


Modular Robotic Arm

3D Printed Modular Robot Arm



This document explains how to construct, use, and troubleshoot a 3D printed Modular Robot Arm. This robot arm uses a Arduino board to register inputs made by the user on a controller and use those inputs to control the servos on the arm. The modular design of this robot also encourages users to create their own features. All components of this arm are openly available online so that anyone can gather the materials themselves and build it. The open source code is also available so a user can modify to match their needs.

 **Note** Read through the entire manual before assembling the robot. This will ensure no important information is missed before assembly.

Contents

Open Source Resources	2
Tools Required	2
Safety Guidelines.....	3
EMC Notices	3
Purchasable Parts.....	4
3D Printed Parts.....	6
Before Assembly	7
Wiring Instructions	7
Build Instructions	13
Final Assembly	30

Open Source Resources

All Files can be found on the git hub page.

- Git hub files are found at this [link](#).
- If this is not a pdf document then they can be found at:
 - <https://github.com/JamesEO5/Modular-Robotic-Arm---UC-Senior-Design-Project>

Tools Required



-
1. #25 Allen Key
 2. #25 Phillips Head Screwdriver
 3. Soldering Iron
 4. Pliers

Safety Guidelines



Caution Observe all instructions and cautions in the user documentation. Constructing the robot arm in a manner not specified can damage the robot arm and injure the user.



Caution The protection provided by the model can be impaired if it is used in a manner not described in the user documentation.



Caution Electrical shock hazard. This device contains electrical components and capacitors. Do not disassemble the electronics of the robot while it is in operation and be sure to discharge the capacitors before disassembly.



Caution Risk of fire if electrical shorts occur. Some 3D printed plastics can burn and catch on fire.

EMC Notices

Refer to the following notices for prevention measures necessary to ensure the specified EMC performance.



Notice For EMC declarations and certifications, and additional information, refer to the [*Product Certifications and Declarations*](#) section.



Notice The performance of this product can be disrupted if subjected to Electrostatic Discharge (ESD) during operation. To prevent damage, industry- standard ESD prevention measures must be employed during installation, maintenance, and operation.

Purchasable Parts

Mechanical Components



1. #25 Screws
 2. Servo Horns
 3. M3 x 5mm Female Press In Inserts
-

Cables



1. 8 Pin Ribbon Connectors
 2. 20 Pin Ribbon Connectors
 3. 8 Pin Ribbon Cable
 4. 20 Pin Ribbon Cable
-

Electrical Components



-
1. Power Adapter
 2. Power Supply
 3. 25kg Servo
 4. 10kg Servo
-

3D Printed Parts

Base

1. Base
2. BP_Center
3. BP_EBox
4. BP_EBox_Lid
5. HoldingBar
6. Turntable
7. ClampFoot
8. ClampSHaft
9. ClampPlate
10. BearingShaftA
11. DriveshaftLower

Link 1

1. Link1
2. JB_EEPlate
3. JB_Link1

Link 2

1. Link 2
2. BearingPlate
3. JB_Lid_EEPlate
4. EEPlate
5. JB_Lid
6. JB_Link2
7. DriveshaftUpper
8. UpperLinkWasher

Gripper

1. ClawBody
 2. Gripper_Right
 3. Gripper_Left
 4. Driveshaft_Claw
 5. Claw_Shaft
 6. ClawShaftSpacer
-

Controller

1. Controller_Top
2. Controller_Bottom

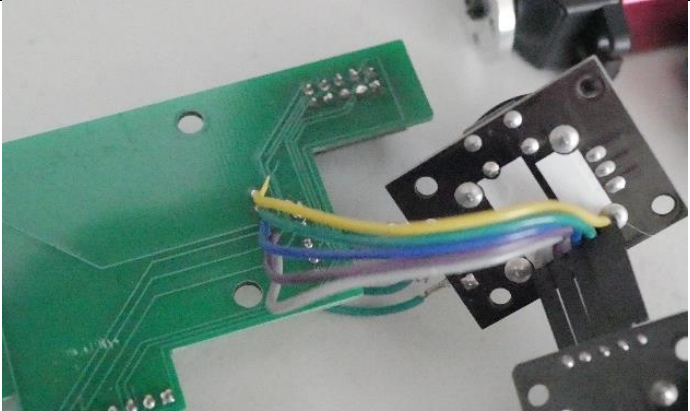
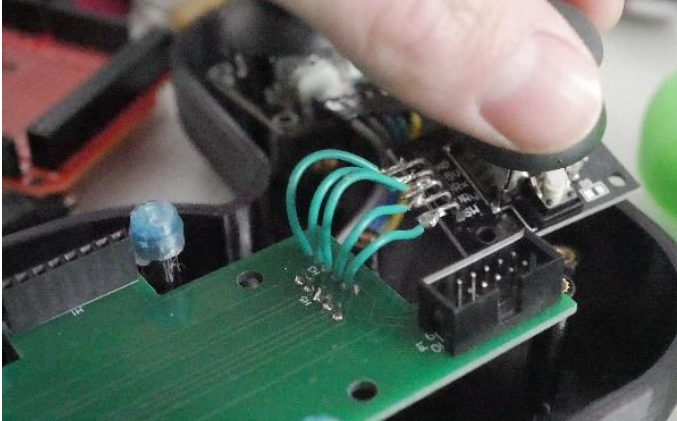
Before Assembly

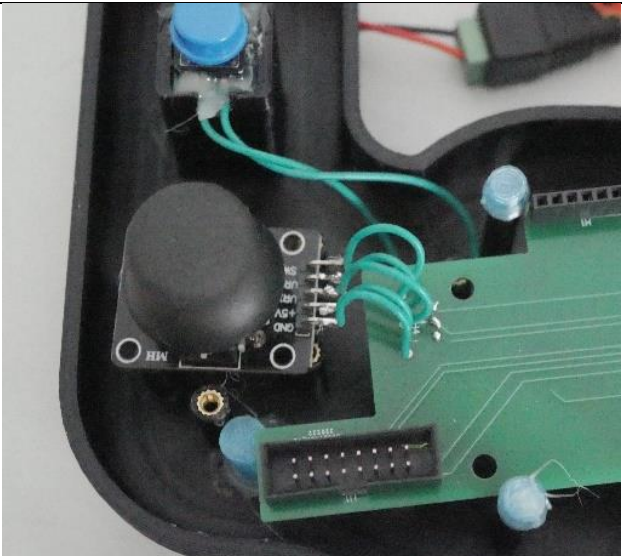
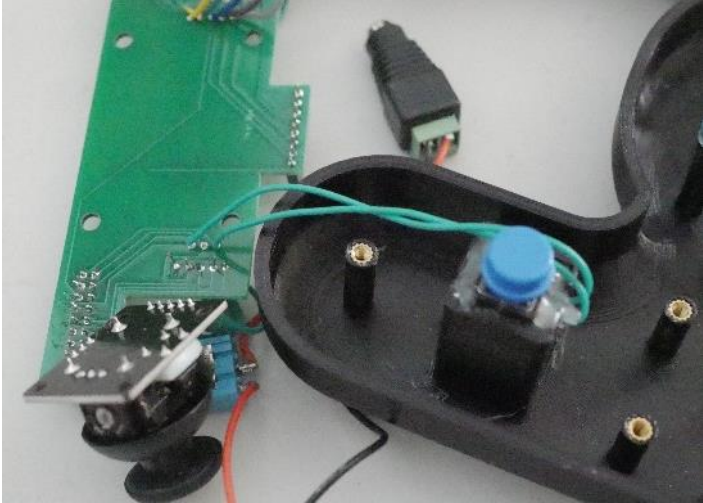
Complete the following tasks before building the Modular Robot Arm. It is very important that you complete the tasks before building to ensure easy assembly and best performance.

