
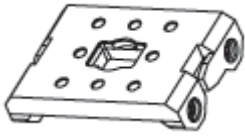

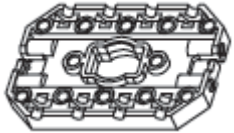
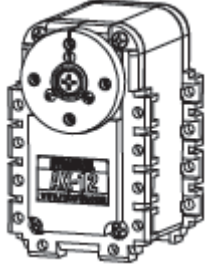




# TURTLEBOT ARM ASSEMBLY INSTRUCTIONS

## REQUIRED PARTS

Quantity	Part	Link	Picture
<b>Dynamixel Frames</b>			
2	F2	<a href="http://www.trossenrobotics.com/store/p/6180-Bioloid-Frame-F2.aspx">http://www.trossenrobotics.com/store/p/6180-Bioloid-Frame-F2.aspx</a>	
6	F3	<a href="http://www.trossenrobotics.com/store/p/6181-Bioloid-Frame-F3.aspx">http://www.trossenrobotics.com/store/p/6181-Bioloid-Frame-F3.aspx</a>	
2	F4	<a href="http://www.trossenrobotics.com/store/p/6182-Bioloid-Frame-F4.aspx">http://www.trossenrobotics.com/store/p/6182-Bioloid-Frame-F4.aspx</a>	
6	F10	<a href="http://www.trossenrobotics.com/store/p/6181-Bioloid-Frame-F3.aspx">http://www.trossenrobotics.com/store/p/6181-Bioloid-Frame-F3.aspx</a>	
<b>Dynamixel Servos</b>			
5	AX-12A	<a href="http://www.trossenrobotics.com/dynamixel-ax-12-robot-actuator.aspx">http://www.trossenrobotics.com/dynamixel-ax-12-robot-actuator.aspx</a>	
<b>Dynamixel Accessories</b>			
5	BU	(Comes with servos)	
5	WA	(Comes with servos)	

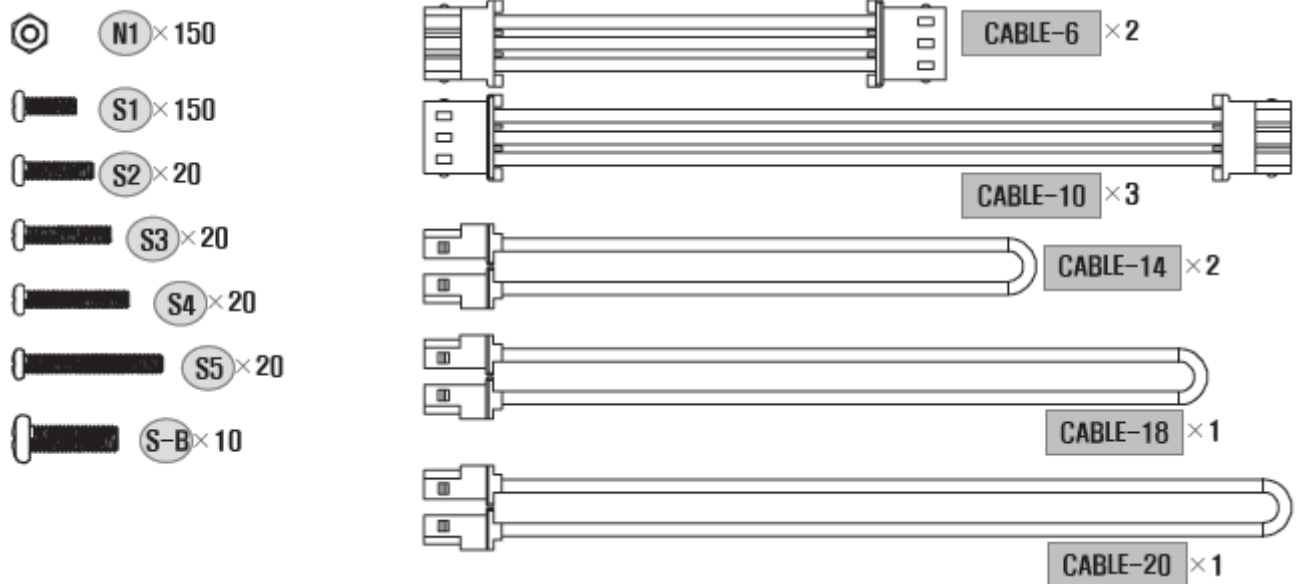
Lasercut/3D Printed Parts			
2	Gripper	Robot gripper	TODO
1	Base	Robot arm base	TODO
Hardware			
47	S1	This is actually an M2x6 (2 mm diameter, 6 mm long Phillips head bolt).	
12	S2	M2x8	
8	S6	M2x20	
5	S-B	M3x10 (comes with servos)	
43	N1	M2 nut	
8	Washer	M2 to M3 washer.	
4	Standoffs	5-40, 2" hex standoffs	
4	5-40 ½"	5-40 ½" Phillips-head bolt	

## SCREW SIZE CHART

This chart is actual size; use it to determine the correct dimensions of screws, nuts, and cables.

Taken from the Bioloid Users Guide

([http://www.trossenrobotics.com/images/productdownloads/Bioloid User Guide%28English%29.pdf](http://www.trossenrobotics.com/images/productdownloads/Bioloid%20User%20Guide%28English%29.pdf)).



