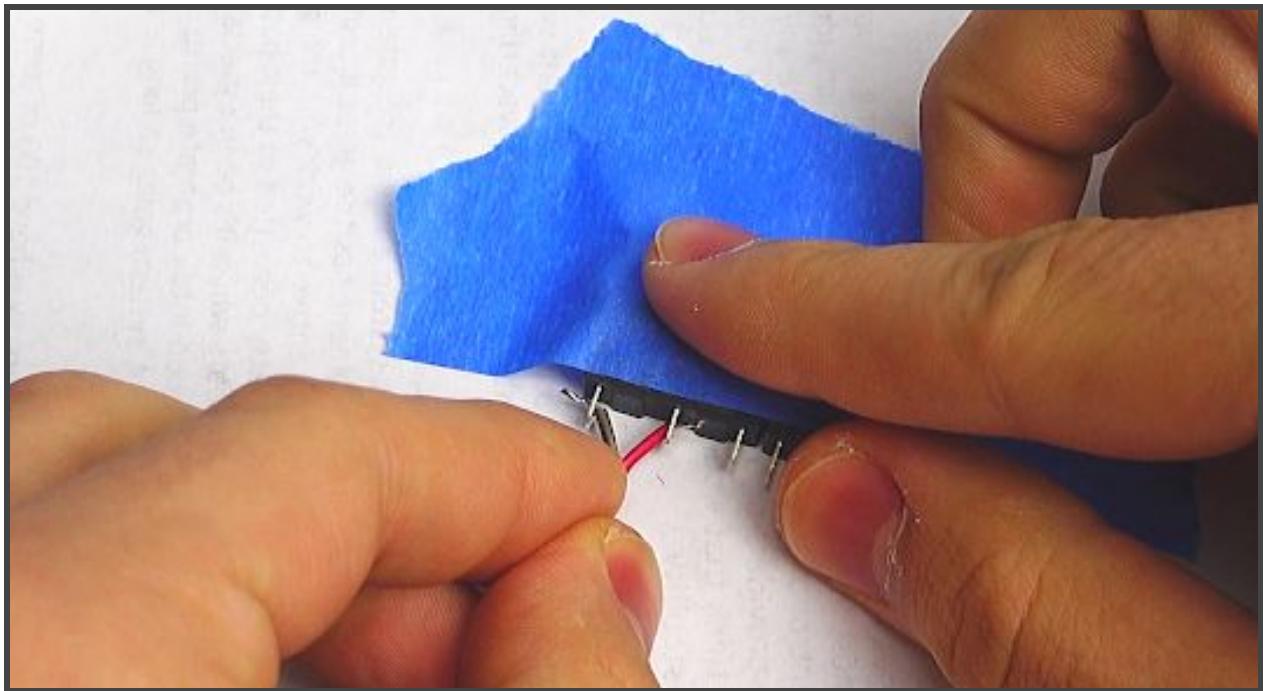
- Secure the sensors so they won't move around



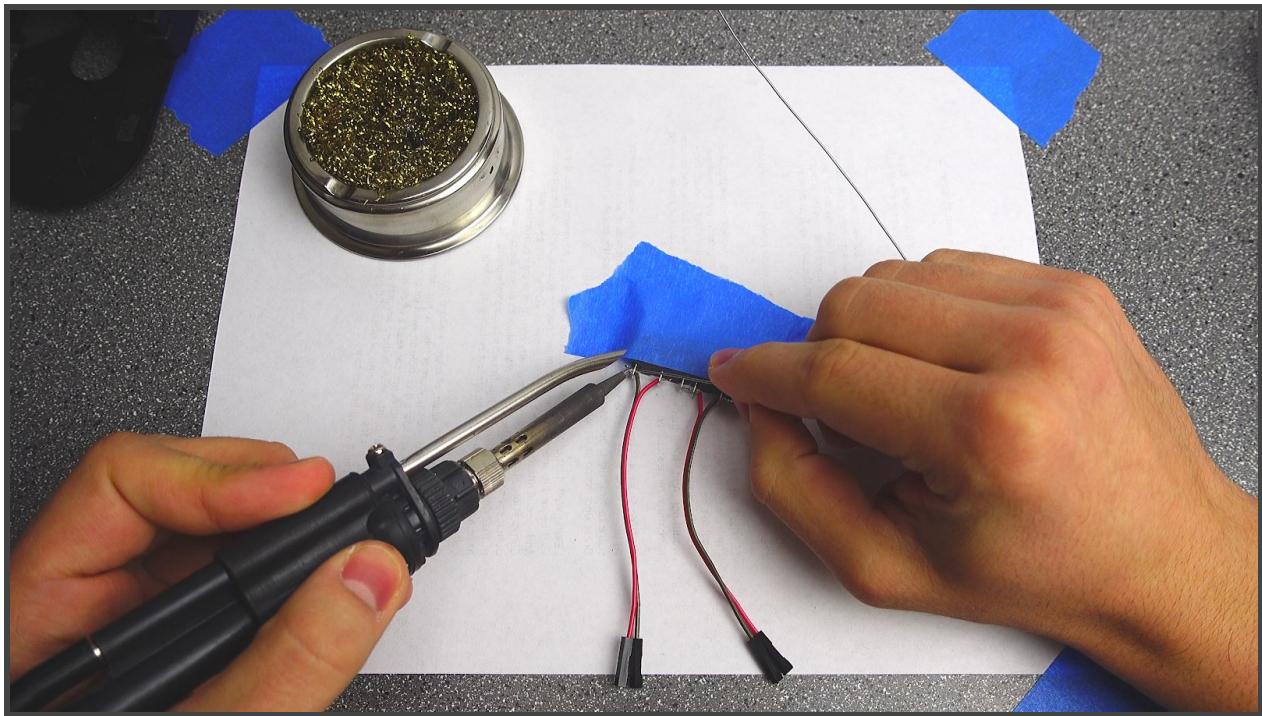
- Bend the tinned ends of each wire so the wires are 180 degrees apart from each other



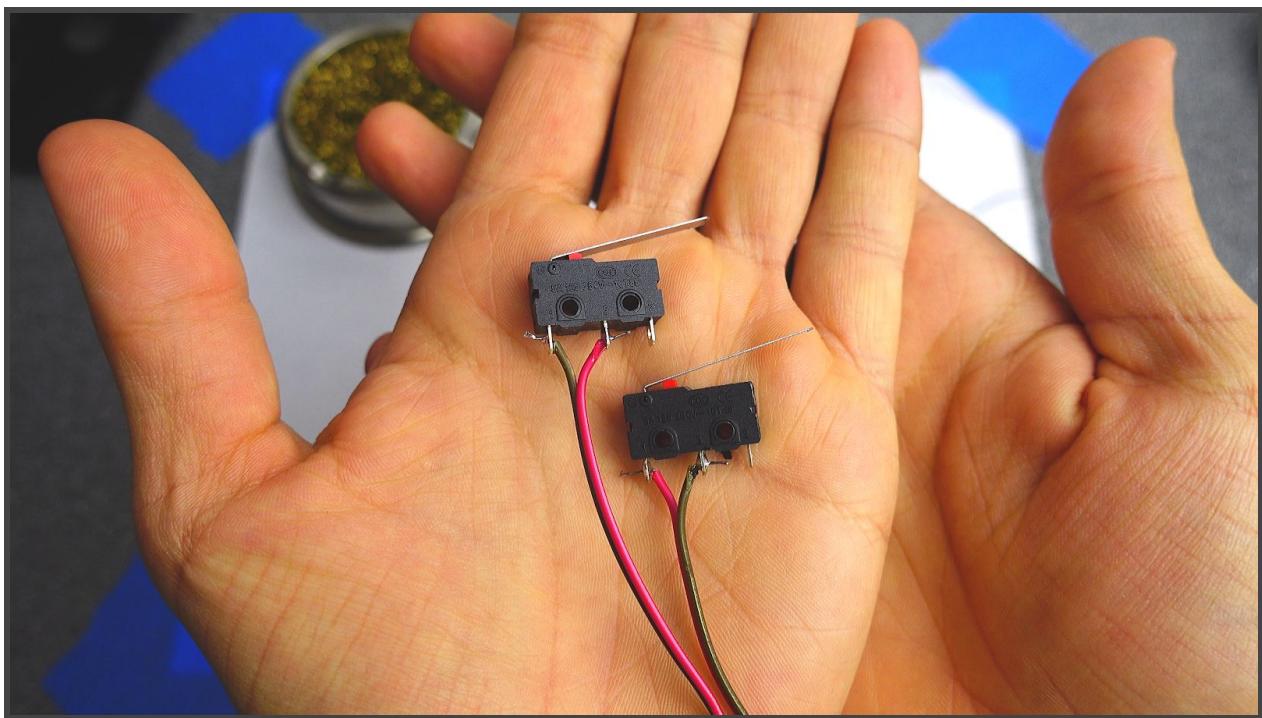
Wires connect to these two connections



- Insert the wires into the correct metal tabs on each of the sensors, as shown.

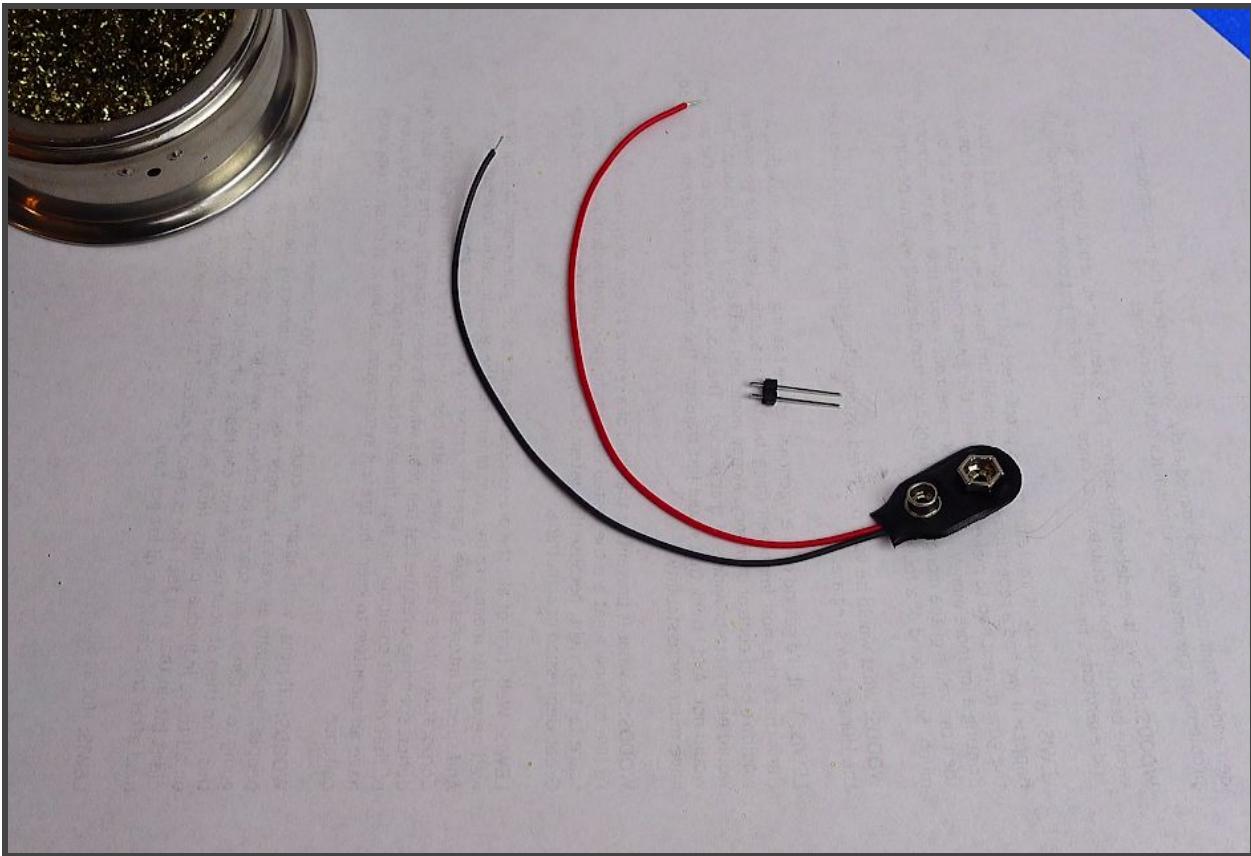


- Solder each of the wires to the metal tabs



Your bump sensors are now ready to be used on a ProtoBot!

9V Battery Lead:



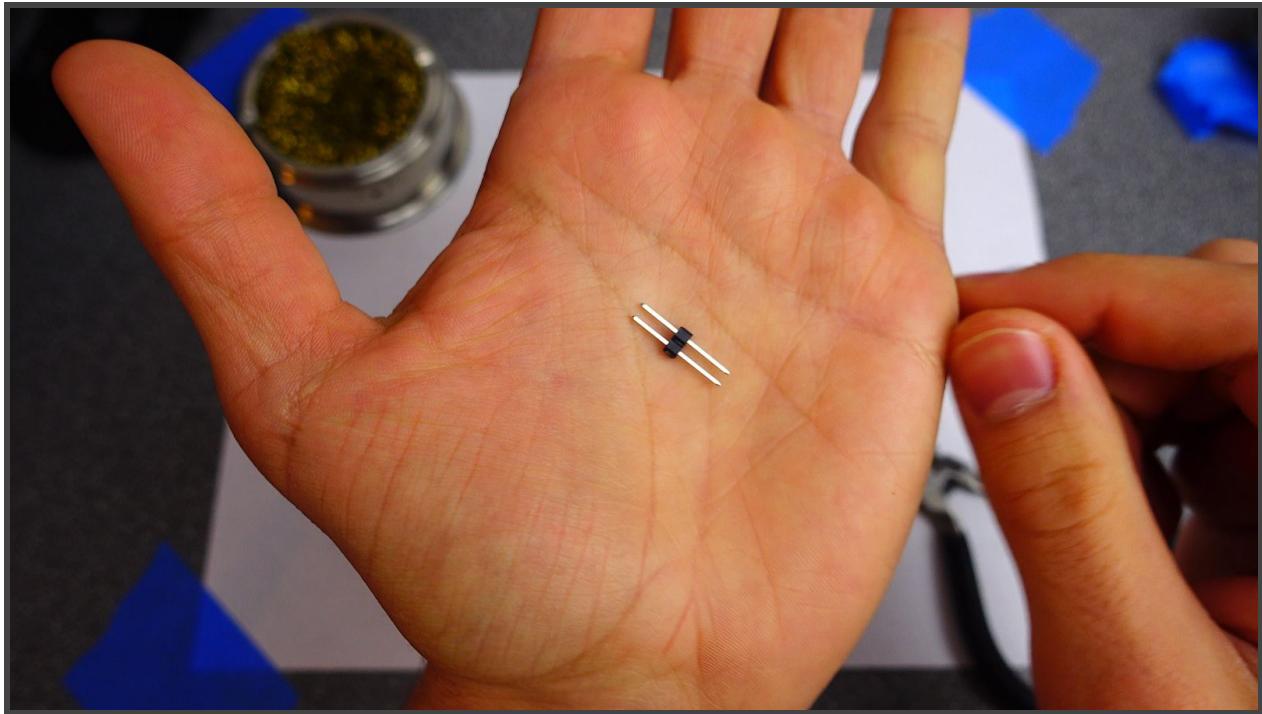
You will need:

Parts:

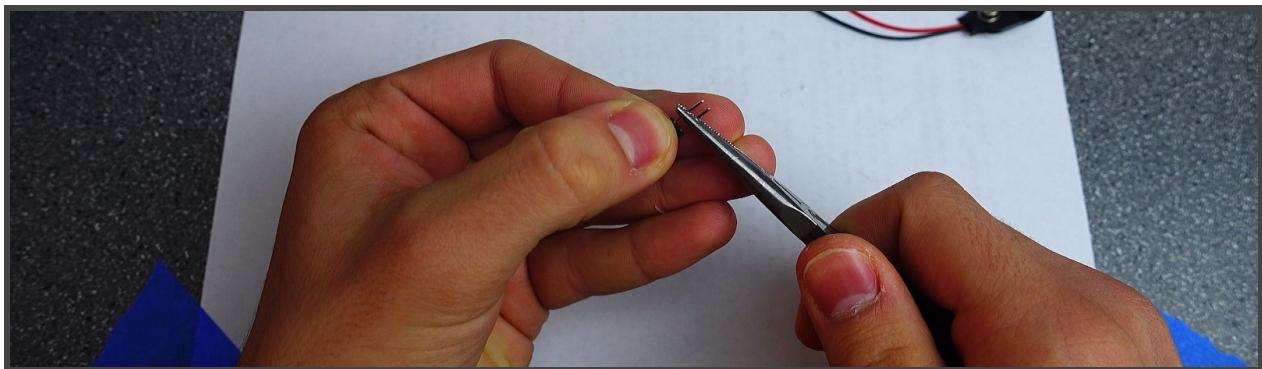
- 1 x 9V battery cable
- 1 x 2-pin length of male pin headers

Tools to prepare:

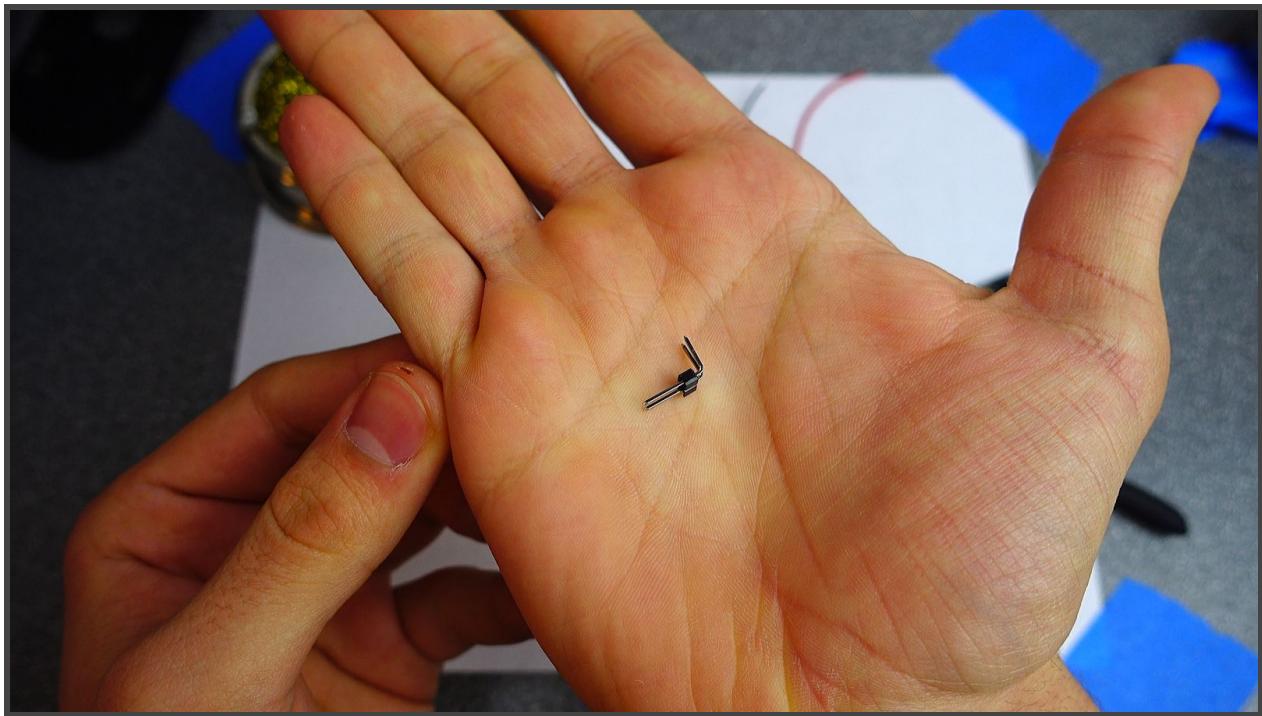
- Soldering Iron
- Helping Hands, or something to hold the cable in place (I used foam and tape)



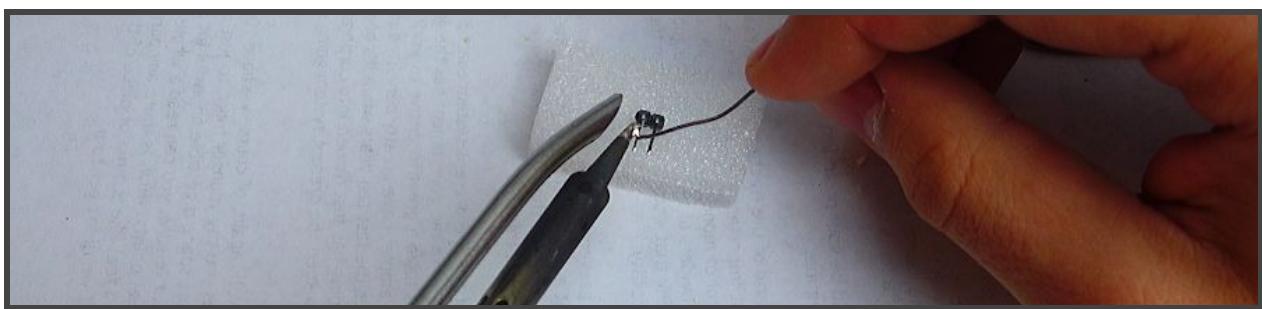
- Take the plastic piece that holds the pins together, and push it down to the middle of the pins



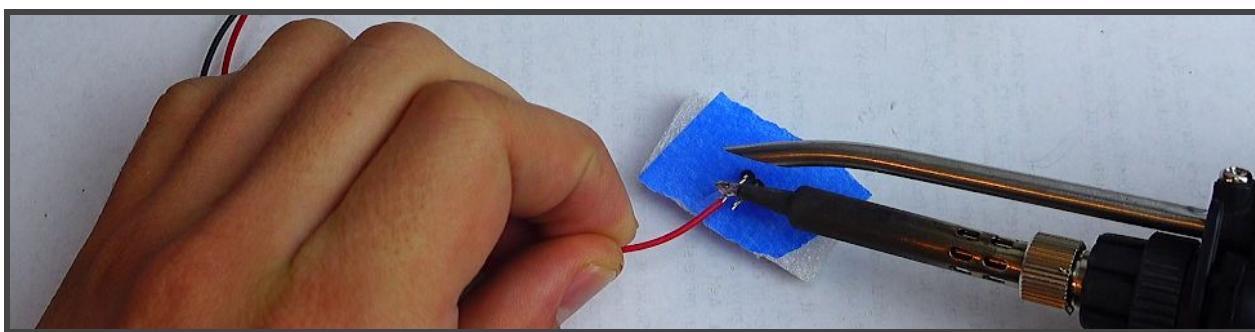
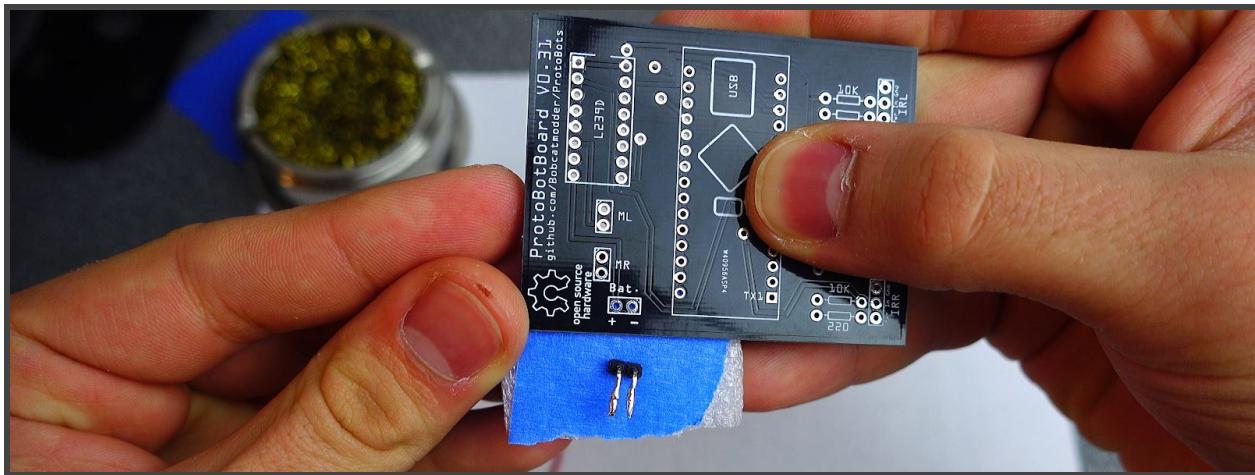
- Bend the pins on one side at a 90 degree angle



- When you're done, the pins will look like this



- Secure the pins, so they don't move around, then tin them, by applying the soldering iron tip to the pins, then applying solder.

