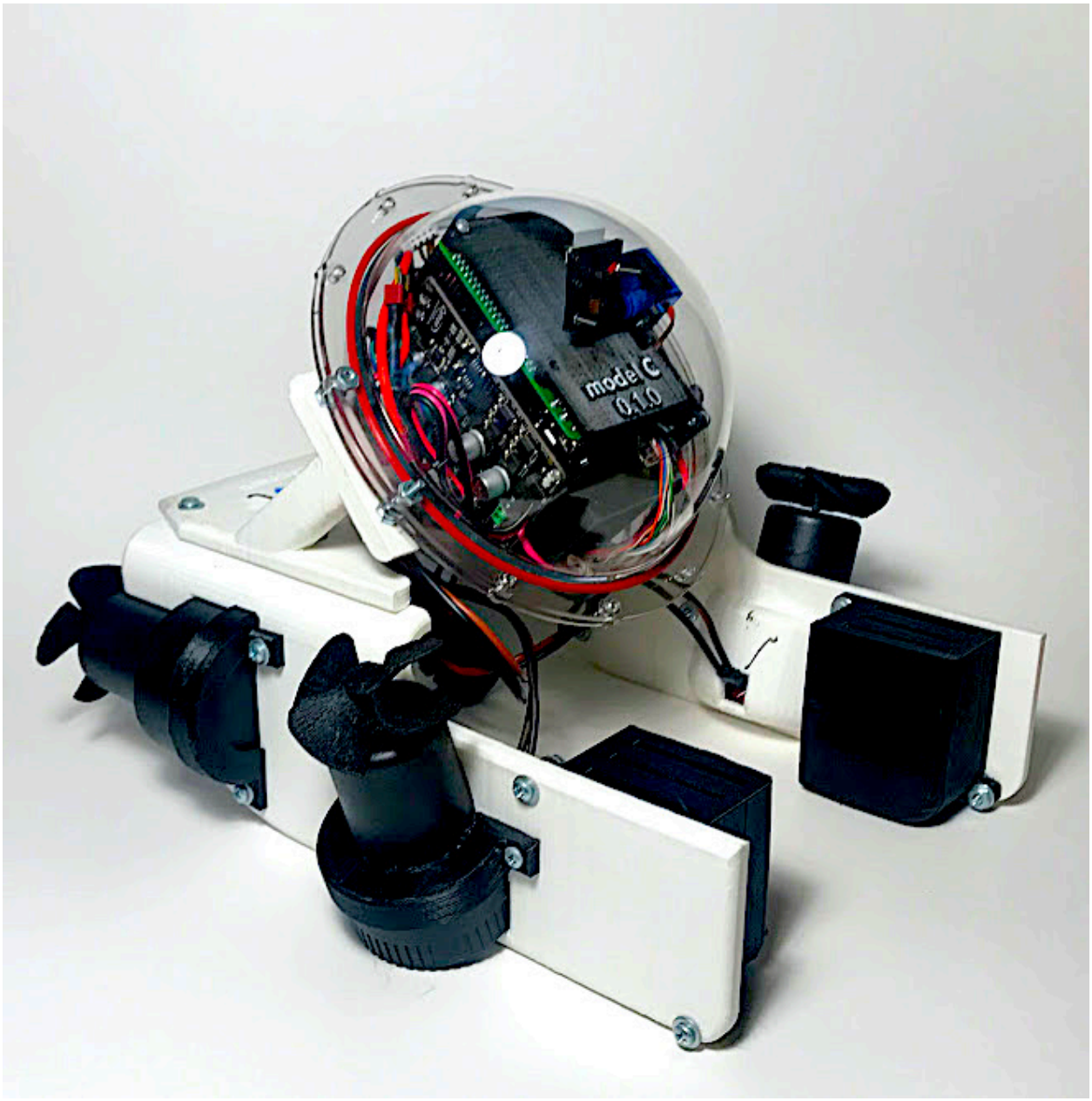
Guide 0

Introduction



MODEL C version 0.1.0
ASSEMBLY MANUAL

PARTS LIST

Submersible Hardware:

Part	Quantity
Forward Acrylic Dome	1
Rear Acrylic Dome + Tether	1
Left Rail	1
Right Rail	1
Left Thruster	2
Right Thruster	2
Internal Electronics Cradle	1
Faceplate	1
Camera Mount	1
Motor Driver	2
Raspberry Pi 3B	1
9 Gram Servo Motor	1
5 Mpx RPi Camera	1
3S 2200 Mah LiPo Battery	1
12V-5V DC Converter	1
Waterproof CAT5 Connector	1
T-Plug Y-Harness	1
Motor Driver Y-Harness	1

Fasteners:

Part	Quantity
6-32 ½ inch Machine Screw	22
6-32 1 inch Machine Screw	2
6-32 Nut	38
2-56 ½ inch Machine Screw	4
2-56 Nut	4
4-40 ½ inch Machine Screw	8
4-40 Nut	6
Servo Screw	1

Topside WiFi Module:

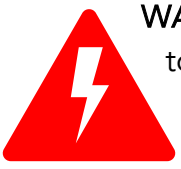
Part	Quantity
Mini WiFi Router	1
Power Source	1
WiFi Module Hatch	1
WiFi Module Housing	1
Micro USB Cable	1

WARNING: Small parts pose a choking hazard to children. Do not allow children to use this product without adult supervision.

Tools:

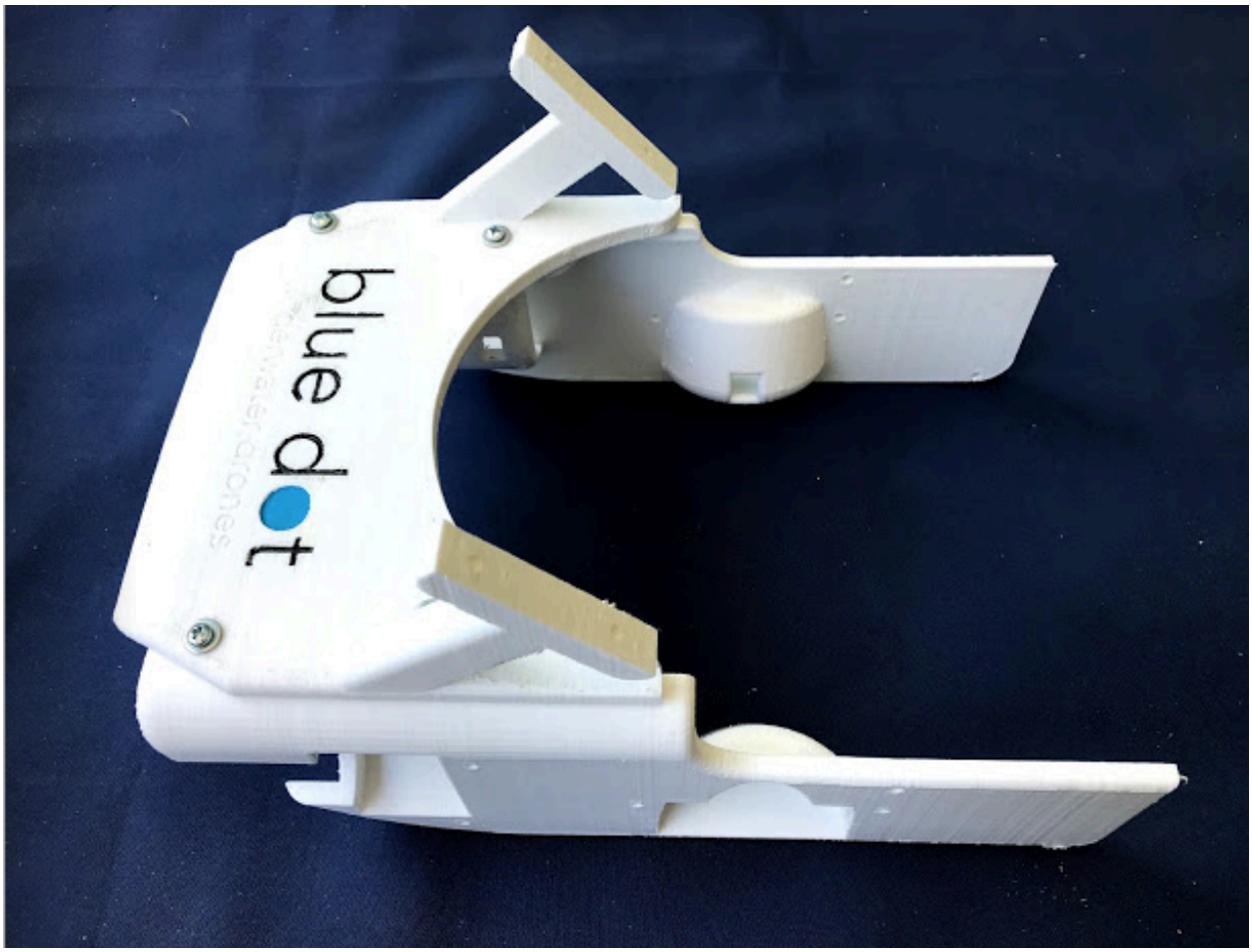
Soldering Iron
Rosin Core Solder
Sandpaper
Epoxy
Phillips Screwdrivers
Flathead Screwdrivers
Balance Charger

WARNING: Follow Balance Charger's Directions carefully to safely charge your LiPo Battery. Failure to do so may cause a fire. Blue Dot ROV is not responsible for any resulting damages.



WARNING: Follow your soldering iron's directions carefully, and make sure to use it in a well-ventilated area. Do not leave your soldering iron plugged in and unattended. Failure to do so may cause serious injury or death. Blue Dot ROV is not responsible for any resulting damages.

Guide 1
External Structure



Parts Needed:

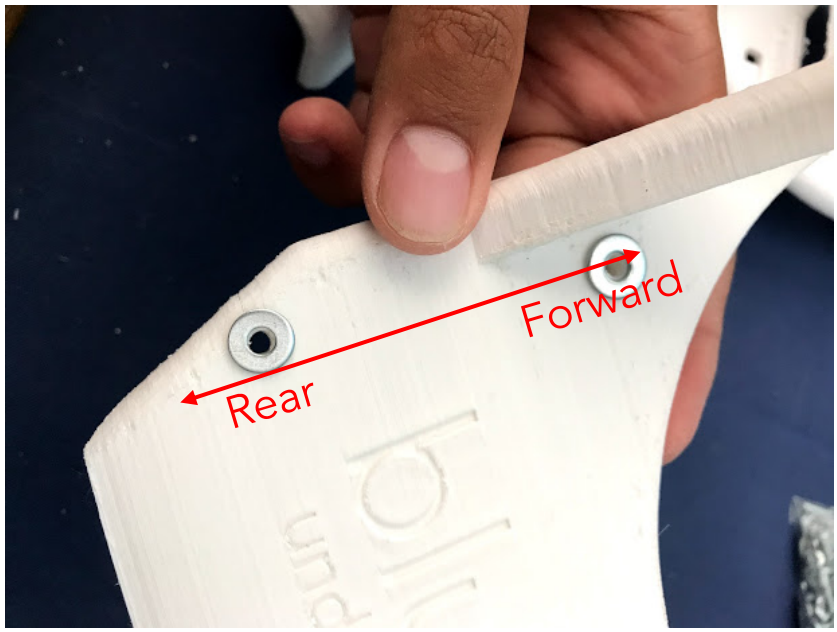
Part	Quantity
Left Rail	1
Right Rail	1
Deck	1
6-32 ½ inch Machine Screw	4
6-32 Nuts	4
6-32 Washer	4

Tools Needed:

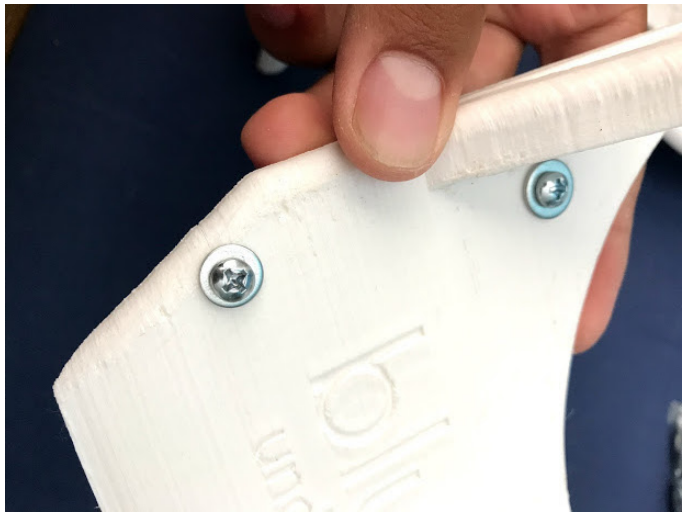
Phillips Screwdriver

Step 1 Attach Left Rail to the Main Deck

- Place one **washer** over each of the two left-hand pre-tapped holes on the **main deck's** left side:



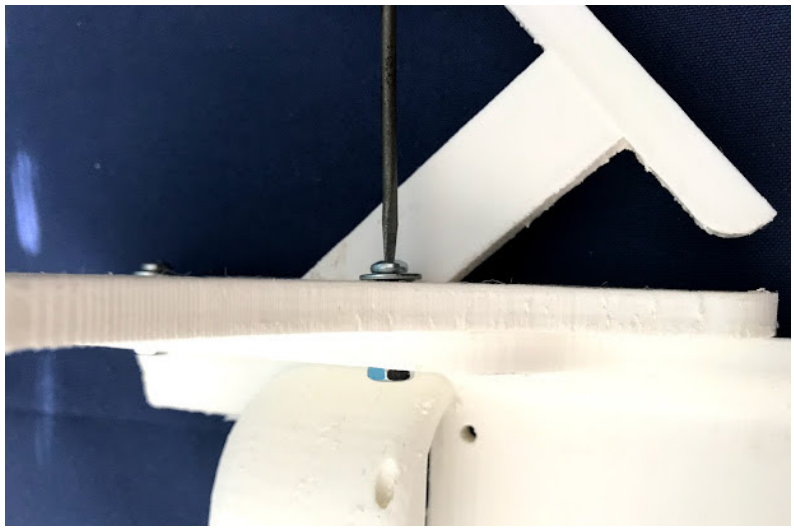
- Thread one **6-32 1-inch machine screw** through the rear pre-tapped hole, and a **6-32 ½-inch machine screw** through the forward pre-tapped hole



- Slide each screw through the corresponding pre-tapped holes on the **left rail**. Continue to push until they emerge on the other side:

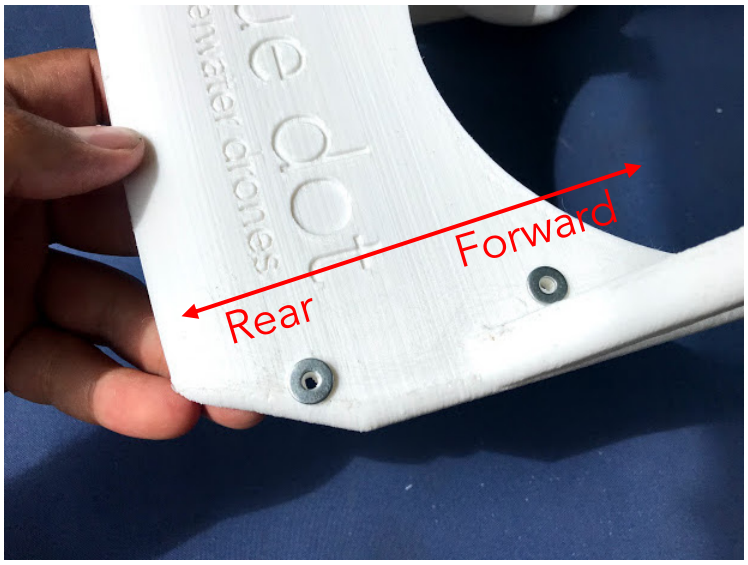
- Thread a **6-32 nut** onto each screw until hand tight.

- Use a screwdriver to further tighten the machine screws, again until hand tight. Be sure that the Left Rail is flush against the Main Deck.