# ARM ASSEMBLY INSTRUCTIONS

## FINISHED ARM



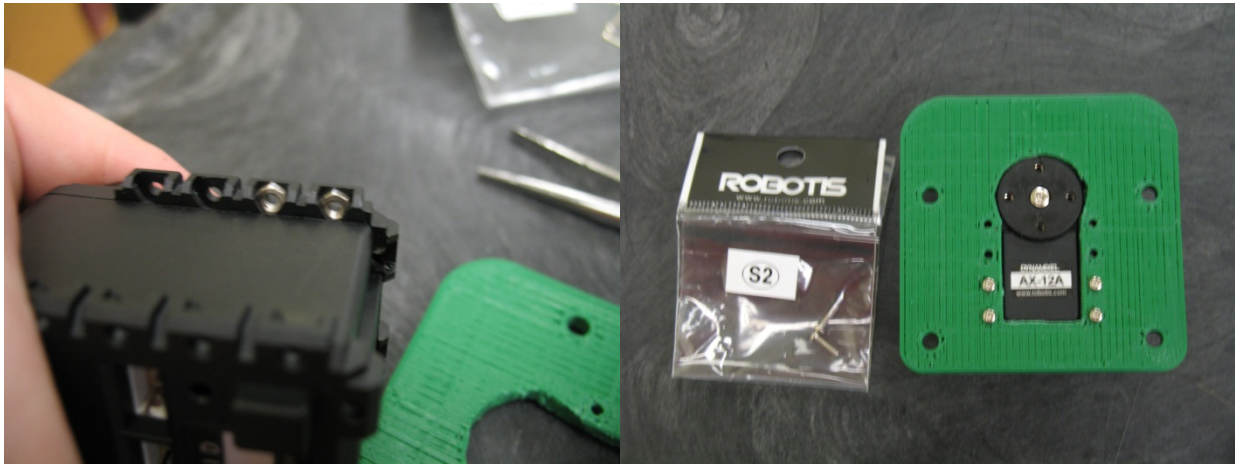
The unassembled arm components (left) and the assembled arm (right) along with associated Dynamixel accessories.

## STEP 1: ARM BASE

First, we will attach the servo to the base.

*You will need:* 1x printed/lasercut base, 1x F3 bracket, 1x AX12-A servo, 8x nuts (N1), 4x S1 (M2-6) screws, 4x S2 (M2-8) screws.

Insert the servo in the base in the only orientation it will fit. Next, put nuts (N1) in the bottom two holes of the servo on either side (below, left).



### ***NOTE ABOUT NUTS:***

There is a special technique to getting the nuts into the servos and to stay: first, push the nut in by hand. Next, take a screwdriver and force it closer into the servo. This will make the nut line up with the hole as shown in the last frame below, allowing you to screw into the nut. A more in-depth demonstration is available at

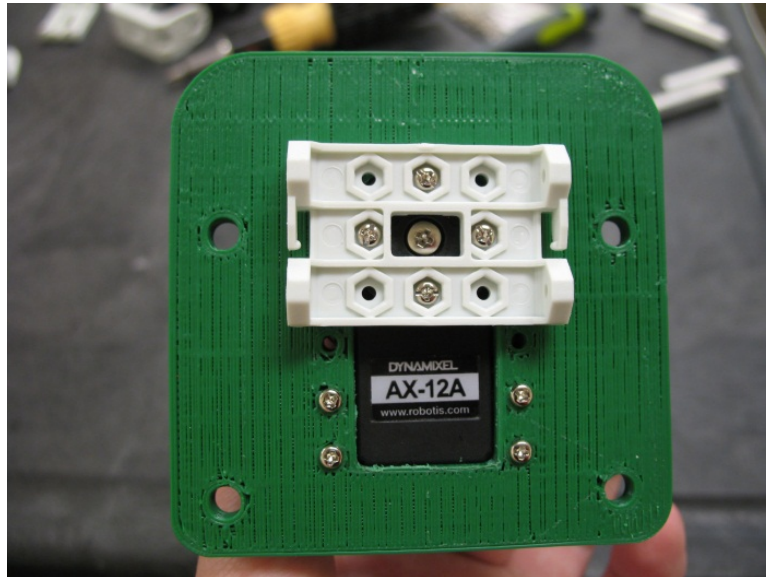
<http://www.crustcrawler.com/videos/bioloid/help/Inserting%20nuts%20for%20AX-12.wmv> .

We will be using this technique throughout the assembly process: to put it briefly, any time there is a nut, put the nut in *first*, lock it in, and then screw into it.



Next, turn the base around and put S2 screws into the corresponding 4 holes in the base plate, as shown above, on the right.

Next, attach an F3 bracket to the servo horn with 4 S1 screws as shown. The bracket should be attached to the servo horn: that is, you can turn the bracket along with the servo horn.





## STEP 2: MAIN JOINTS

Now we will assemble two of the main joints of the arm.

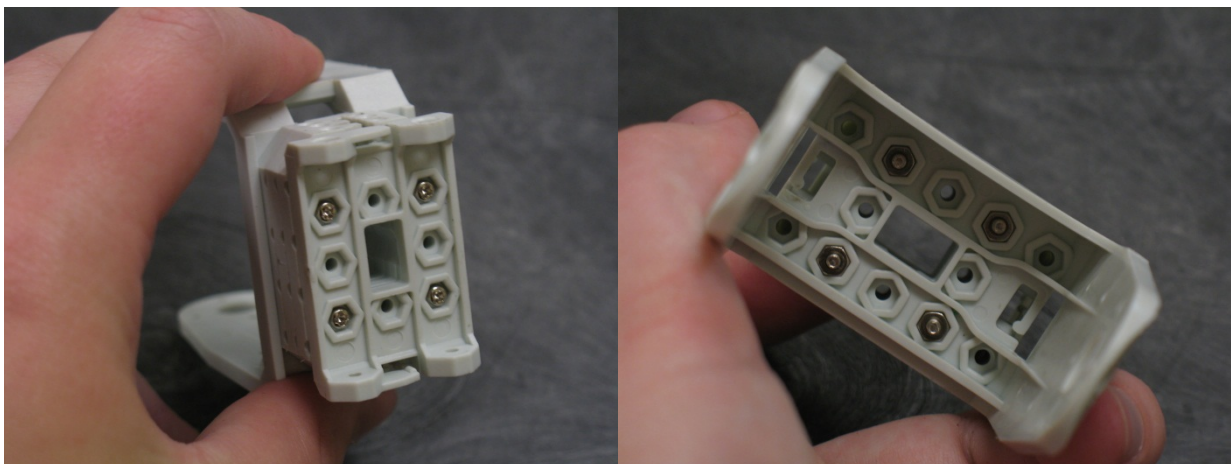
*You will need **per joint**:* 4x S6 (M2-???) screws, 4x nuts (N1), 1x F3 bracket, 1x F4 bracket, and 3x F10 spacers.