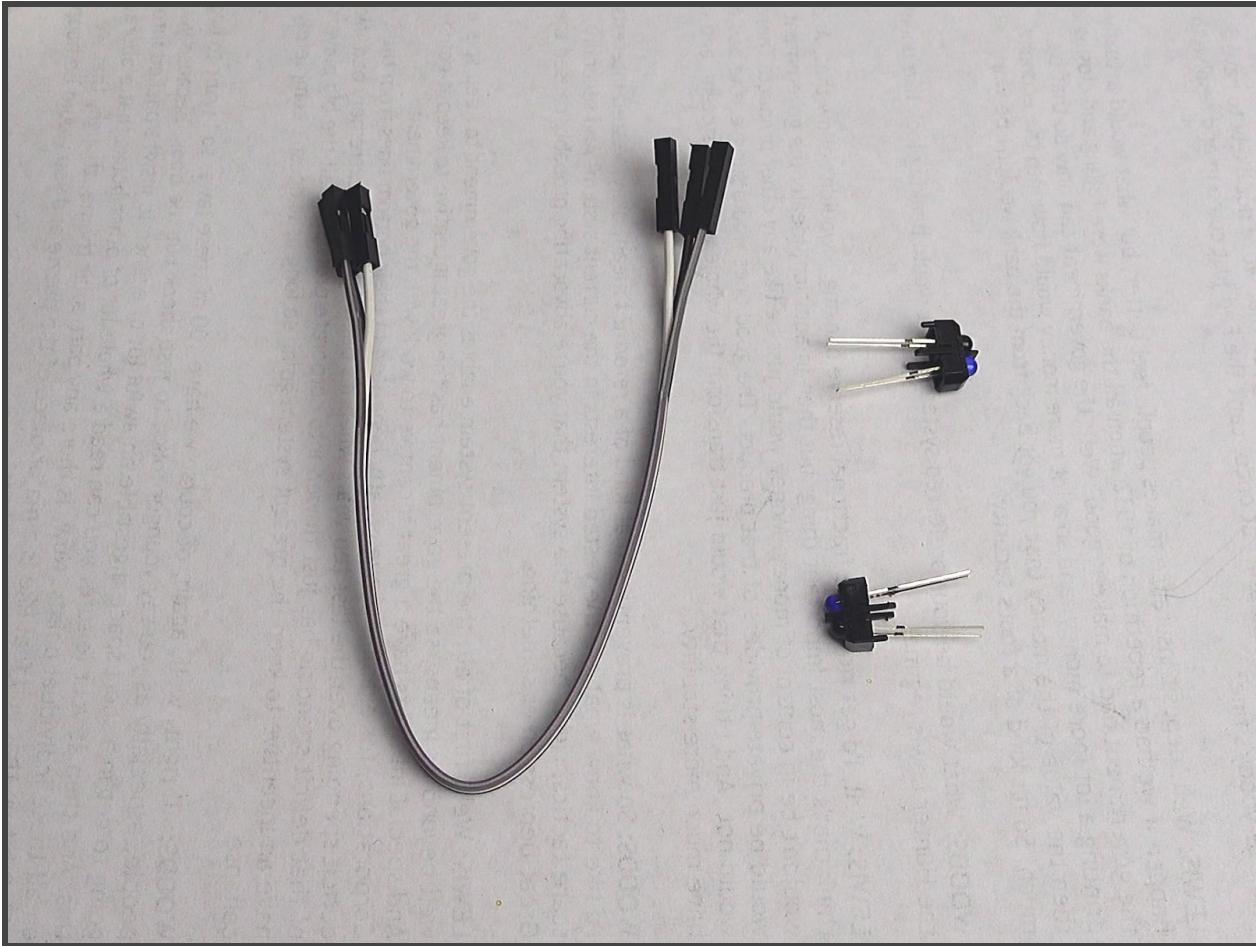


- Using the board as reference, solder the positive wire (red) to the correct pin, then solder the negative wire (black) to the other pin



Your 9V Battery clip is ready to use!

IR Sensors:



You will need:

Parts:

- 2 x IR Sensors
- 1 set of two DuPont Female-Female jumper wires

Tools:

- Wire cutters/Strippers
- Soldering Iron with Fine tip
- Helping Hands, or something to hold the bump sensors in place (I used tape)



- Use your wire cutters to cut the set of jumper wires in half



- Strip about 5MM or $\frac{1}{4}$ " insulation off the wire ends

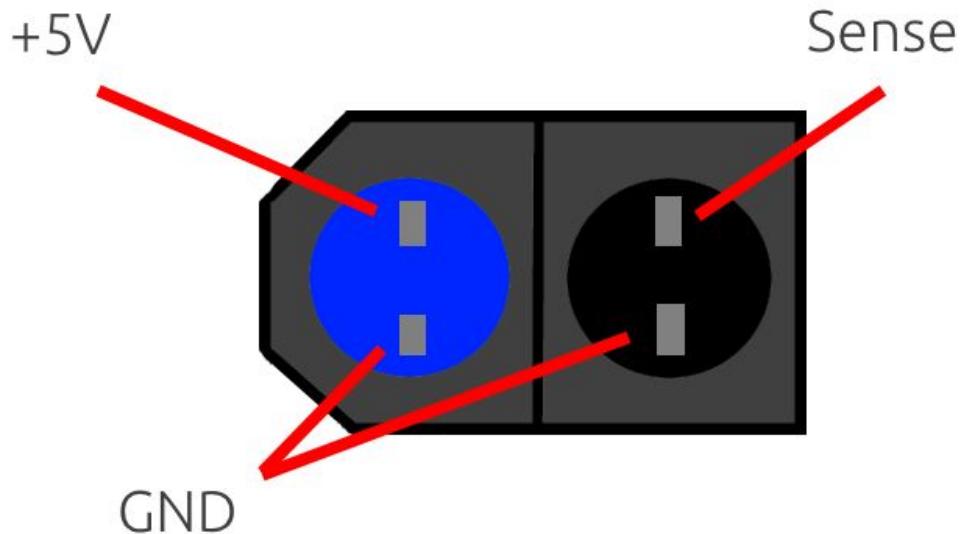


- Tin the wires by holding them on top of the solder, then apply your tinned iron

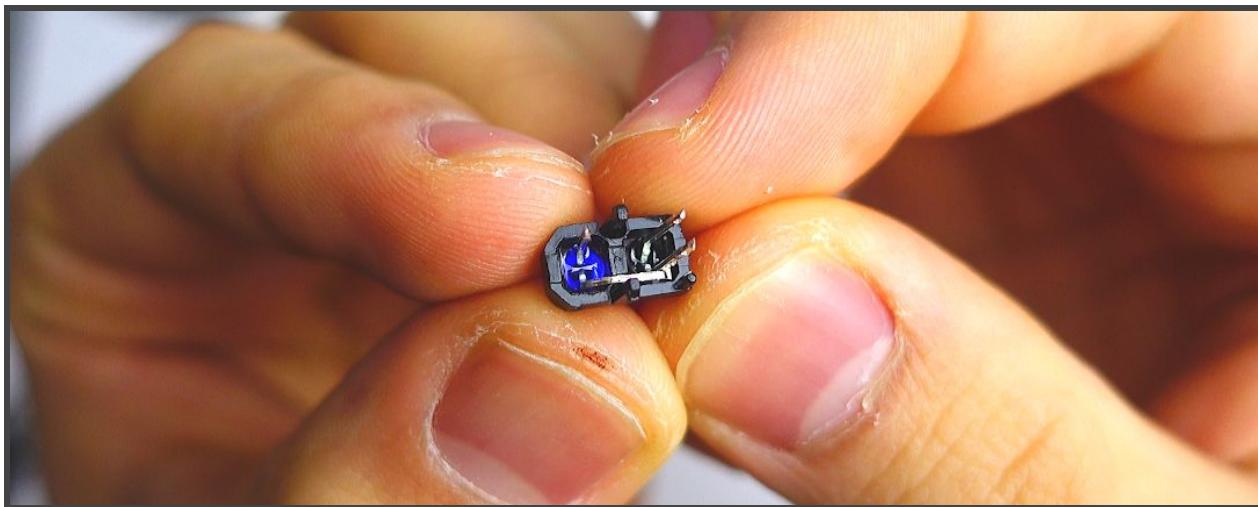


- Use your wire cutters to cut most of the leads off the IR Sensors, leaving about 5MM or $\frac{1}{4}$ " leads exposed from the plastic sensor body

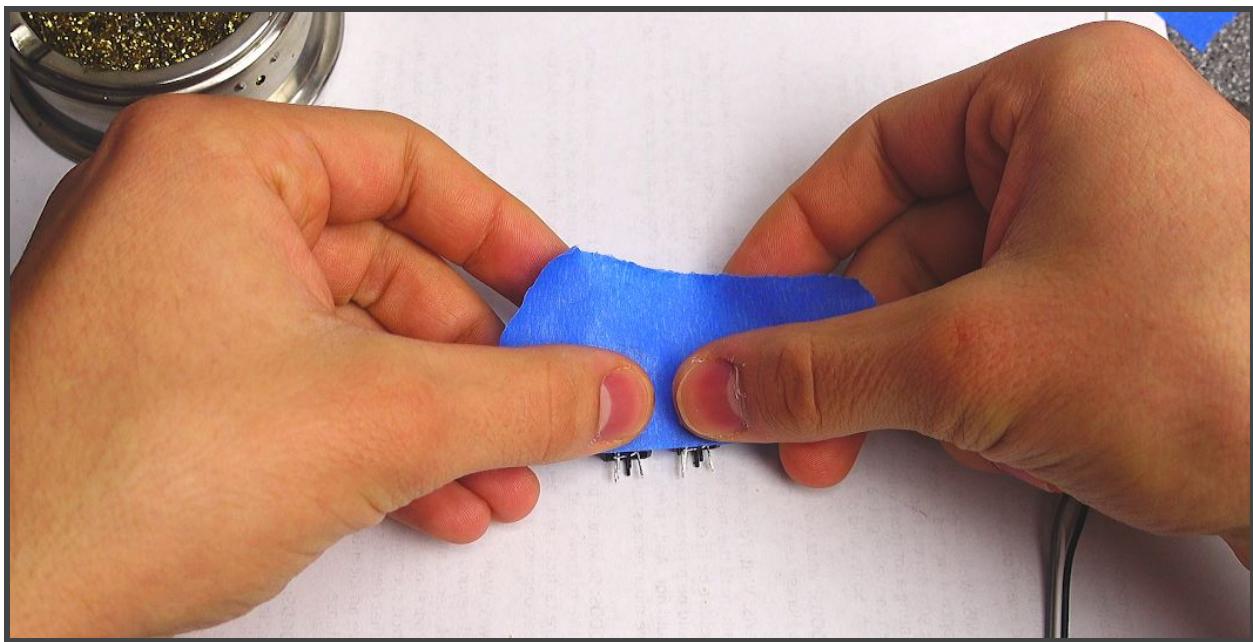
TCRT5000L IR Sensor - Pinout from Underside



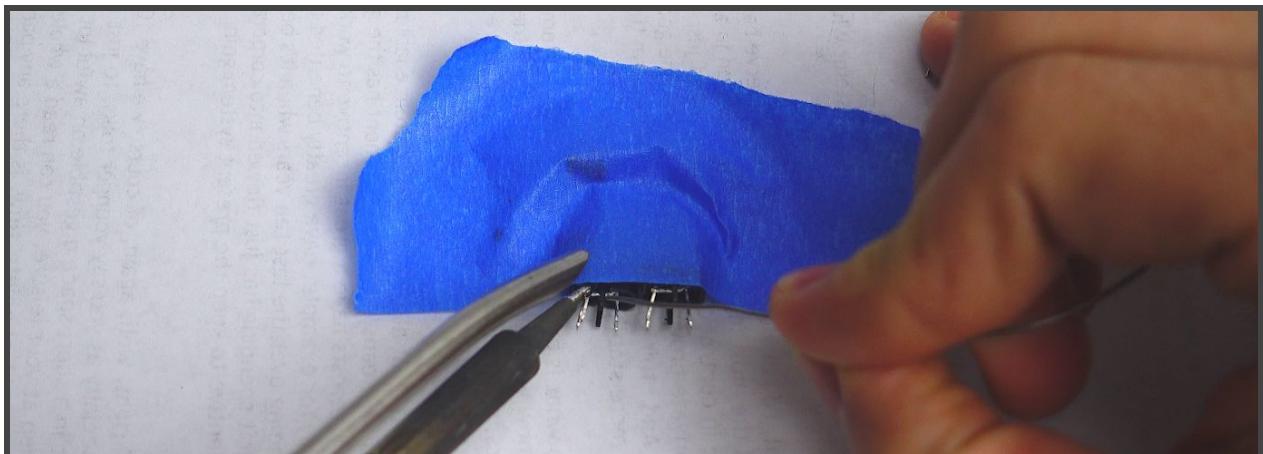
To use the sensor, connect both GNDs to Ground, then connect +5V to 5V through a 220ohm resistor. The sense pin connects to an analog Read pin on your microcontroller, with an additional 10K resistor between that and 5V. The higher the returned value, the less light is being receiving by the receiver.



- Orient your sensor as shown in the diagram above
- Bend the GND lead of the blue IR LED over to touch the GND lead on the black receiver LED.



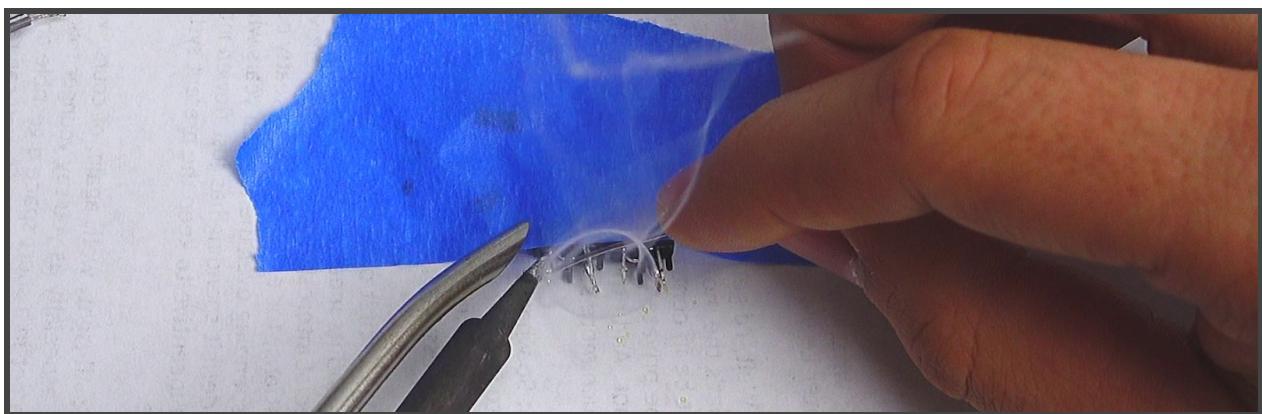
- Secure the IR Sensors somehow



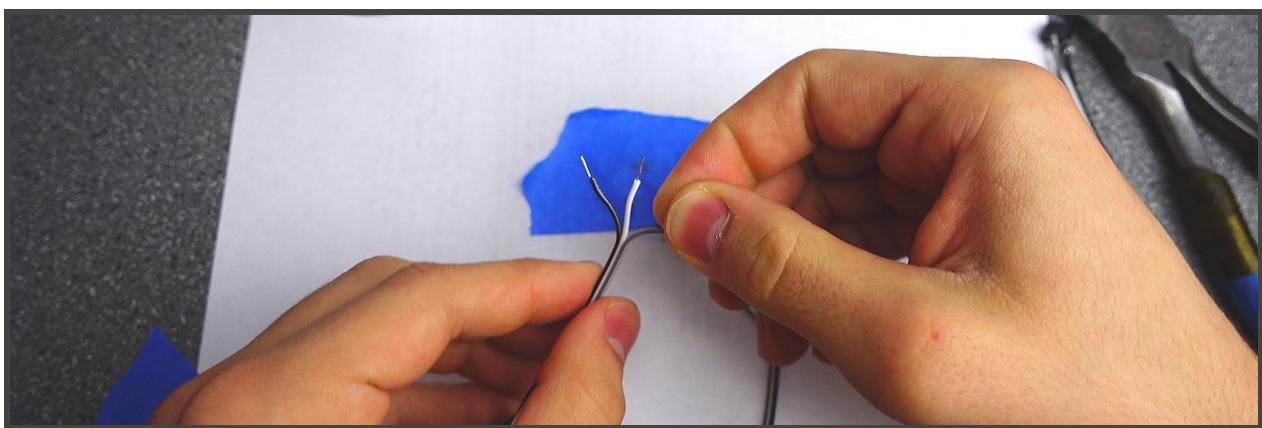
- Solder the GND pins together, so they make a good electrical connections



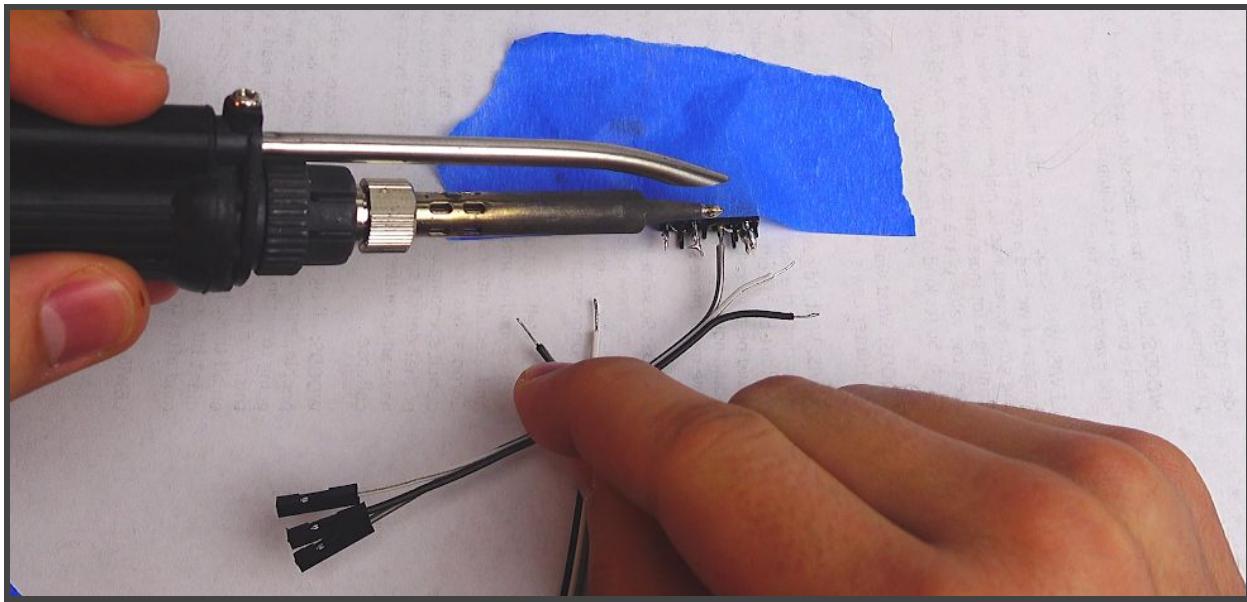
- When you're done, your sensor should look like this.



- Flip the sensors over, and tin the pins on the opposite side.

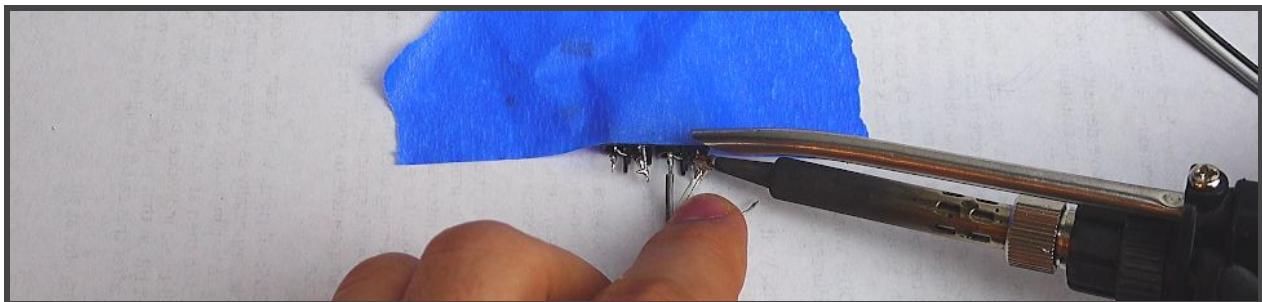


- Separate the ends of the tinned wires

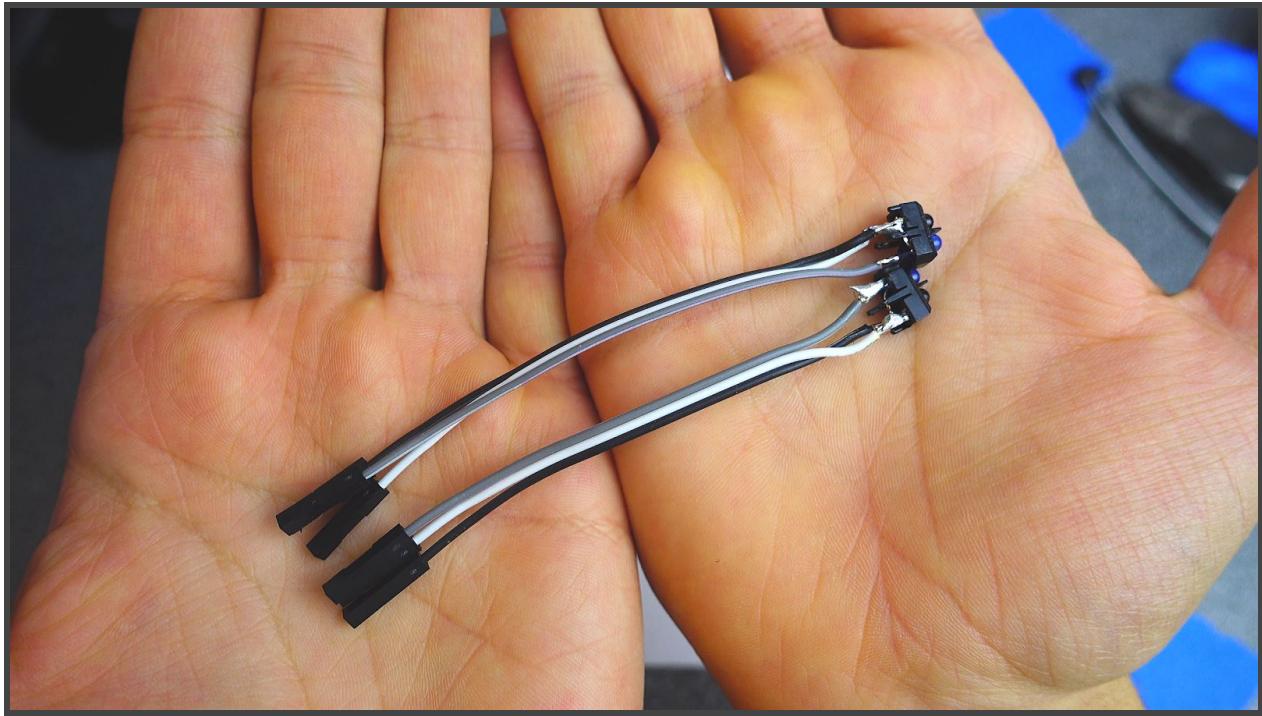


- Beginning with the GND pin, solder the wires to the pins.

Note: Since DuPont wires are randomly colored, it's hard to keep a color convention. I usually try to use the darkest wire on the end as GND, then solder them in order.

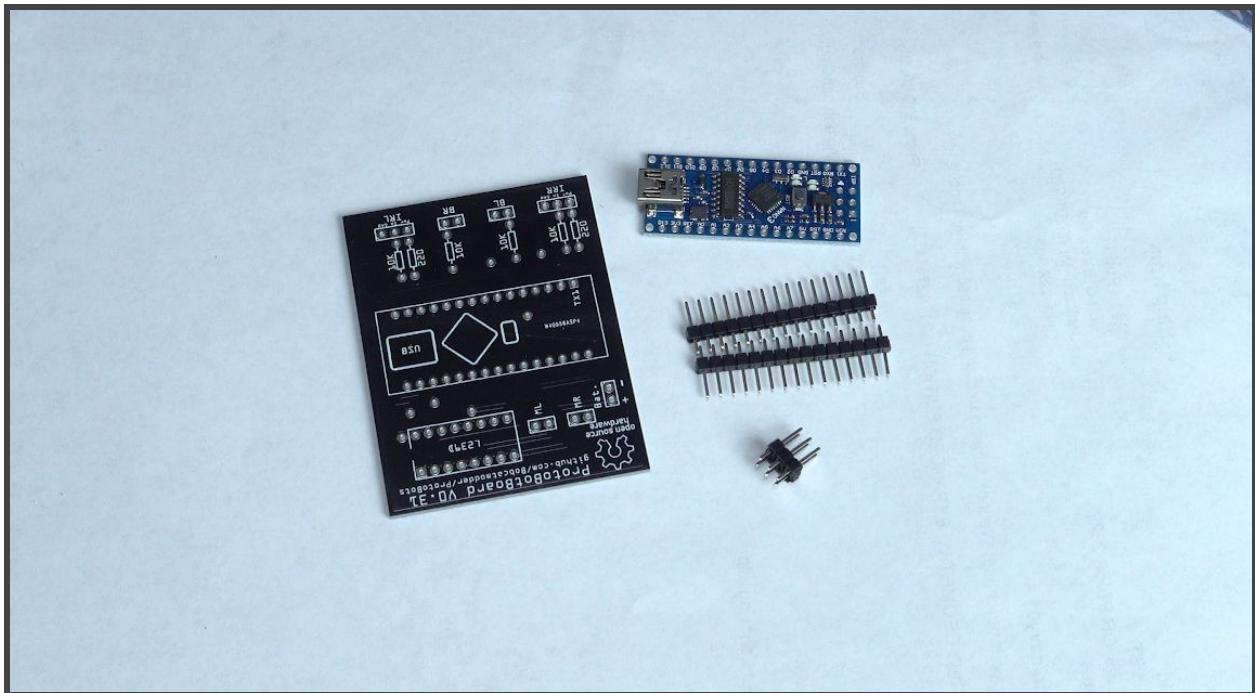


- Solder the other two wires, then remove the sensors



Your IR Sensors are ready to use on your ProtoBot!