1. Purchase all necessary parts.
2. Print all parts that need to be 3D printed.
3. Be sure your work surface is completely free of other materials not related to the build.

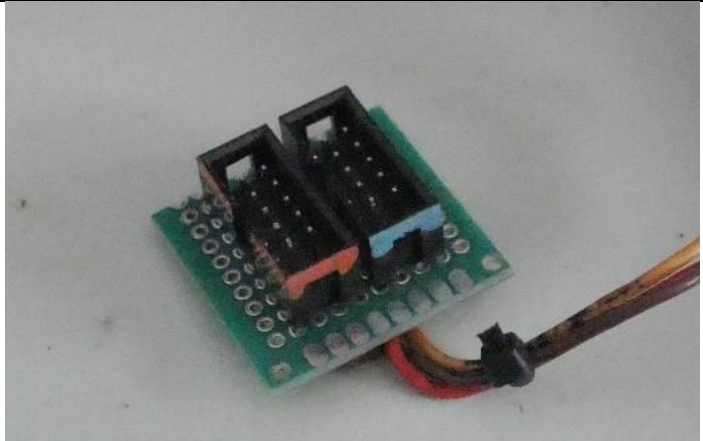
Wiring Instructions

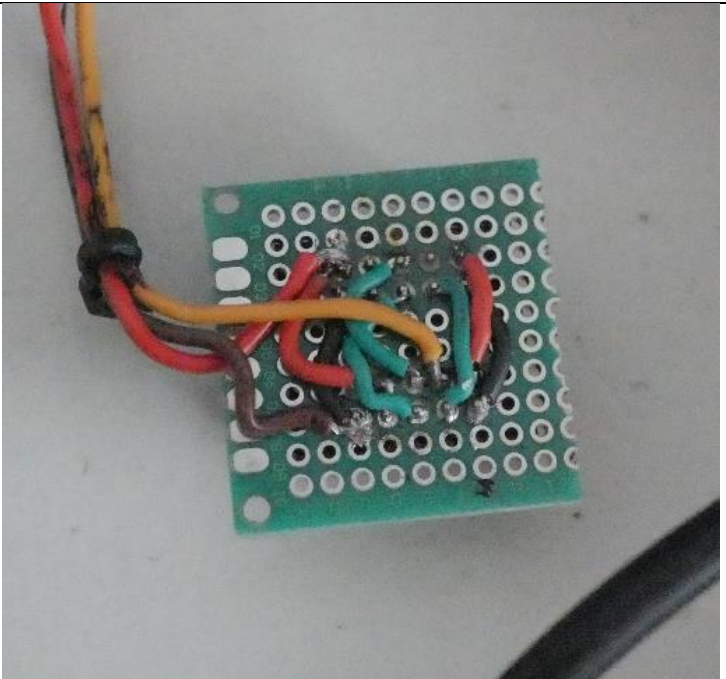
Controller

1	Start by soldering the 8 and 20 pin connector to the controller motherboard. Then solder the straight 8 pin connector to the bottom section of the controller board	
2	Flip the board over and solder 5 wires to the underside of the board according to the picture seen Then connect the J3 joystick to the wires as seen	
3	Turn the board back over to the top side and solder 5 wires to the top of the board Then solder those wires to the J1 joystick as seen	

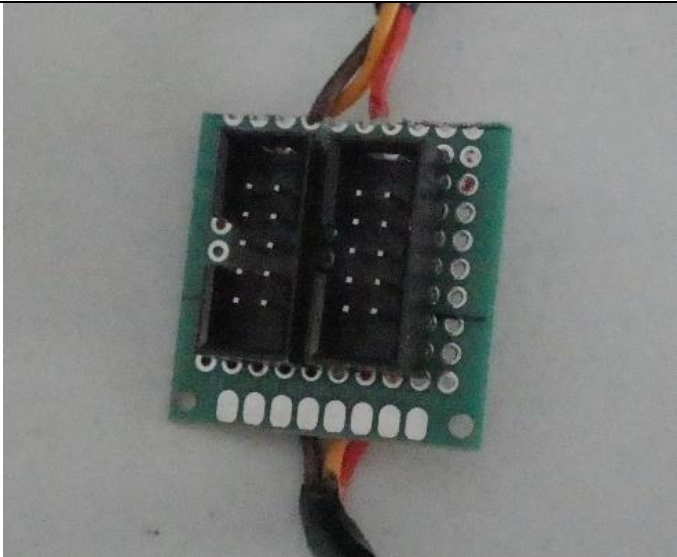
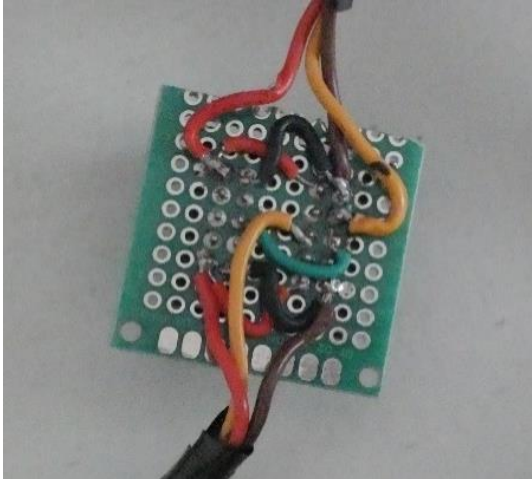
4	Solder the J2 joystick in the same way as J2 on the opposite side of the board.	
5	Solder two wires to the underside of the controller board and then connect these wires to the button	