Put the parts together as shown in the picture below (F3 bracket on top, F4 on the bottom, F10s inbetween), and put nuts in 4 holes on the inside of the F4 bracket. This is a similar procedure to the first step, where you want to force the nuts in first so that they don't fall out as you put in the screws. However, since this is less of a press-fit, you may want to put your finger over the nut as you insert and tighten the screw.

Assemble **two** of these parts.



The pictures below illustrate screw and nut placement within the parts.

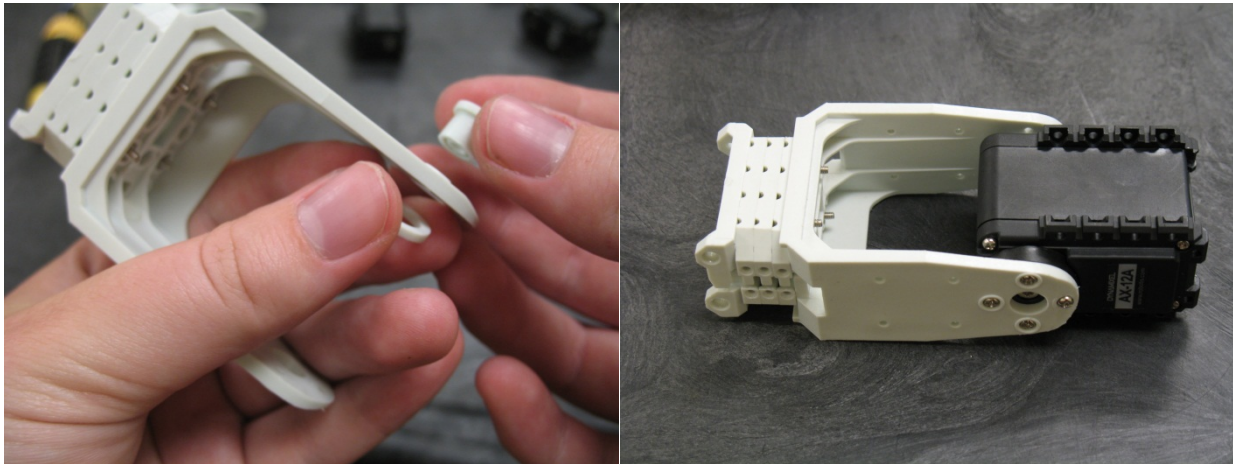


### STEP 3: INSERT SERVOS INTO JOINTS

Insert servos in to the joints assembled in Step 2.

*You will need **per joint**:* 1x main joint from Step 2, 1x AX12-A servo, 4x S1 (M2-6) screws, 1x S-B (???) screw, 1x WA washer and 1x BU insert.

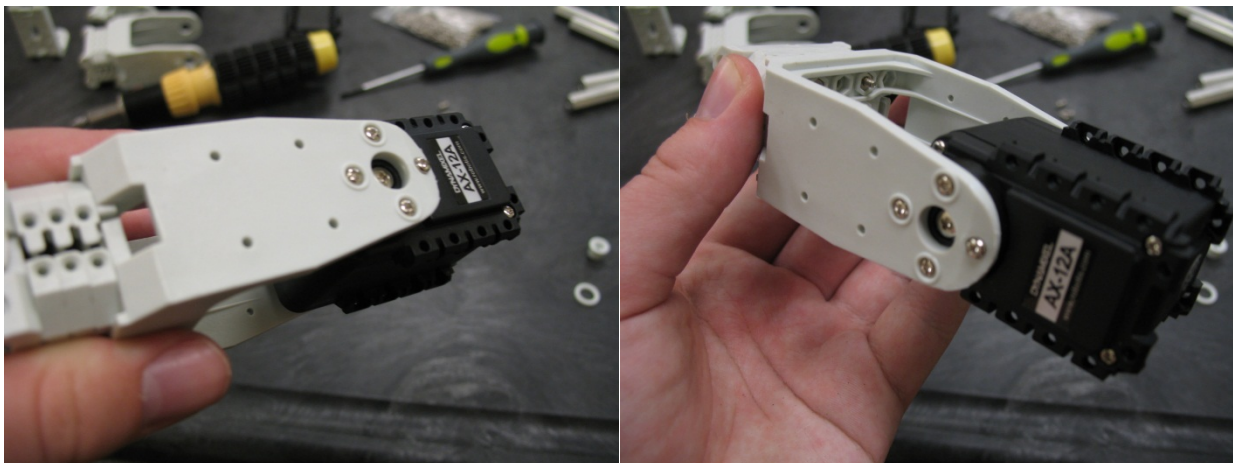
Insert BU into the hole on the right side of the F4 bracket, and the washer on the inside of the bracket, as shown in the left image below.



Insert the servo into the assembly, and use 4 S1 screws to fix the bracket to the horn (above, right), and 1 S-B screw on the opposite side (to fix the washer and insert).