Arduino:



You will need:

Parts:

- 1 x Arduino with pin headers (comes in a little antistatic baggy)

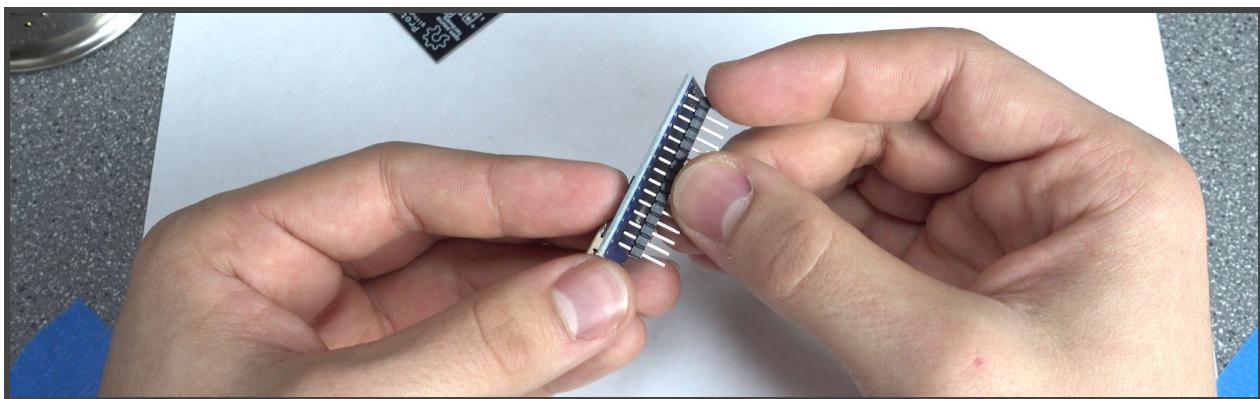
Tools to prepare:

- Soldering iron with fine tip

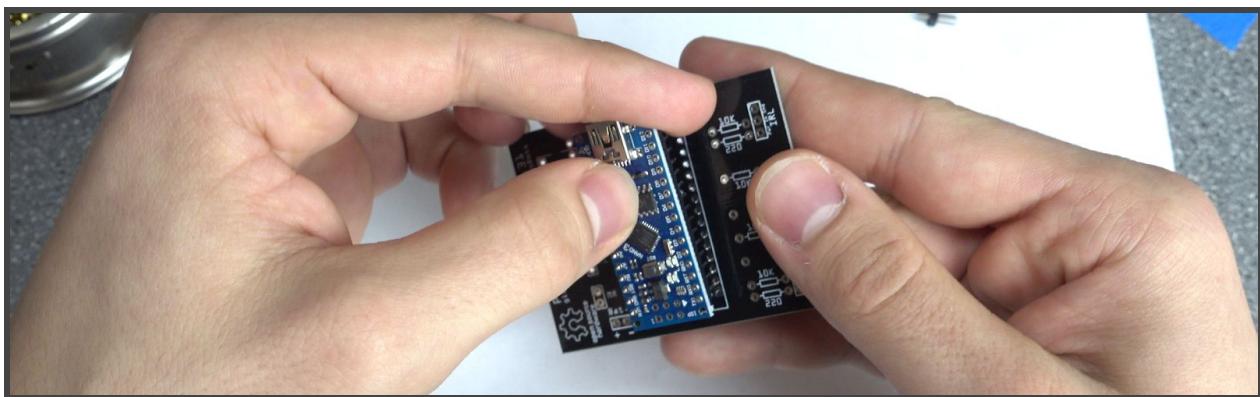
Note: The board is nice to have on hand to keep the pins at the correct angle while soldering.



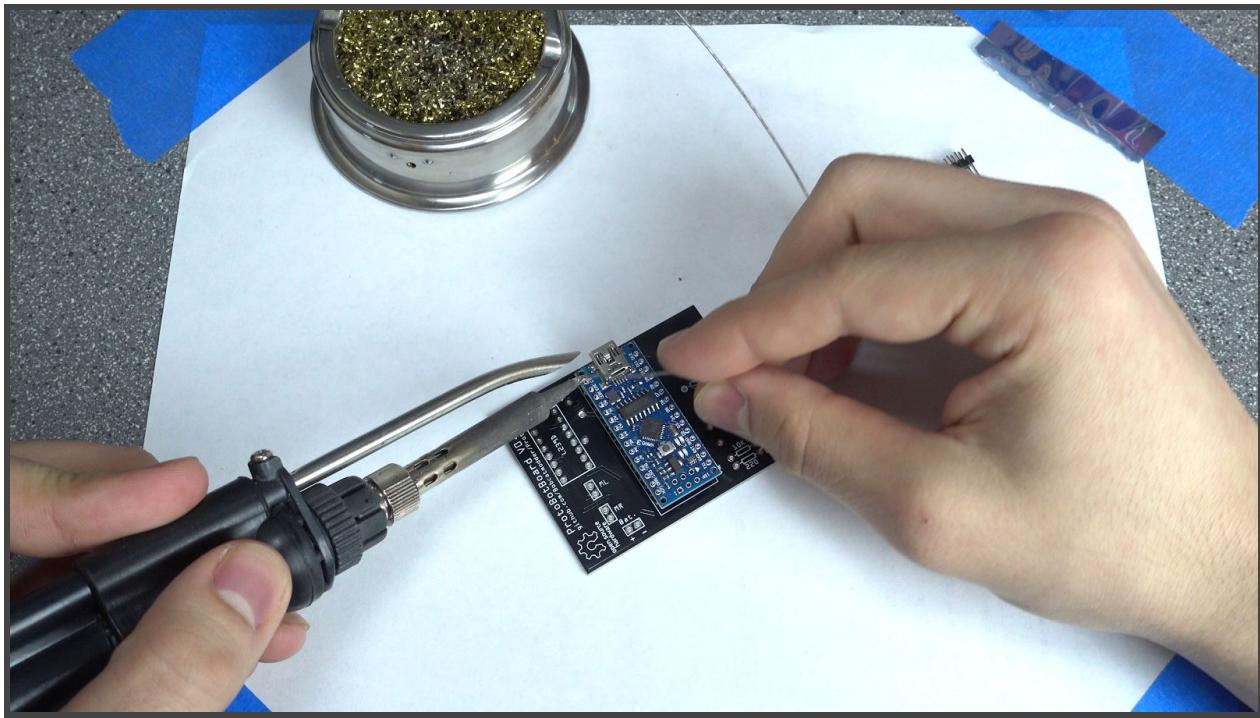
- Open the anti-static baggy and remove its contents



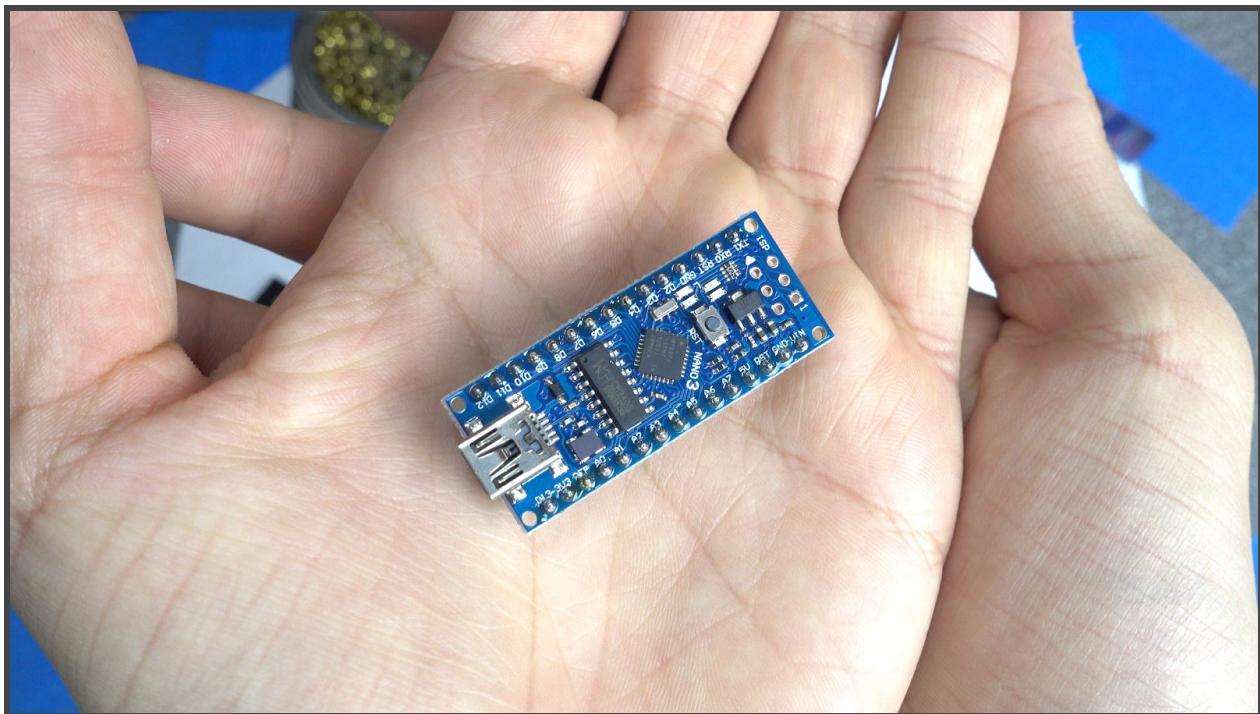
- Insert the long rows of header pins into the bottom of the arduino, short side up, on both sides



- Insert the arduino and header pins into the board, to hold it in place while soldering

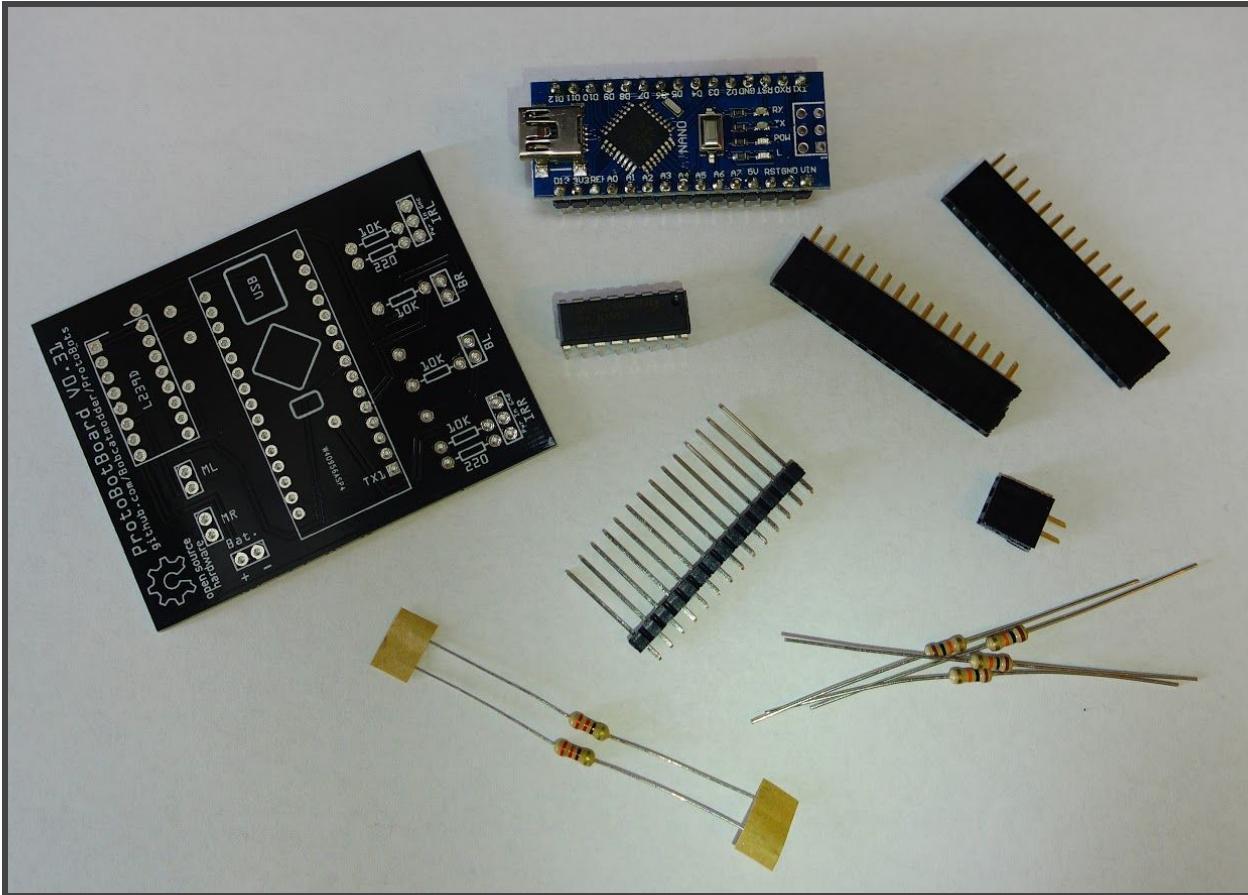


- Begin with the corner pins, and solder each pin to the Arduino



Your Arduino is ready to use!

Assembling the Board:



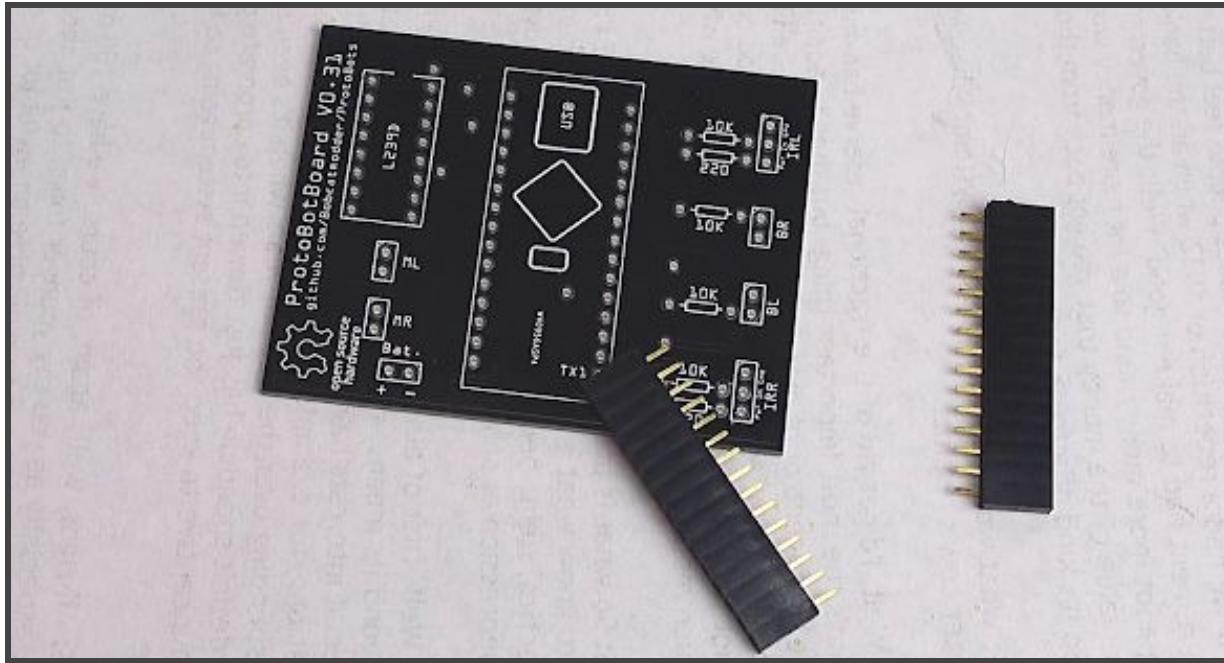
You will need:

Parts:

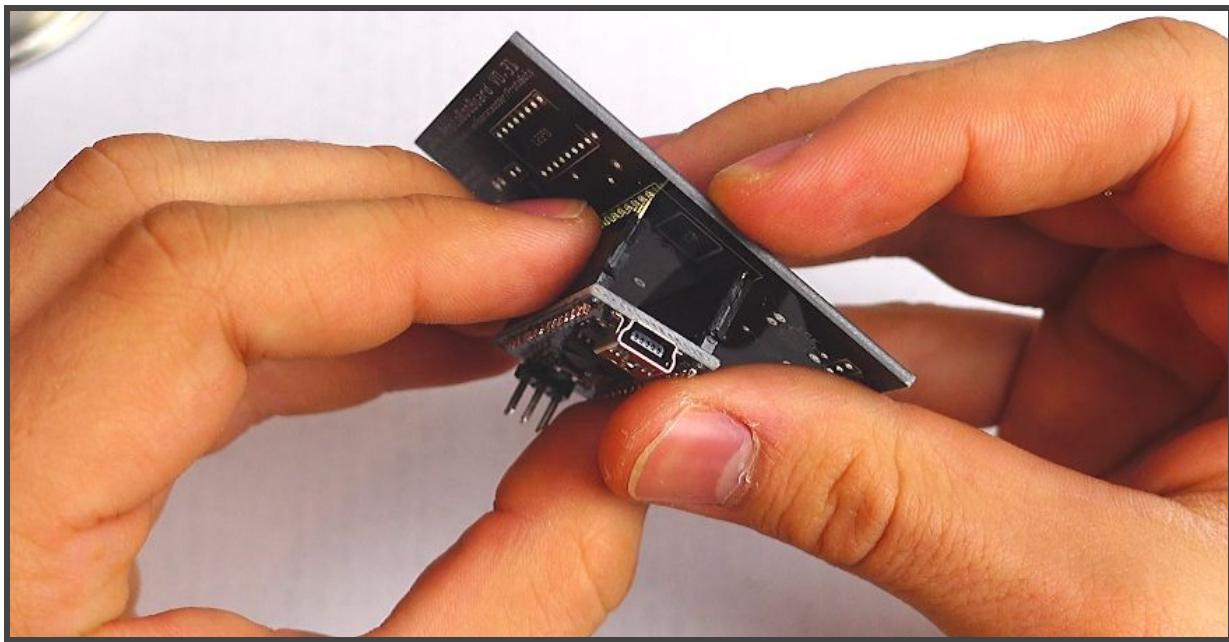
- ProtoBotBoard
- Assembled Arduino Uno
- 1 x Motor Driver chip (L293D)
- 2 x 220 Ohm resistors
- 4 x 10K Ohm resistors
- 14-pin length of header pins
- 2 x 15-pin length of female header pins
- 1 x 2-pin length of female header pins

Tools to Prepare:

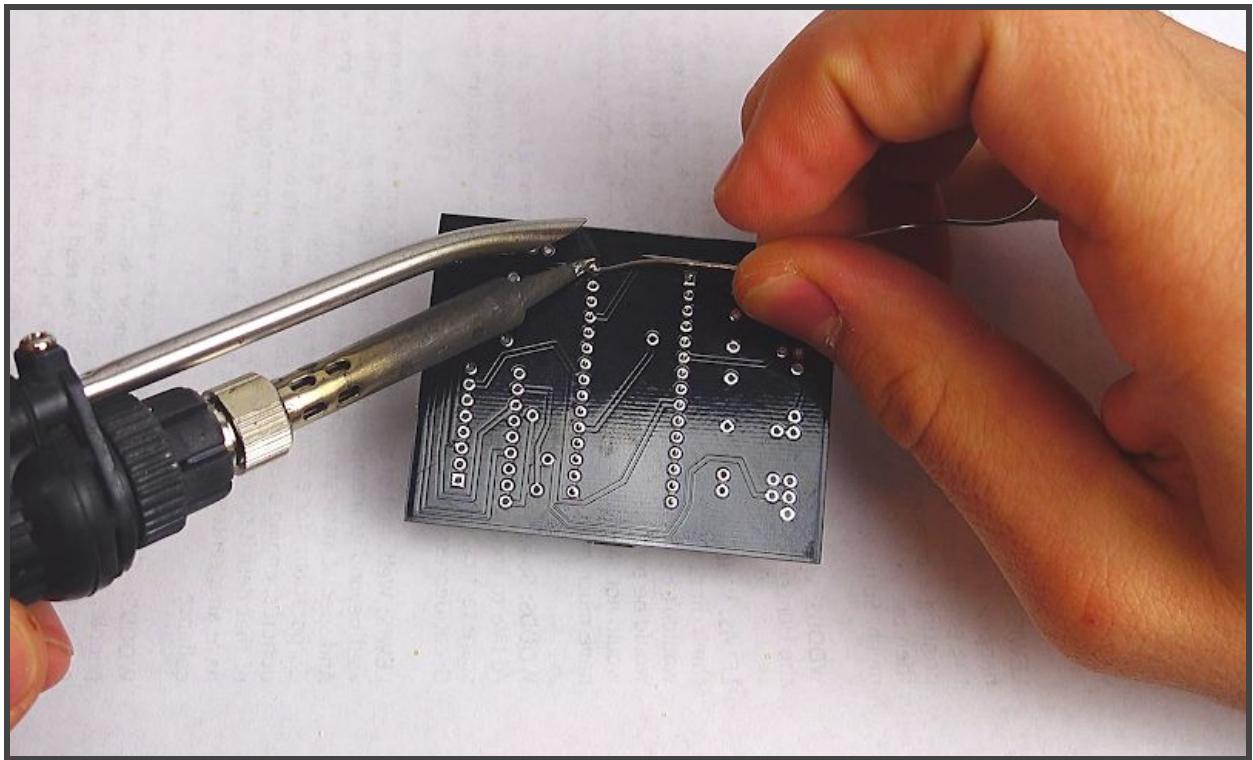
- Soldering iron with Fine tip
- Masking tape, or Helping Hands
- Wire clippers (*not* wire strippers/cutters)
- Pliers



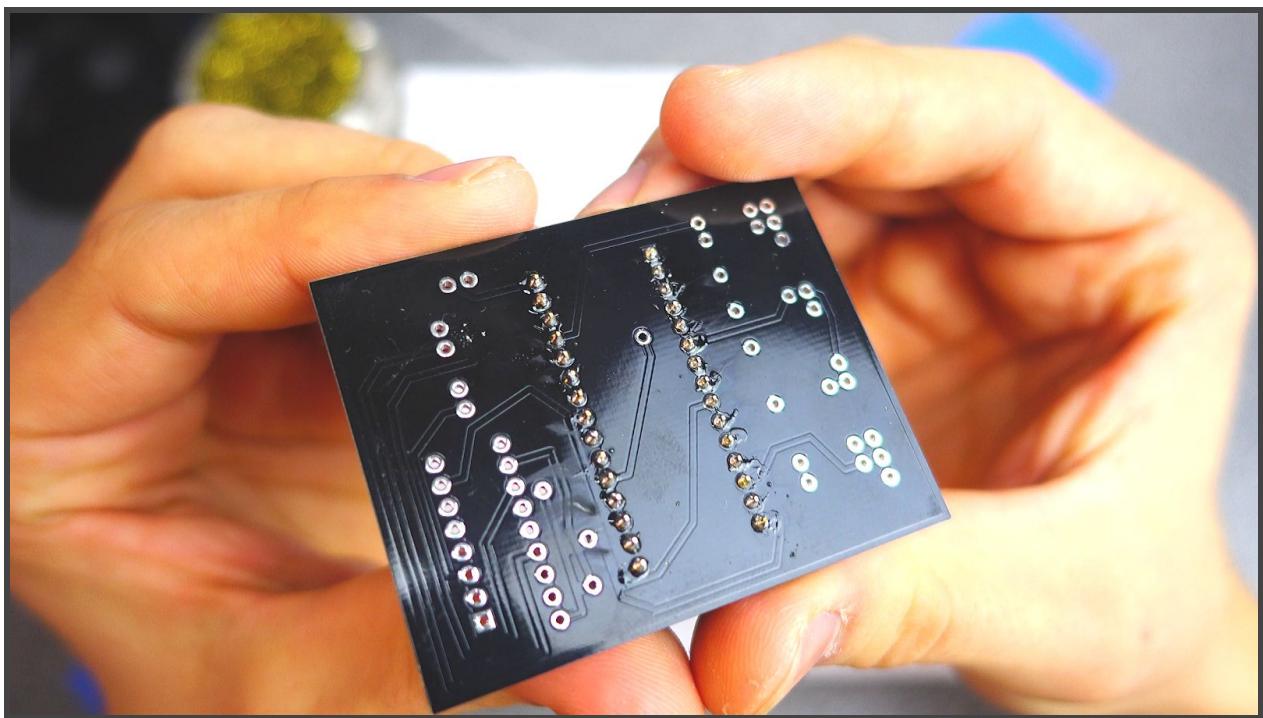
- Get your board, and your female header pins.