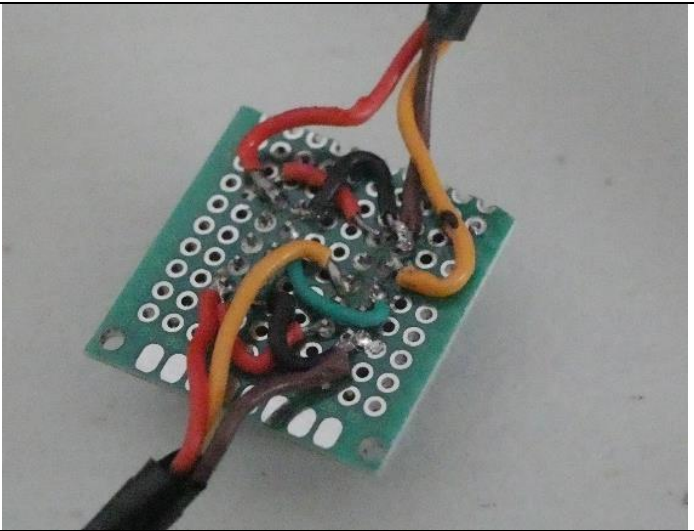
Link 1

1	Take a small board and solder 2, 8 pin connectors to it	
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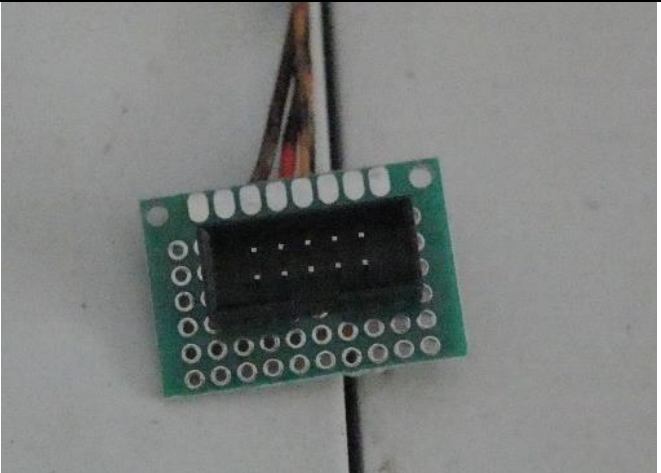
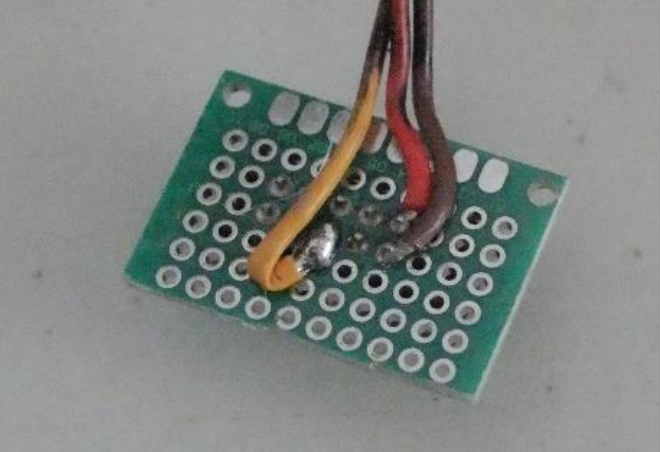
2	On the other side of the board solder the Link 1 Servo as shown	
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Link 2

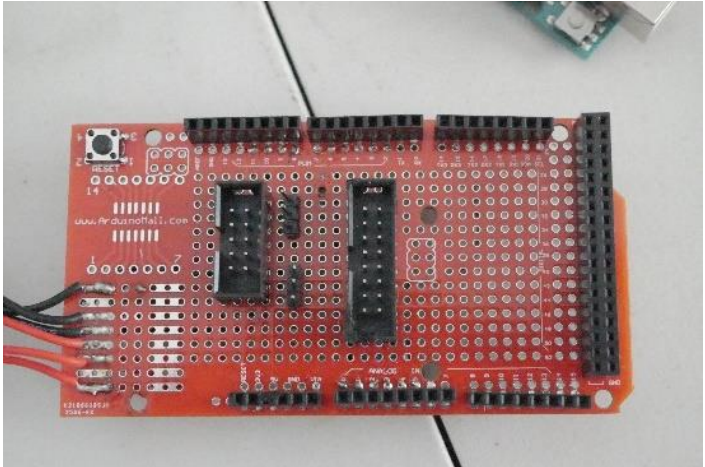
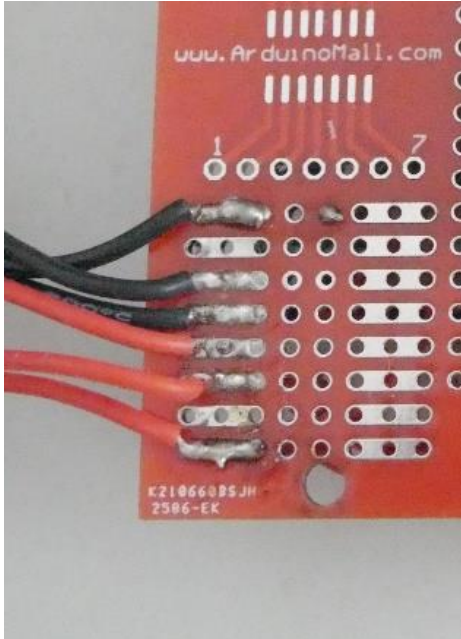
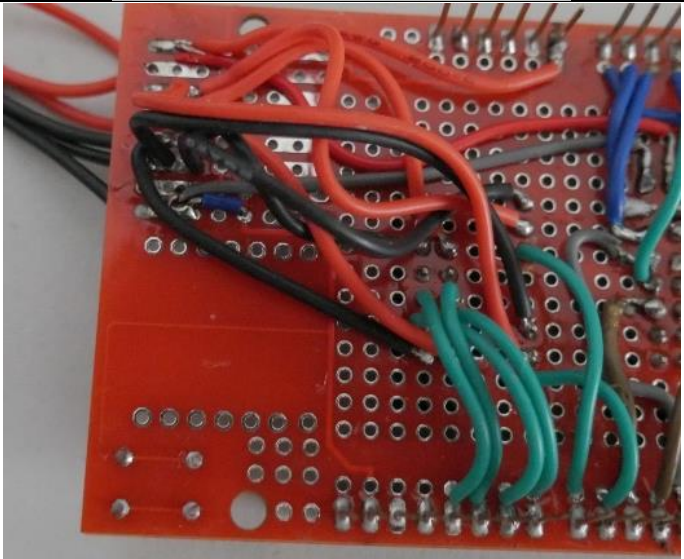
1	Start by soldering 2 8 pin connectors to the top of a cut board	
2	Solder the link 2 wrist swivel servo to one 8 pin connector according to the picture to the right	