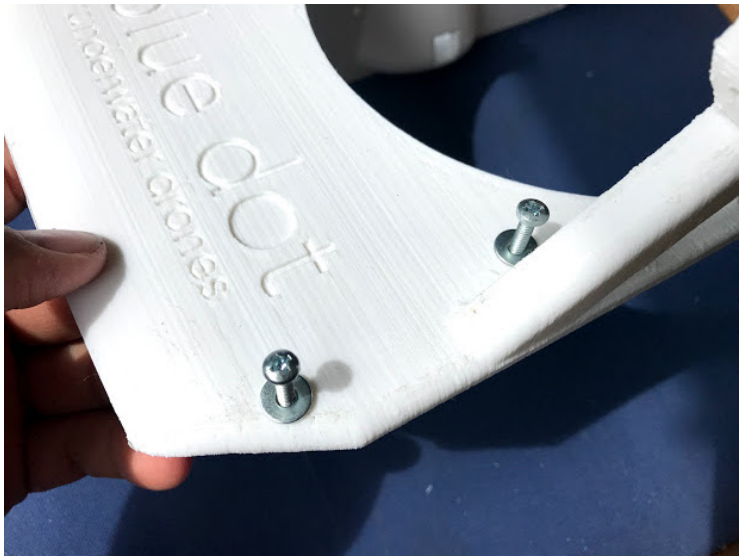


Step 2 Attach Right Rail to the Main Deck

- Place one **washer** over each of the deck's two right-hand pre-tapped holes:



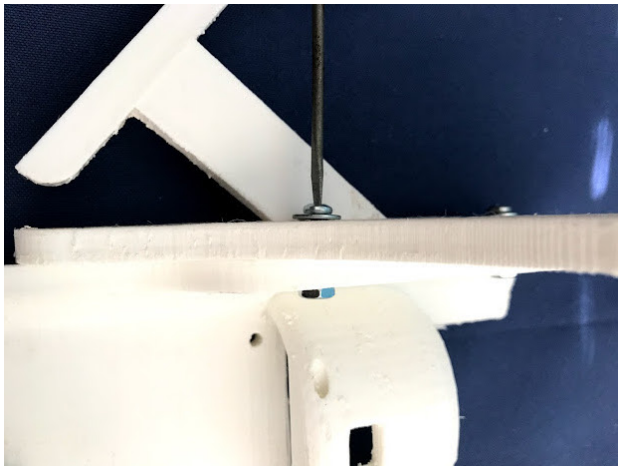
- Thread one **6-32 1-inch machine screw** through each rear pre-tapped hole, and a **6-32 ½-inch** machine screw through the forward pre-tapped hole



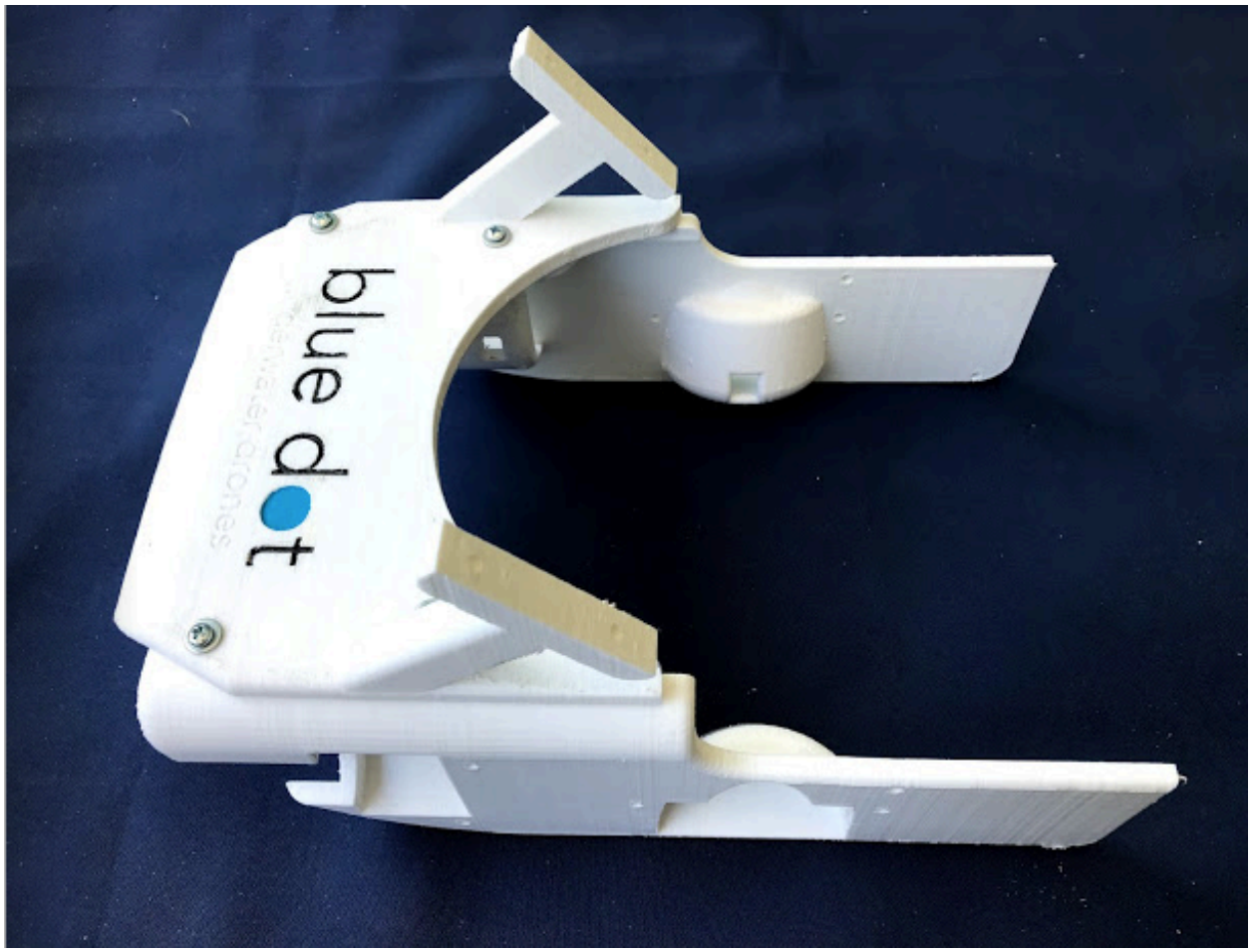
- Slide each screw through the corresponding pre-tapped holes on the **right rail** Continue to push until they emerge on the other side:

- Thread a **6-32 nut** onto each screw until hand-tight:

- Use a screwdriver to further tighten the machine screws, again until hand tight. Be sure that the left rail is flush against the main deck.



- Now, your external assembly should look like this:



Step 2 Mounting the Thrusters

Parts:

Part	Quantity
Left Thruster	2
Right Thruster	2
Left Horizontal Motor Brace	1
Right Horizontal Motor Brace	1
Vertical Motor Brace	2
6-32 ½ inch Machine Screw	8
Machine Nut	8

Tools:

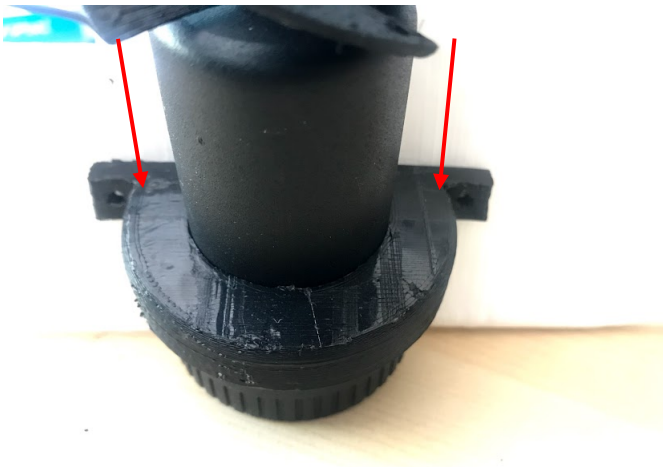
Phillips Screwdriver
Soldering Iron
Rosin Core Solder

WARNING: Follow your soldering iron's directions carefully, and make sure to use it in a well-ventilated area. Do not leave your soldering iron plugged in and unattended. Failure to do so may cause serious injury or death. Blue Dot ROV is not responsible for any resulting damages.

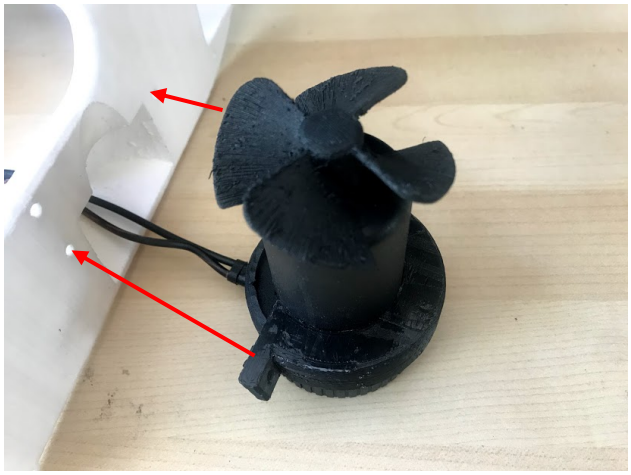
Step 2.1 Mounting the Left Vertical Thruster

- With your soldering iron, tin the metal leads of a **left thruster**

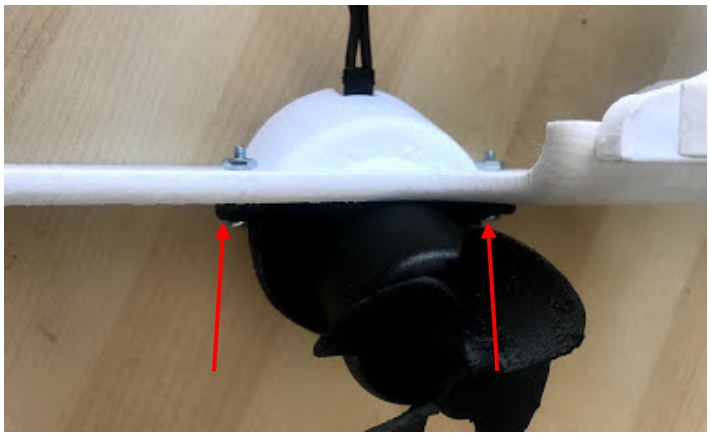
- Slide a **vertical motor brace** just beneath the propeller. Then slide it down to the base of the motor.



- Thread the two leads of your left thruster through the hole in the vertical motor mount on the Left Rail.



- Push the motor into the vertical motor mount. Meanwhile, keep pulling the leads through the hole to make sure no slack gets caught between the thruster and the mount. Continue until the motor is flush against the vertical motor mount.

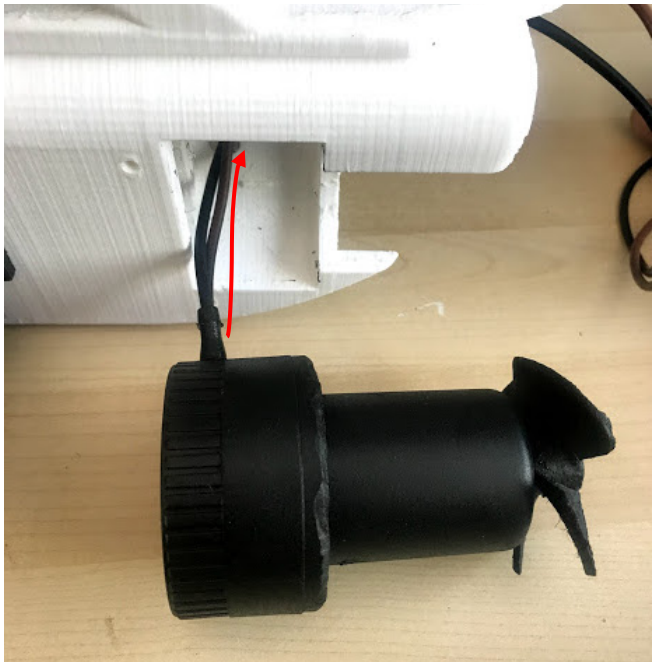


- Thread a **6-32 ½ inch machine screw** through the pre-tapped holes on the motor brace, and the corresponding holes on the rail. Tighten each into place with a 6-32 nut.

- To install the **right vertical thruster**, use a right thruster and repeat step 2.1 on the Right Rail.

Step 2.2 Installing the Left Horizontal Motor

- Use your soldering iron to tin the metal leads of your remaining **left horizontal thruster**.

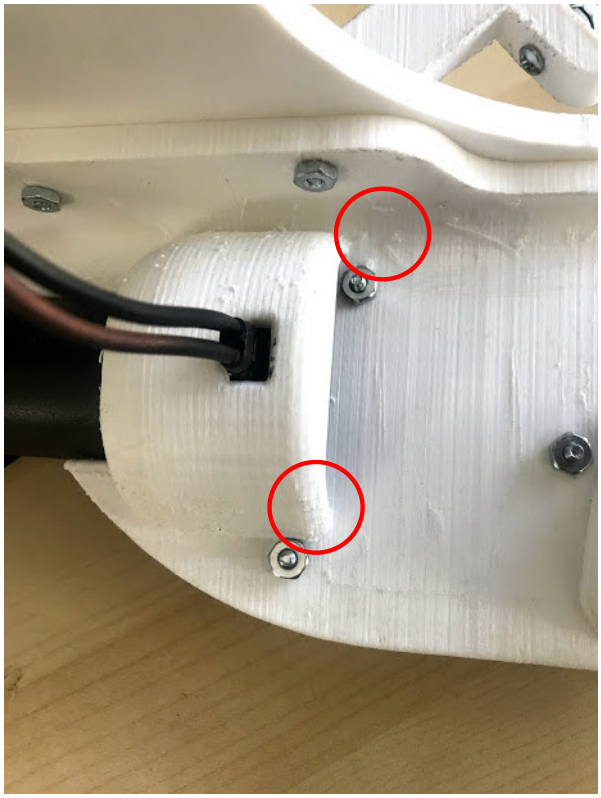


- Thread the thruster's wires through the small rectangular opening on the inside of the left motor mount:

- Push the motor into the horizontal motor mount. As with the vertical motors, keep pulling the leads through the hole to make sure no slack gets caught between the thruster and the mount. Continue until the motor is flush against the inside of the motor mount.

- Slide the **left horizontal motor brace** over the forward edge of the motor. Make sure the brace's pre-tapped holes are aligned with those of the Left Rail.

- Screw one **6-32 ½ inch machine screw** through each of the two pre tapped holes on the brace until they emerge from the inner side of the Left Rail.



- Thread a **6-32 nut** on each screw from the inside of the left rail until hand tight. Then, use your screwdriver to tighten the machine screws until hand tight.

Step 2.3 Installing the Right Horizontal Thruster

- Use your soldering iron to tin the metal leads of your remaining **right thruster**.

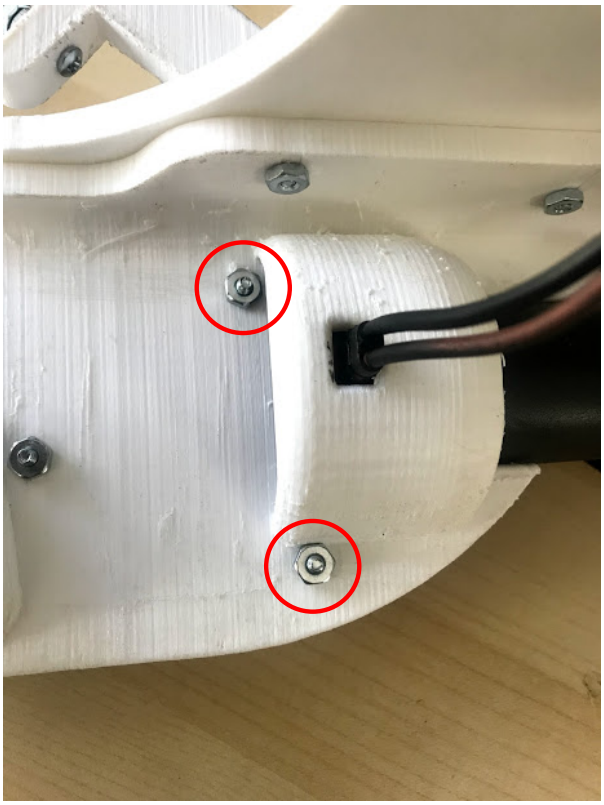
- Thread the right thruster's wires through the small rectangular opening on the inside of the right rail's horizontal motor mount:

- Push the motor into the horizontal motor mount. Pull the leads through the hole to make sure no slack gets caught between the thruster and the mount. Continue until the motor is flush against the vertical motor mount.

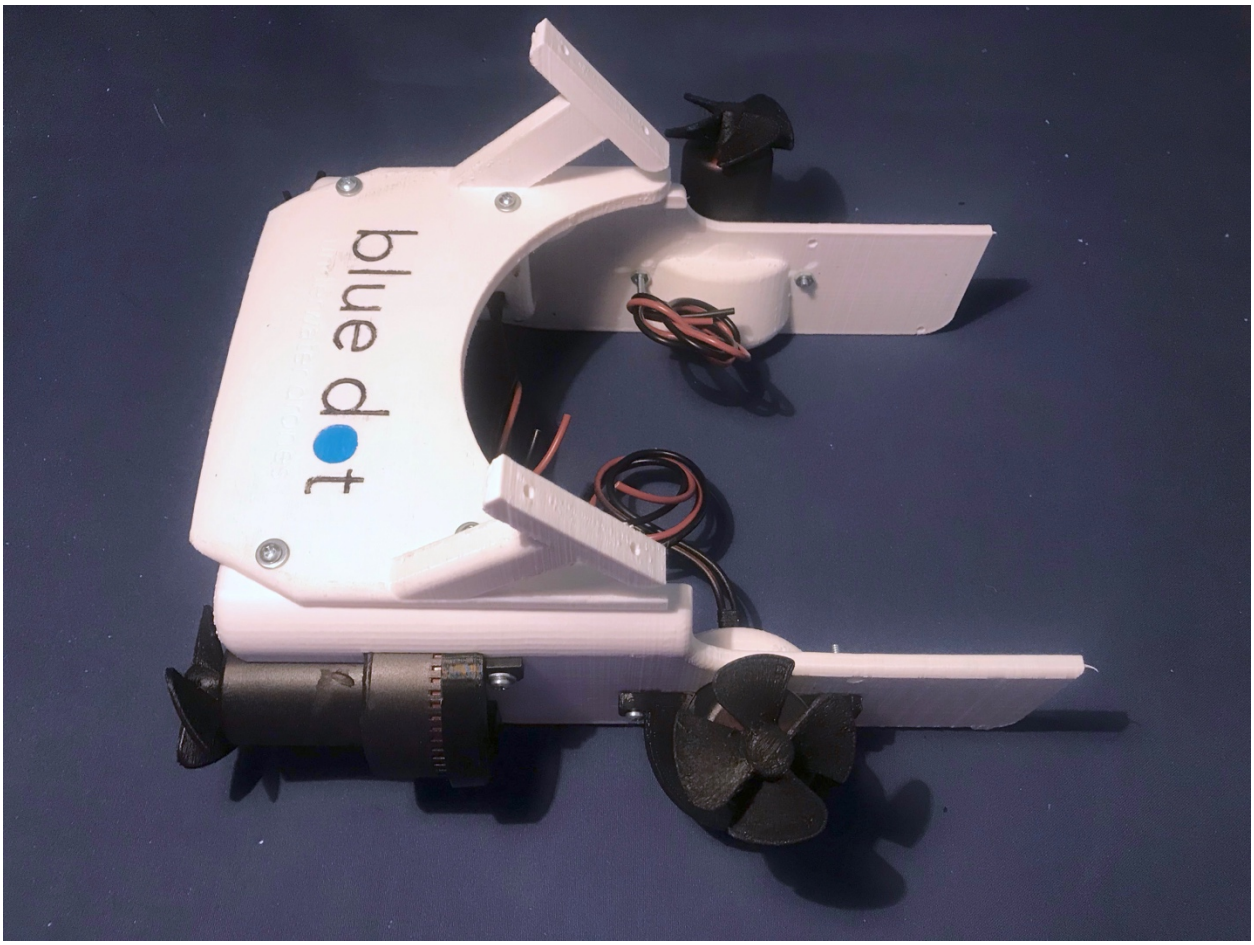
- Slide the **right horizontal motor brace** over the forward edge of the motor. Make sure the brace's pre-tapped holes are aligned with those of the Left Rail.

- Thread a **6-32 ½ inch machine screw** through each of the two pre-tapped holes on the brace until they emerge from the inner side of the Left Rail.