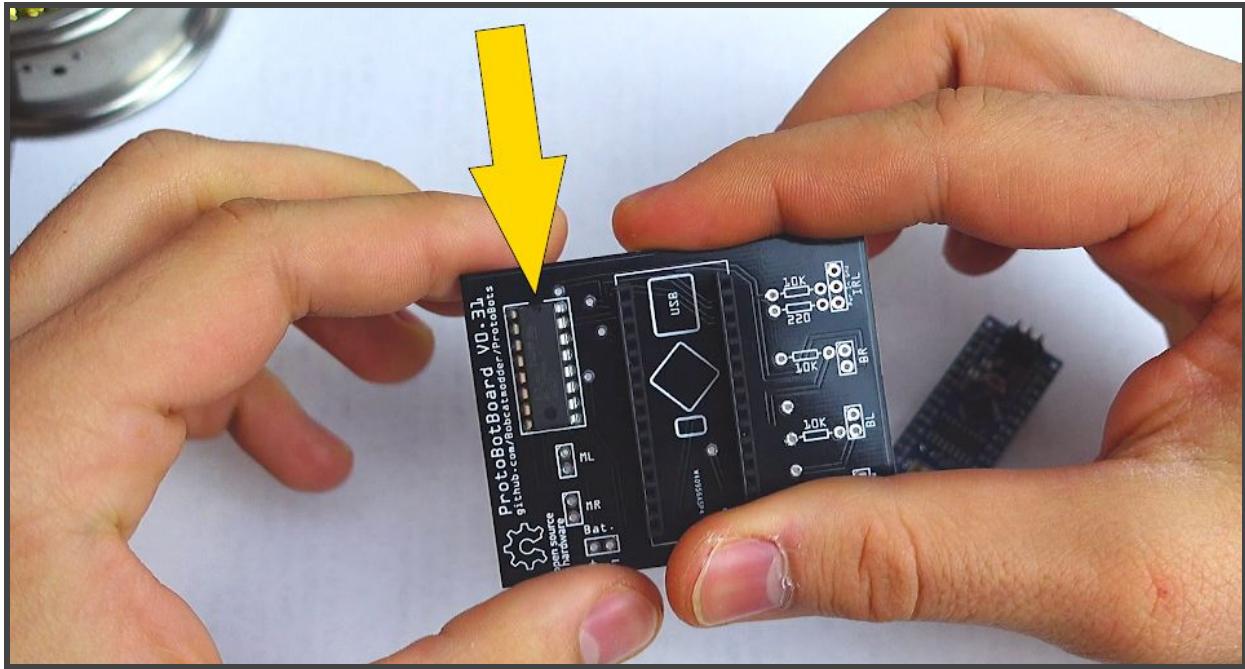
- Insert the arduino into the female header pins, then insert them into the board.



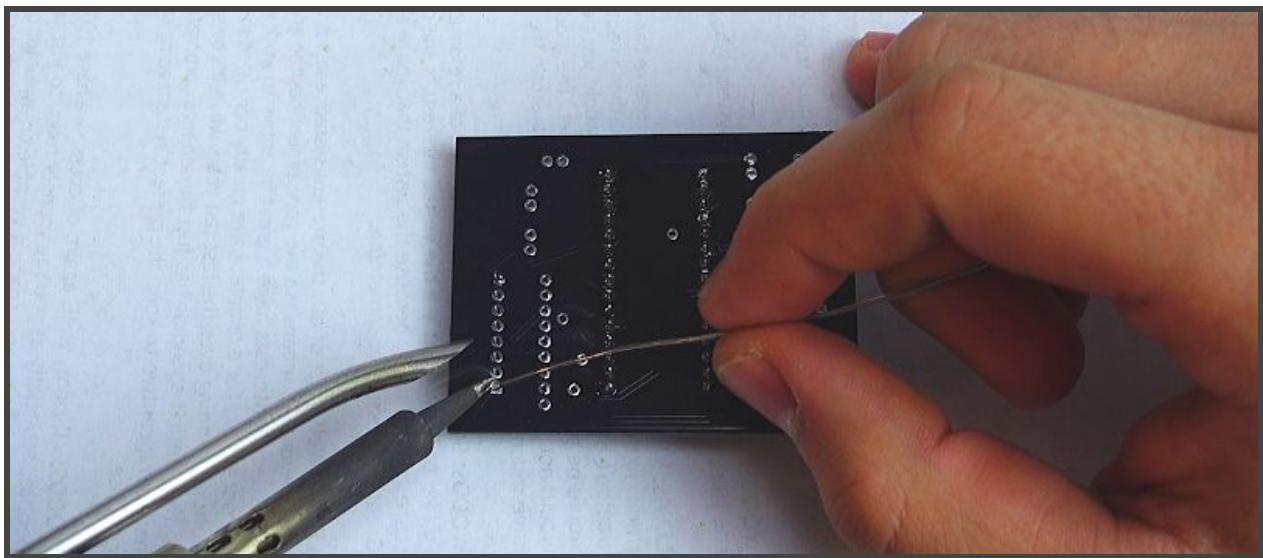
- Starting with the pins in the corner, solder each pin to the board.



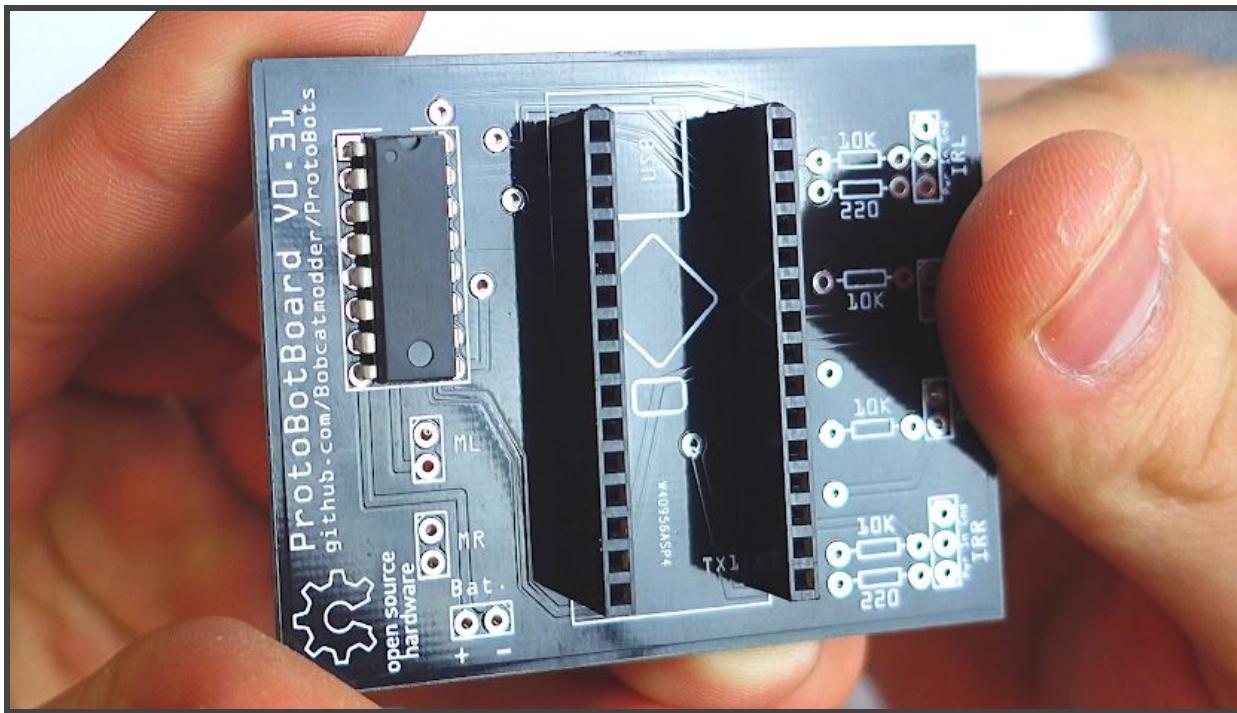
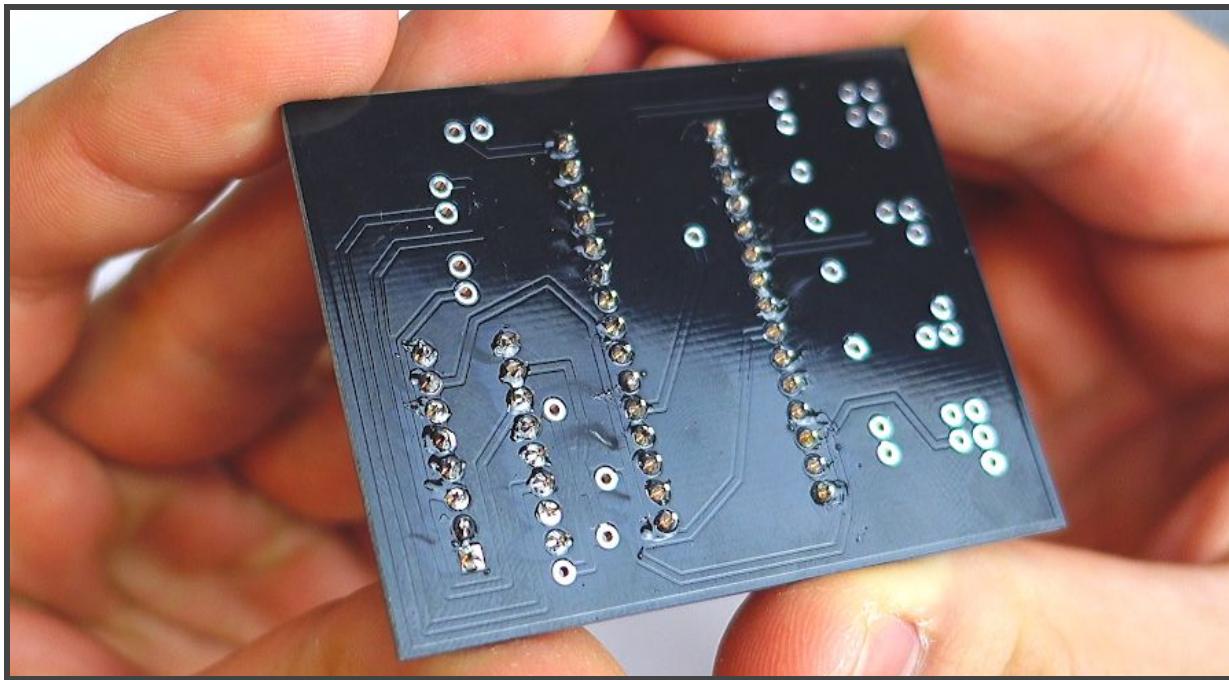
- When you're finished, it should look like this.



- Take your motor driver chip, and insert it into the board as shown, with the notch at the top lined up with the gap in the outline on the board.

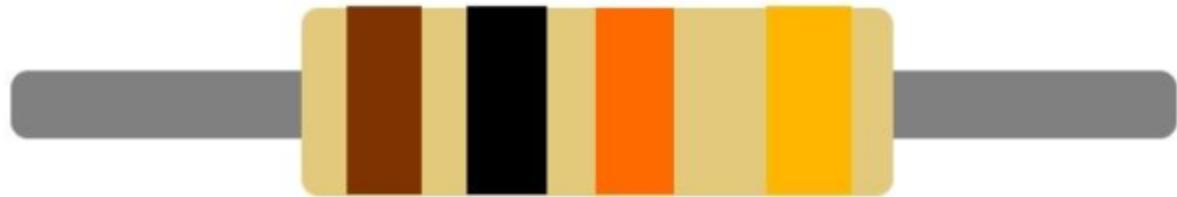


- Starting at the corners, solder the chip into the board.



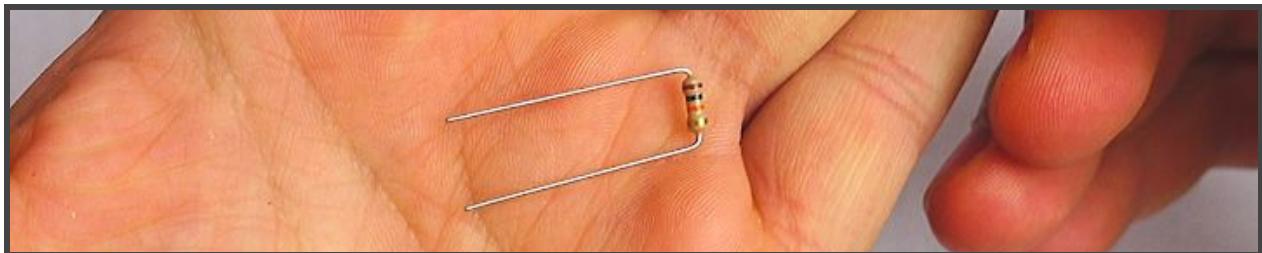
- When you're done, it should look like this.

10K Ohm Resistor - Tan color

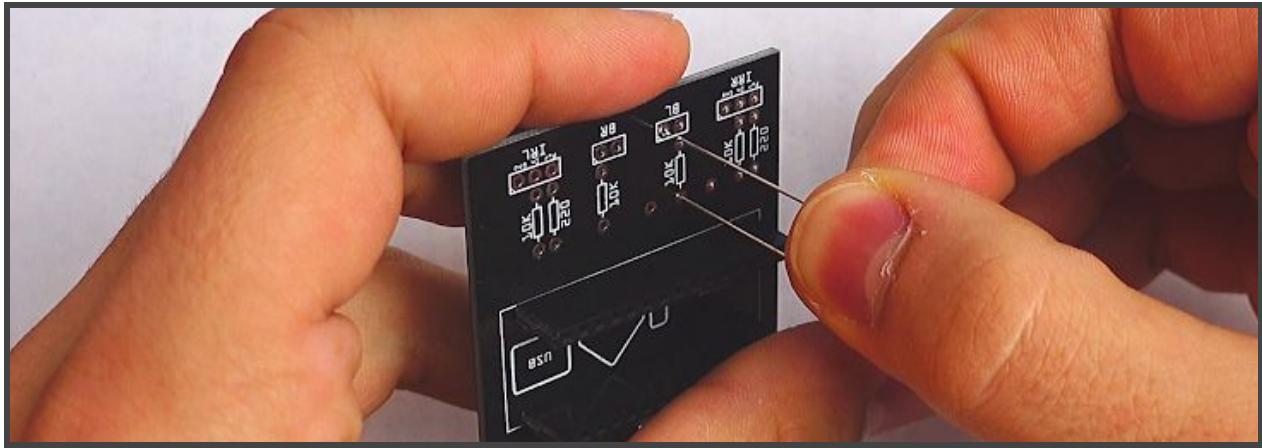


10K Ohm Resistor - Blue Color

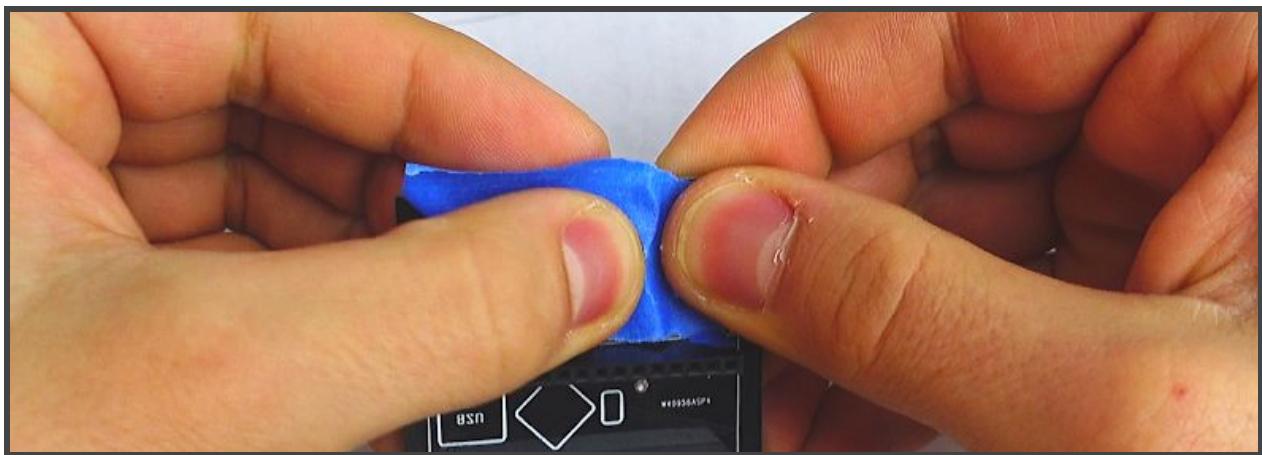
- Find four 10K resistors.
- Your 10K resistors can be either blue or tan. Make sure the color bands match the color bands in the picture for whichever color you have.



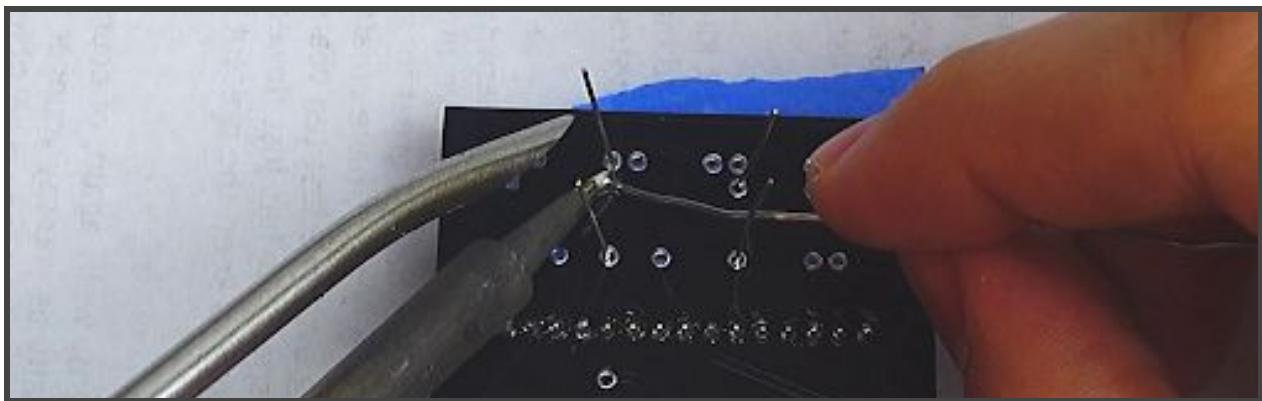
- Bend the leads of each resistor at a 90 degree angle, as shown.



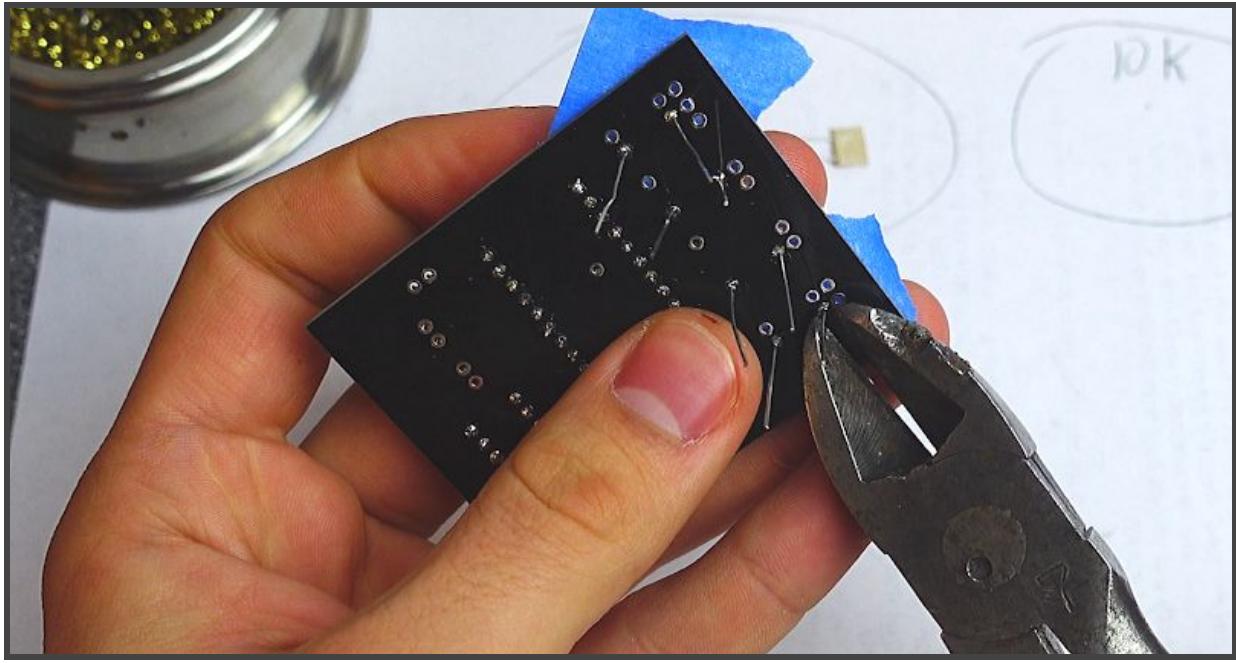
- Insert each 10K resistors into the spots on the board marked "10K".



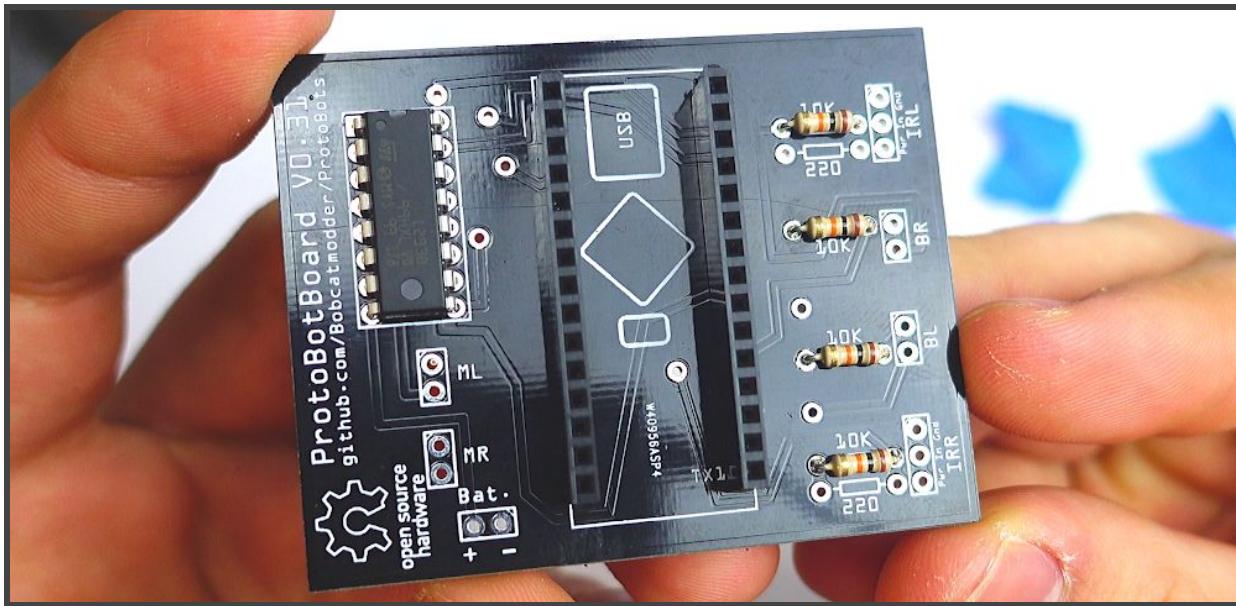
- Use some masking tape to hold down the resistors while you're soldering them.



- Solder the leads of each resistor to the board



- Use your wire clippers to cut off the extra leads.



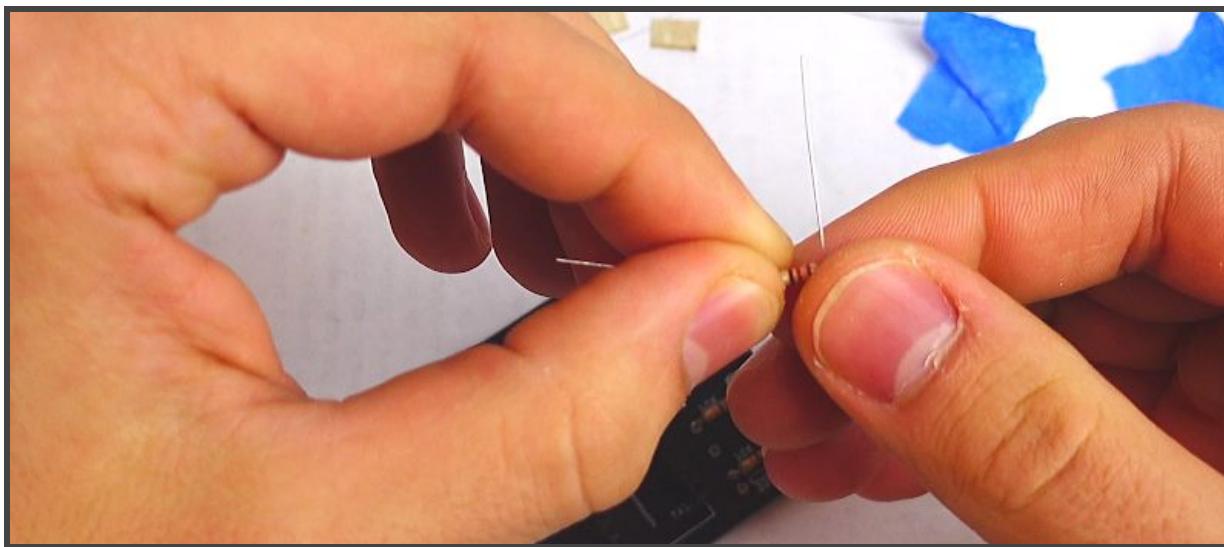
- When you're done, it should look like this.