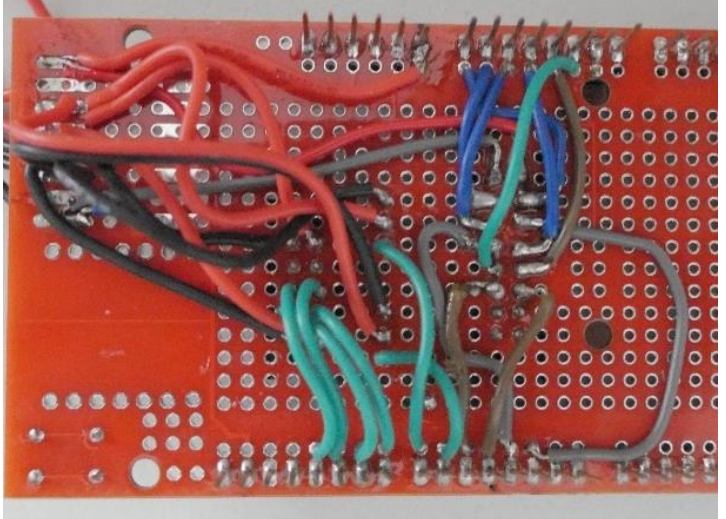
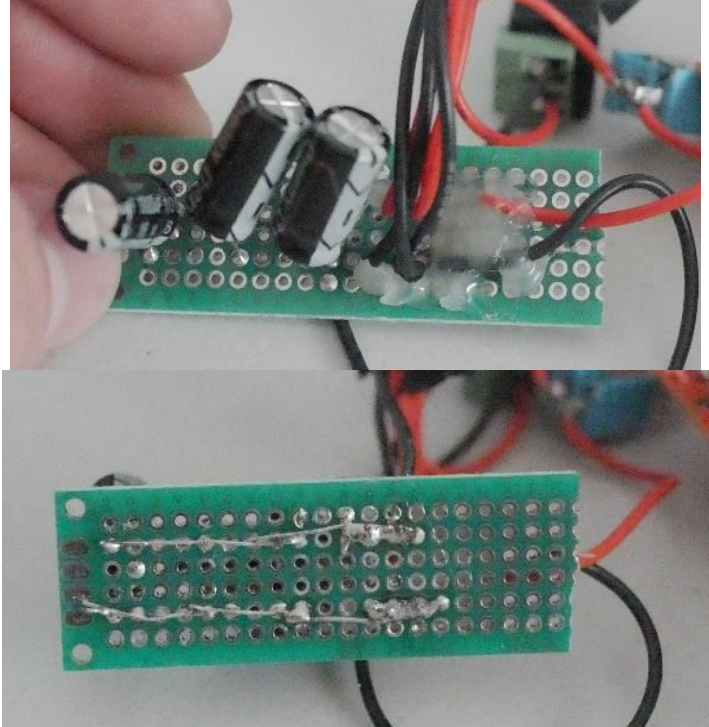
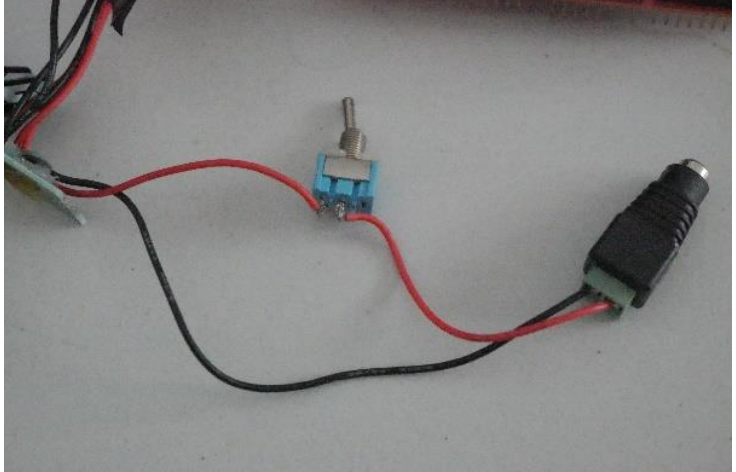
3	Solder the link 2 wrist bend servo to the other 8 pin connector according to the picture to the right	
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Gripper

1	Solder the 8 pin connector to a small board	
2	Solder the gripper servo to the board as seen on the right	

Main Board

1	Solder an 8 pin connector, a 20 pin connector, and 2 3 pin connectors to a Arduino cover board as shown	
2	Solder 3 black wires and 3 red wires to the side of the board as shown	
3	Flip the board over and solder red and black wires to the board as shown to the right	

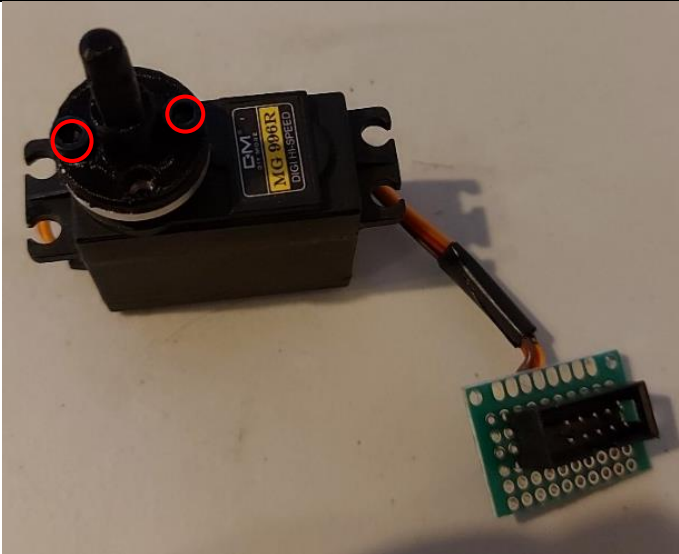
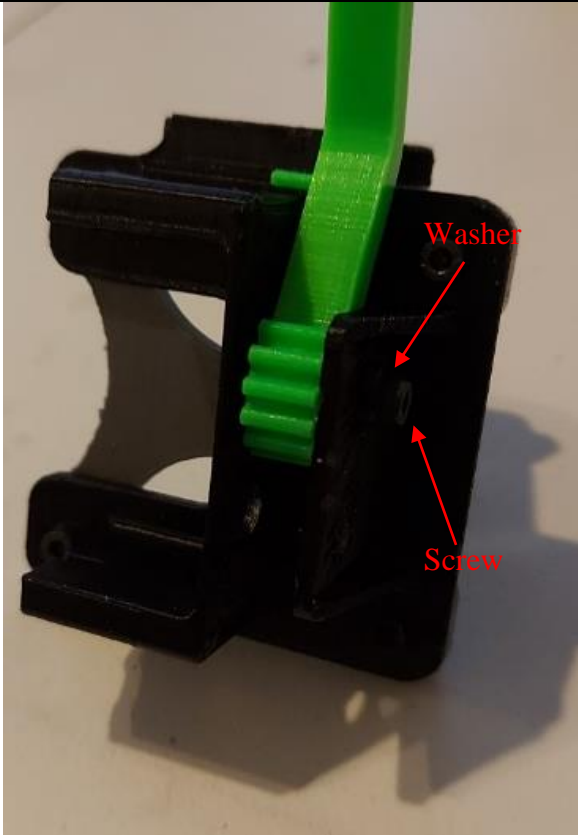
4	<p>Solder the rest of the blue and green wires to the board as shown to the right. These wires are for the pin outs for the servos and controller</p>	
5	<p>Take another small board and solder the red and black wires coming off the board in parallel with their respective colors. Then solder 3 capacitors in parallel with the red and black wires</p>	
6	<p>Finally solder a power input in series with the red and black wires and add a switch to the red wire. Wire it according to the picture to the right</p>	