- Thread a **6-32 nut** on each screw from the inside of the Left Rail until hand tight. Then, use your screwdriver to tighten the machine screws until hand tight.



- Your External Structure should now look like this:



Guide 2
The Pressure Sphere

Parts:

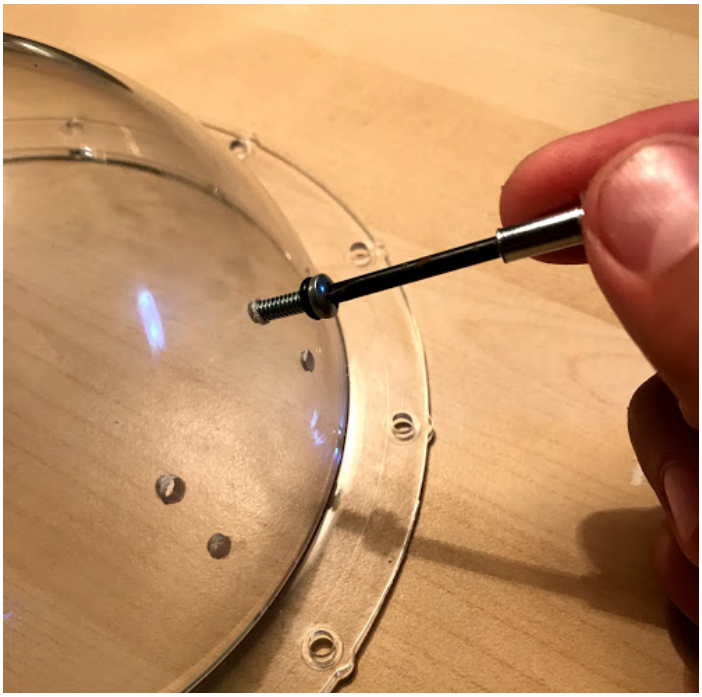
Part	Quantity
Self-Sealing Machine Screw	8
6-32 Nut	8
Forward Dome	1
Rear Dome + Tether	1
Internal Motor Leads	4

Tools:

Sandpaper
Soldering Iron
Epoxy

Step 1: Install Bulkheads

- Locate the 10 pre-tapped holes on the right and left hand sides of the **rear dome**. Using a **screwdriver**, thread one **O-ring machine screw** through each hole. As the O-rings form a tight seal, these screws will form watertight bulkheads that allow the internal electronics to safely power the thrusters.



- With a screwdriver, screw each O-ring machine screw until a bead forms along the O-ring (see photos below). Be careful to ensure that the bead surrounds each screw. This will act as a watertight seal when your ROV is diving:

- Thread a **6-32 nut** onto each machine screw until hand tight. Once each nut is hand tight, use your screwdriver to tighten each screw 1/2 to 1 full turn.

- At this point, the entire rear dome assembly should look like this:

- Each O-ring should appear noticeably more flattened. This increases the amount of contact between the O-rings, Machine Screws, and the dome.

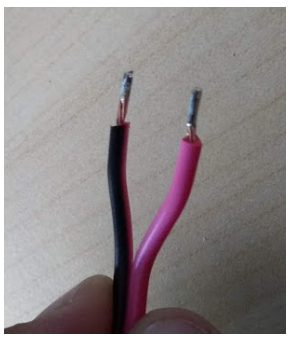
Step 2 Installing the Internal Motor Leads

- Sand the inward-facing surface of each nut.

- With your soldering iron, tin the sanded surface of each nut:

- Tin positive and negative metal leads on only <u>one end</u> of each **internal motor lead**.

A quick note: Though it's okay if you solder both ends of the lead, we find it helpful to leave one end of each lead without any solder. The wire braid is more malleable and forms a better contact with the motor driver when we install the internal electronics assembly.



- Solder the Internal Motor Leads to the tinned 6-32 Nuts. Although there are many ways to do this, we like to use a few specific conventions:

- Each adjacent pair of nuts connects to one individual motor

- We attach the negative leads to the leftmost nuts. (when the dome is oriented as below, with the inside facing us)

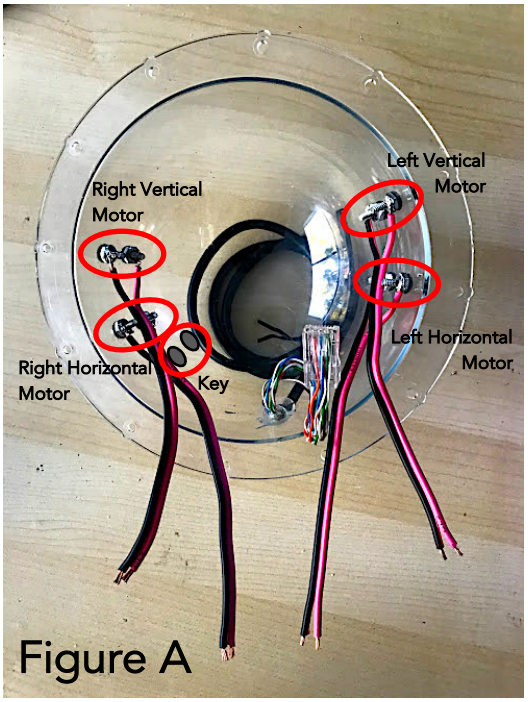
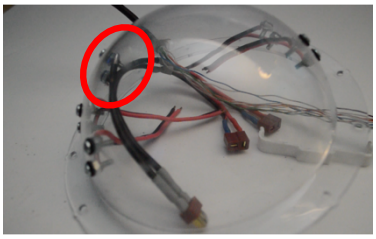


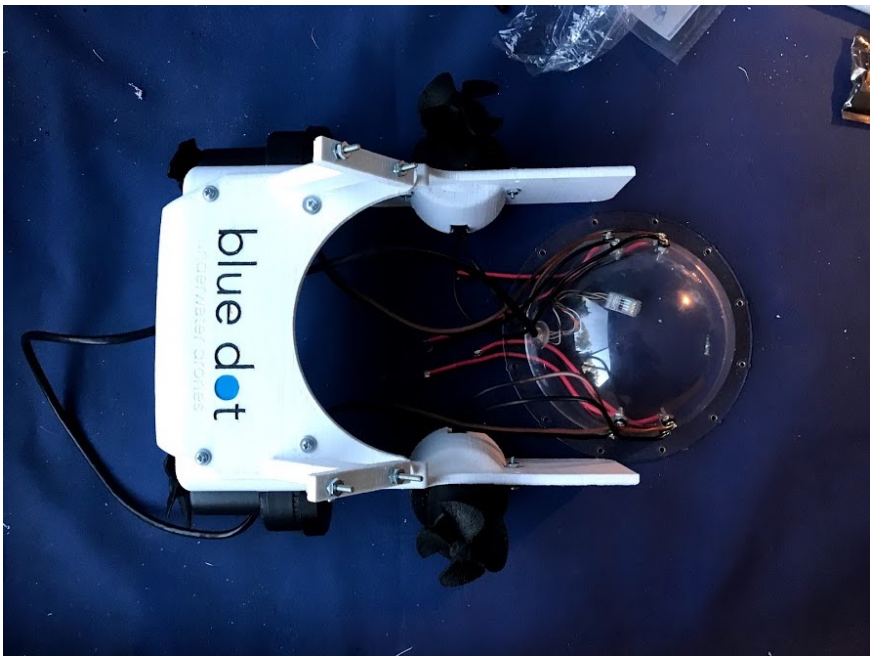
Figure A

- Solder the stripped ends of the **T-plug y-harness** onto the "key" nuts.



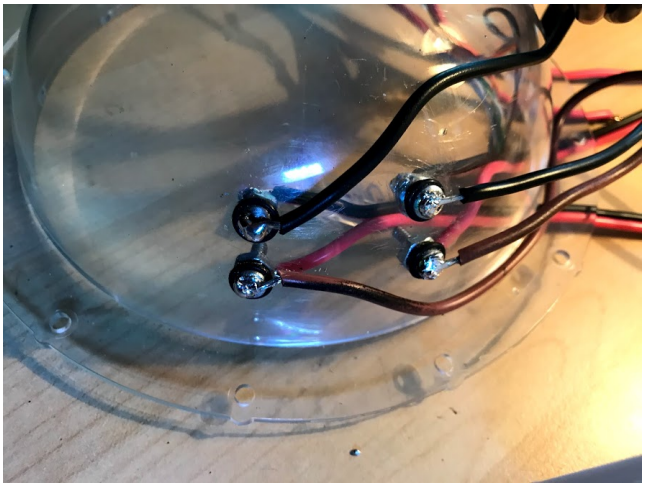
Step 4 Install the Rear Dome Assembly on the Main Structure

- Place the Rear Dome Assembly face-down on your work surface at the front of your completed External Structure:

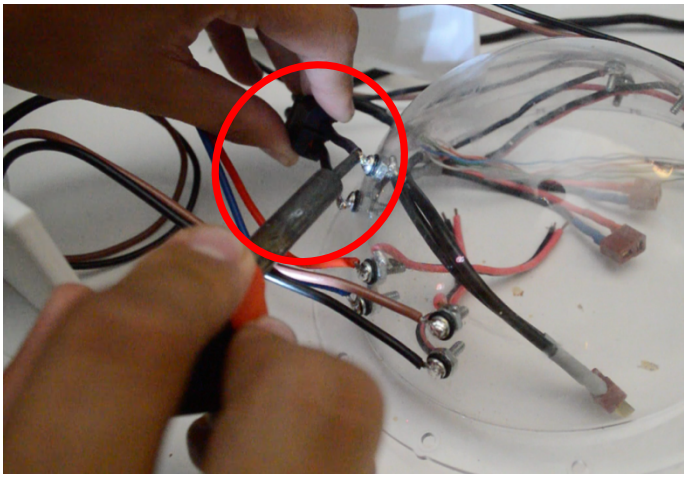


- Sand the screw heads on the outside of the dome, and then tin them with your soldering iron. Take care not to melt your O-rings! To avoid this, we try not to leave the soldering iron

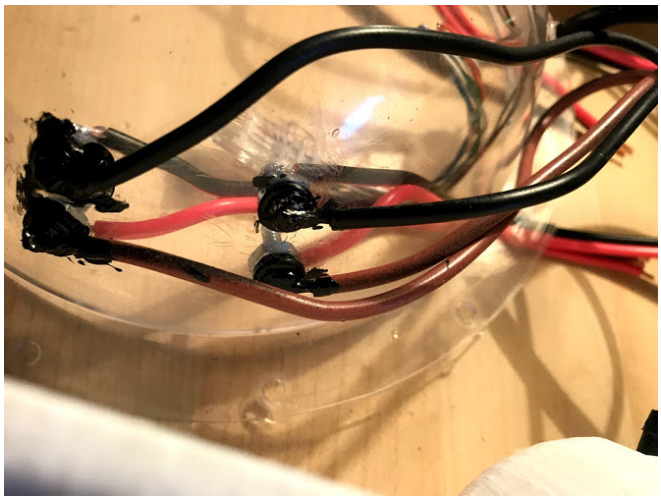
- Solder the tinned thruster leads to the tinned screw heads. Make sure to:
  I. Connect each motor's leads to their corresponding pair of bulkheads as outlined in **Figure A**
  II. Double check that the color of the leads outside each bulkhead match the color of the leads inside that bulkhead. Only solder negative thruster leads (black) to negative Internal Motor Leads (black), and positive thruster leads (brown) to positive Internal Motor Leads (red).



- Tin the **waterproof key socket**, and solder it onto the two remaining outer bulkheads that connect to the T-Plug Y-Harness.

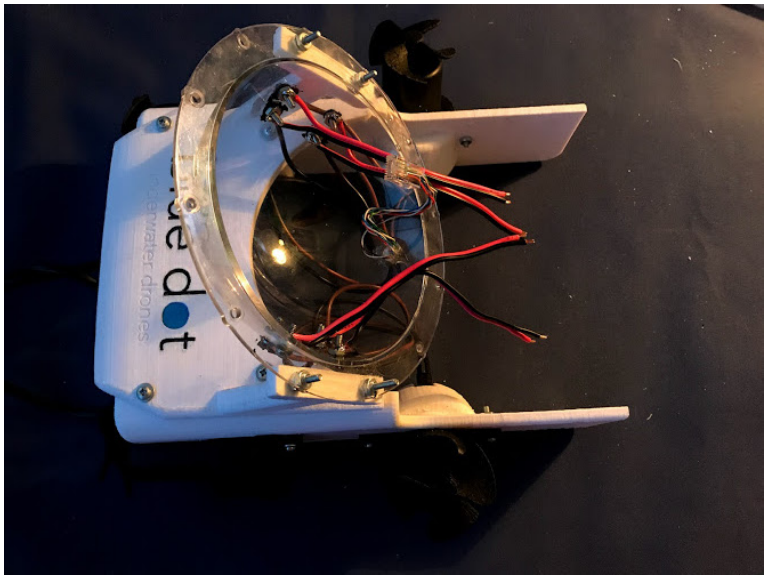


- Paint over the outer bulkheads and leads with epoxy or liquid electrical tape. You may want to paint several coats to ensure that no metal surface remains exposed on the outside of the dome. This step is crucial to prevent corrosion from taking place when your ROV is exposed to water.



Wait 1 hour for the epoxy to set.

- Tilt the Rear Dome Assembly upward, so its open side faces the front of the External Assembly. Lift and move the Rear Dome Assembly as necessary to thread it over the four pre-installed machine screws on the deck's dome mounts:



- Make sure the Rear Dome Assembly's rim lies flush against the four sets of support nuts. Also check that the ethernet cable enters the dome through the bottom. If not, remove the Rear Dome Assembly, rotate it as necessary, and mount it again.

Before exposing your ROV to water, wait 24 hours for the epoxy to fully cure

Guide 3
Internal Electronics Assembly

Parts:

Part	Quantity
Internal Electronics Cradle	1
Raspberry Pi 3B	1
Dual Channel Motor Driver	2
Jumper Wires (female – female)	8
Jumper Wires (female – male)	3
Raspberry Pi Camera	1
Faceplate	1
Camera Mount	1
9-gram servo	1
Servo Screw	1
12V – 5V DC Converter	1
4-40 ½ inch Machine Screw	8
4-40 Nut	6
T-Plug Motor Driver Cable	1

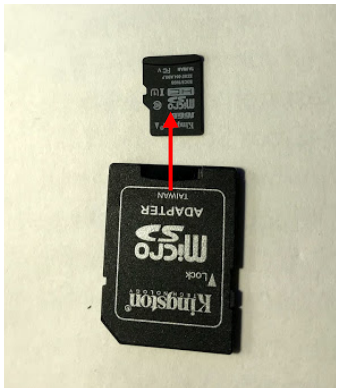
Tools:

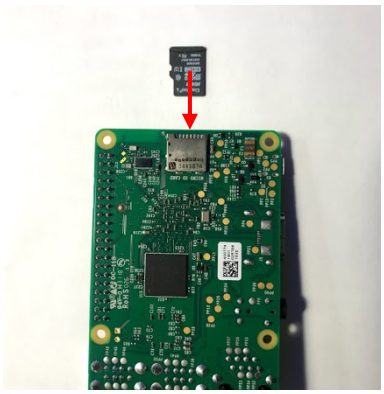
Phillips Screwdriver
Flathead Screwdriver

Step 1 Preparing the Raspberry Pi for Installation

Step 1.0 Install the pre-programmed SD card

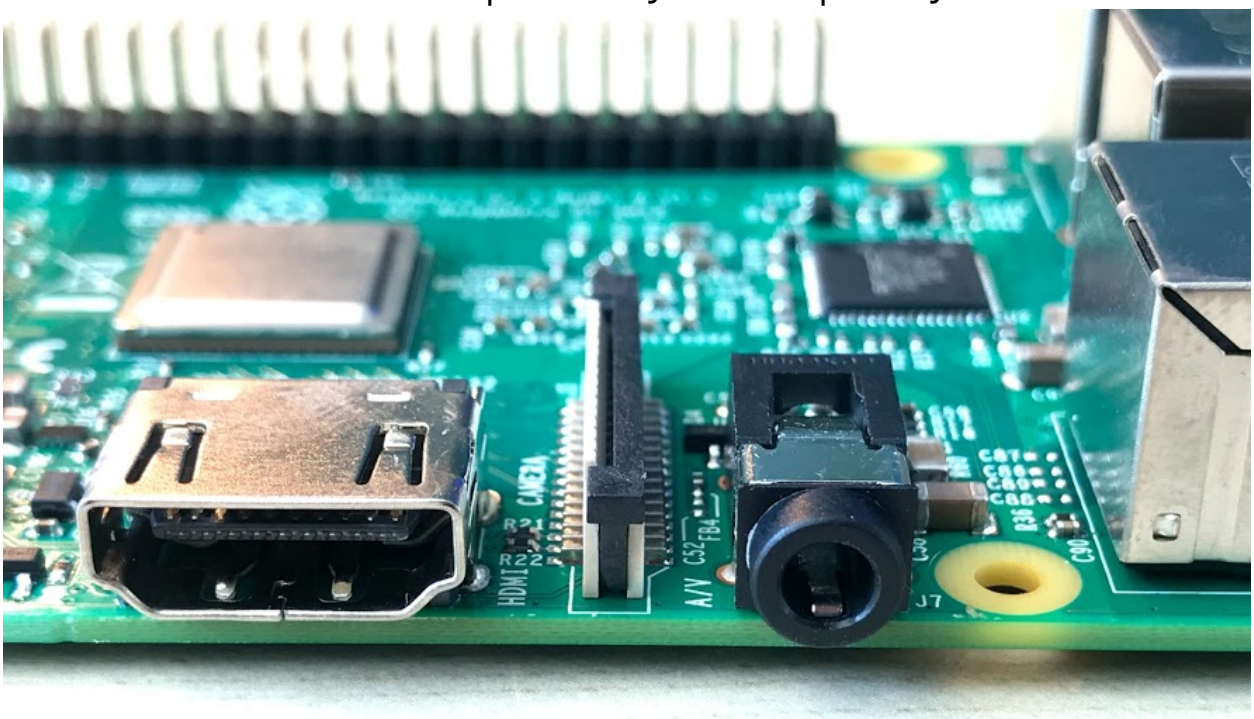
- Remove the **pre-programmed micro SD card** from its holder, and inset it into the **Raspberry Pi's** micro SD slot:



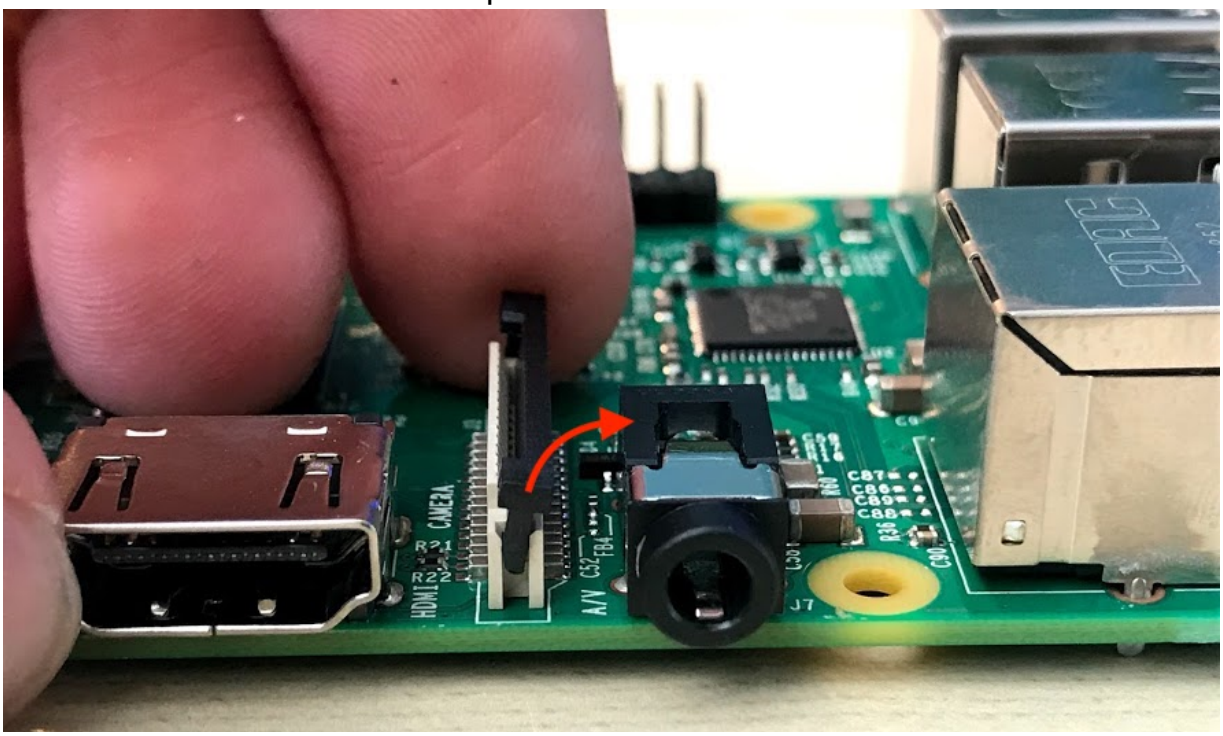


Step 1.1 Installing the Onboard Camera

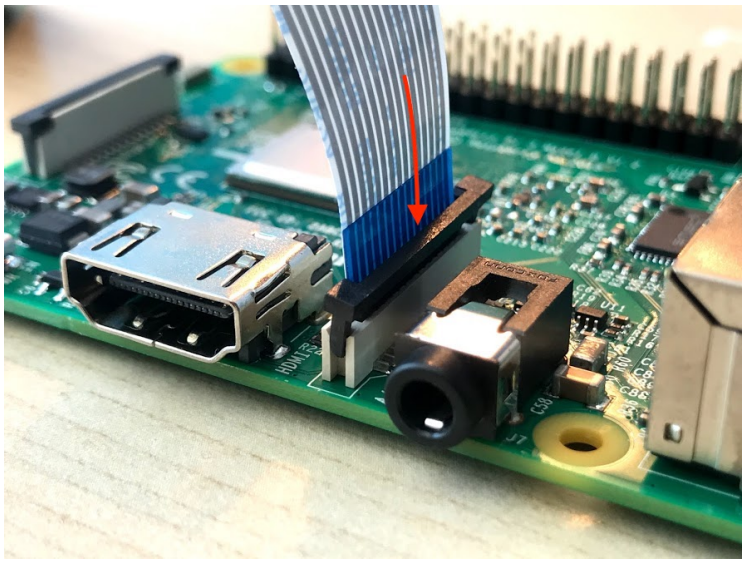
- Locate the camera port on your Raspberry Pi.



- Pull the black tab upward and out as shown:



- Slide the **Raspberry Pi camera's** ribbon cable all the way into the slot. Make sure the blue side faces the black tab. Lock the ribbon cable in place by pushing the black tab back to its original position. Gently tug the cable to make sure it's secure.



Step 1.2 Installing the Jumper Wires

- Use your strip of **8 jumper wires** as leads to the motor drivers. You'll want to attach one wire to the following pins on your Raspberry Pi:

GPIO 2
GPIO 3
GPIO 4
GPIO 17
GPIO 27
GPIO 22
GPIO 10
GPIO 9

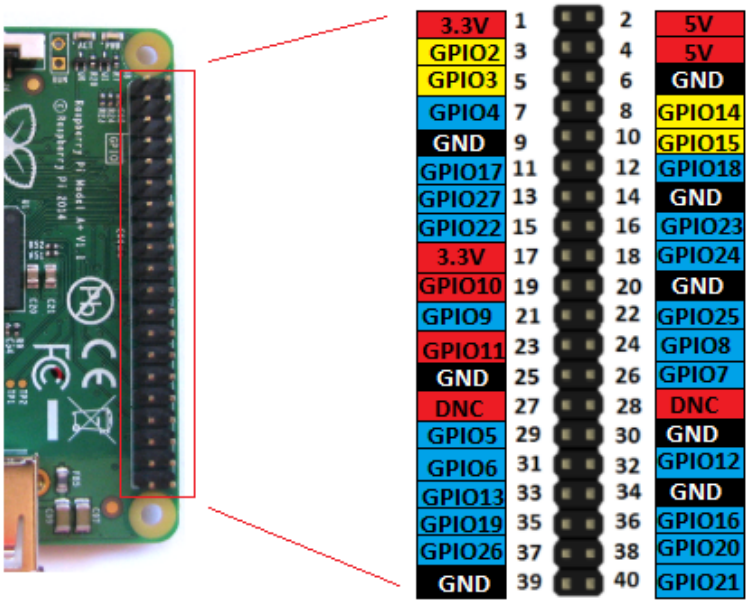
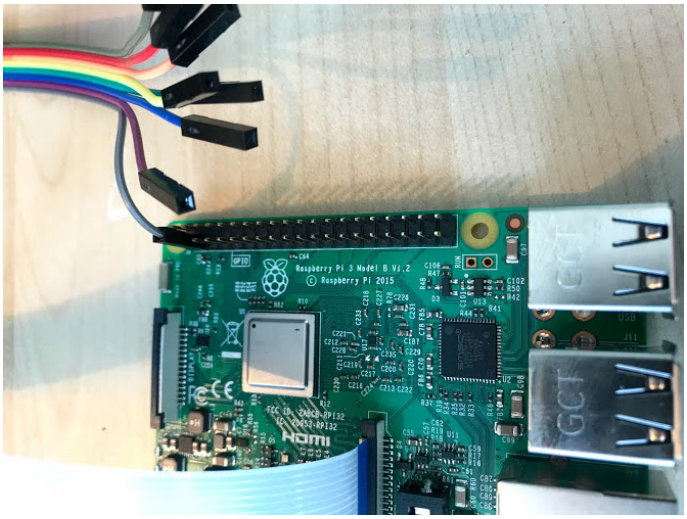
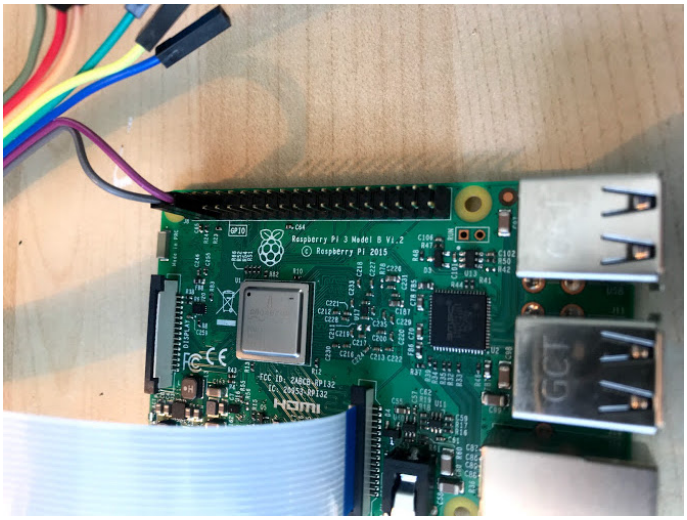


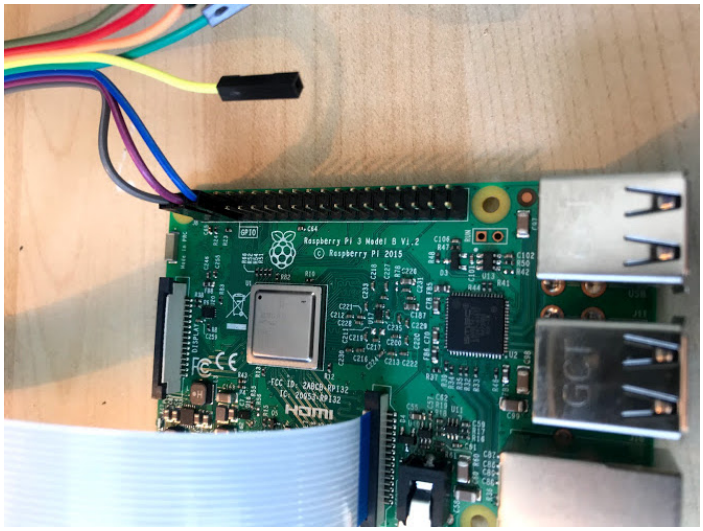
Figure B This is the "Pinout" for your Raspberry Pi 3 B. It's basically a legend that tells you which pin is which. It can still be confusing to visualize on the actual raspberry Pi, so the pictures below will walk you through the installation of each jumper

- Connect a jumper wire to GPIO 2. Note the color, because you'll want to connect this wire to the Dir1 Pin on your right-side motor driver.



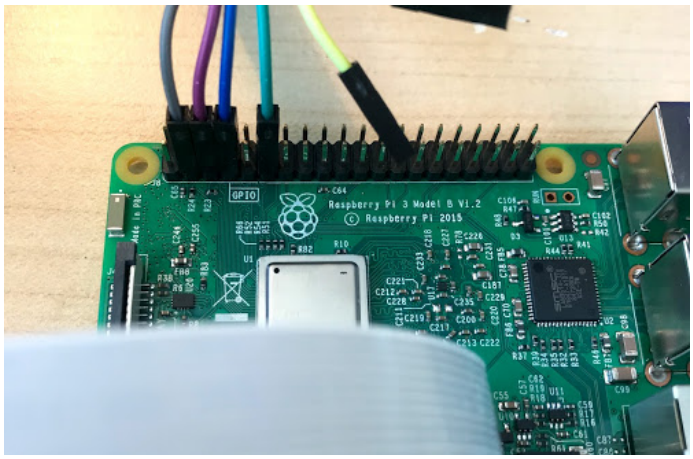
- Connect the next jumper wire to GPIO 3. Note the color, you'll later connect this wire to the PWM1 Pin on your right-side motor driver.





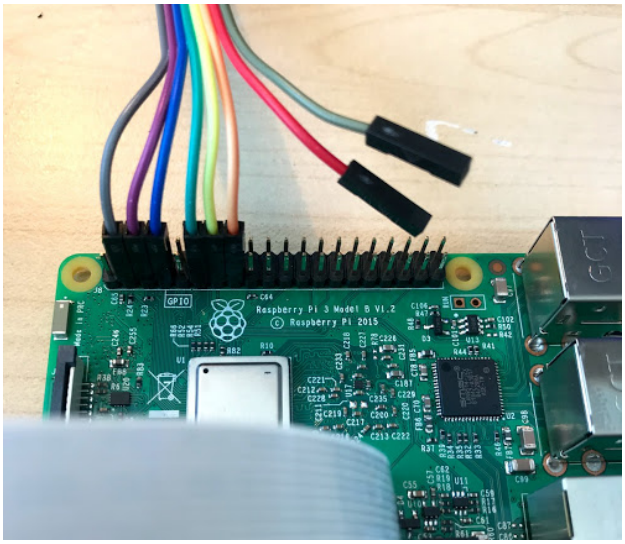
- Connect the next jumper wire to GPIO 4. Note the color, you'll later connect this wire to the DIR2 Pin on your right-side motor driver.

- Connect the next jumper wire to GPIO 17. Note the color, you'll later connect this wire to the PWM2 Pin on your right-side motor driver.

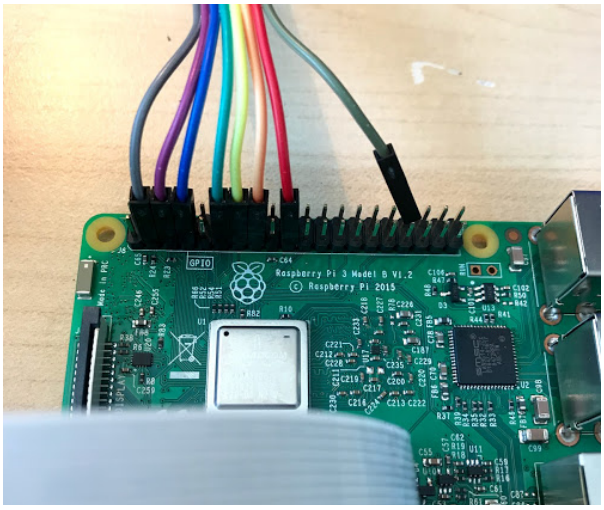


- Connect the next jumper wire to GPIO 27. Note the color, you'll later connect this wire to the DIR1 Pin on your left-side motor driver.

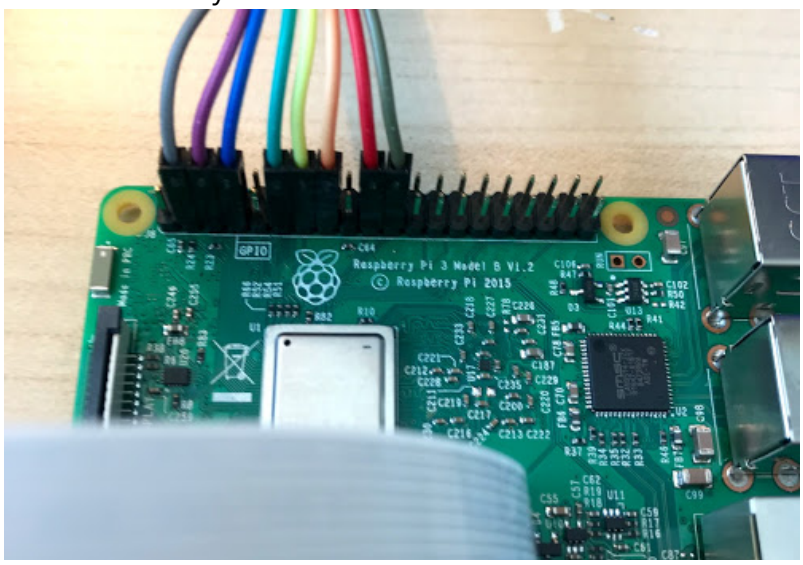
- Connect the next jumper wire to GPIO 22. Note the color, you'll later connect this wire to the PWM1 Pin on your left-side motor driver.



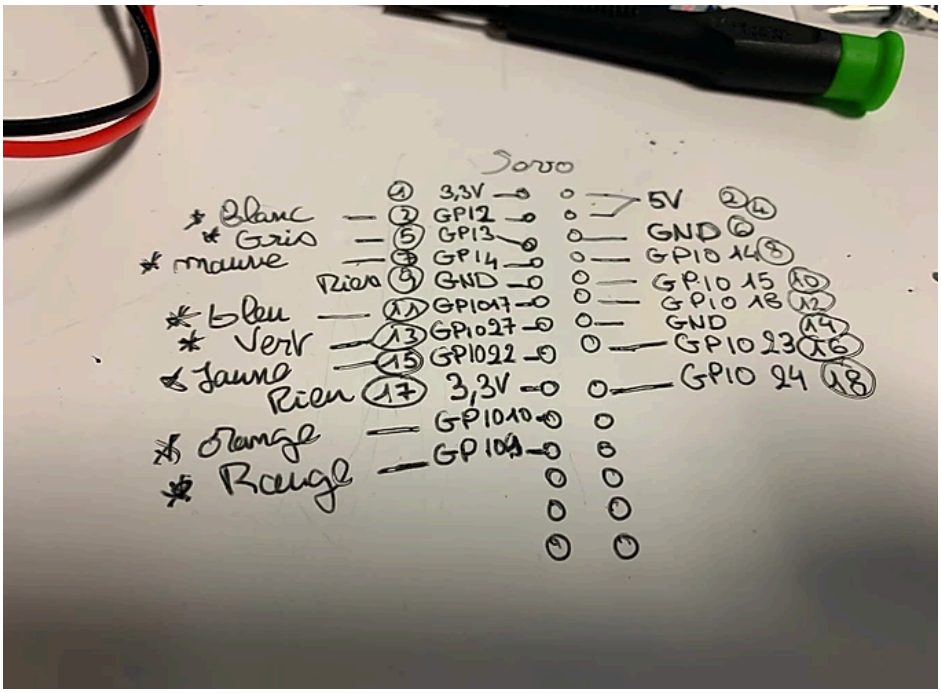
- Connect the next jumper wire to GPIO 10. Note the color, you'll later connect this wire to the DIR2 Pin on your left-side motor driver.



- Connect the next jumper wire to GPIO 9. Note the color, you'll later connect this wire to the DIR1 Pin on your left-side motor driver.