220 Ohm Resistor - Tan color

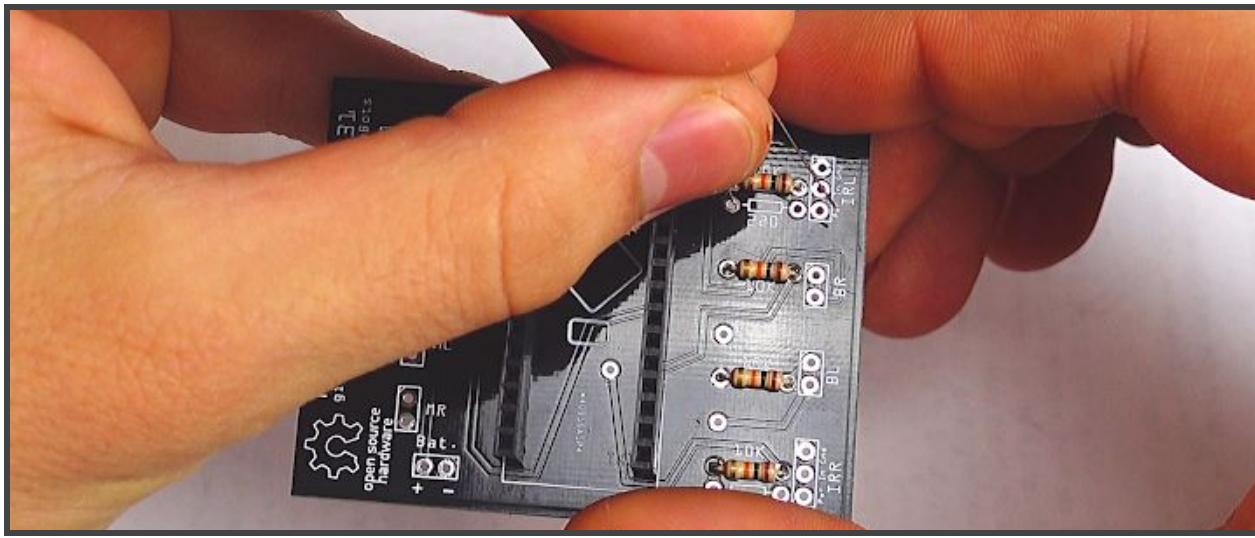


220 Ohm Resistor - Blue color

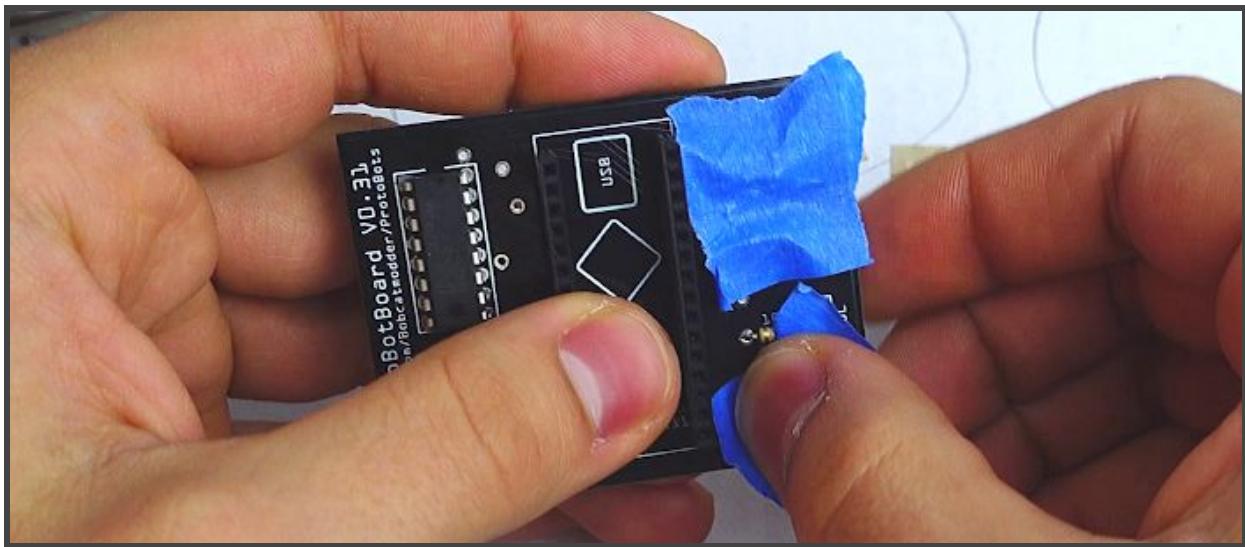
- Find two 220 ohm resistors.
- Yours might be blue or tan, but make sure the color bands match whichever color you have.



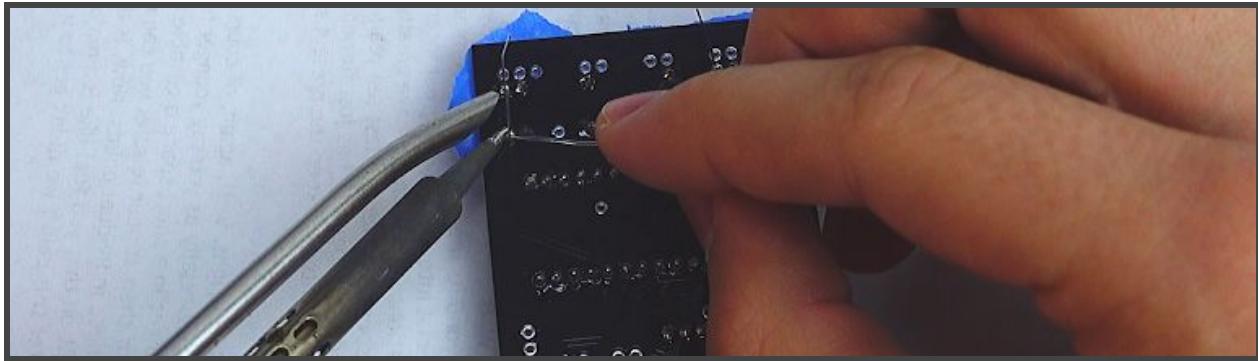
- Bend the leads of each resistor at a 90 degree angle, as shown.



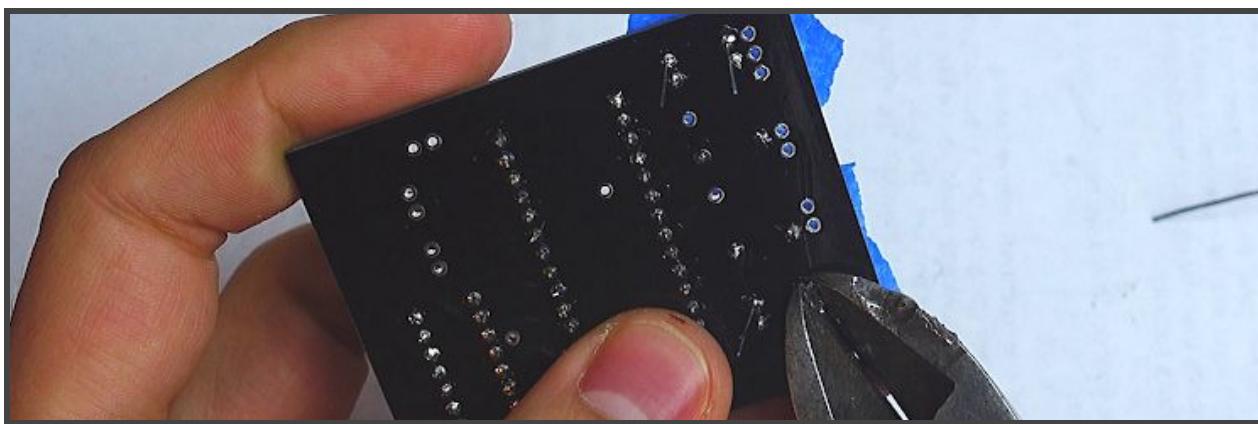
- Insert the 220 ohm resistors into the spots marked “220” on the board.



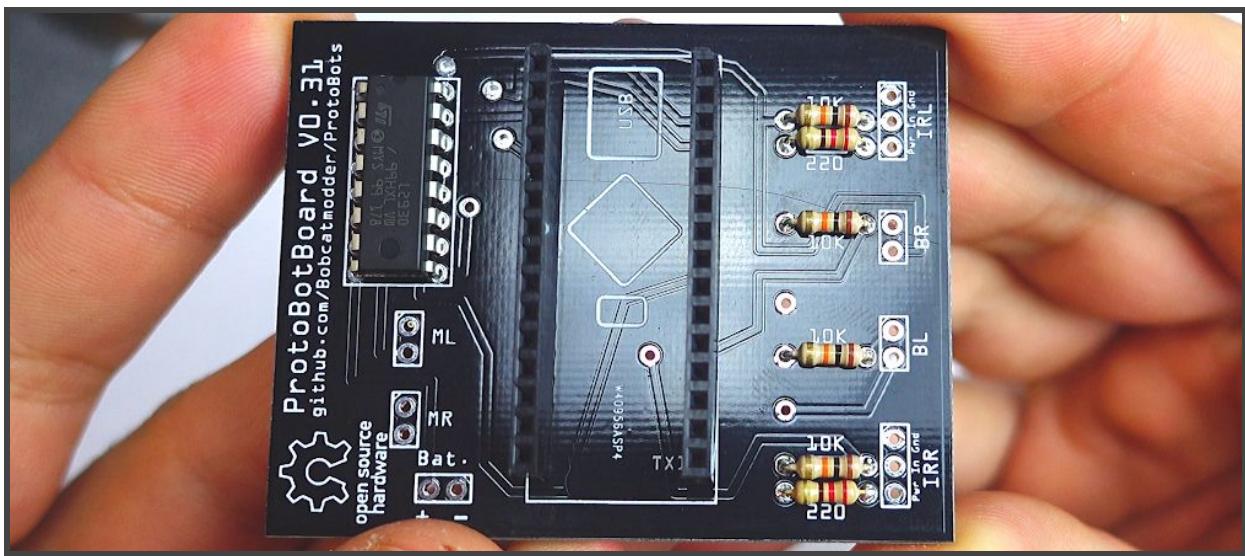
- Use some masking tape to hold the resistors in place while you solder.



- Solder the leads from the resistors into the board.



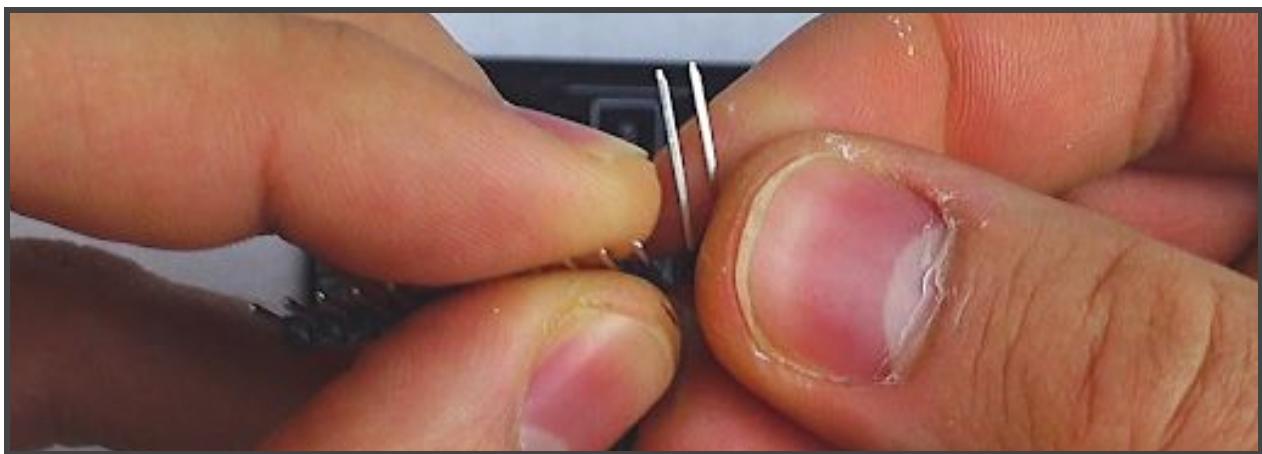
- Use the wire clippers to cut off the extra leads.



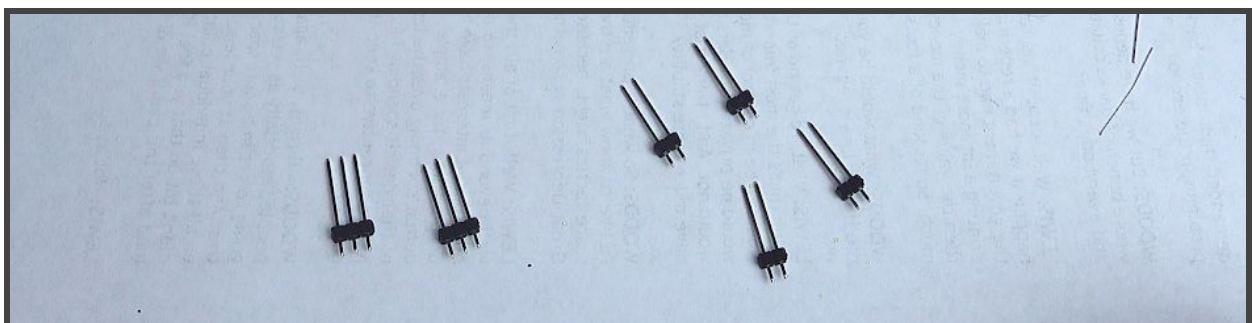
- When you're done, remove the masking tape. It should look like this.

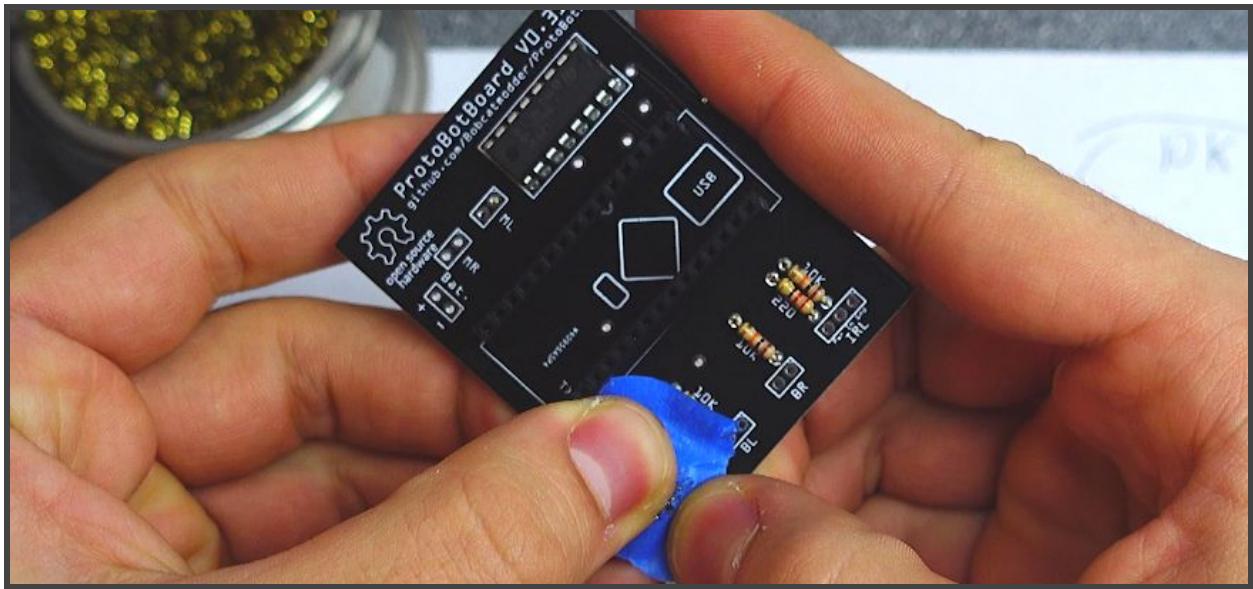


- Find your header pins. You'll need a row of 14 of them.

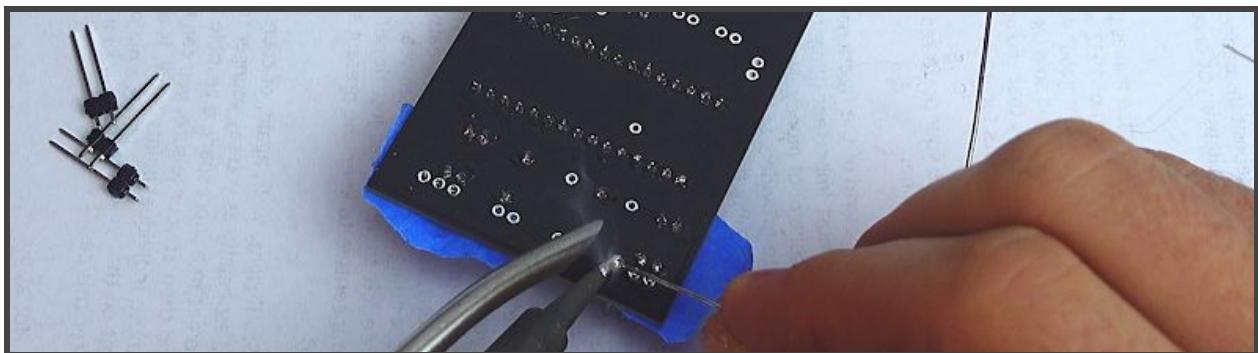


- Using your fingers as shown, break the header pins into 4 sections of 2, and 2 sections of 3, like so:

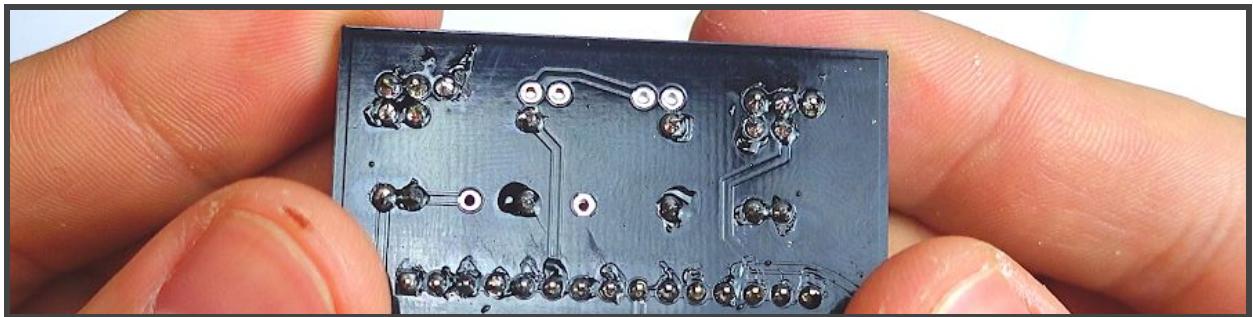




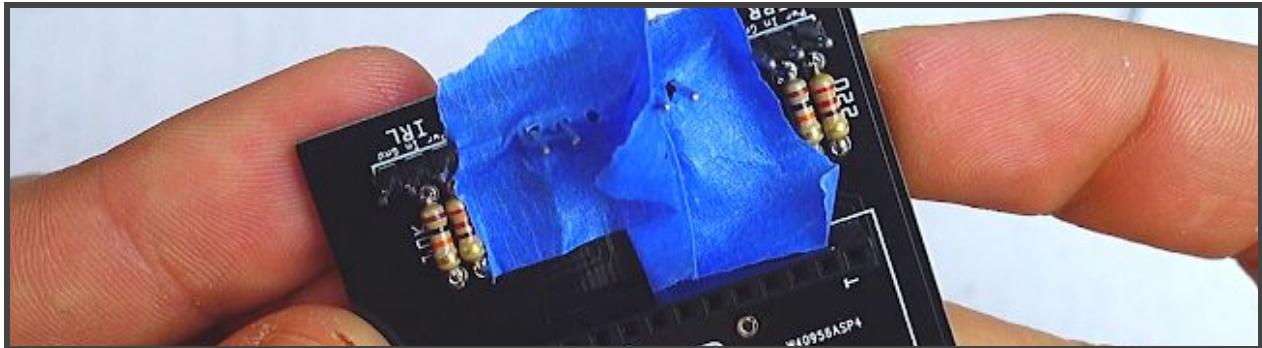
- Insert each of the 3-pin lengths into the spots marked "IRR" and "IRL", with the *short side down*, and use masking tape to hold it in place for soldering.



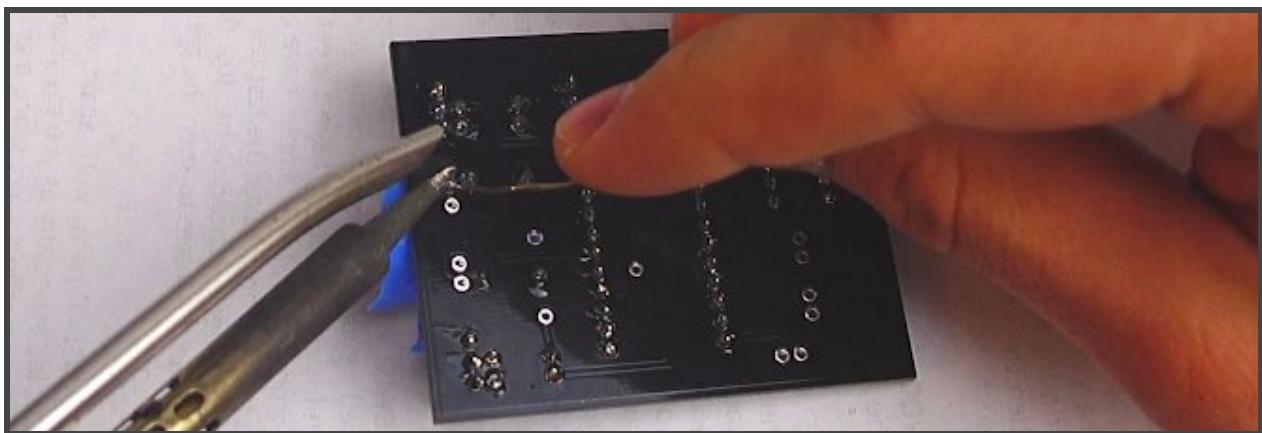
- Solder them in place.



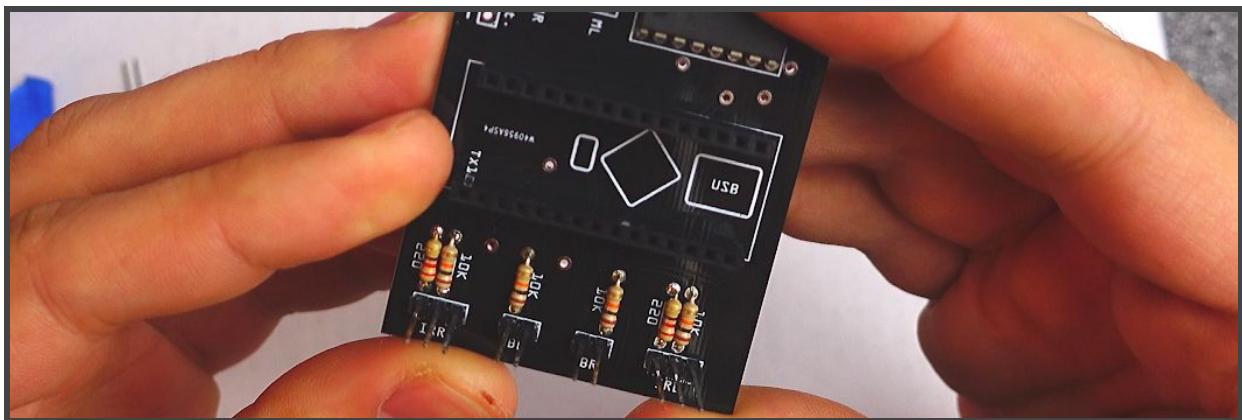
- When you're done, it should look like this.



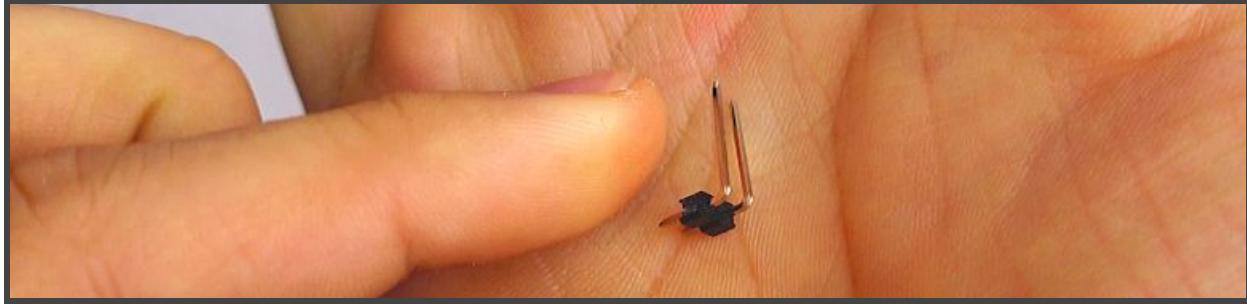
- Insert each 2-pin length into the spots marked "BL" and "BR", with the *short side down*.
- Use a bit of masking tape to hold them in for soldering.