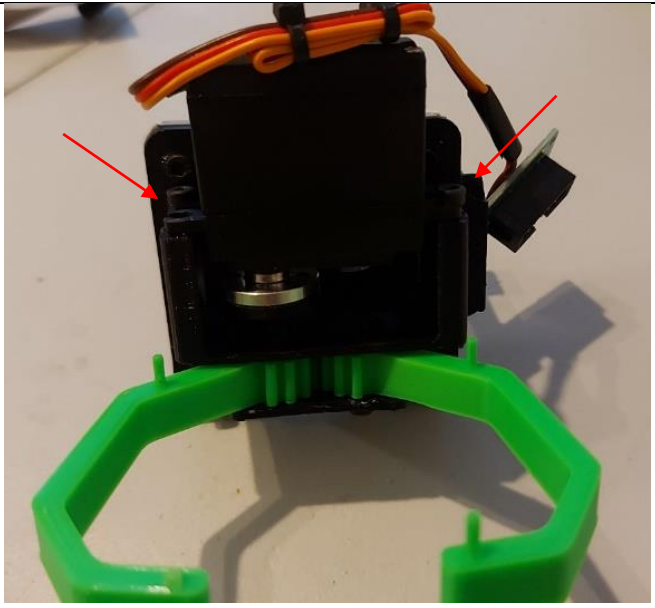
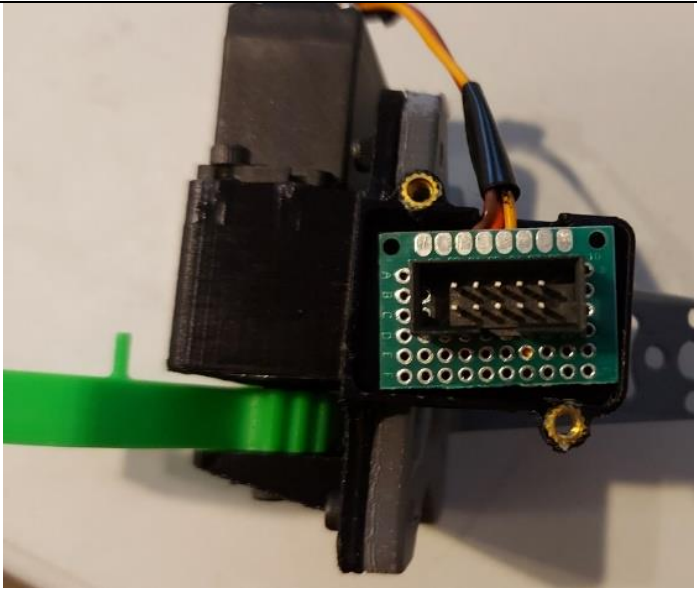
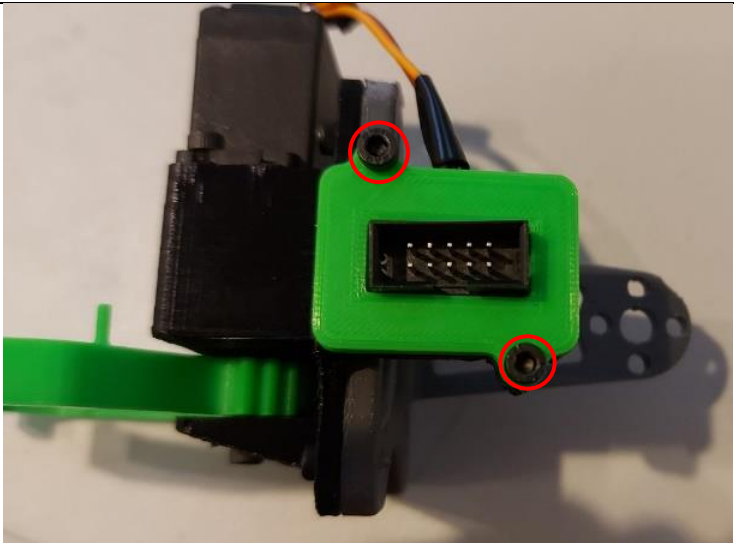
Build Instructions

When building the robot arm use the #25 screw driver on all Phillips head screws and a #25 allen wrench on all other fasteners. Follow the instructions carefully and follow each step to ensure no components are damaged during the build process. Be sure to also follow all wiring guides mentioned so no wires get entangled during operation.