Repeat the process with the other joint. You should again have **two** of these parts.

The photos below show how to attach to the servo horn.



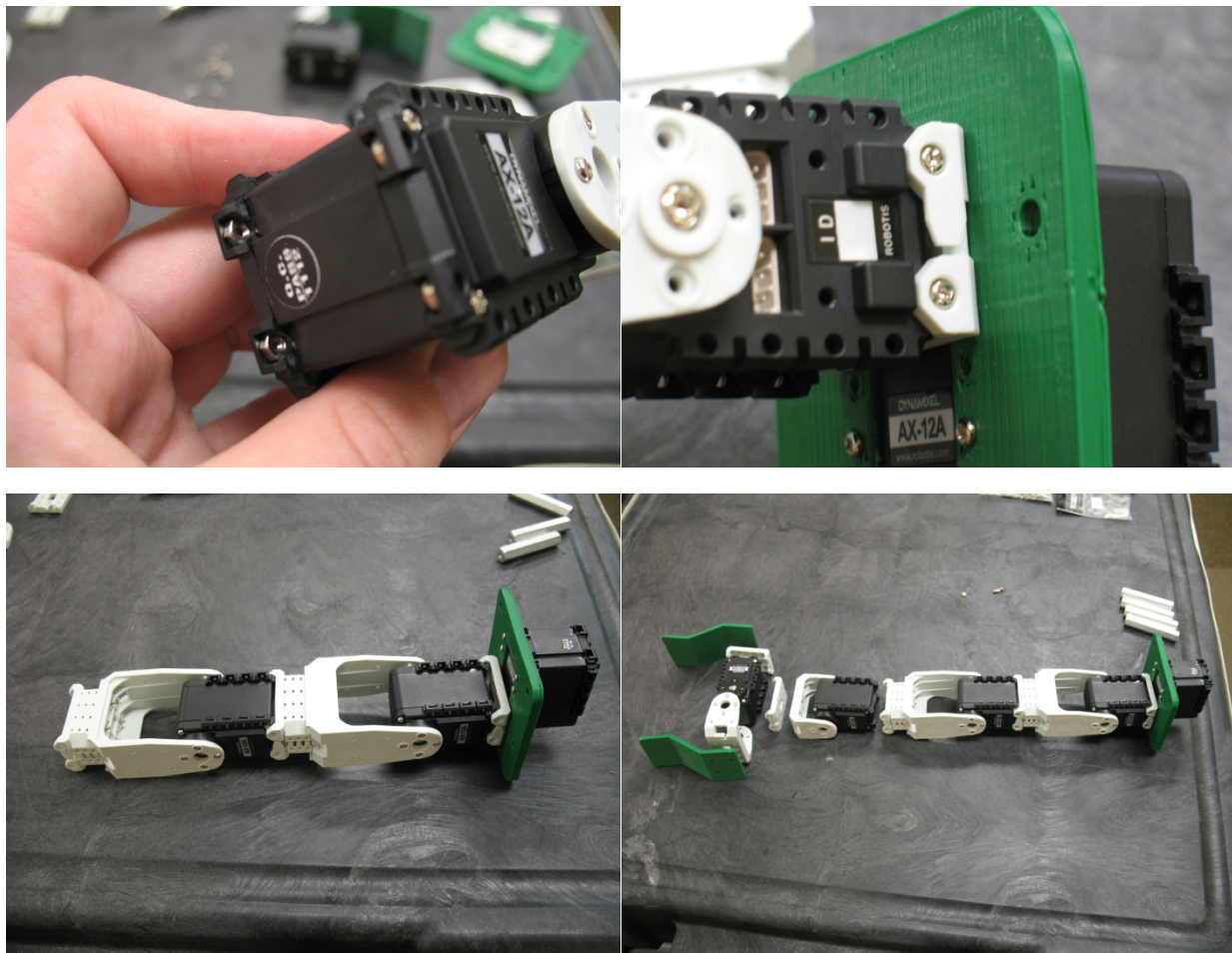
#### STEP 4: ASSEMBLE ARM

Assemble the main part of the arm (everything but the gripper).

*You will need:* 2x joints from Part 3, 1x base from Part 1, 4x S1 (M2-6) screws, 4x nuts.

Put together 2 of the parts from Step 3 and the base from Step 1 together as shown in the photo below.

First, put 4 nuts into the 4 slots on the bottom of each servo (pic). Then, attach the top of the F3 bracket to the bottom of each servo and screw them in with S1 screws. Note that it *will* take some force to snap the servos into the F3 brackets; make sure the holes on the bracket line up with the holes on the servos before you start screwing them in.