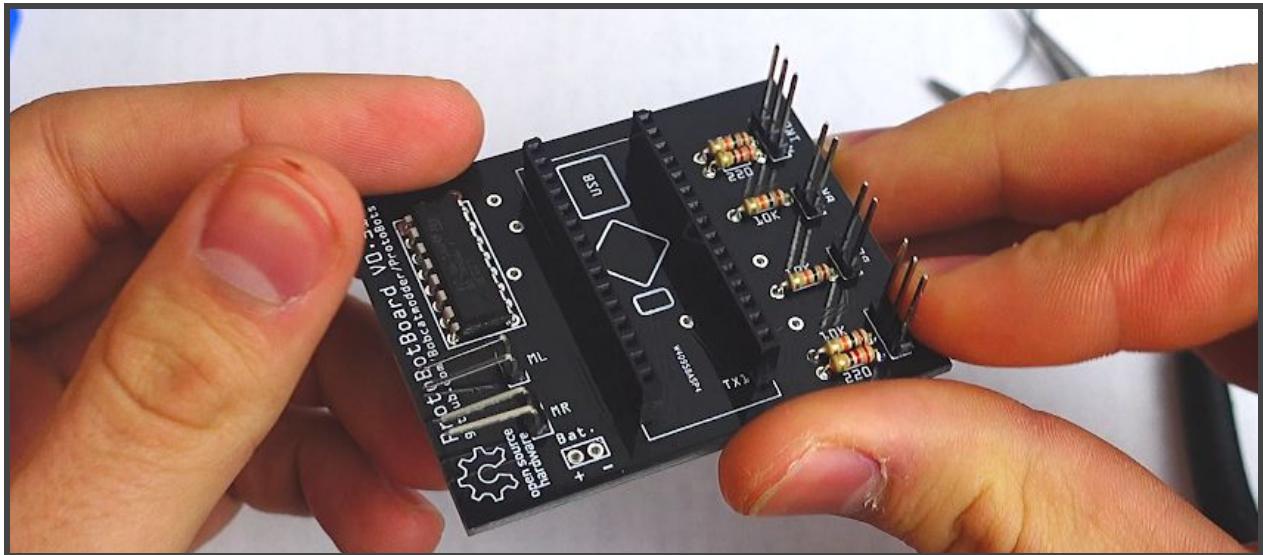
- Solder each pin into the board.
- When you're done, remove the masking tape.



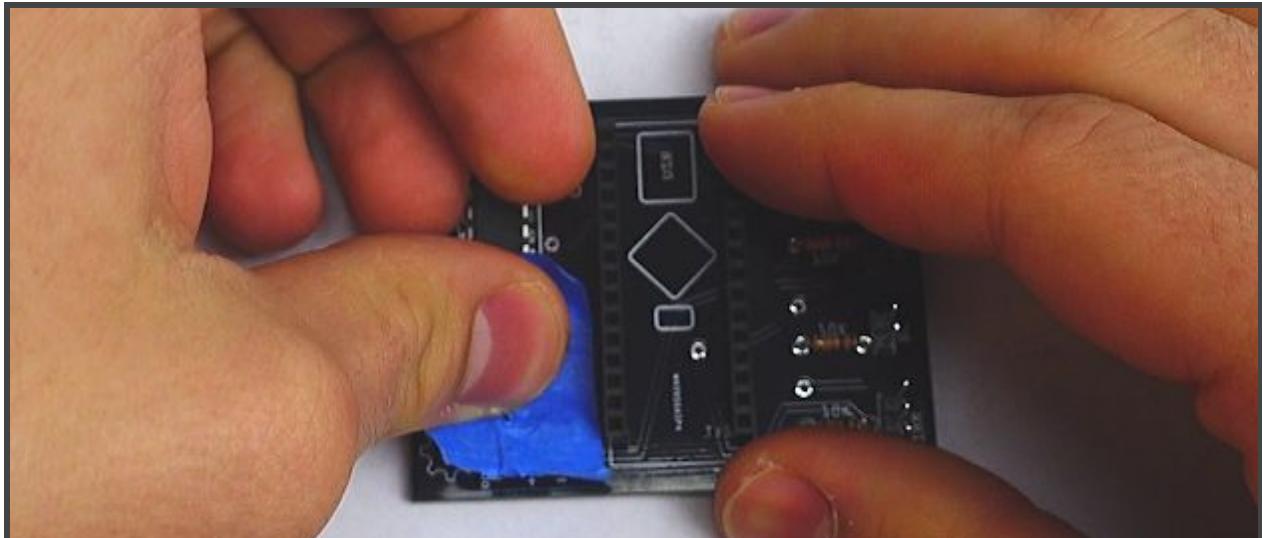
- Once you're done, it should look like this.



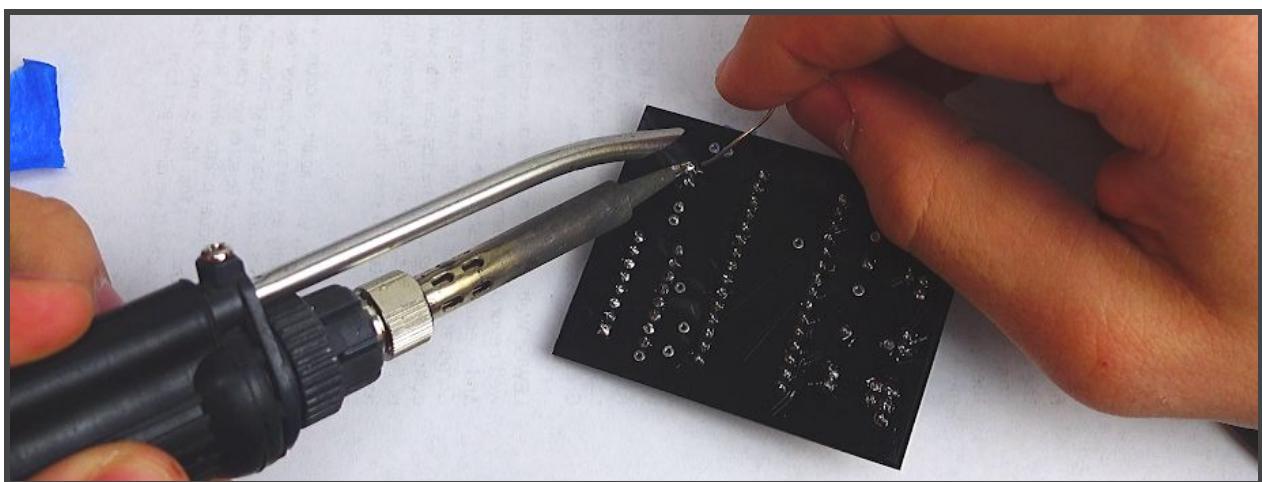
- Find the last two 2-pin lengths of header pins.
- Using a pair of pliers, bend the longer side at a 90 degree angle.



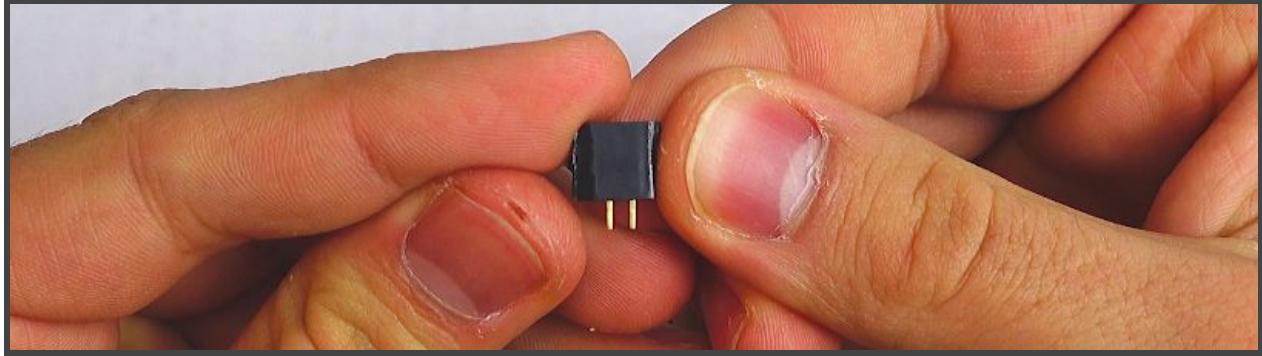
- Insert the bent headers, with the *short end down*, into the spots marked "MR" and "ML" on the board.



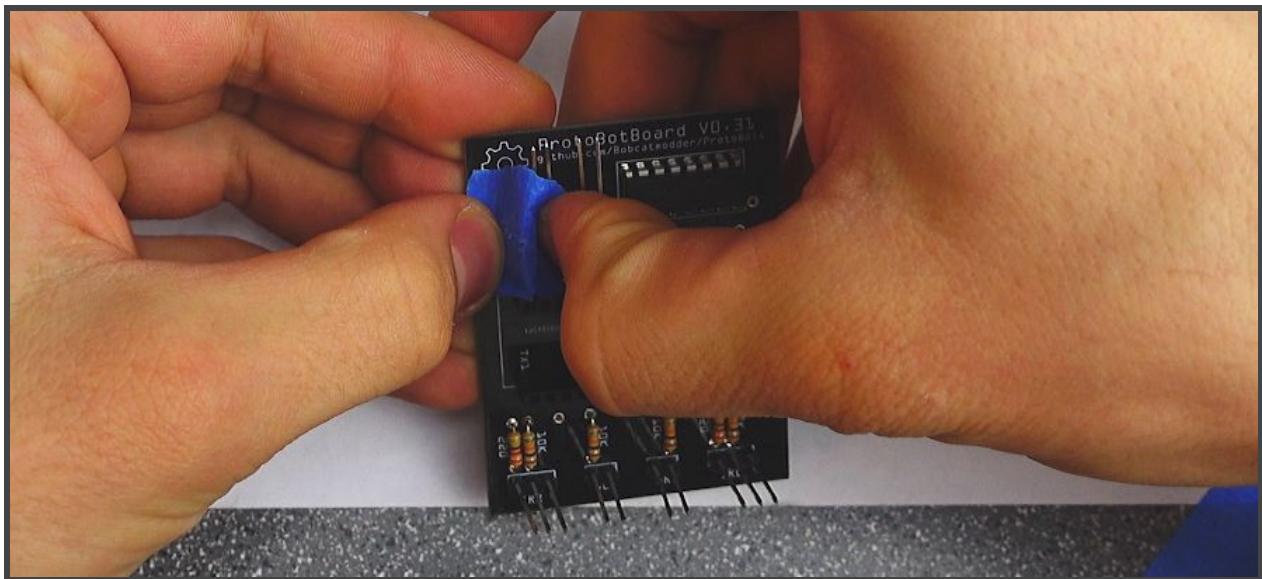
- Use a piece of masking tape to hold the headers in place while you solder them.



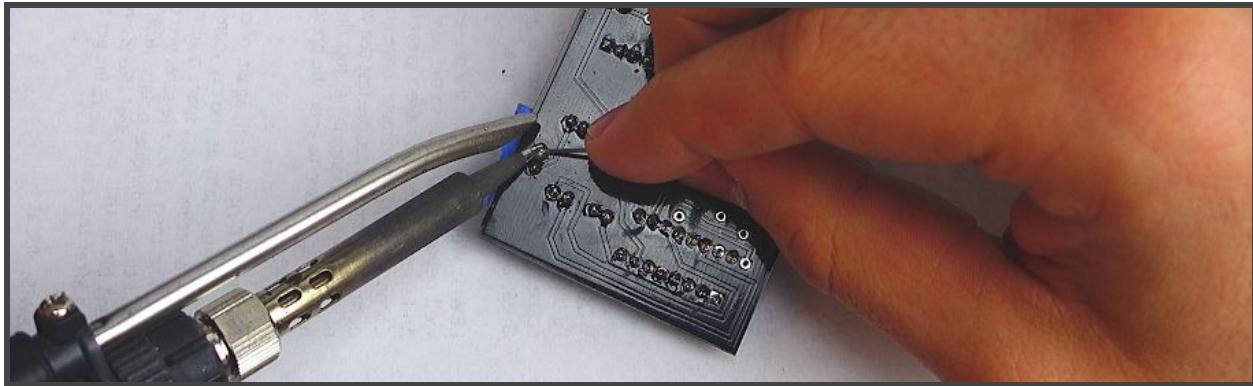
- Solder the pins to the board.



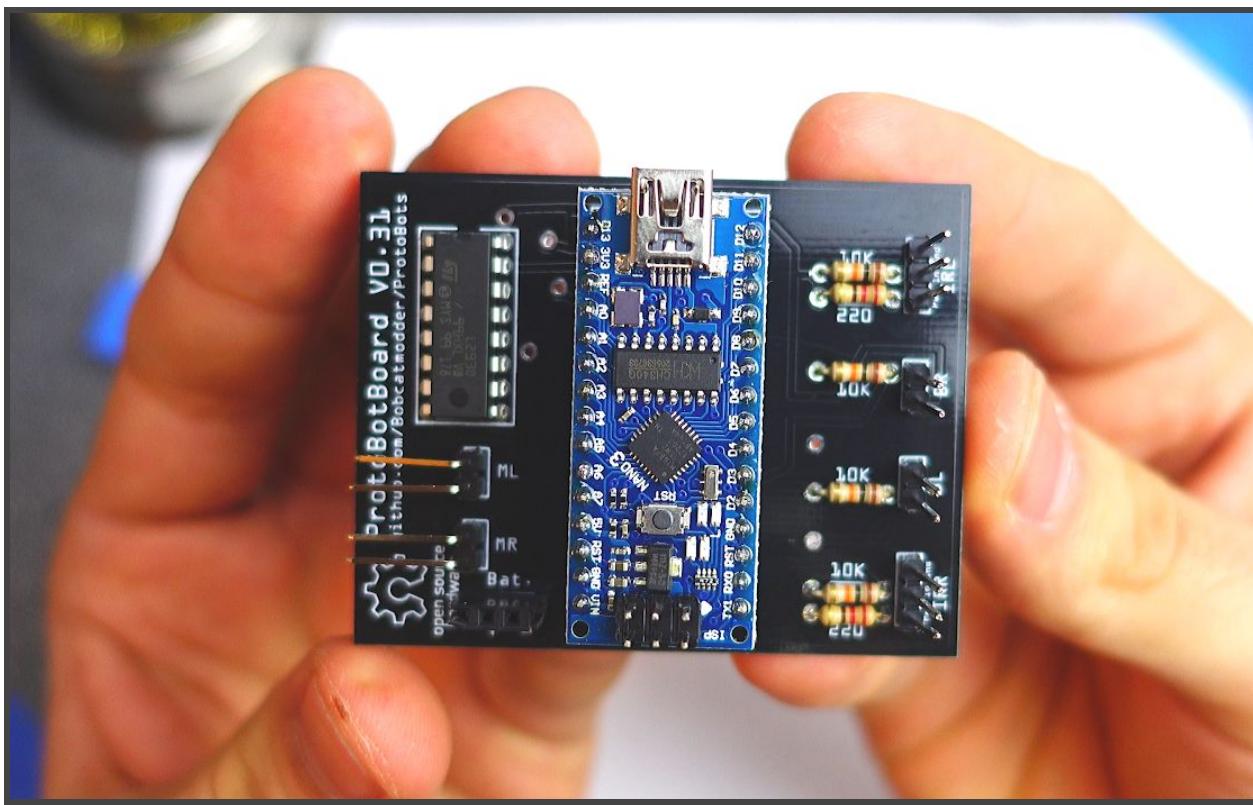
- Find your 2-pin length of female header pins



- Insert it into the spot marked "Bat.", and use a piece of masking tape to hold it down.

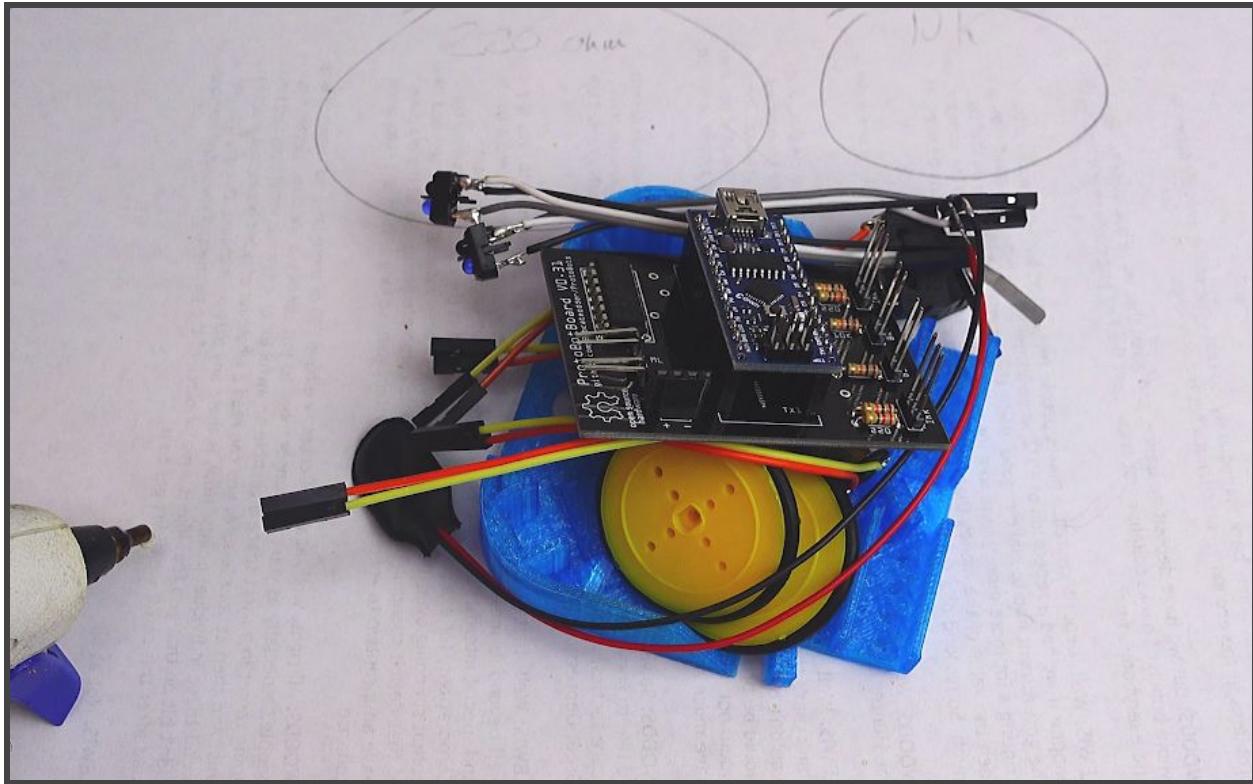


- Solder it into the board, then remove the masking tape.



Your board is ready to use!

Assembling the Probot:



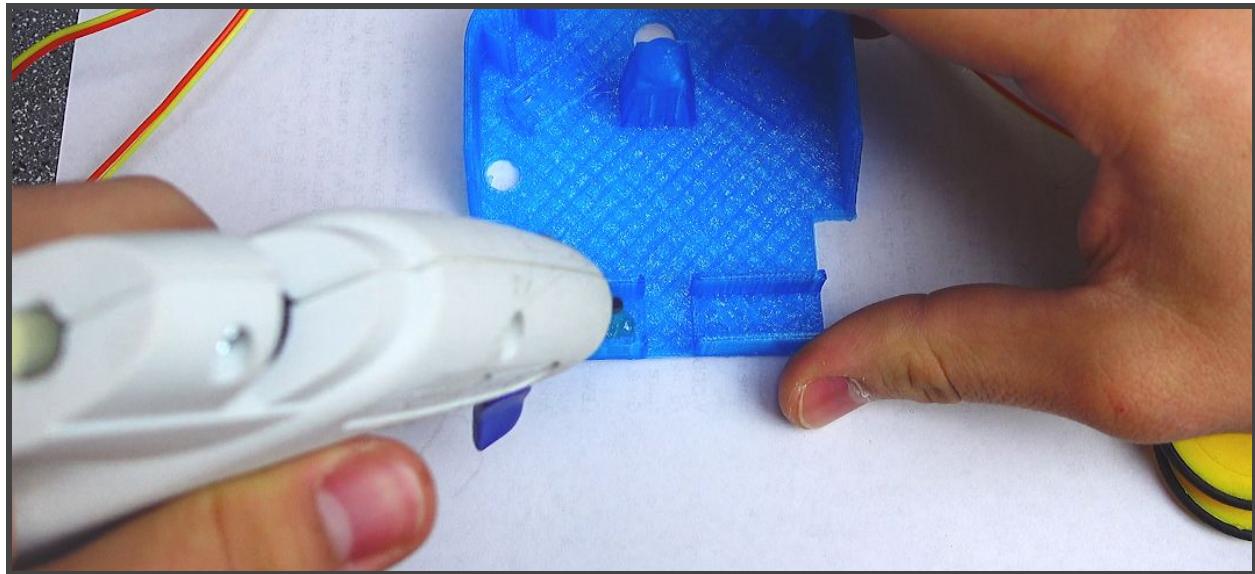
You will need:

- 3D printed base part
- 2 x 3D printed Antenna parts
- 4 x 3D printed ProtoBotBoard Supports
- 2 x Bump sensors
- 2 x Motors
- 2 x IR Sensors
- 1 x 9V Battery clip
- 1 x 9V Battery
- A length of Hook and Loop fastener (Such as VELCRO), about as long as the battery

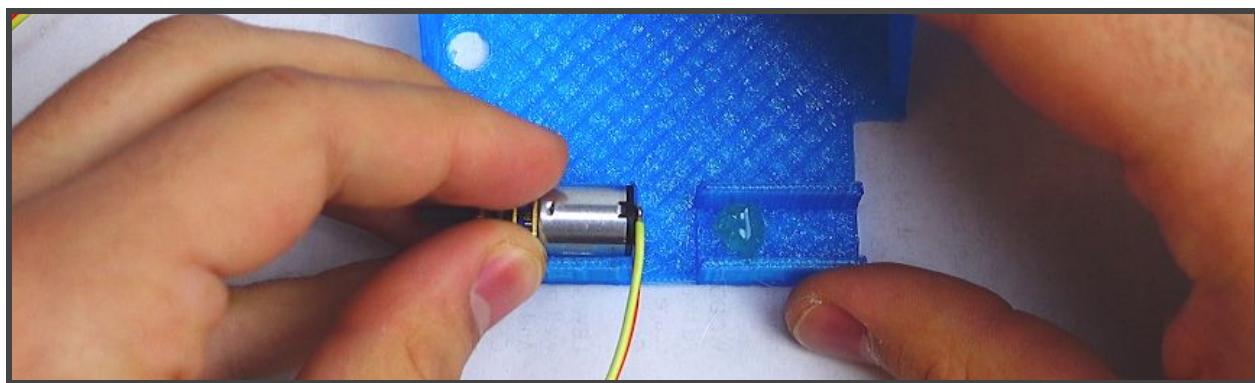
Tools to prepare:

- A hot glue gun (High-Temp is better)

Note: A piece of scrap paper taped to whatever worksurface you have is a good way to protect the surface underneath.