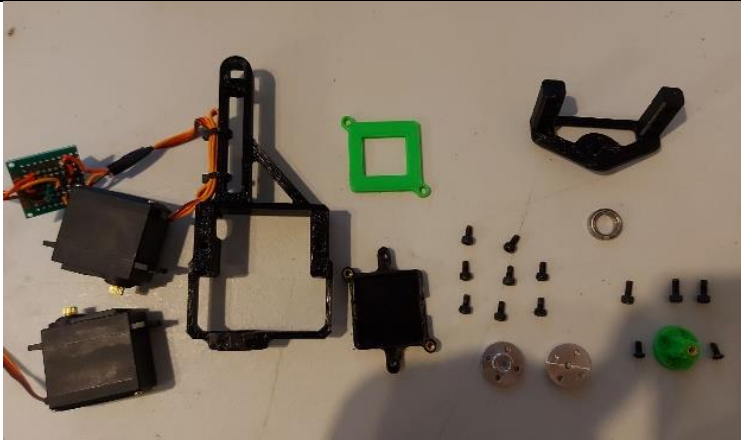

Gripper

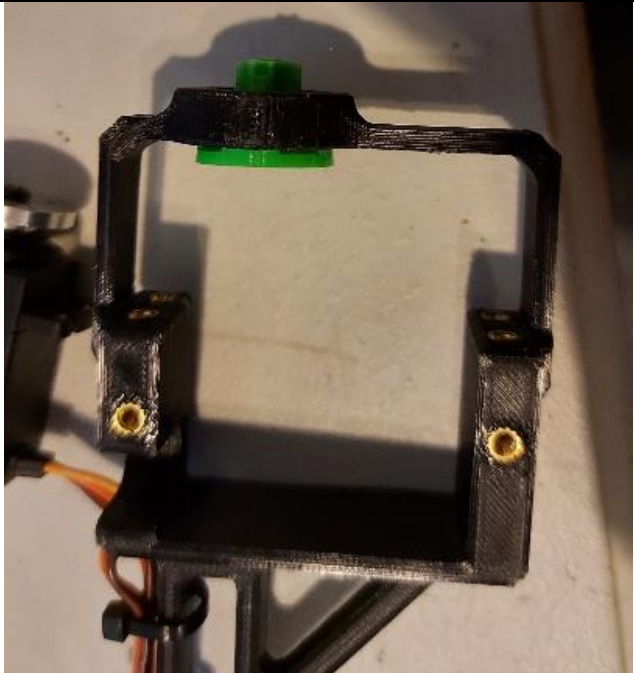
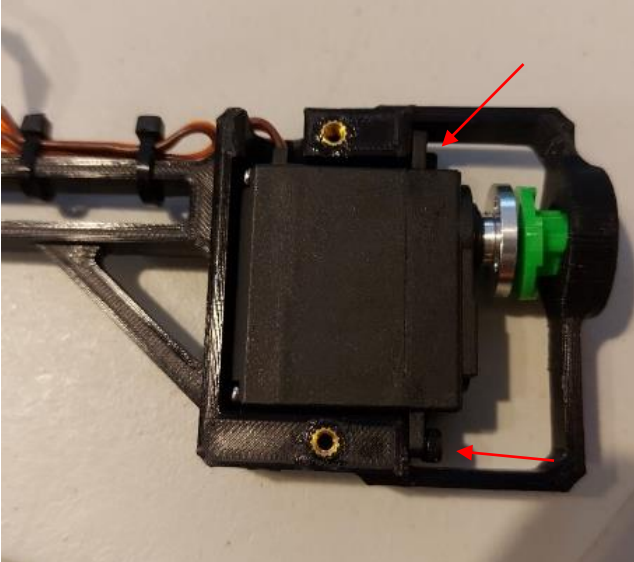

1	<p>Parts Required:</p> <ol style="list-style-type: none">1. 10 short screws2. 2 medium screws3. 1 servo bracket screw4. gripper pin5. Washer6. Aluminum servo interface bracket7. Gripper interface pin8. Servo circuit board cover9. Left and right grippers10. 10 kg Servo11. Servo Bracket12. Hand Connector bracket	
2	<p>Place the Hand connector bracket on the large flat surface of the servo bracket and secure it with 4 short screws</p>	
3	<p>Snap on the aluminum servo interface bracket onto the 10kg servo and secure it with the servo screw</p>	

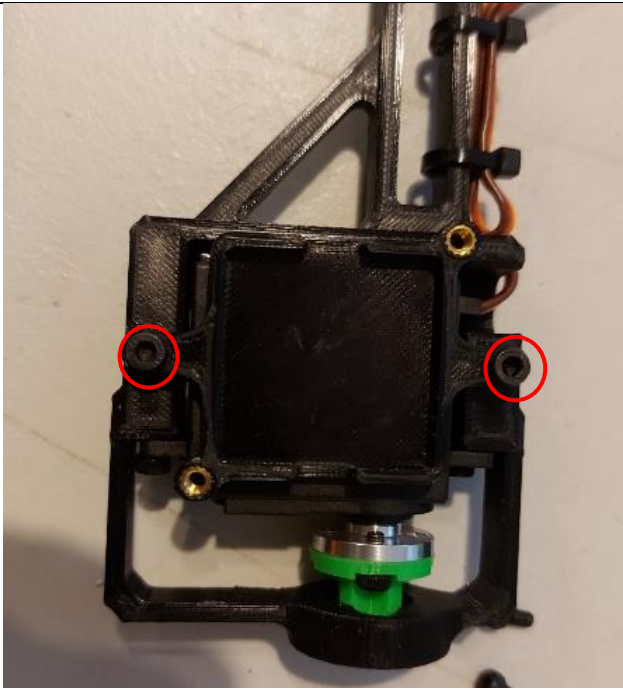
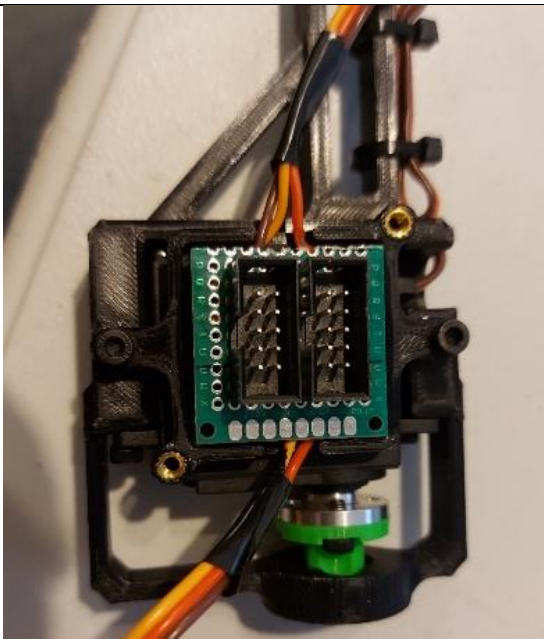

4	<p>Secure the gripper interface pin on the aluminum bracket using 2 short screws</p>	
5	<p>Place the left hand gripper in the slot located on the hand connector bracket and slide the gripper pin in the slot to secure the hand.</p> <p>Secure the pion using a short screw and washer.</p>	


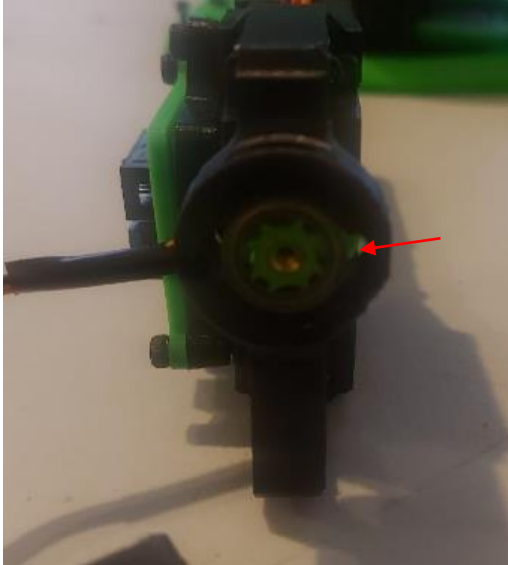

6	<p>Place the right hand gripper in the other slot and interface the gears with the left gripper</p> <p>Secure the right gripper with the servo assembly and fasten 2 medium screws through the servo holes and into the servo bracket</p>	
7	<p>Place the circuit board connected to the servo in the circuit board slot on the servo bracket</p>	
8	<p>Secure the circuit board using the circuit board cover and fasten it down using 2 short screws</p>	