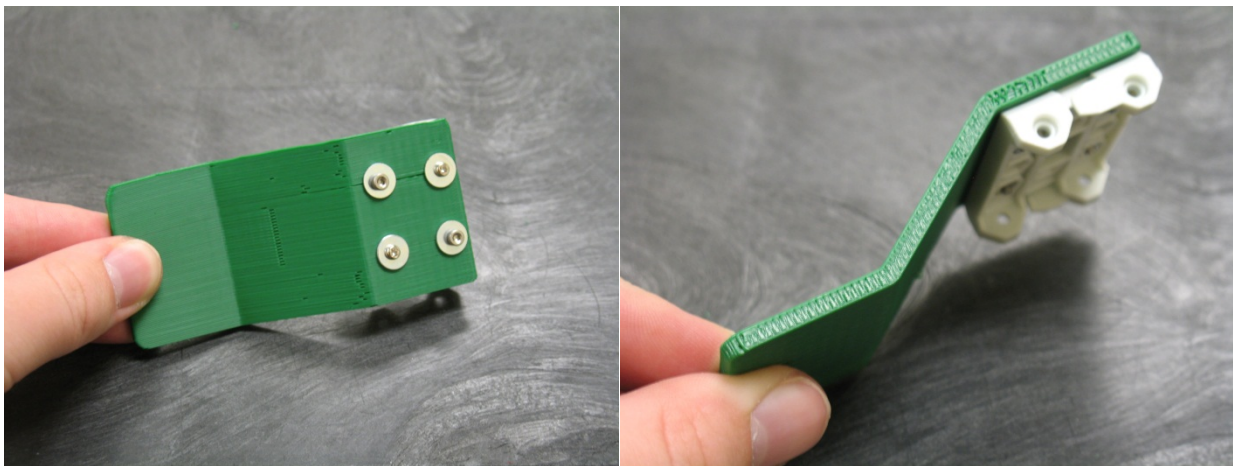
## STEP 5: ASSEMBLE GRIPPERS

Now we're creating the gripper.

*You will need for **left** gripper:* 1x 3D printed gripper part, 1x F3 bracket, 4x S2 (M2-8) screws, 4x nuts (N1), 4x M2 fender washers.

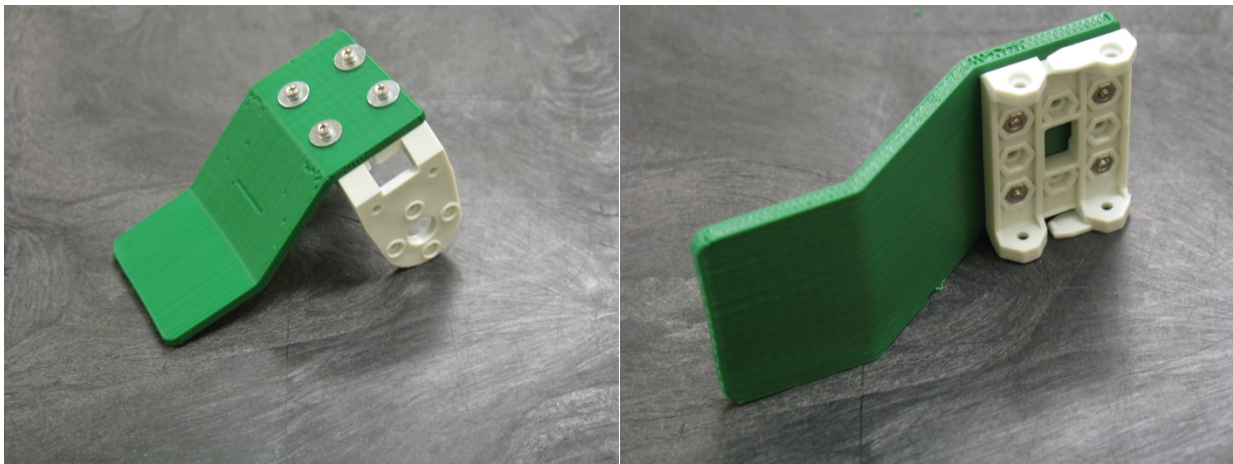
*You will need for **right** gripper:* 1x 3D printed gripper part, 1x F4 bracket, 4x S2 (M2-8) screws, 4x nuts, 4x M2 fender washers

First, attach the left side of the gripper to an F3 bracket with 4 S2 screws, 4 nuts, and 4 washers (picture below). As before, put the nuts in the bracket first, then hold the nuts while you screw the bolts in.



Attach the right side of the gripper to an F2 bracket, again with 4 S2 screws, 4 nuts, and 4 washers.

For both grippers, make sure the tabs on the brackets face the same way as the bend in the gripper (that is, the gripper is closing *towards* the direction the tabs are pointing).



## STEP 6: ATTACH GRIPPER SERVO

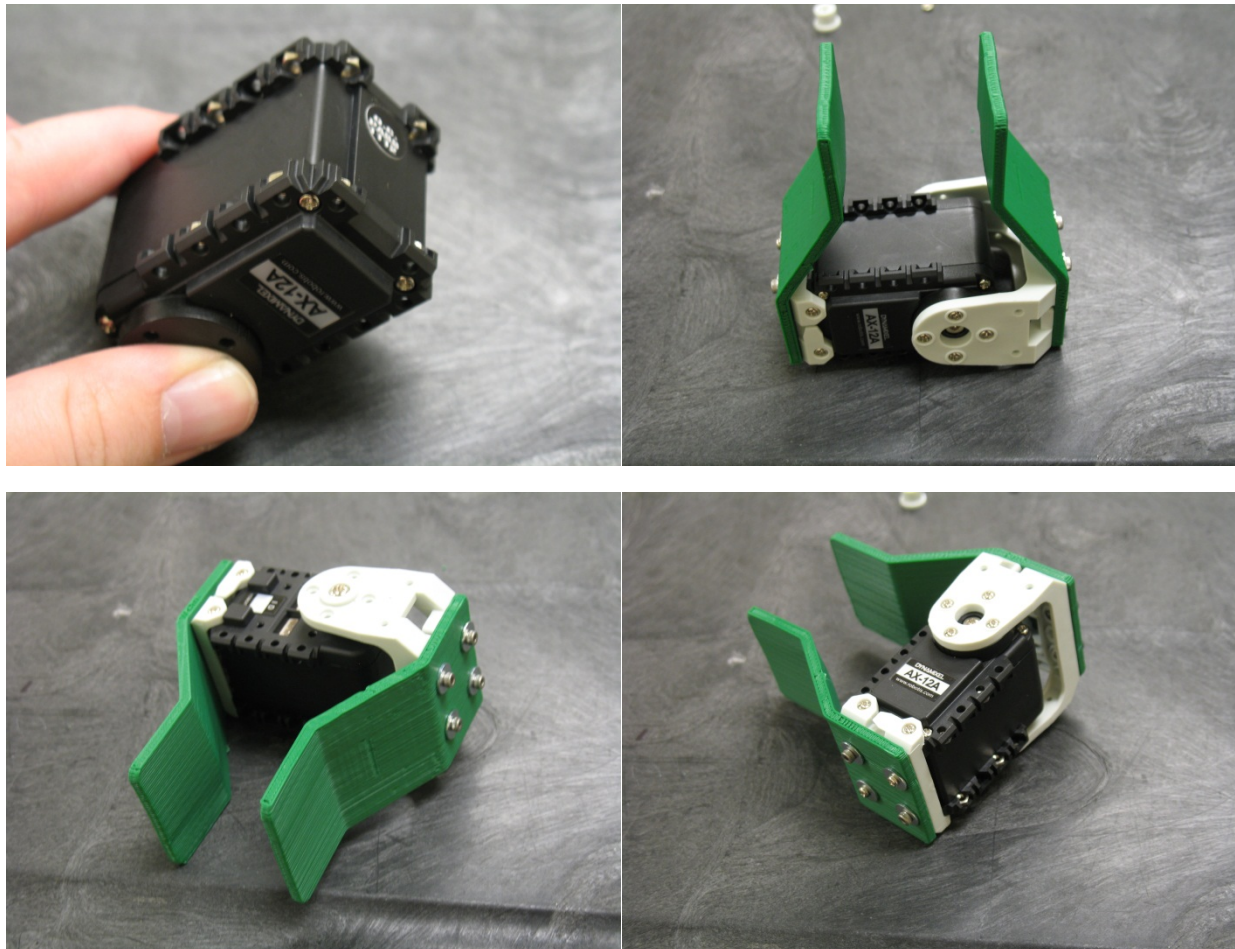
Attach the gripper to a servo and create a wrist assembly.