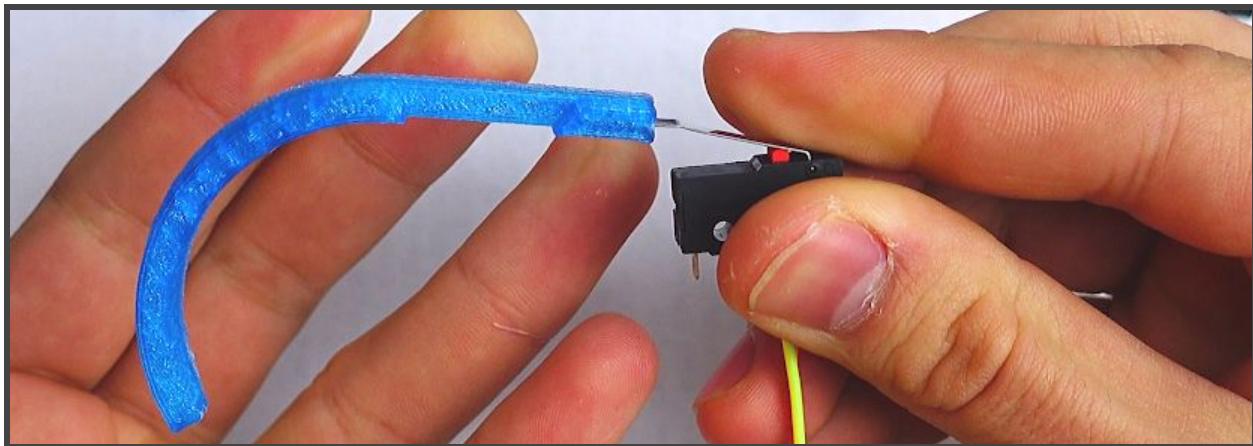
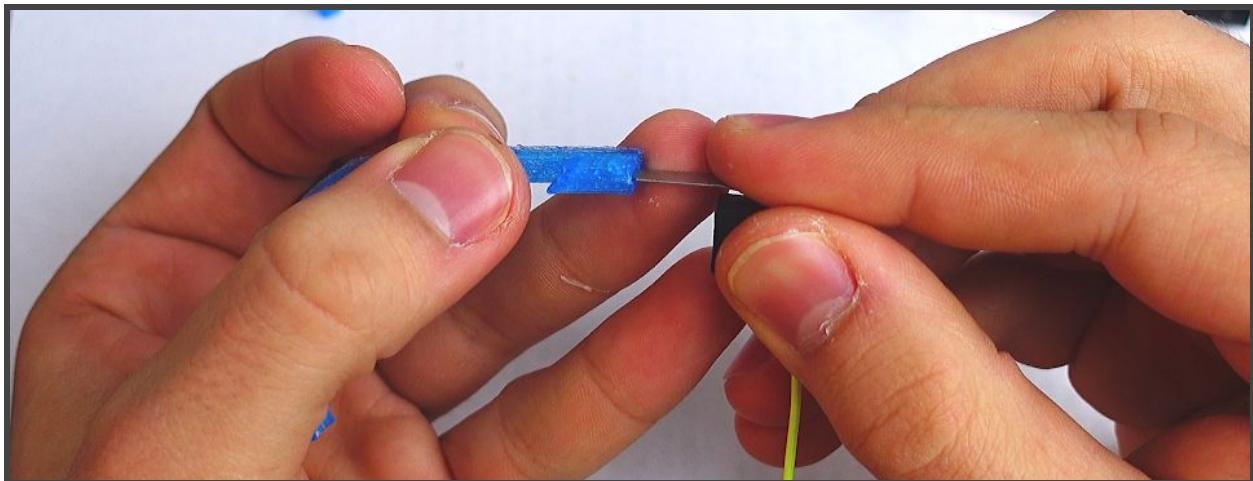
- Apply a large dab of hot glue to the inner end of each motor mount



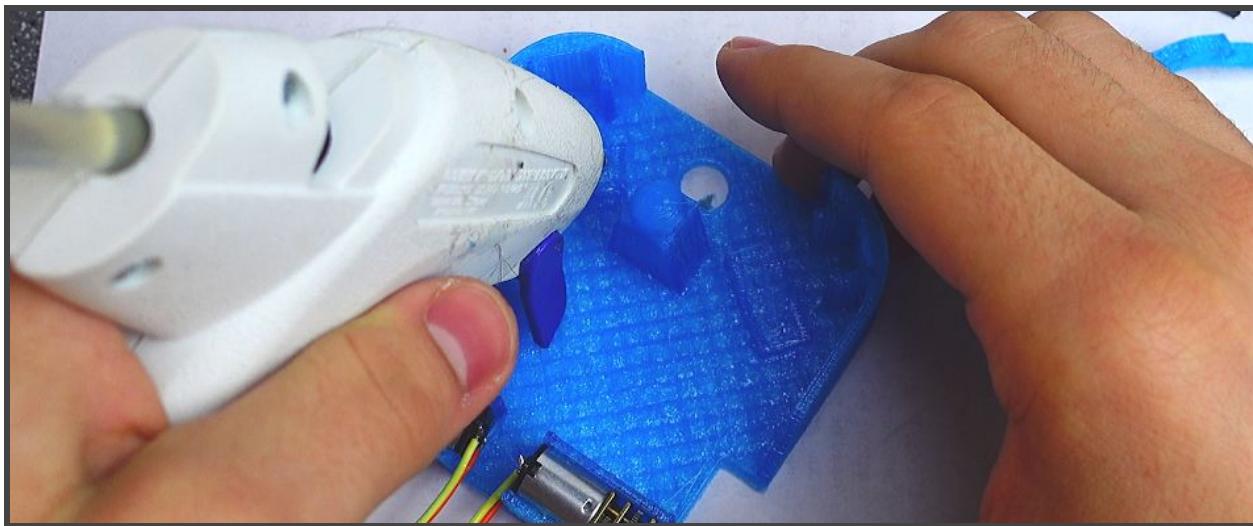
- Insert each motor into the mount, with the wires facing as shown

Note: Be careful not to get glue into the gearboxes!

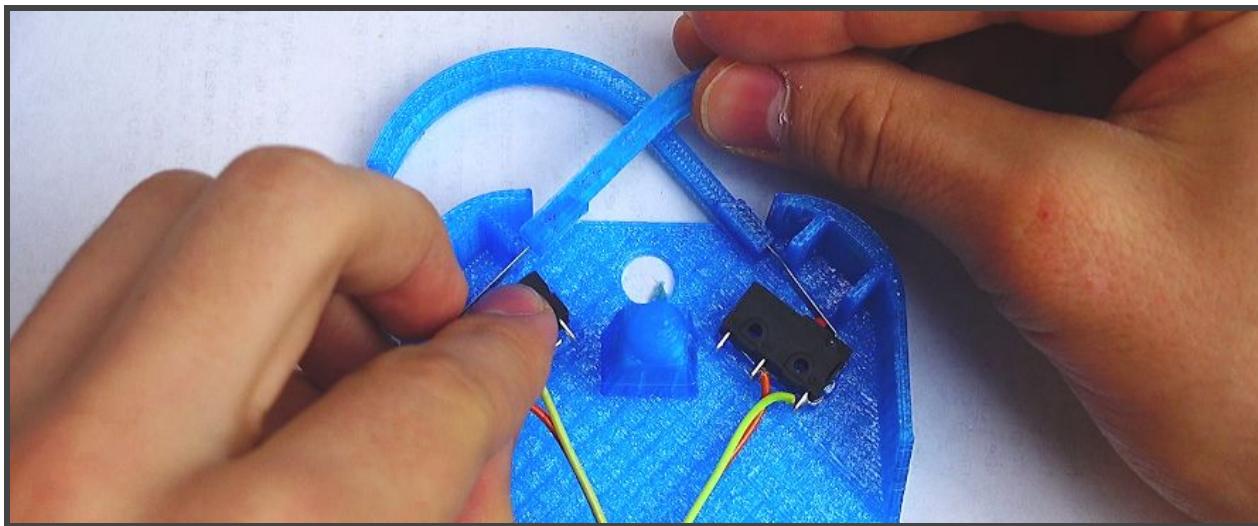
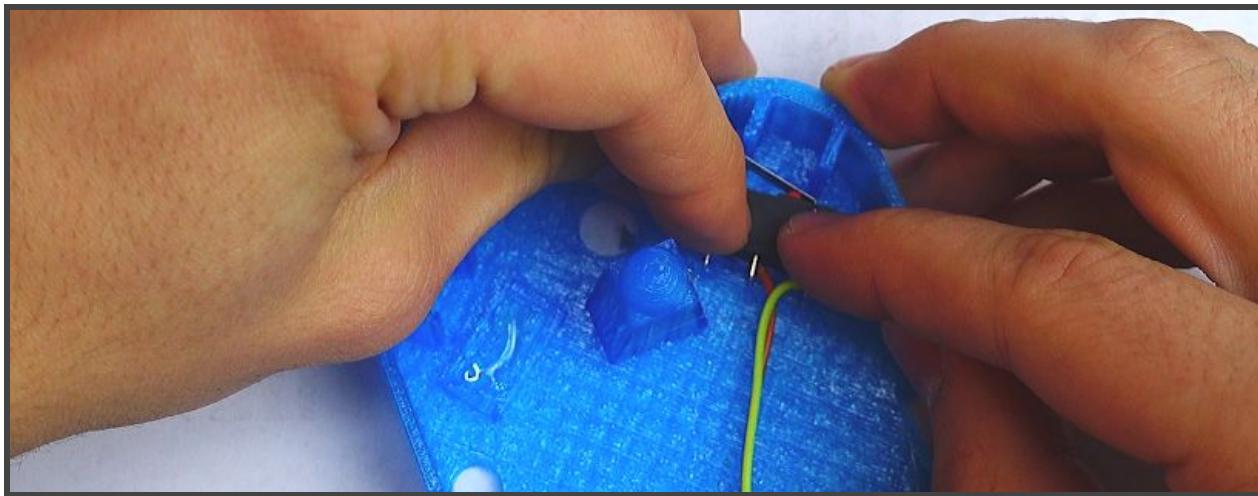




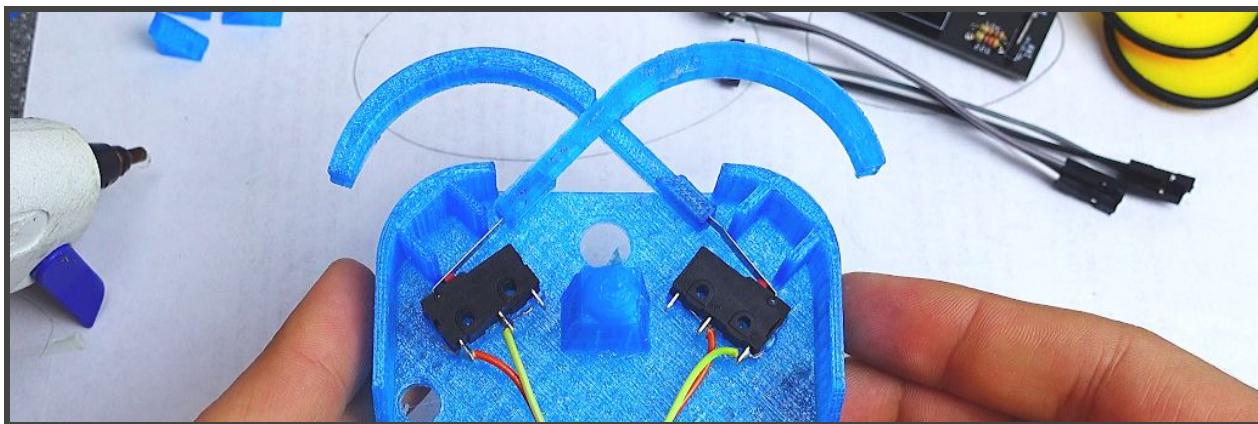
- Insert the bump sensors into the antenna pieces, as shown

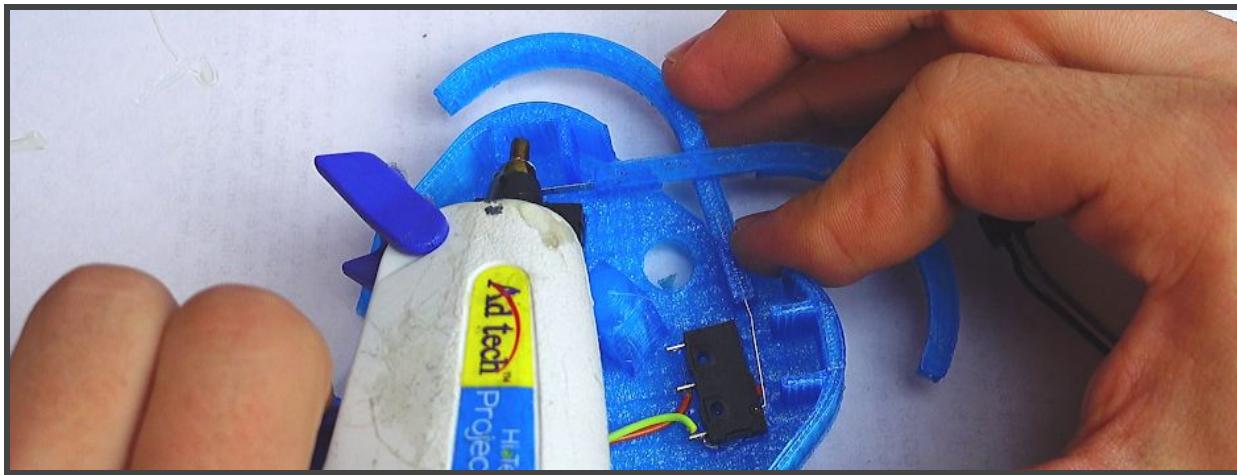


- Put a dab of hot glue on each of the bump sensor platforms

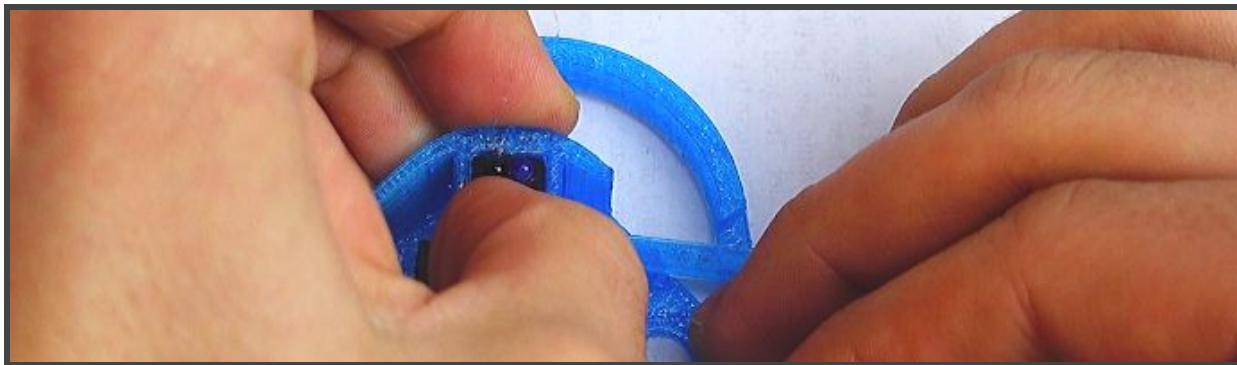


- Place each bump sensor on a platform, lining the sensors up with the edges of the platforms.

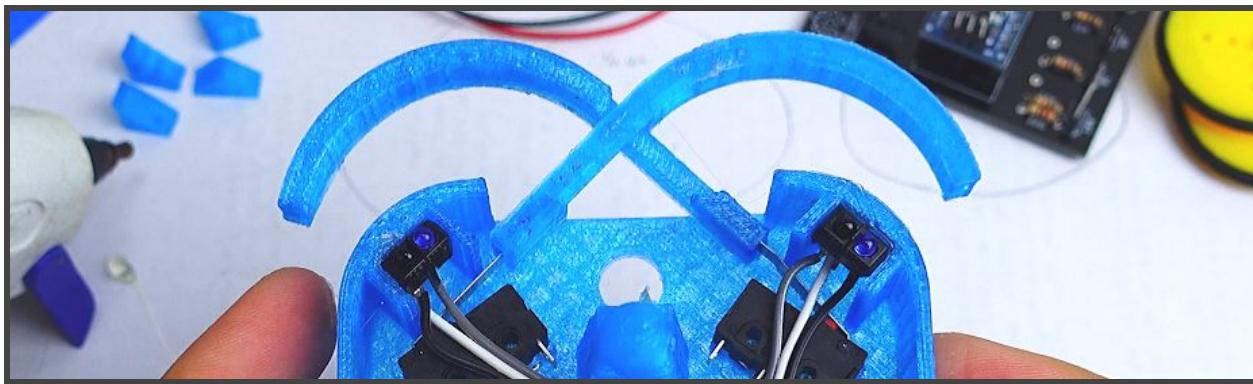




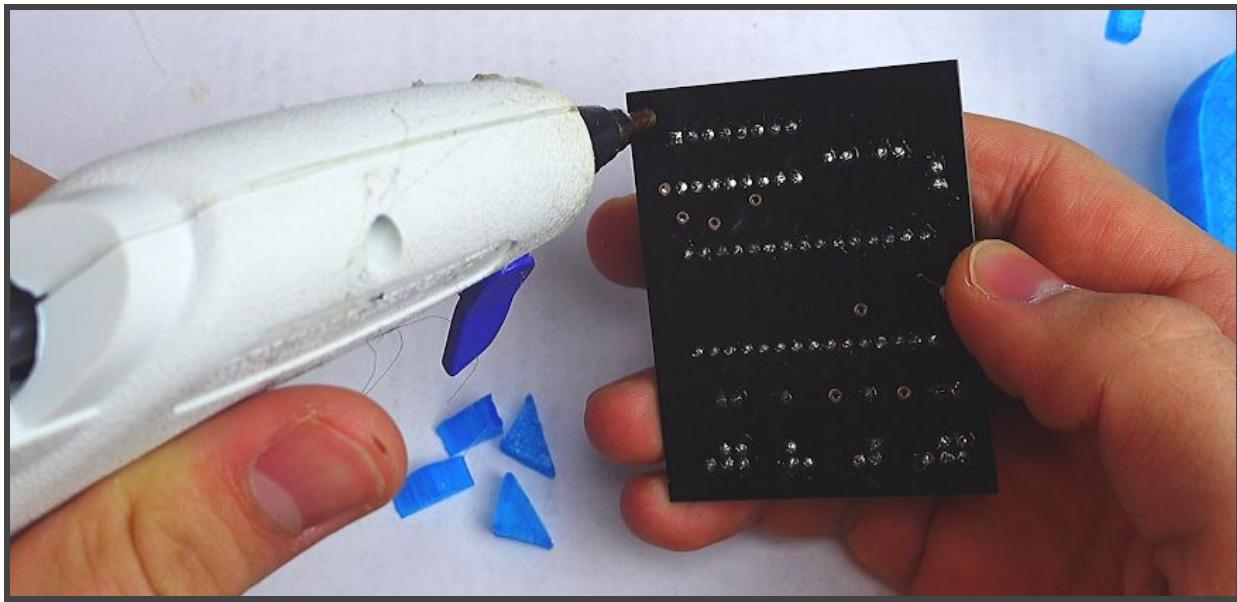
- Put a dab of glue at the top of one of the IR Sensor mounts



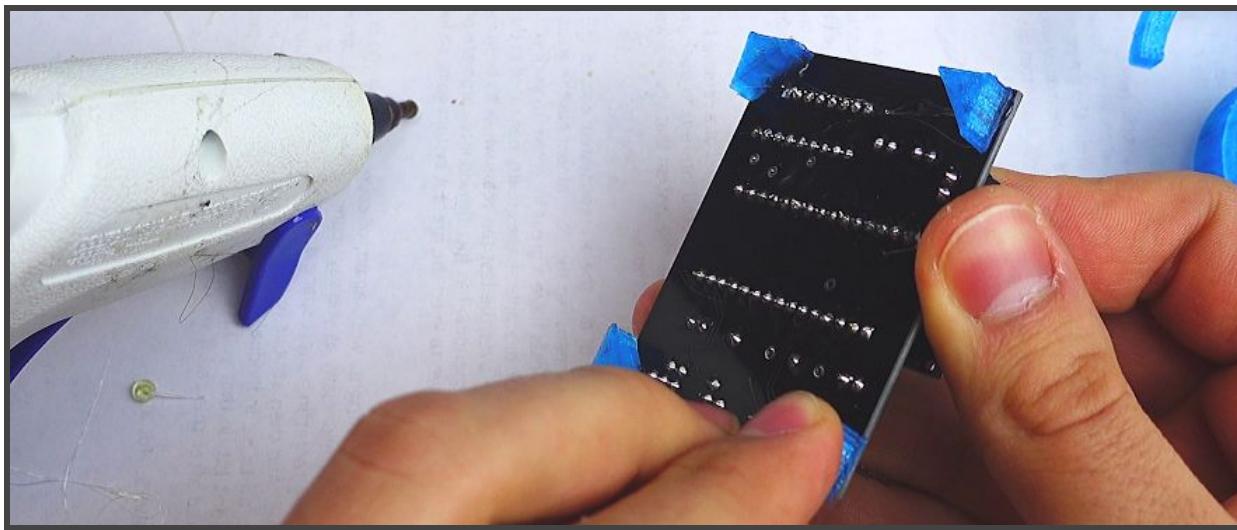
- Bend the wires out of the way, then insert an IR Sensor, so that the top is a little higher than the top of the base



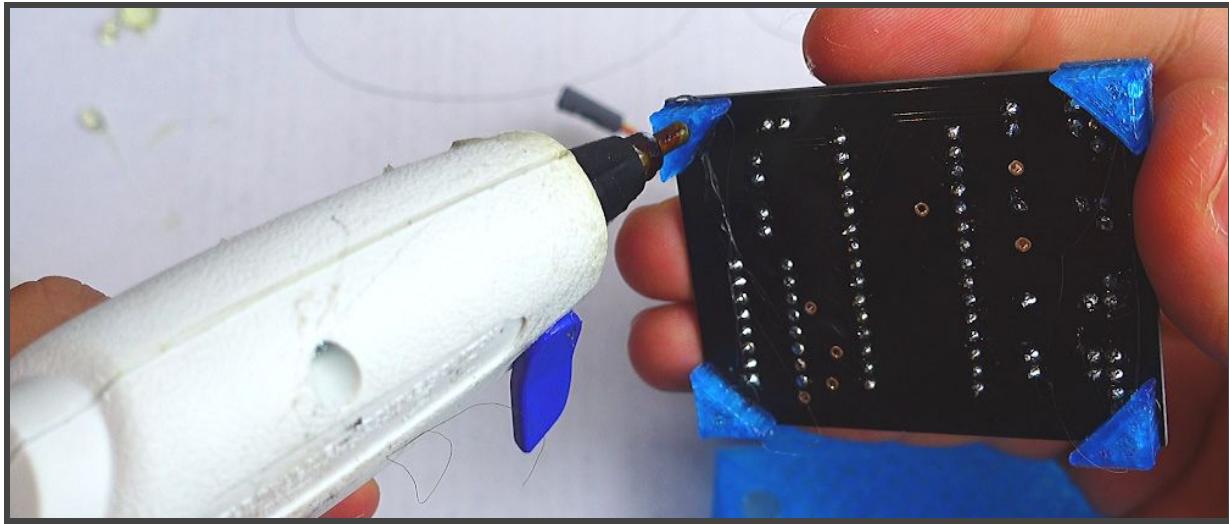
- Repeat for the other side and sensor



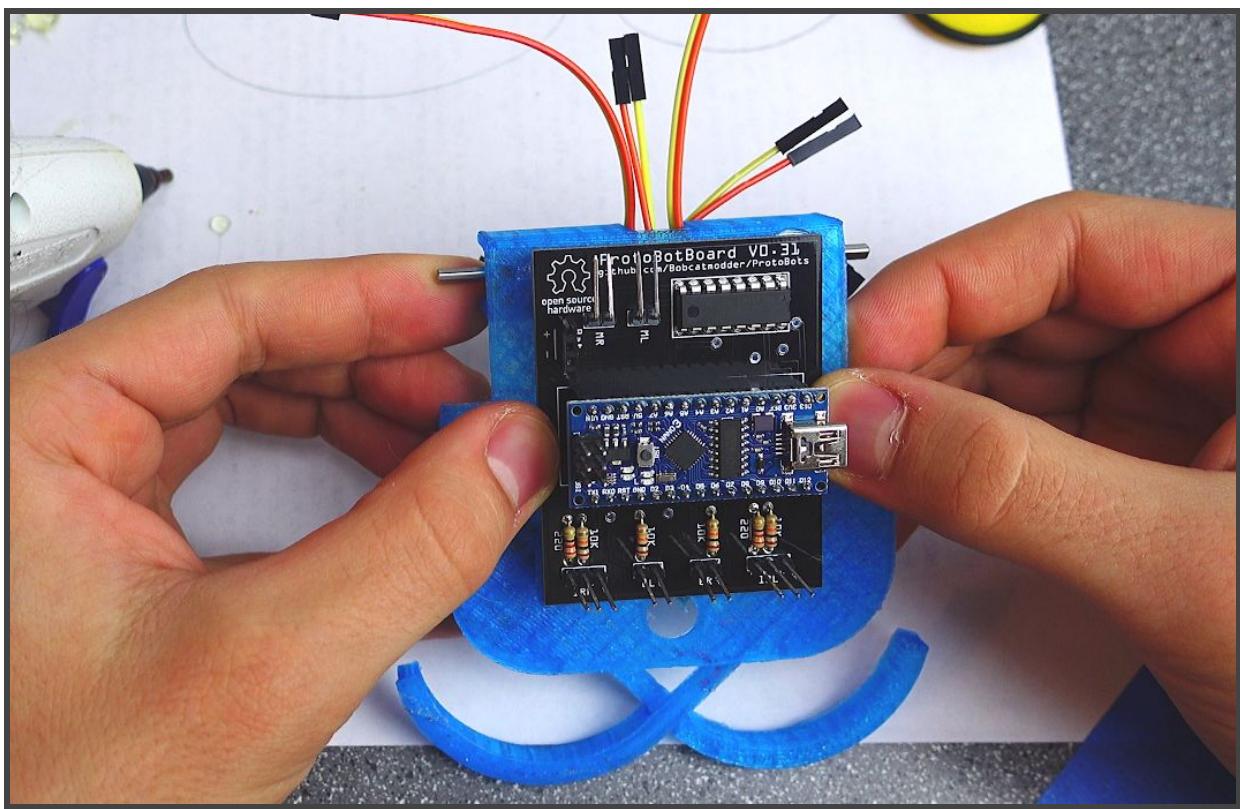
- Put a dab of hot glue on each corner on the underside of the ProtoBotBoard