Link 2

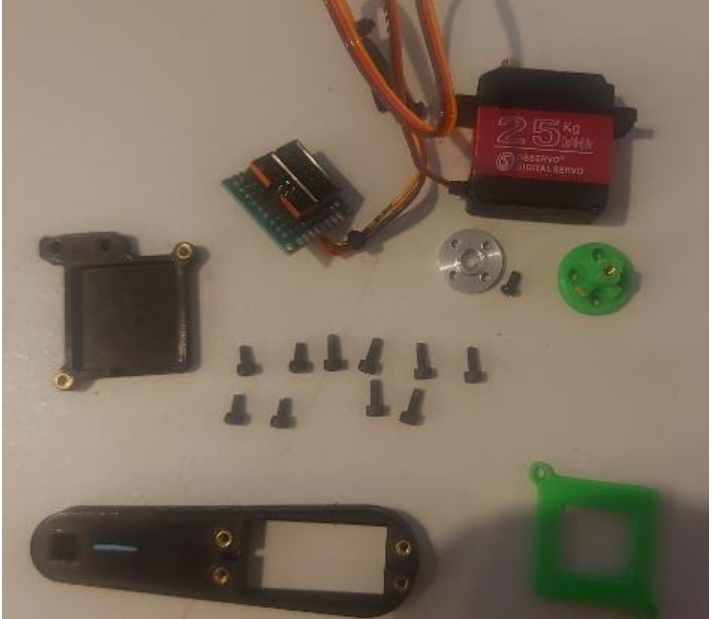
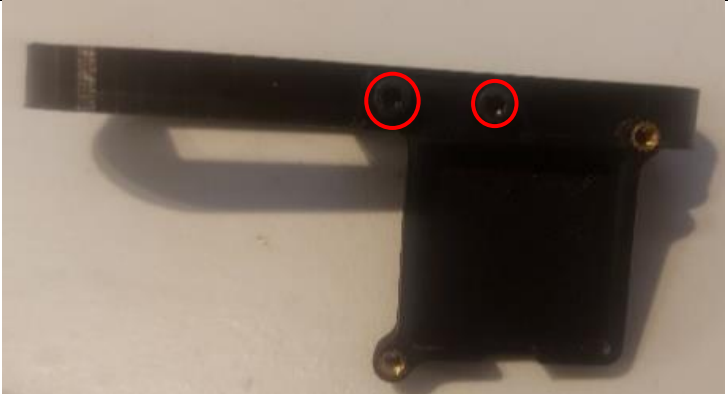

1	<p>Parts Required:</p> <ol style="list-style-type: none">1. 2 10kg Servos connected with circuit board2. Wrist/Elbow bracket3. Circuit board mount4. Circuit board cover5. hand Servo Bracket6. Bearing7. 8 short screws8. 2 aluminum servo interface bracket9. 3 medium screws10. 2 servo screws11. wrist interface pin	
2	<p>Place one of the aluminum servo interface brackets on the wrist servo and secure it with a servo screw</p>	



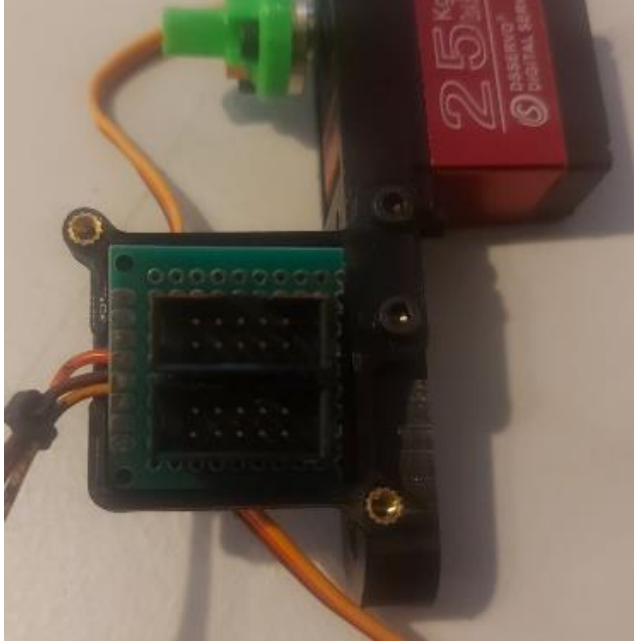
3	Place the wrist interface pin into the slot located on the Wrist/Elbow bracket	
4	Insert the wrist servo assembly into the Wrist/Elbow bracket and secure it with 2 short screws	
5	Secure the wrist pin to the aluminum servo bracket using 2 short screws	

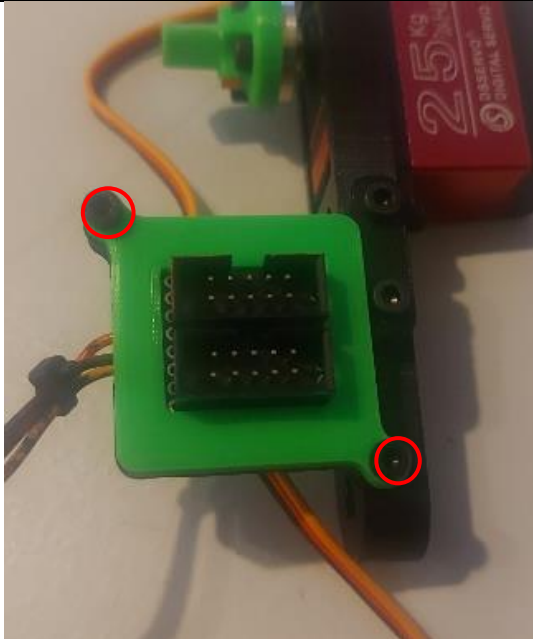
6	Place the circuit board mount onto the Wrist/Elbow bracket and secure it with 2 short screws	
7	Place the circuit board for the servos into the circuit board mount	
8	Place the other aluminum servo bracket onto the servo and secure it with a servo screw	

9	Mount the hand servo to the hand servo bracket and secure it with 2 short screws	
10	Place the bearing onto the hand pin	
11	Secure the hand bracket assembly to the hand pin using a medium screw	