*You will need:* 4x nuts, 8x S1 (M2-6) screws, 1 S-B (???) screw, 1x BU insert, 1x WA washer.

First, insert 8 nuts into the spaces shown in the picture below (4 on the bottom of the servo, 4 on the right side of the servo).

Then, attach the right side of the gripper (with the bigger bracket) to the servo horn. Insert the BU and WA parts on the opposite side of the bracket as before, use 4 S1 screws to fix the gripper bracket to the servo horn, and finally use an S-B screw to fix the bracket to the shaft on the other side.

Attach the left side of the gripper (smaller bracket) to the bottom of the servo as shown below using 4 S1 screws.



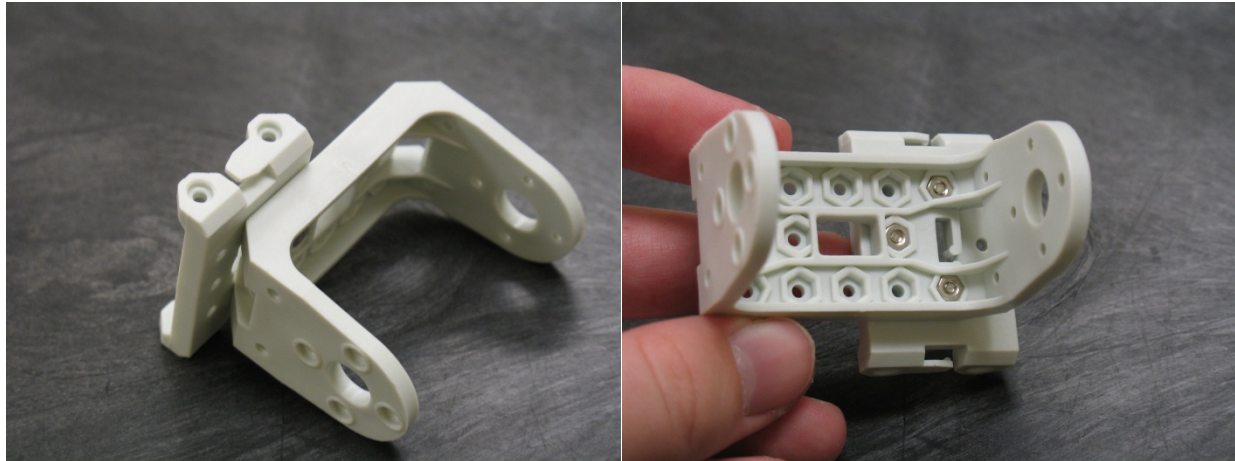


## STEP 7: WRIST ASSEMBLY

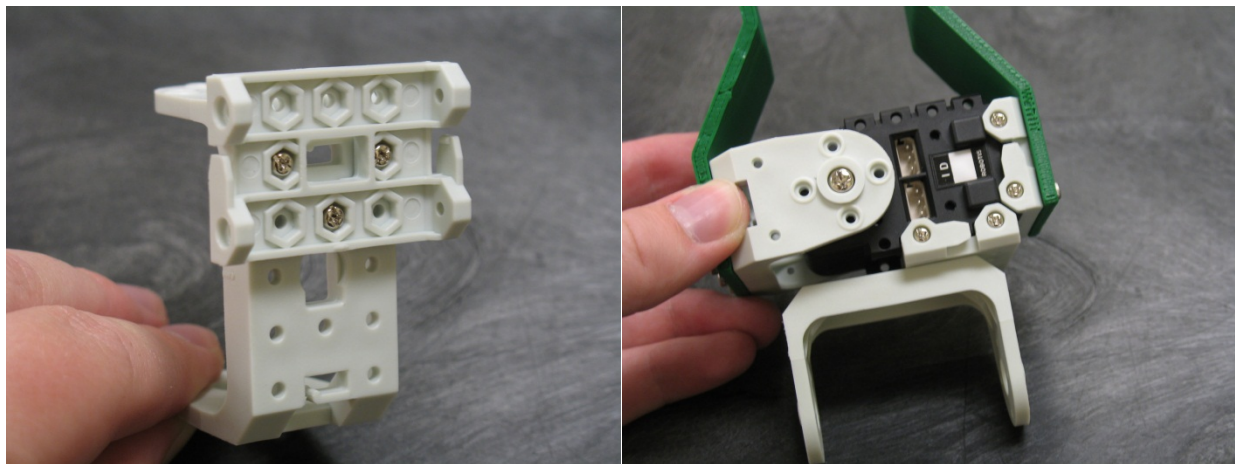
Assemble the wrist and attach it to the gripper.