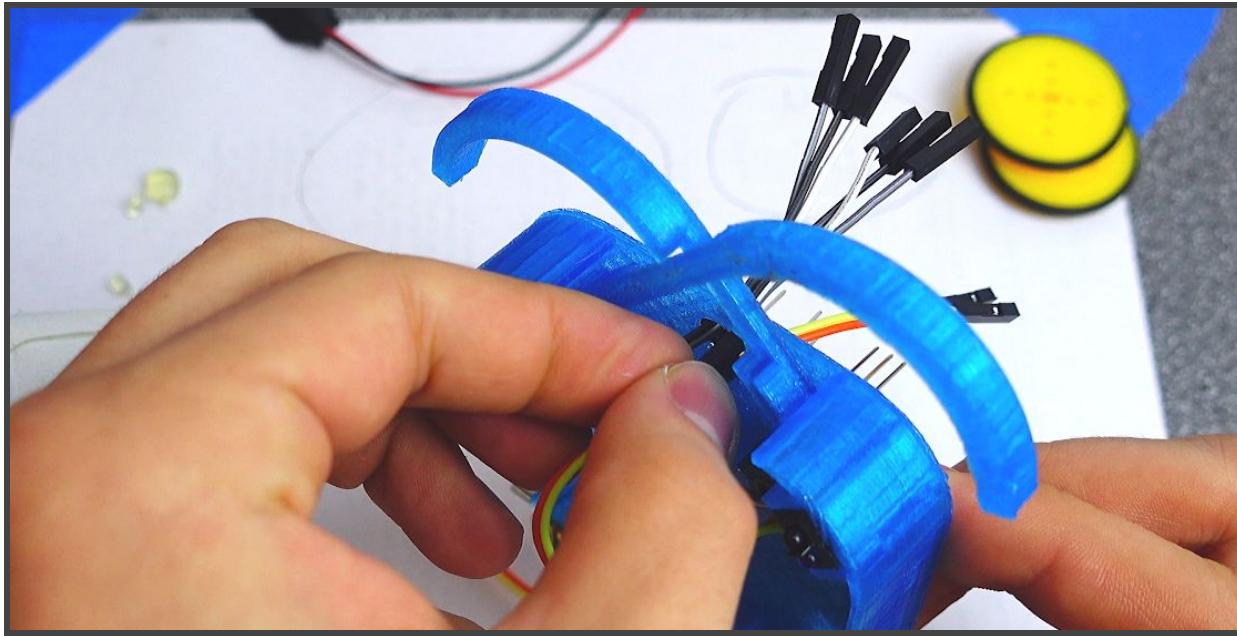
- Glue each of the board supports in place, at the four corners



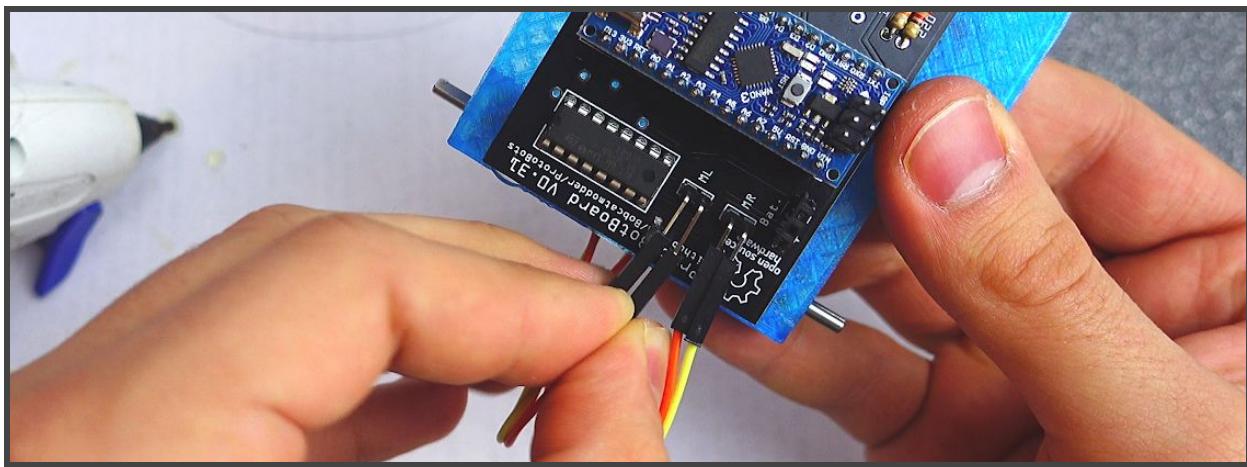
- Add a dab of glue to each ProtoBotBoard support



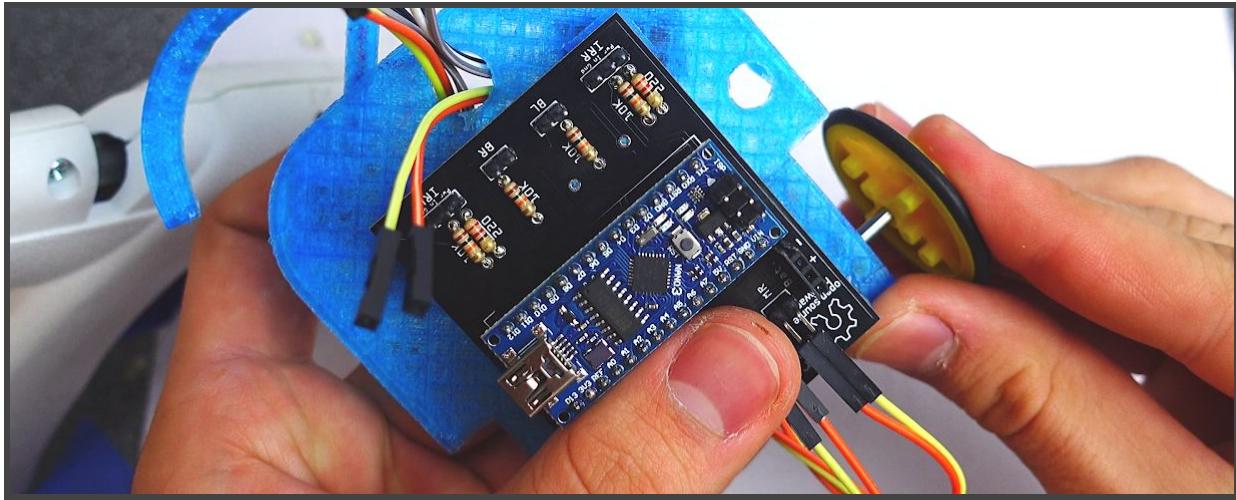
- Glue the ProtoBotBoard to the base, with the sensor pins facing forwards, as shown.



- Feed all the sensor wires through the hole in the front of the ProtoBot Base

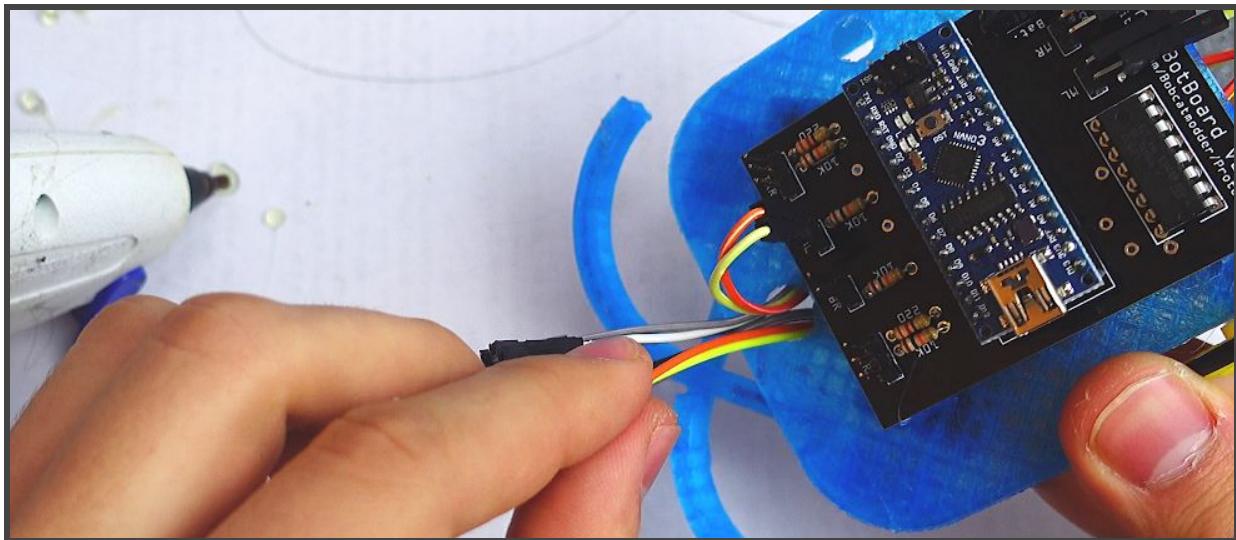


- Connect the wires from the motors to their respective ports, "ML" for the left motor, and "MR" for the right



- Attach the wheels to the motors

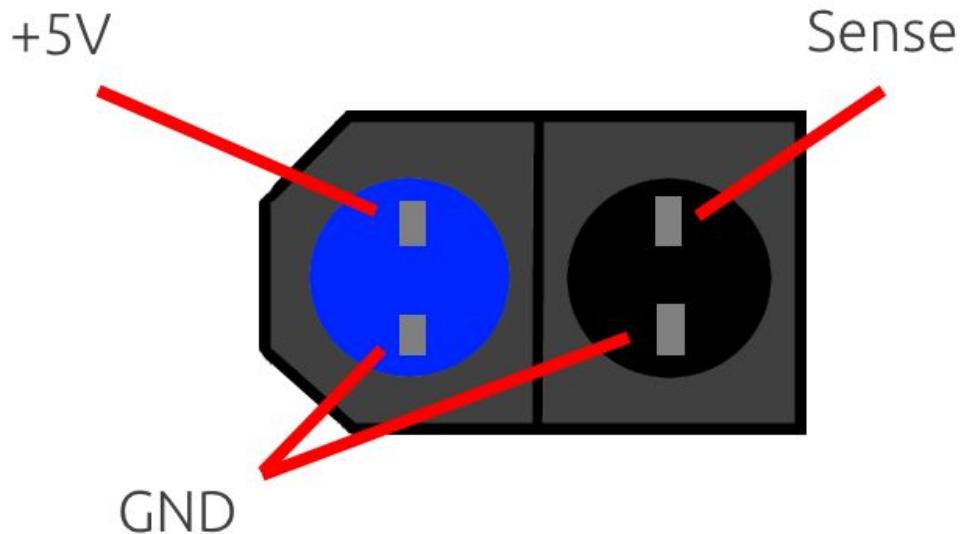
If the wheels are yellow, you might want to add a bit of hot glue to hold them in place. If they are pink, they will have a “D” shaped hole, and they do not need glue.



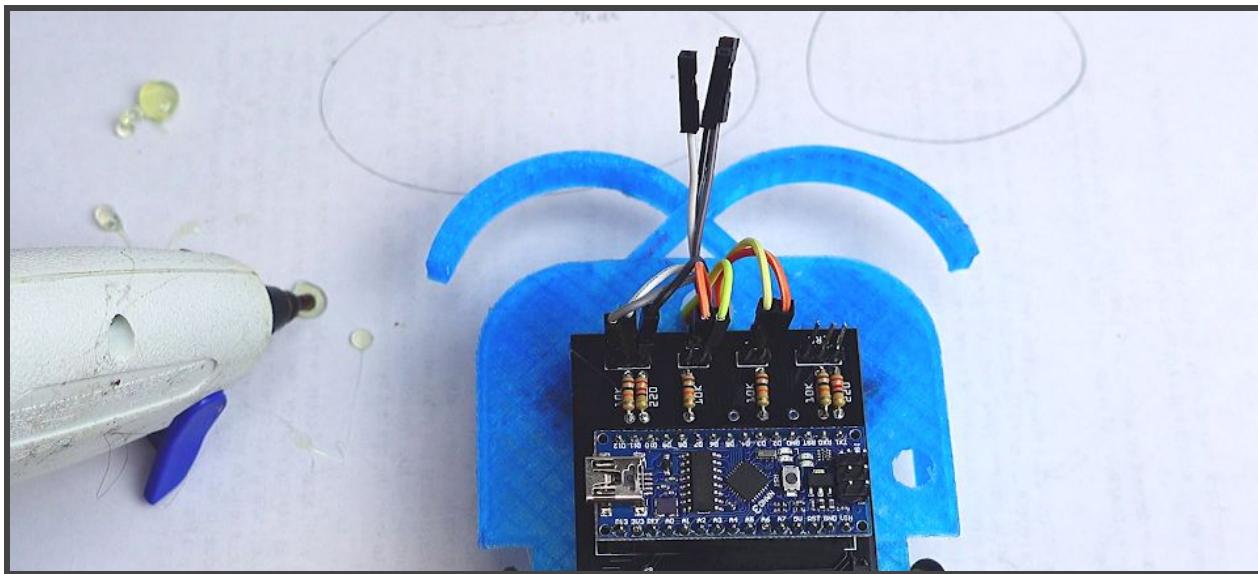
- Attach the bump sensors to their ports, “BL”, and “BR”.

Note: The sensor on the right side is actually the left sensor, because the antenna is on the left.

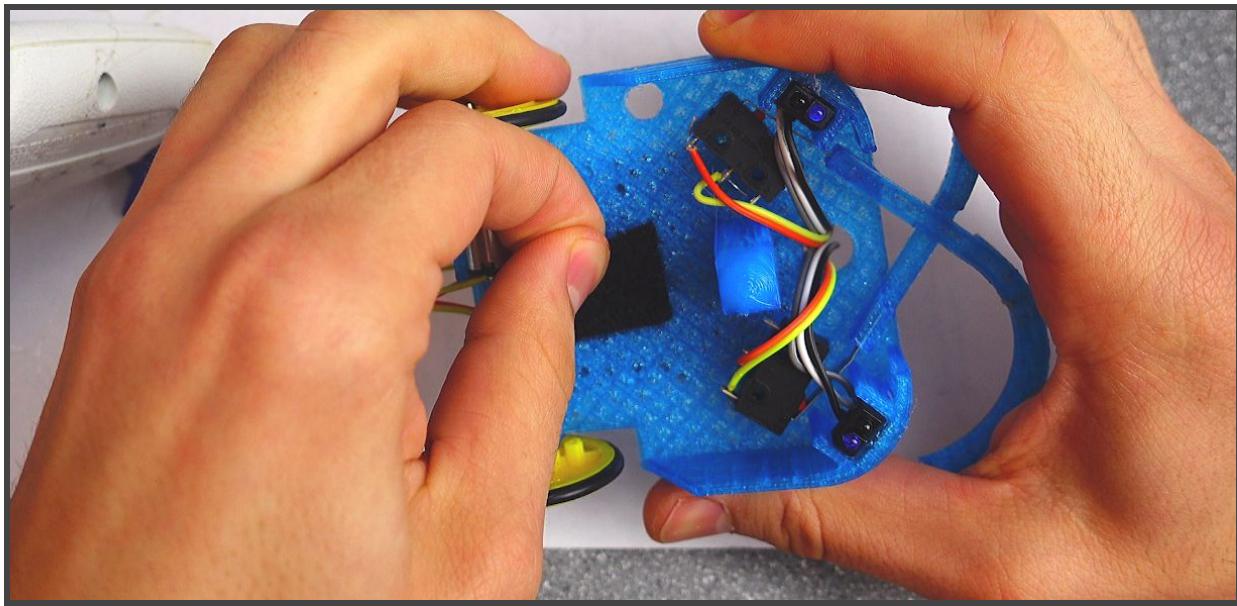
TCRT5000L IR Sensor - Pinout from Underside



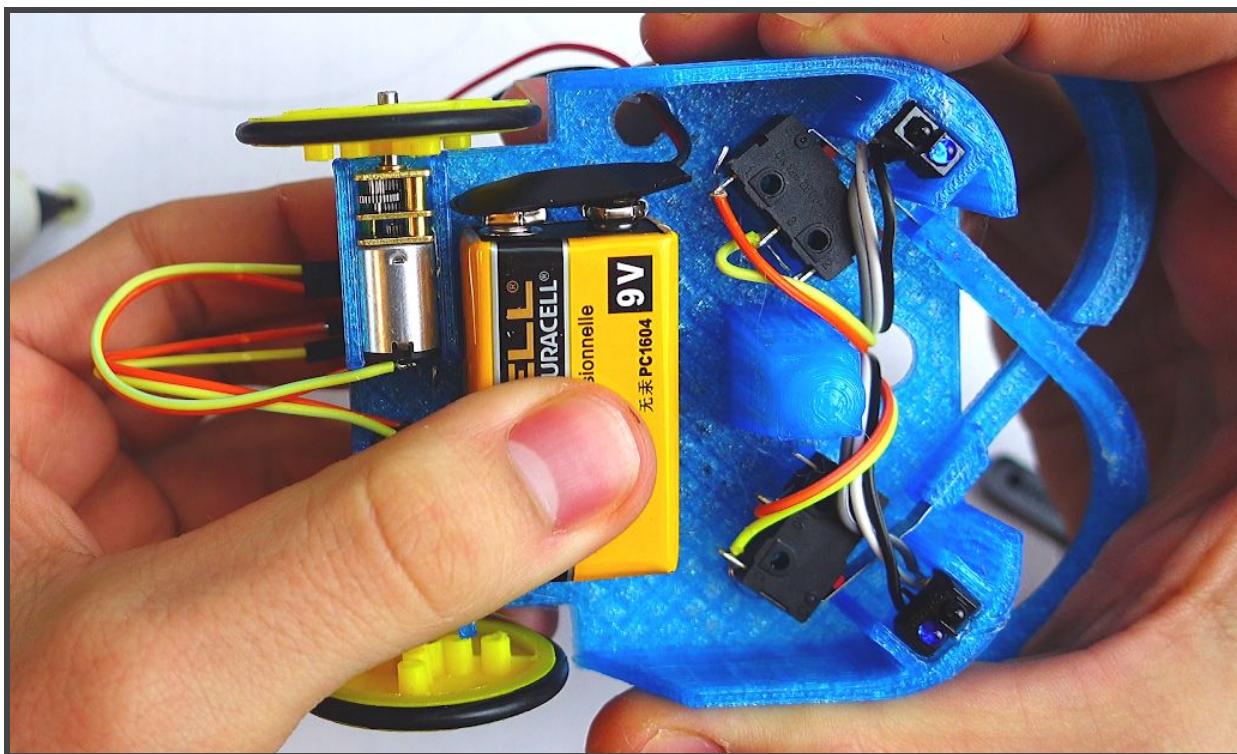
To use the sensor, connect both GNDs to Ground, then connect +5V to 5V through a 220ohm resistor. The sense pin connects to an analog Read pin on your microcontroller, with an additional 10K resistor between that and 5V. The higher the returned value, the less light is being receiving by the receiver.



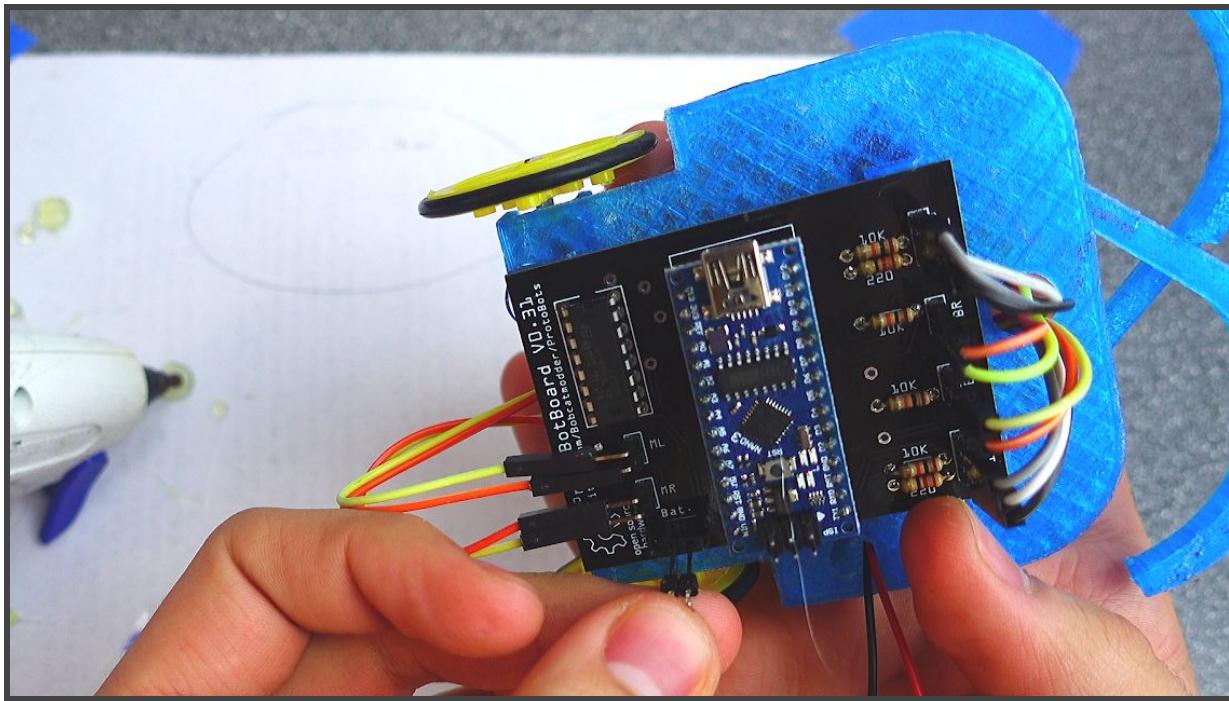
- Based on the diagram, figure out which wires should go where. "+5V" goes to "Pwr", "Sense" goes to "In" and "GND" goes to "GND". The left and right infrared sensors go into their respective ports, "IRL" and "IRR".



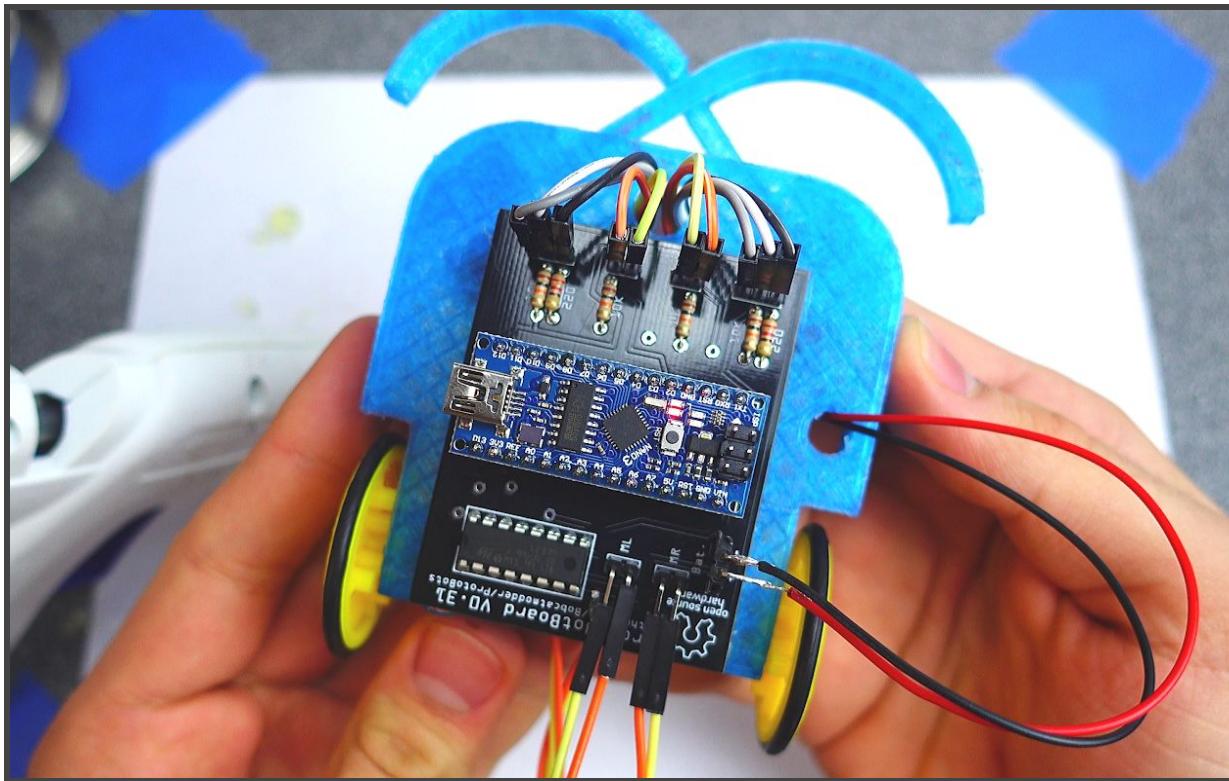
- Place one of the pieces of hook and loop fastener, and attach it to where the battery will be under the ProtoBot base



- Attach the other piece to the 9V Battery, then feed the wire through the hole in the side of the base



- Plug the battery into the ProtoBotBoard



If the Arduino lights up, and no magic smoke escapes, you've successfully built a ProtoBot!