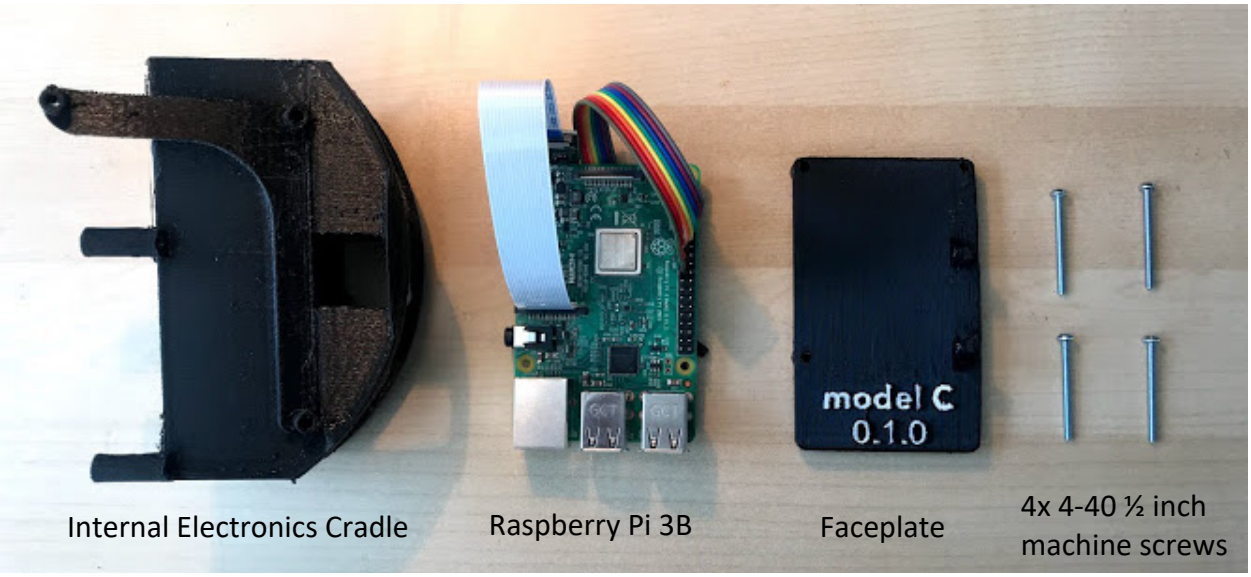


Pro Tip:
Check out this awesome example from one of our first users, **virtualmoving**. He drew a quick pinout diagram to keep track of the color and GPIO number for each jumper wire.

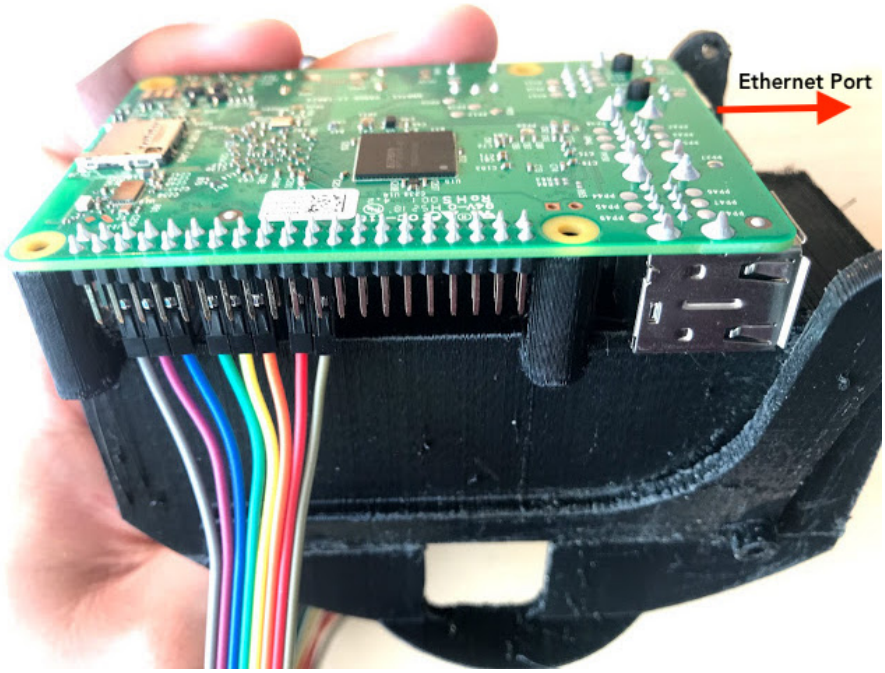


Step 2 Installing the Raspberry Pi and Faceplate

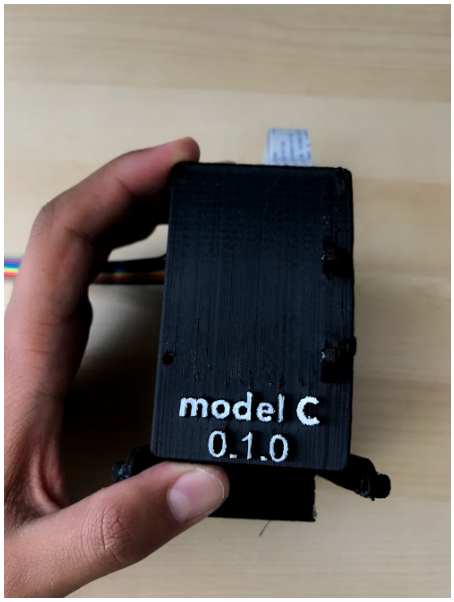
You'll need…



- Slide the Raspberry Pi onto the **internal electronics cradle.** Once the pre-tapped holes on the Raspberry Pi align with those on the cradle, the Raspberry Pi should fit snugly as below:

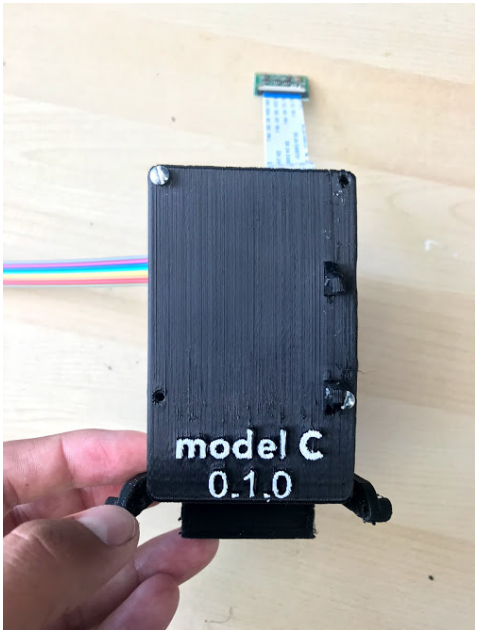


- Place the **faceplate** over the exposed surface of the Raspberry Pi. As above, make sure the Faceplate's pre-tapped holes align with those on the Raspberry Pi.



A quick note: this is a good time to make sure the Raspberry Pi Camera and the jumper wires drape out of the assembly without any kinks or folds.

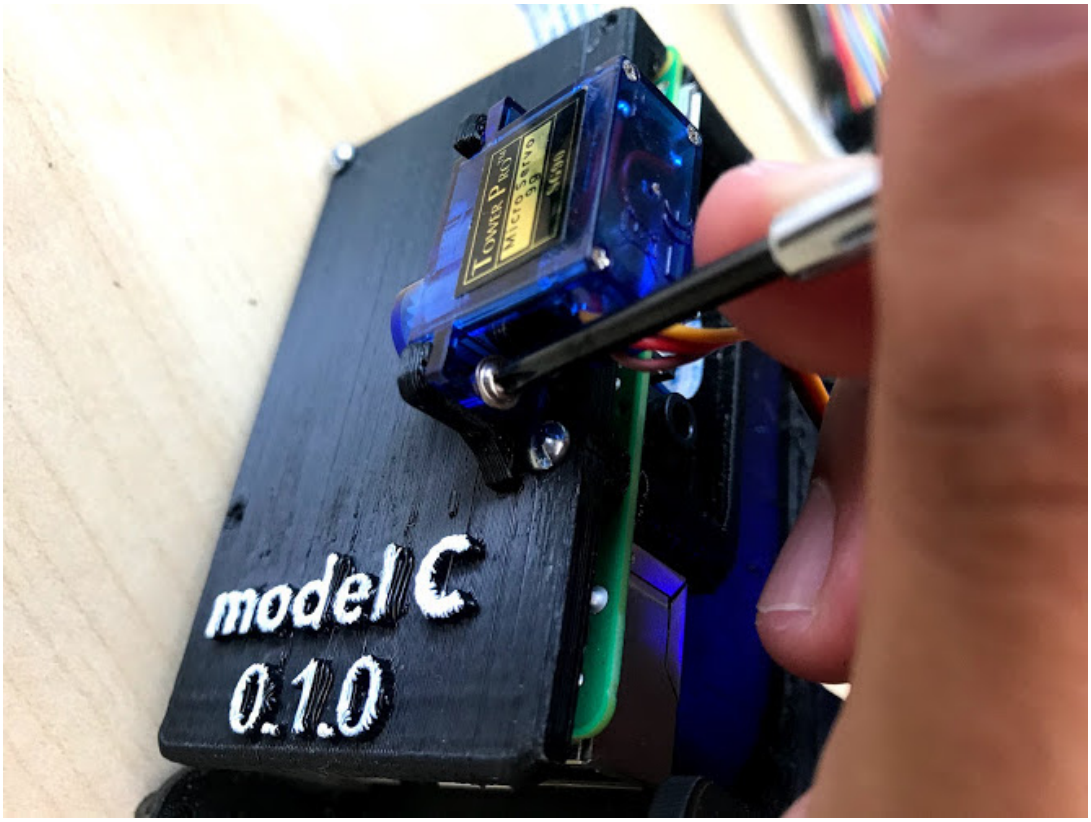
- Then use your screwdriver to thread two **4-40 ½ machine screws** through the faceplate, through the Raspberry Pi, and into the cradle. We like to use two 4-40s at opposing corners of the faceplate.



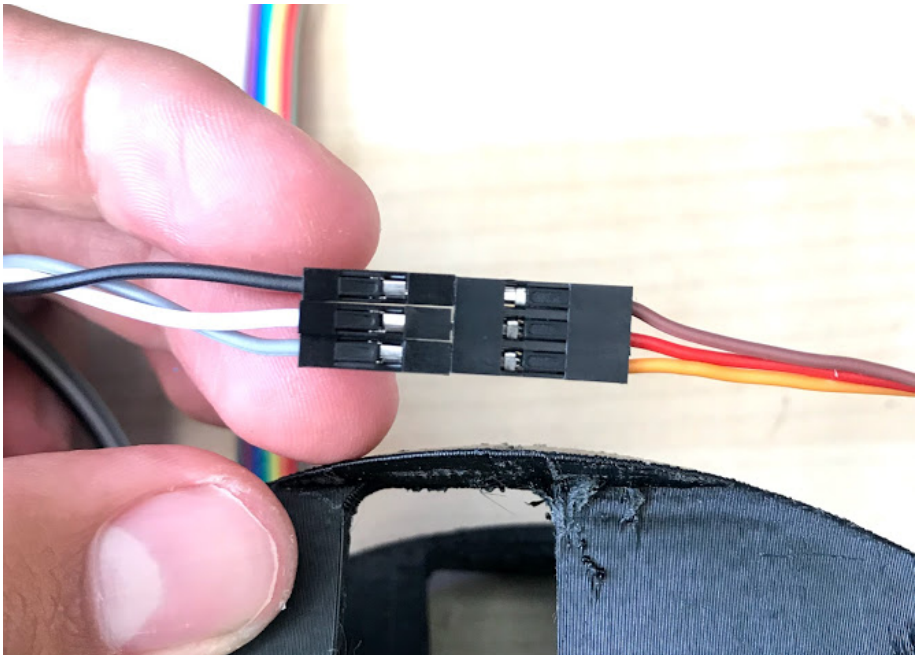
Step 3 Installing the Camera Tilt Assembly

Step 3.1 Attaching the Servo Motor

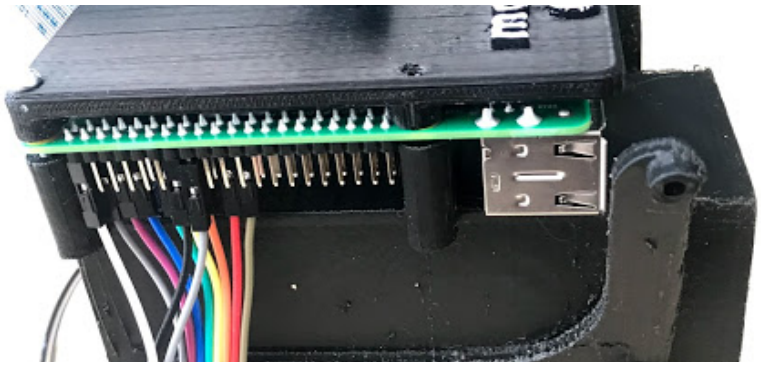
- Hold the **9 gram servo motor** flush against the two tabs on the Faceplate. Make sure the gear head faces the center of the Faceplate. Use your screwdriver to thread one **2-56 screw** through each of the Servo's tabs and into those on the faceplate. Secure each with a **2-56 nut**. Your servo should now be attached to the internal assembly:



- Attach one of the three **male-female jumper wires** to each of the servo's three female leads. On our servos, Yellow = Signal, Red = +5v, and Brown = GND. Remember which color jumper wire corresponds to each of the servo's leads.



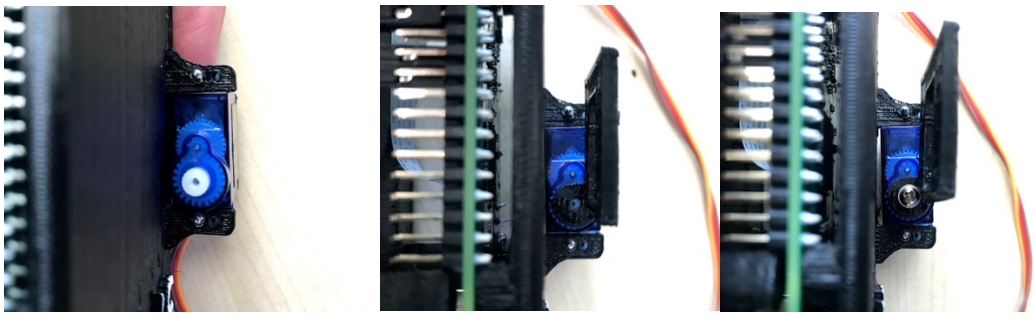
- Loop the female end of the jumper wires around to the Raspberry Pi's array of GPIO pins. Connect the Signal Lead to GPIO23, the +5v lead a +5v pins, and the GND lead to a GND pin. Use the picture below, as well as our trusty pinout diagram (**Figure B**) to do this.



A quick Note: you might notice that there are multiple +5V and GND pins on the Raspberry Pi 3 B. Feel free to pick any of these to power your servo motor. Our photo represents just one of many ways to do so.

Step 3.2 Install the Camera Mount

- Orient the Internal Electronics Assembly so the Servo's gear faces you.
- With your fingers, gently but firmly turn the gear counterclockwise until it stops.
- Hold the **camera mount** parallel to the faceplate. Then, wiggle the camera mount onto the servo motor's gear head. It should be a very tight fit. Try not to turn the gear as you do this.
- Use a screwdriver to thread a **servo screw** through the camera mount and into the gear head. Your camera mount is now attached!



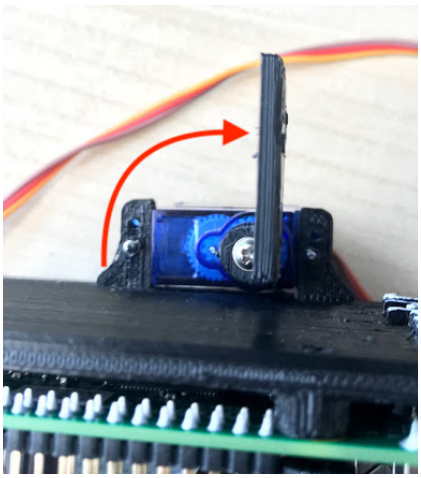
Step 3.3 Mount the Raspberry Pi Camera

- Turn the camera mount about 90 degrees forward. You should hear the little gears turning inside the servo motor as you do this.

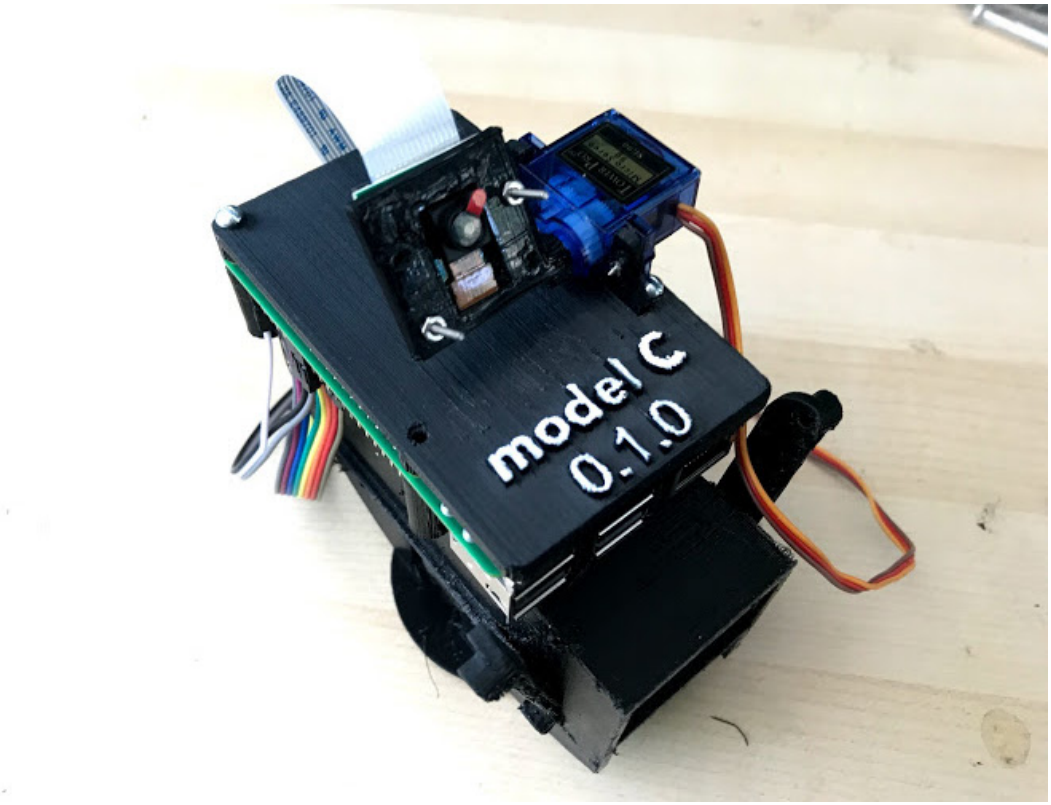
- Gently move the Raspberry Pi Camera as necessary to bring it flush against the camera mount. Make sure the holes in the mount align with the holes through the camera. Be mindful not to kink the camera's delicate ribbon cable.