*You will need:* 1x F3 bracket, 1x F2 bracket, 11x S1 (M2-6) screws, 7x nuts, 1x S-B screw, 1x BU insert, 1x WA washer.

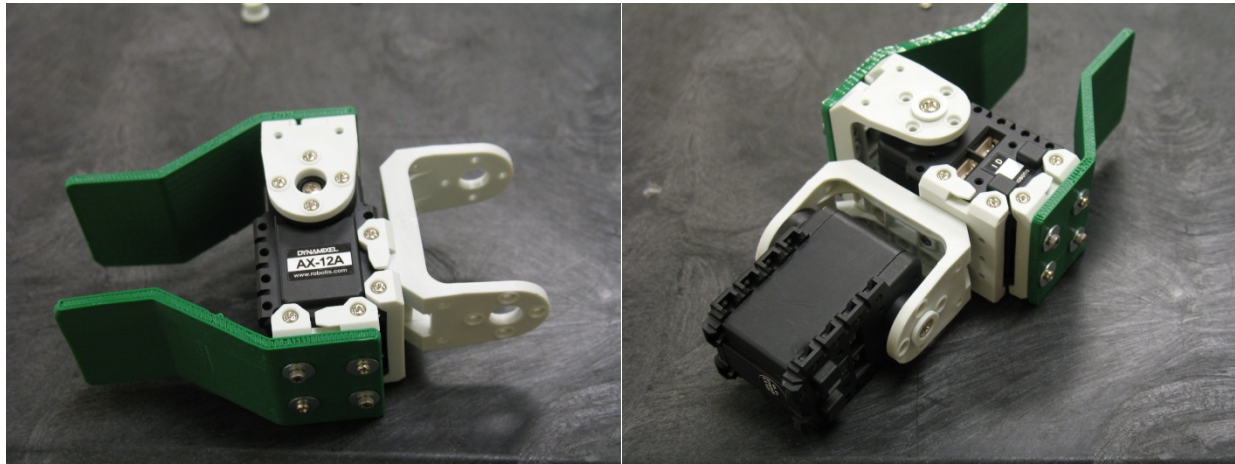
Use 3 S1 screws and nuts to attach the F3 and F2 brackets together at a 90 degree angle. Note in the pictures that the bigger bracket is *offset* on the smaller one: you should see three holes unobstructed on the smaller bracket.



Next, attach the wrist assembly using 4 nuts (that should already be inserted from the previous step) and 4 S1 screws to the side of the gripper servo (furthest from the horn) so that the large bracket is centered on the side of the servo.



Insert the servo into the assembly using, as always, 4 S1 screws for the horn, the dynamixel insert and washer, and 1 S-B screw. The wrist servo horn should be on the same side of the arm as the gripper servo horn (see below).

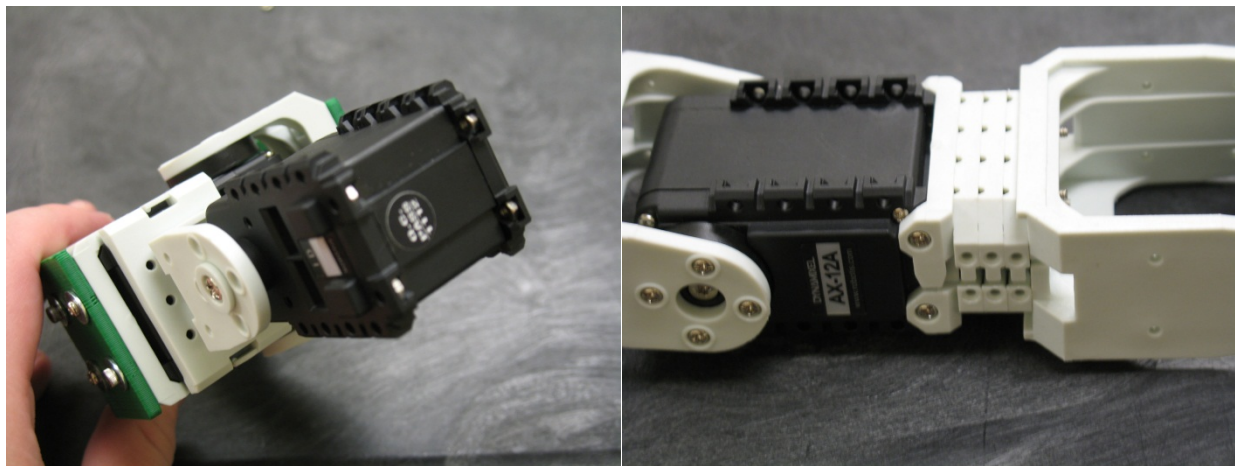


### STEP 8: CONNECT GRIPPER TO ARM

Finish assembling the arm by attaching the gripper and wrist assembly to the joints on the arm.