- From the rear insert two **2-56 ¼ machine screws** through the camera and mount as below. Each screw should be on opposite corners.

- Thread a **2-56 nut** onto each screw from the front of the camera mount. Threading until they are hand tight will do just fine. If you want an extra firm fit, you can carefully use your small screwdriver to tighten the screws a half turn past hand tight. If you decide to do this, be careful not to bend the camera's chip!

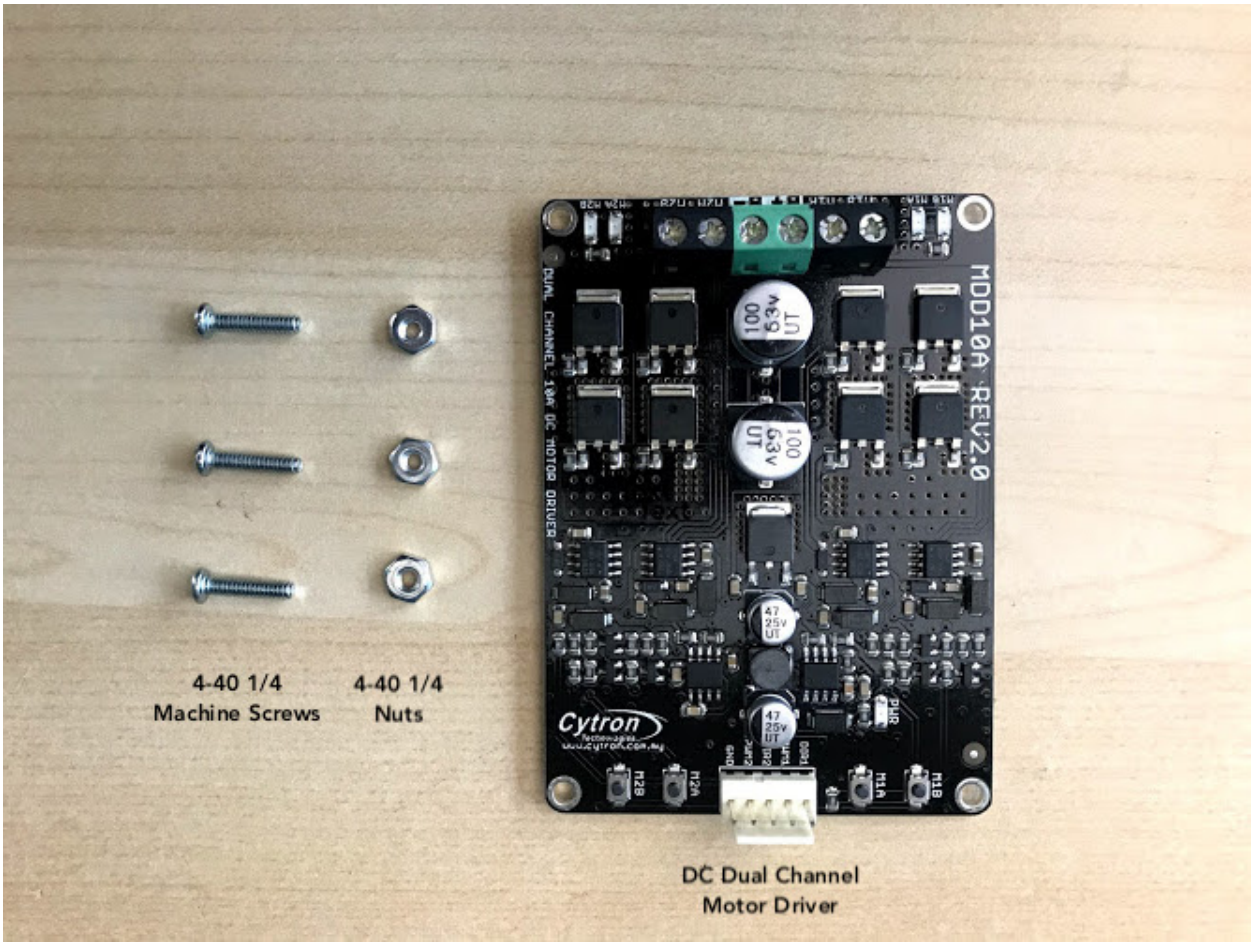


Your Internal Assembly should now look like this:



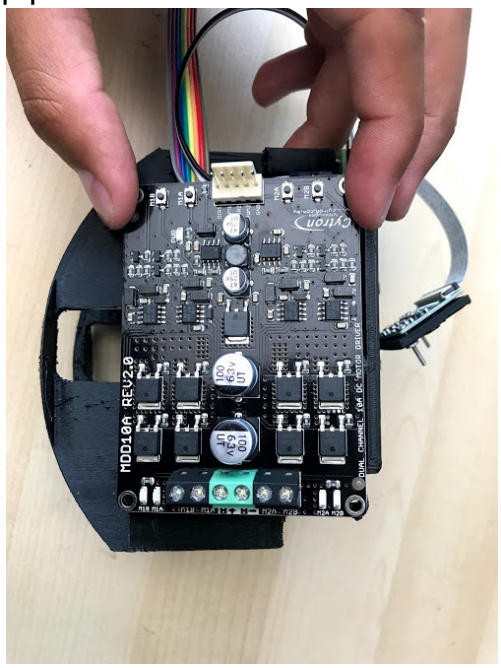
Step 4 Install Right Motor Driver

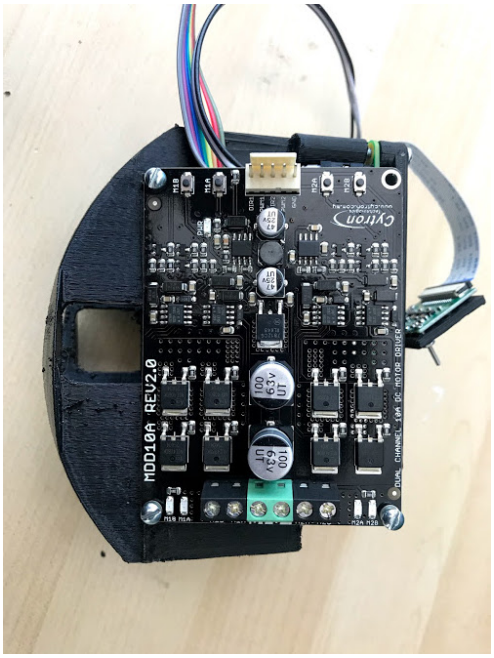
You'll need…



- Turn the entire internal assembly onto its left side.
- Place the **motor driver** on the right side of the Internal assembly, and make sure the holes align with those on the internal electronics cradle.

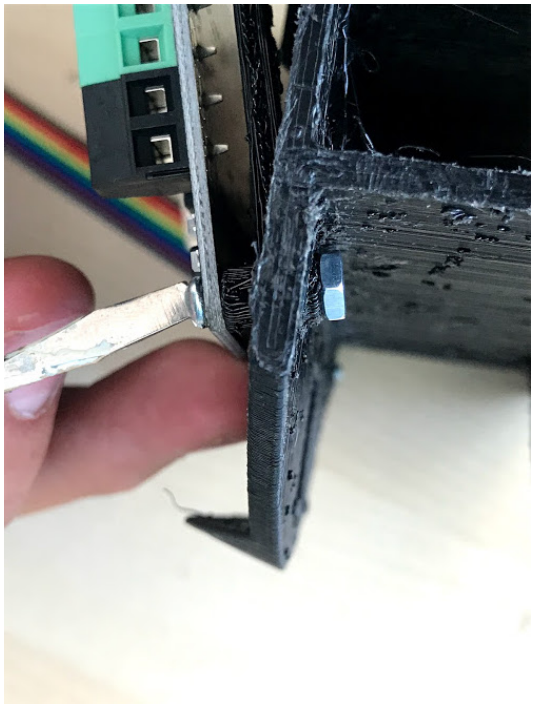
- Use a screwdriver to thread three **4-40 ½ machine screws** through the motor driver and into the pre-tapped holes on the cradle.



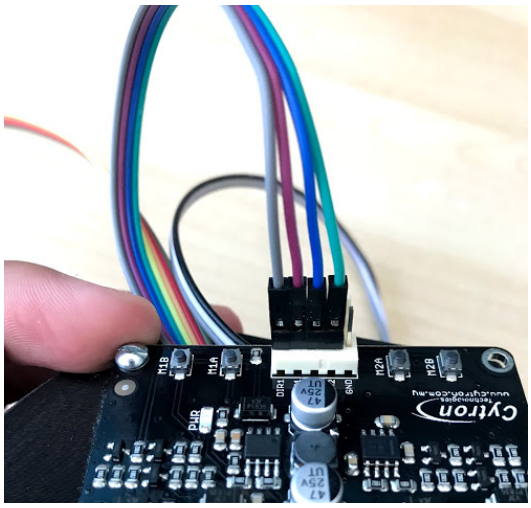


- Make sure the side with the green power slots faces the same direction as the camera.

- Thread a **4-40 nut** onto each screw from inside the cradle for additional security.



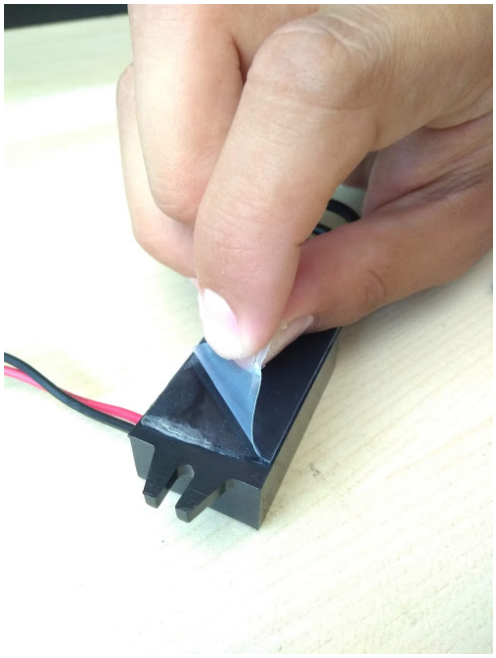
- Attach the remaining jumper wires to the motor driver's corresponding pins. GPIO2 connects to DIR1, GPIO3 connects to PWM1, GPIO4 connects to DIR2, and GPIO17 connects to PWM2:



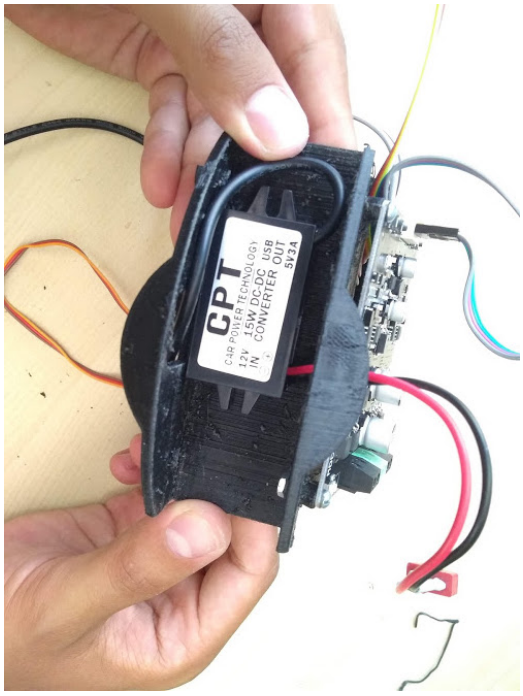
Step 5 Install the 5V converter

You'll need…

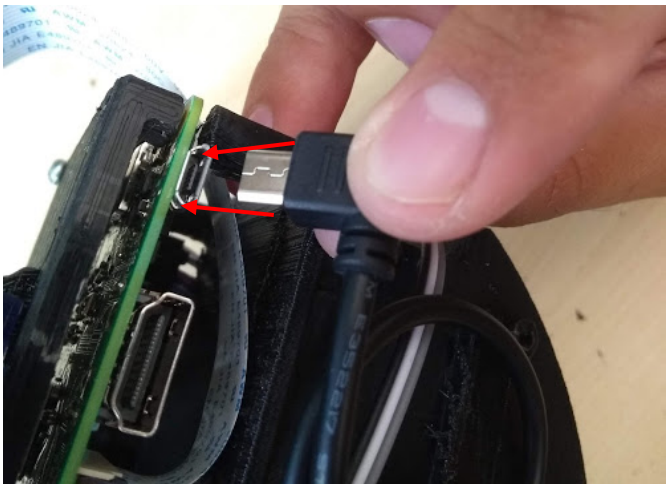
- Turn the **5v DC converter** so the lettering faces away from you. You'll find a piece of double-sided tape attached to the underside. Peel off the protective sheet:



- Attach the converter to the underside of the Internal Assembly. Pull the power leads and micro USB cable through the right and left side holes, respectively.

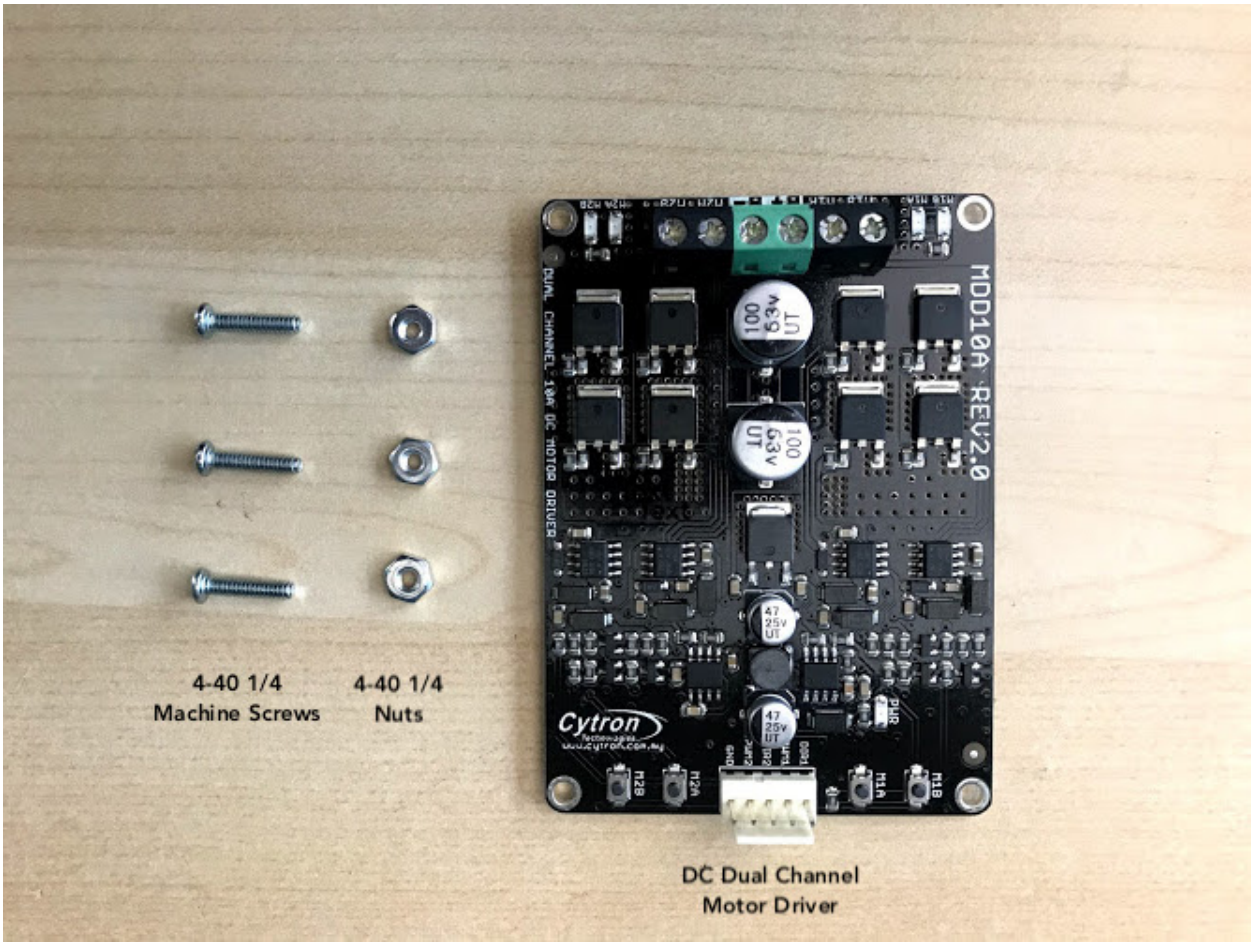


- Turn the assembly over, and plug the male micro USB cable into the Raspberry Pi's micro USB slot:

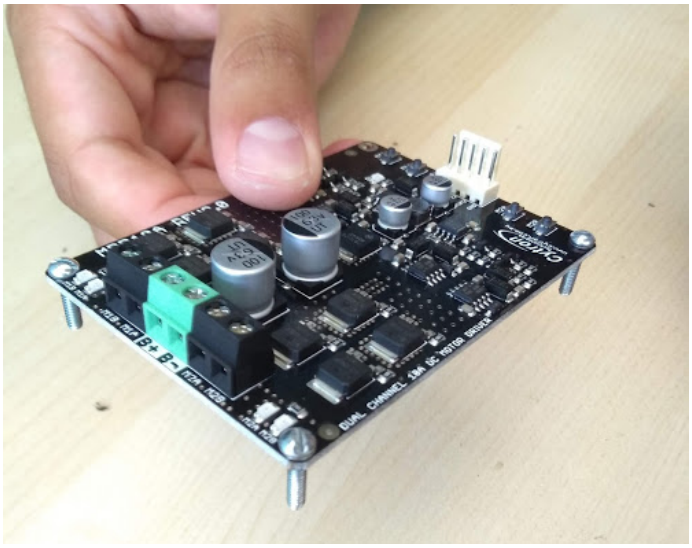


Step 6 Install Left Motor Driver

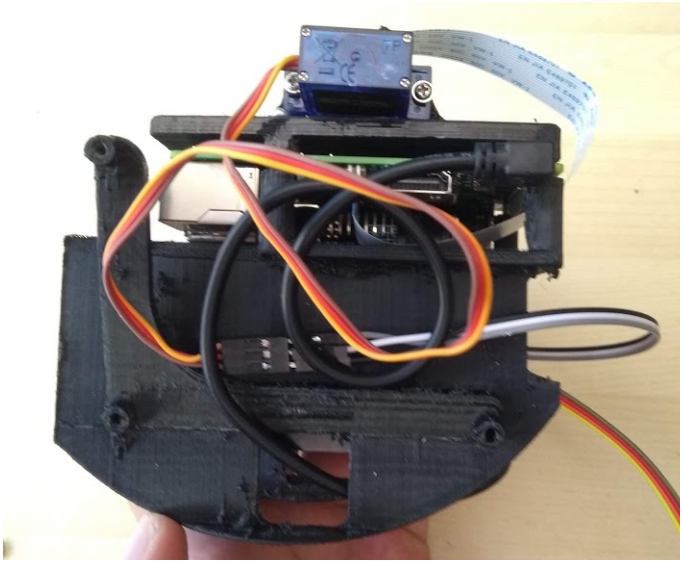
You'll need…



- Insert three 4-40 ¼ Machine Screws through the corners of the Motor Driver as shown:

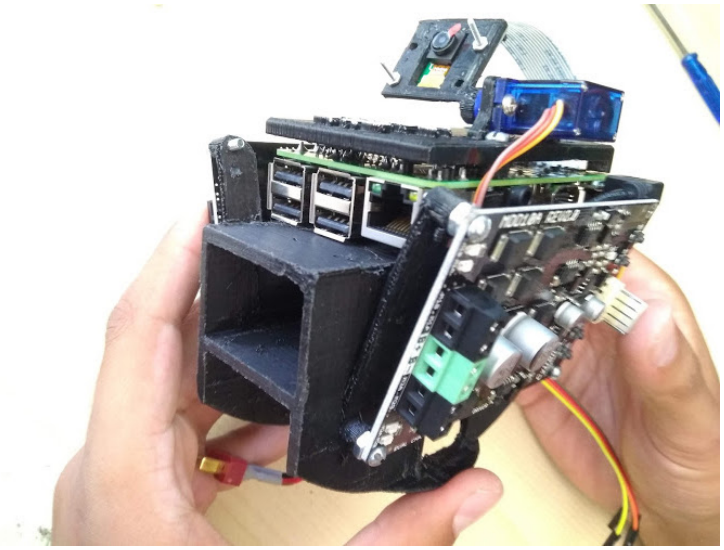


- Organize excess wiring on the left side of the Internal Assembly into loops. Lay the loops flat against the side:



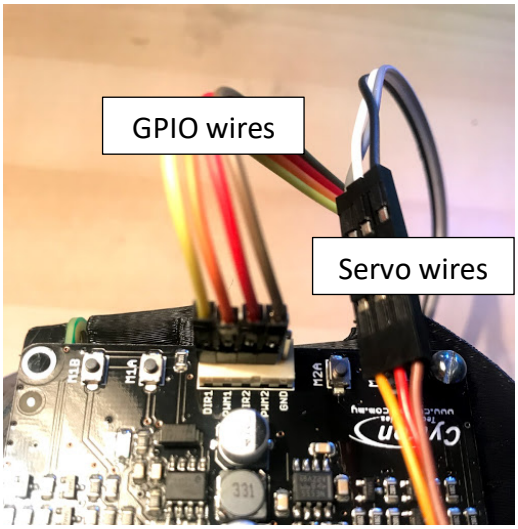
- Thread a **4-40 nut** onto each screw from inside the electronics assembly until hand tight. These will serve as spacers to accommodate the excess wire.

- Position the motor driver so the screws align with the pre-tapped holes on the internal assembly. Use your flathead screwdriver to thread the 4-40's and tighten the driver against the assembly.



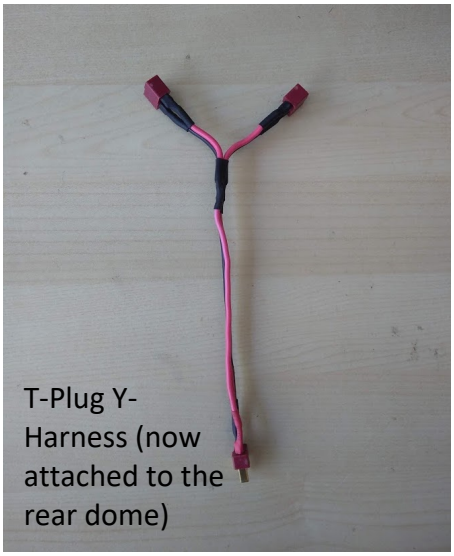
- Attach the remaining GPIO jumper wires to the motor driver's corresponding pins.

GPIO27 connects to DIR1
GPIO22 connects to PWM1
GPIO10 connects to DIR2
GPIO9 connects to PWM2



Step 7 Additional Wiring

You'll need…

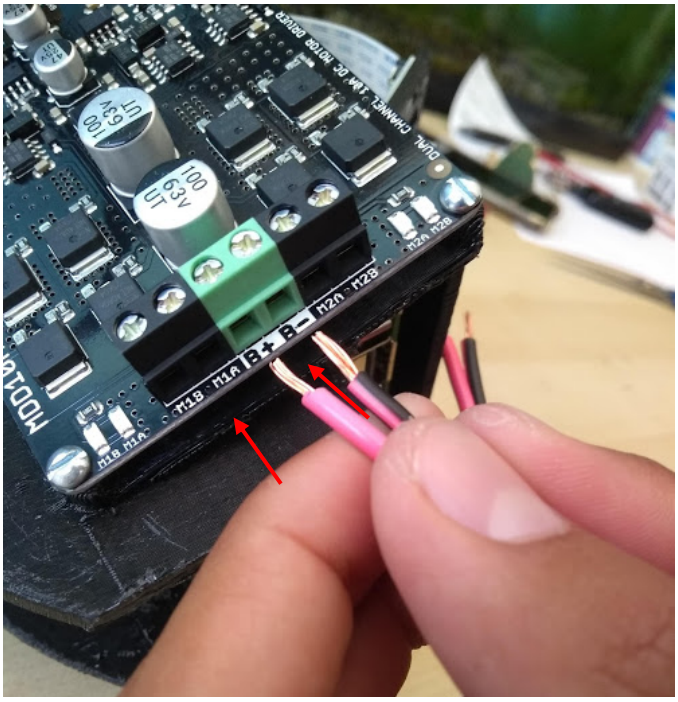


T-Plug Y-Harness (now attached to the rear dome)

T-Plug Motor Driver Cable

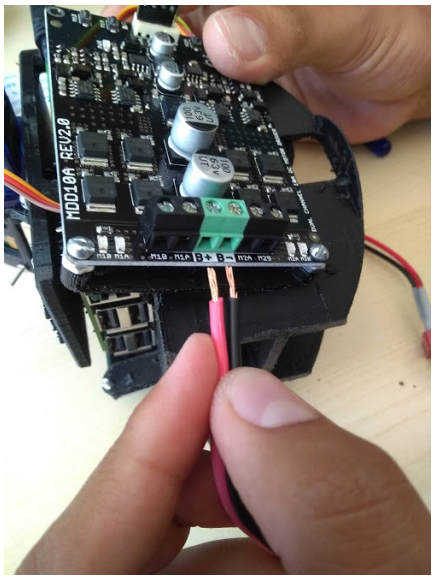
WARNING – The T-Plug – Motor Driver Cable connects the motor drivers, and, in turn, the motors, to their power source. It is ***absolutely critical*** to connect the BLACK wires to the driver's NEGATIVE (-) port, and RED to the motor driver's POSITIVE (+) port. Failure to do so will cause damage to your electronics, and it may result in a fire.

- Turn the Internal assembly onto its left side.
- Insert one of the driver harness's red leads into the **right motor driver's** green slot marked with a "+"
- Insert one of the driver harness's BLACK leads into the right motor driver's green slot marked with a "-"



- Use a screwdriver to tighten the set screws. Give the leads a gentle tug to make sure they are secure.

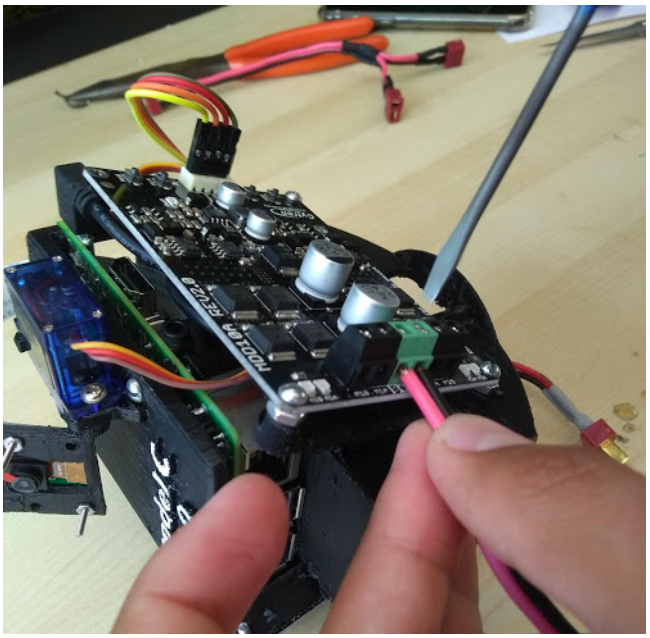
- Flip the internal assembly onto its right side



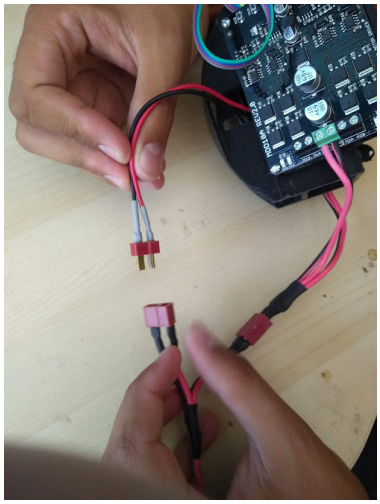
- Insert one of the driver harness's red leads into the **left motor driver's** green slot marked with a "+"

- Insert one of the driver harness's BLACK leads into the green slot marked with a "-"

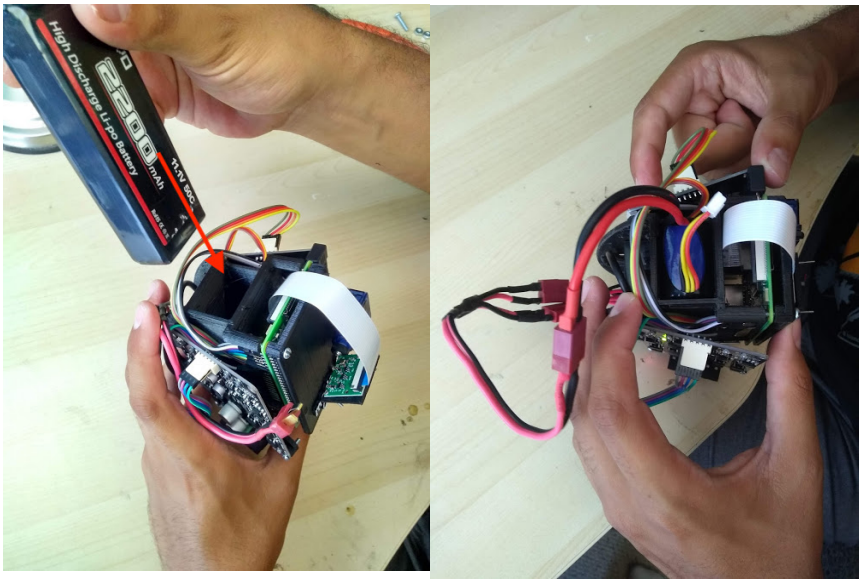
- Use a screwdriver to tighten the set screws. Give the leads a gentle tug to make sure they are secure.



- Connect the **T-plug Y-harness** (from the rear dome) to the **5v DC converter**'s T-plug, and to the motor driver harness. We like to run power lines along the underside of the internal assembly.

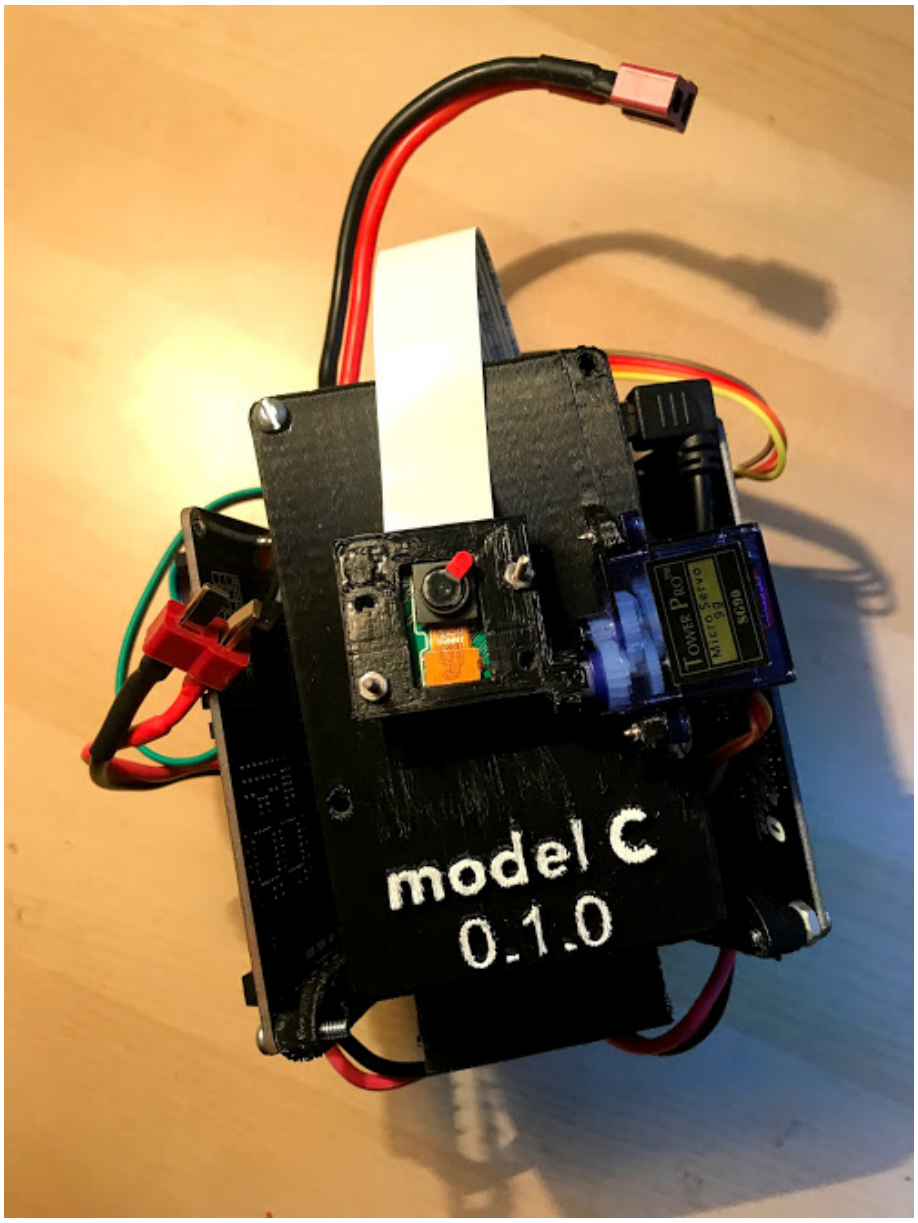


- To finish the internal assembly, insert the **LiPo battery** into the battery compartment that runs down the center of the internal assembly. The red and black leads should be on the same side as the notch in the battery compartment's opening. Work the battery into the compartment; it will be held in place by friction:

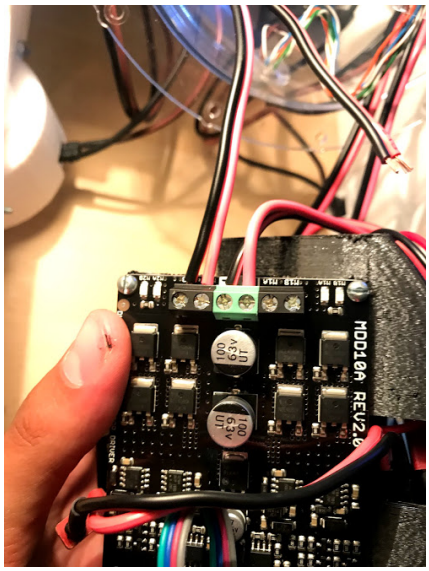


WARNING: Follow both the Balance Charger's and LiPo Battery's directions carefully to safely charge and use your LiPo Battery. Failure to do so may cause a fire. Blue Dot ROV is not responsible for any resulting damages.

- Your finished Internal Electronics Assembly should look like this:



Step 8 Install the Internal Electronics Assembly



- Turn the internal assembly onto its face, and place in front of the mounted rear dome, between the left and right Rails.

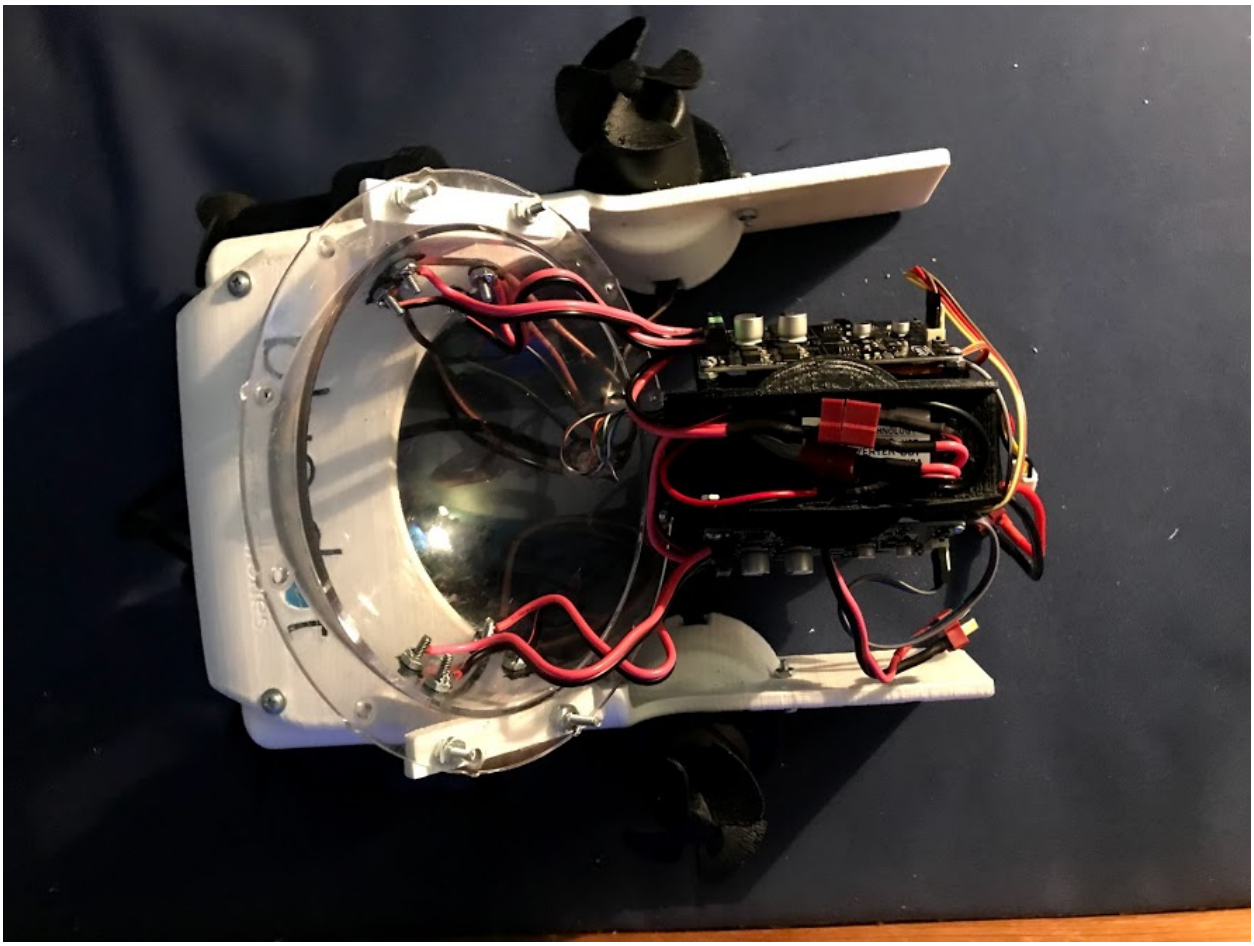
- Using a flathead screwdriver, insert and fasten the right horizontal thruster's internal motor leads into the slots marked M2B and M2A on the right motor driver

- Using the screwdriver, insert and fasten the right vertical thruster's **internal motor leads** into the slots marked M1B and M1A on the **right motor driver**

> **A quick note:** Our software follows the convention that, when looking down on a motor driver, the black (ground) lead of any pair of wires is on the left

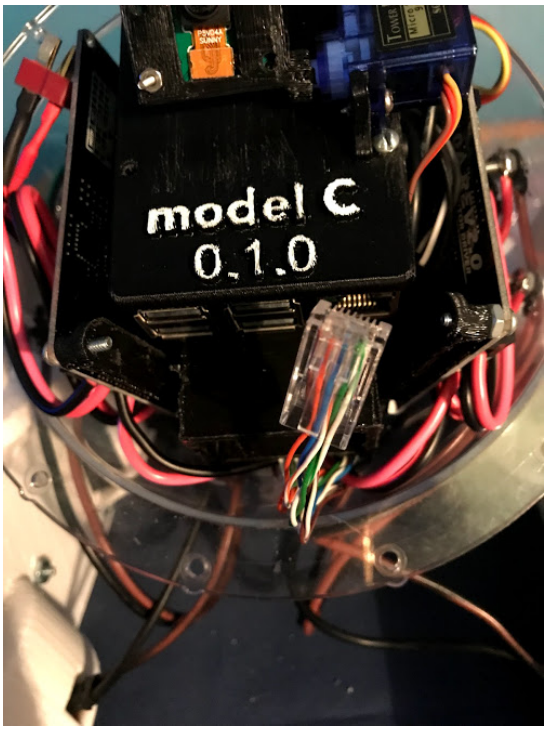
- Follow a similar procedure for the **left motor driver**. Insert and fasten the left vertical thruster's internal leads to the slots marked M2A and M2B. Make sure the black wire is in the left slot (as seen when looking down on the motor driver). Then, insert and fasten the left horizontal thruster's leads to the remaining slots marked M1A and M1B. As above, make sure the black wire is on the left slot:

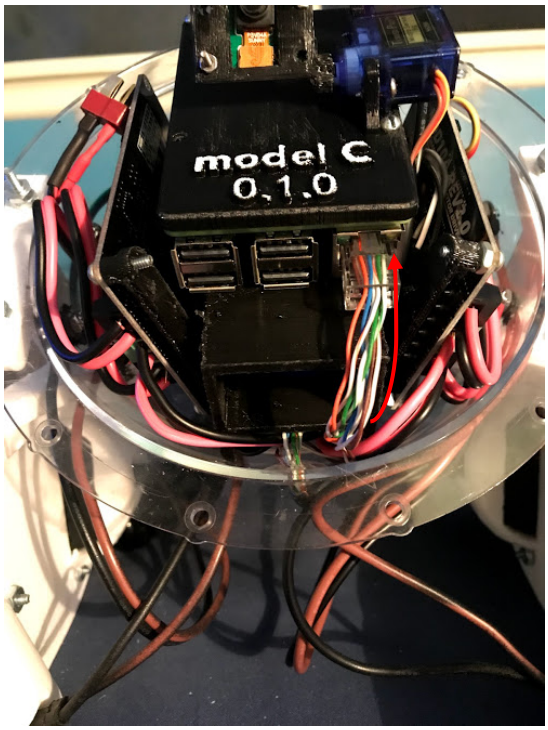
- Your ROV should now look like this:



- To complete the installation of the internal electronics assembly, tilt the entire assembly backwards into the dome. It should rest flush against the interior of the rear dome.

- Once the internal assembly is resting snugly inside the rear dome, it's time to plug in the ethernet connection:





Guide 4
Finishing Your ROV

Parts:

Part	Quantity
6-32 ½ inch Machine Screw	4
6-32 Nuts	8
4-40 Machine Screw	4
4-40 Nut	4
Right Weight Container	1
Rear Weight Container	1
Rear Weight Lid	1
Scuba Shot	2 lbs
Support Strut	1

Tools

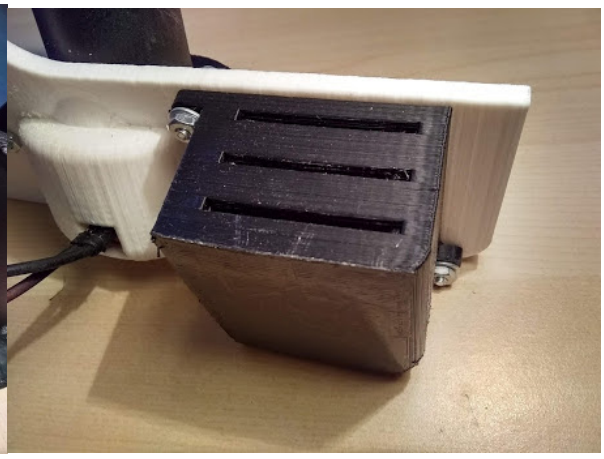
Phillips Screwdriver

Step 1 Install Weights

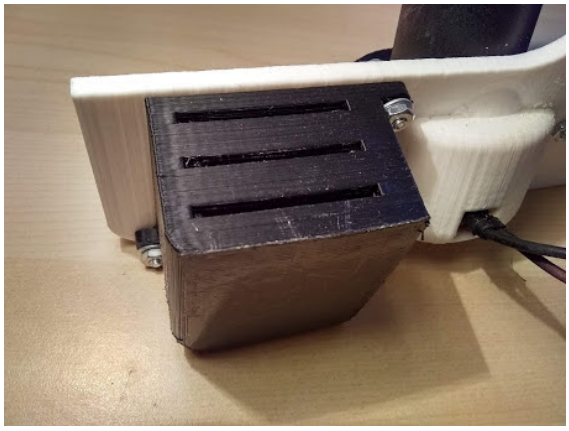
- Add roughly 1/3 of the **lead shot** to the Left weight holder

- Hold the **left weight container** flush against the left rail, and make sure the pre-tapped holes are aligned.

- From the outside of the left rail, use a screwdriver to thread the machine screw through the rail and the weight holder. Secure each corner with a 6-32 nut until hand tight:



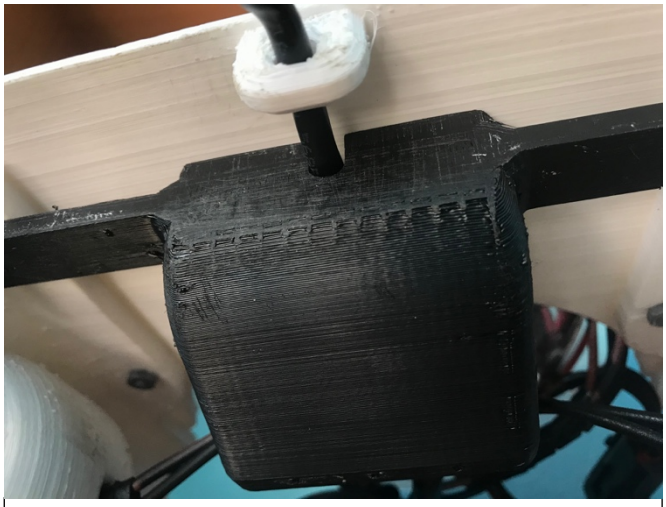
- Repeat these steps for the **right weight container**



Step 2 Installing the Rear Weight

- Pour the remaining shot into the **rear weight container**. Slide the rear weight lid into the chamber to hold the shot in place.

- Remove the rear 6-32 nuts on the Left and Right Rails.



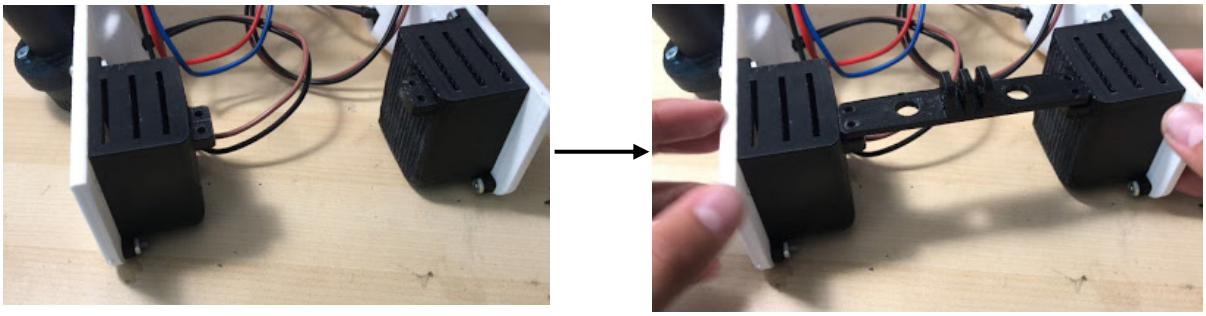
The rear weight is flush against the main deck and rails. Thread the nuts back into the screws to secure the weight container in place. Make sure you run the tether through the container as shown.

- Thread the rear weight onto the rear screws until it is flush with the external assembly. While doing this, feed the tether through the notches in the rear weight. The weight will hold the tether in place here, which will prevent damage to the horizontal propellers.

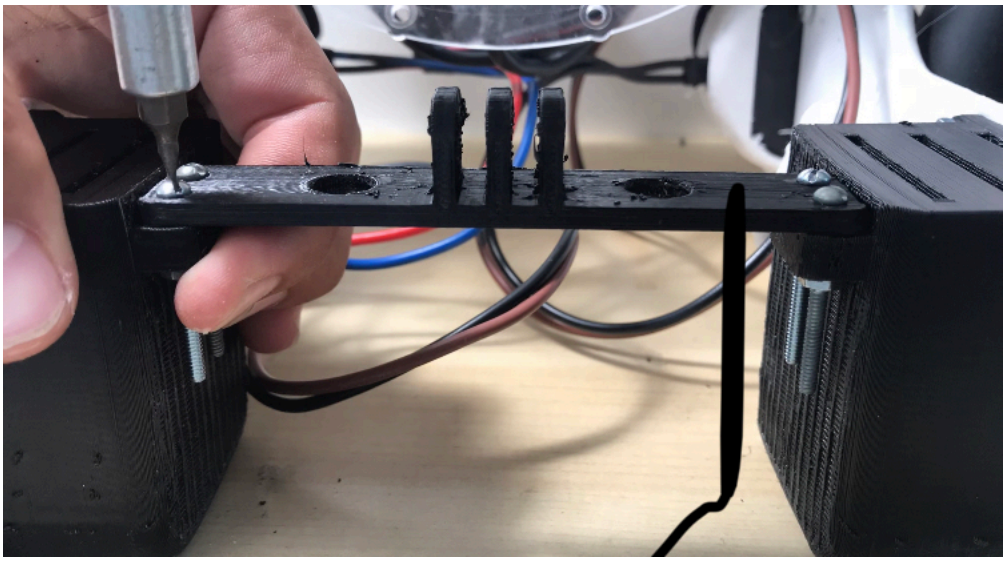
Step 3 Print and Install the Support Strut (optional)

If you want, print out a support strut. We have a version with a GoPro mount, as well as a version with a hook on our GitHub repository: https://github.com/costassoler/BlueDotROV

- Align the **support strut** with the pre-tapped holes on the weight containers.



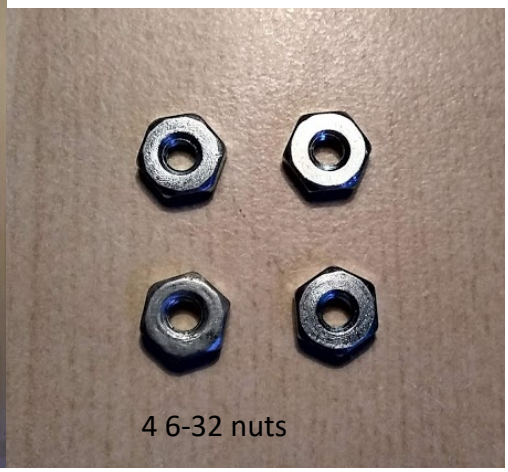
- Thread one **brass 4-40 machine screw** through each of the holes. Thread a **4-40 nut** onto each screw to fasten the support strut in place.



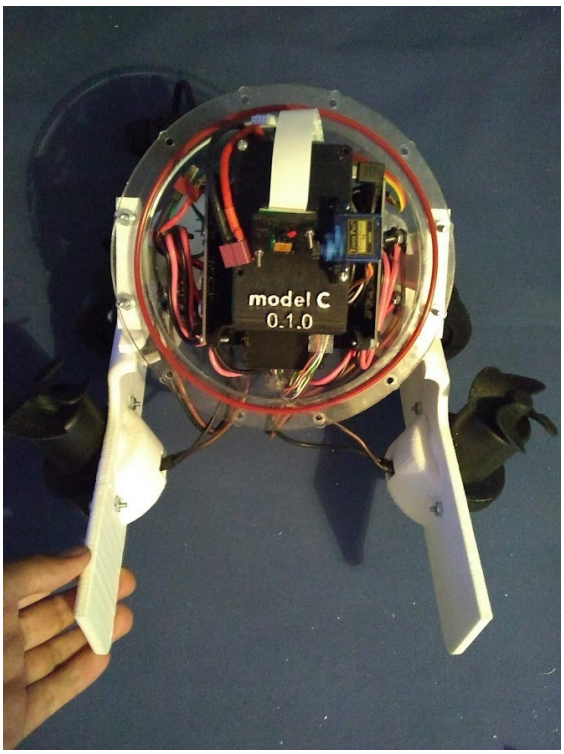
A quick note: You can use the structure on the support strut to mount a GoPro or a similar waterproof action cam!

Step 2 Attach the Forward Dome

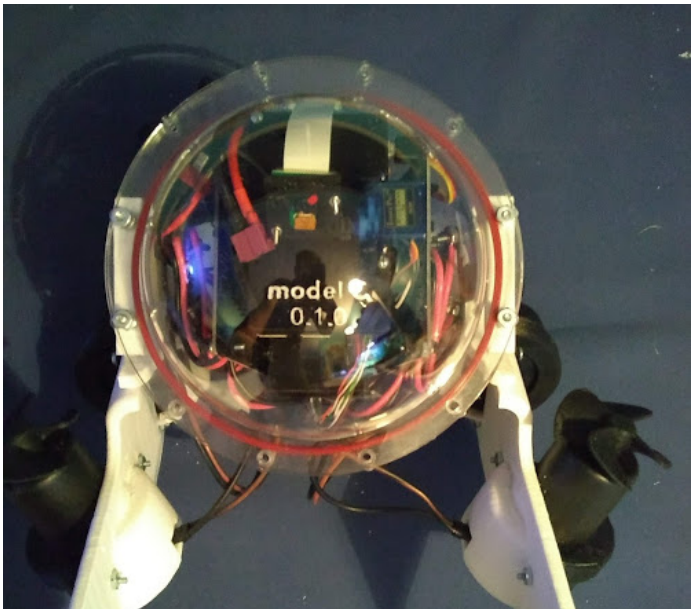
You'll need…



- Place the **main seal o-ring** flat on the **rear dome's** forward rim. You may need to tilt your Model C ROV backwards for a moment to prevent it from sliding off:



- Slide the forward dome over the red O-ring, using the **6-32 machine screws** as guides. Use the **6-32 nuts** to fasten the dome into place. The forward dome should cover the internal assembly:



Tip: To keep the o-ring in place, use your fingers to squeeze the forward and rear dome rims together at each mounting location until you see a bead form. While squeezing, thread the nuts into place until hand tight. The nuts should then maintain enough pressure between the domes to hold the O-ring in place during storage

Congratulations, and welcome to the team! You just built your own underwater drone.