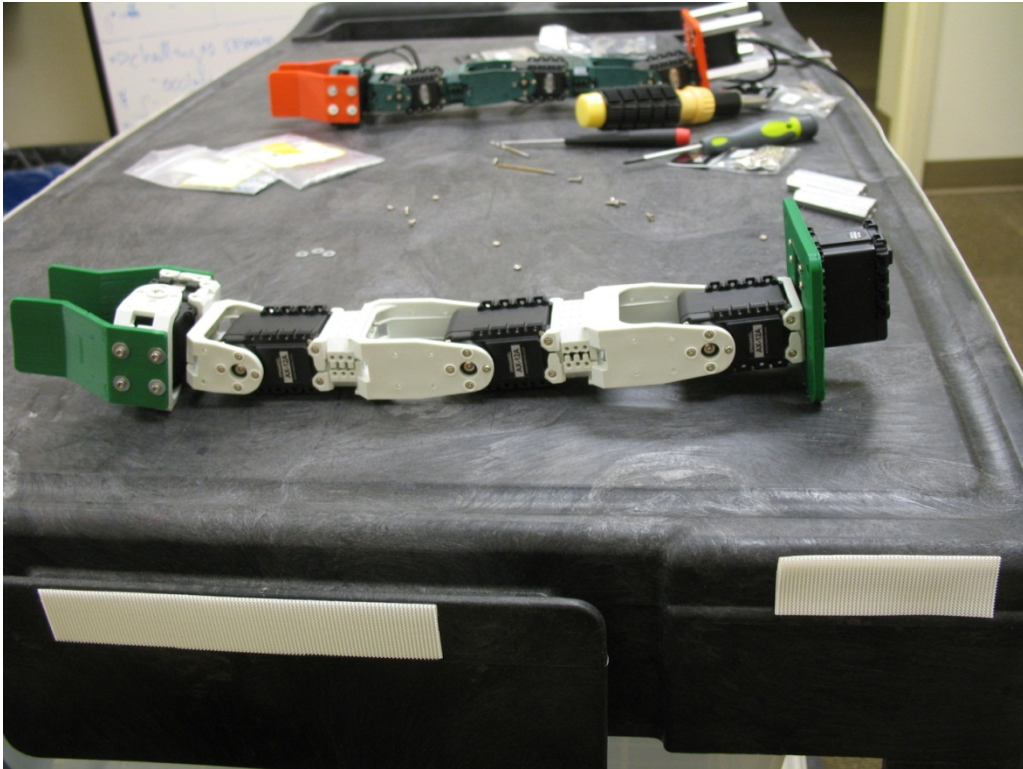
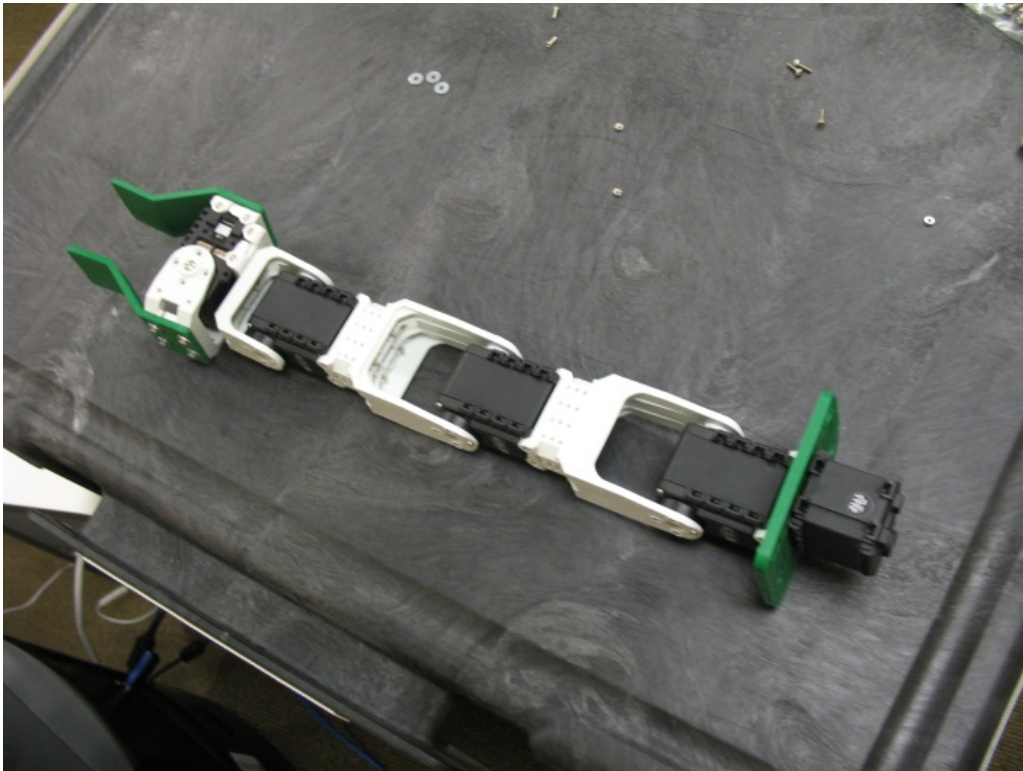
*You will need: 4x S1 (M2-6) screws, 4x nuts*

Slot 4 nuts into the bottom face of the wrist servo as shown below. Next, attach the top of the F3 bracket on the rest of the arm to the bottom of that servo. Make sure that all the servo horns face the same direction.





The assembled arm should look like the images below.



## STEP 9: ATTACH STANDOFFS

The last step is to attach the standoffs to the base of the arm.

*You will need: 4x 5-40 2" hex standoffs, 4x 5-40 ½" screws*

Screw the four standoffs into the holes on the base of the arm using 5-40 screws. Your arm is done!