Link 1

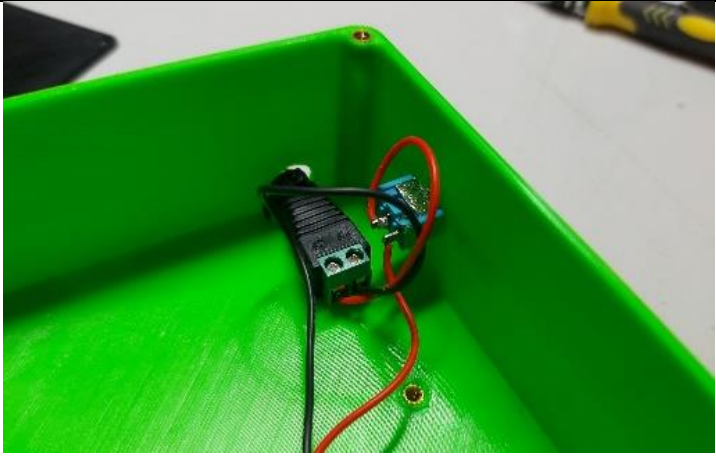


1	<p>Parts list</p> <ol style="list-style-type: none">1. 25kg servo2. Circuit board mount3. 6 medium screws4. 4 short screws5. Aluminum servo interface bracket6. Elbow pin7. Servo screw8. Circuit board cover9. Elbow/Shoulder	
2	<p>Secure the circuit board mount to the elbow/shoulder bracket using 2 medium screws</p>	
3	<p>Snap on the aluminum servo bracket and secure it with the servo screw</p>	

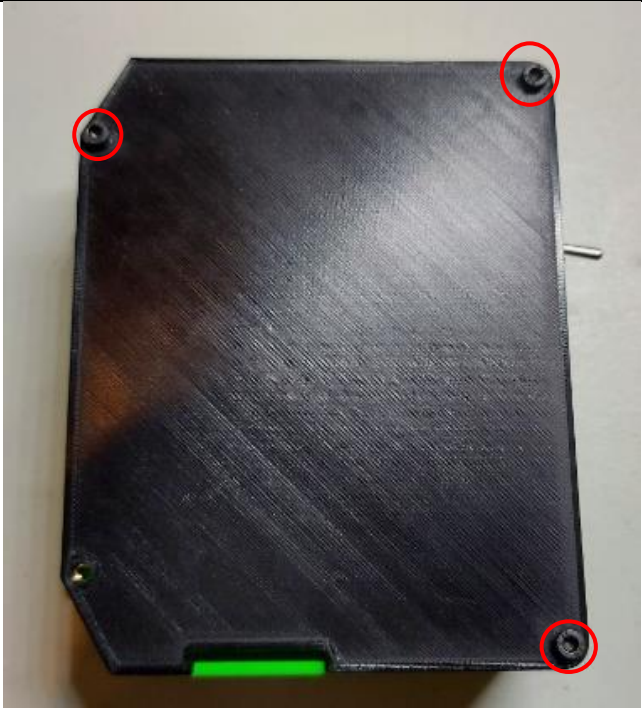
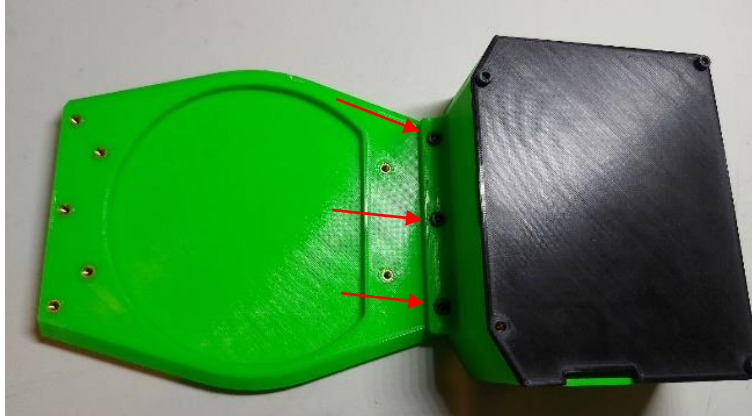
4	Mount the servo to the elbow/shoulder bracket assembly using 2 medium screws	
5	Attach the elbow pin to the aluminum servo bracket using 4 short screws	
6	Place the circuit board onto the circuit board mount	

7	Attach the circuit board cover to the circuit board mount using 2 medium screws	
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EEBox

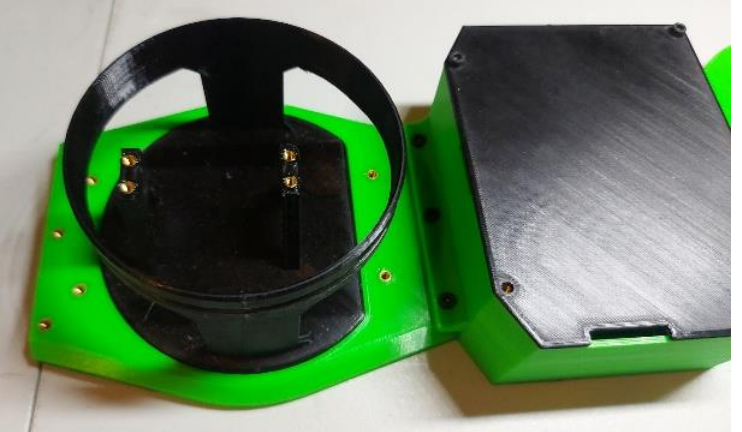


1	<p>Parts list</p> <ol style="list-style-type: none"> 1. Main Circuit board 2. Main Board box 3. Main board box cover 4. Arm base 5. 3 long screws 6. 6 medium screws 7. Switch washer 8. Switch nut 9. Wide washer 	
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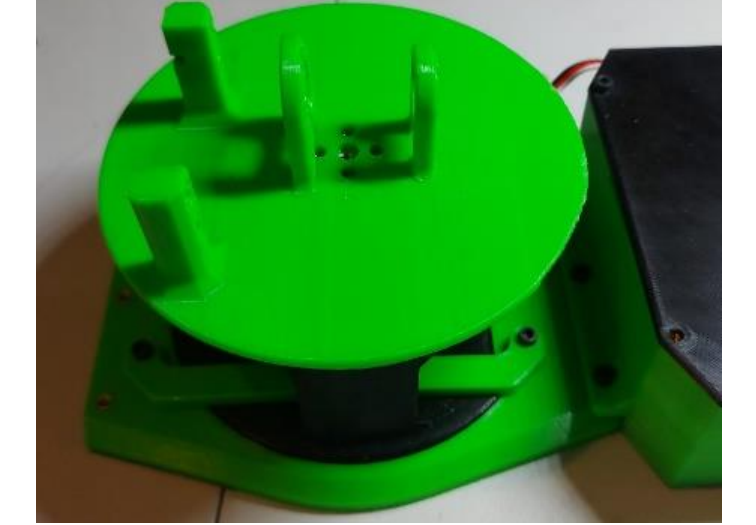
2	<p>Hot glue the switch and power plug to the bottom of the main board box</p>	
3	<p>Secure the switch using the switch washer and nut</p>	
4	<p>Place the main board and auxiliary board in the main board box and secure them with 3 medium screws and the large washer</p> <p>The auxiliary board is secured using one of the screws and washer</p> <p>The main board is secured using 2 of the screws</p>	

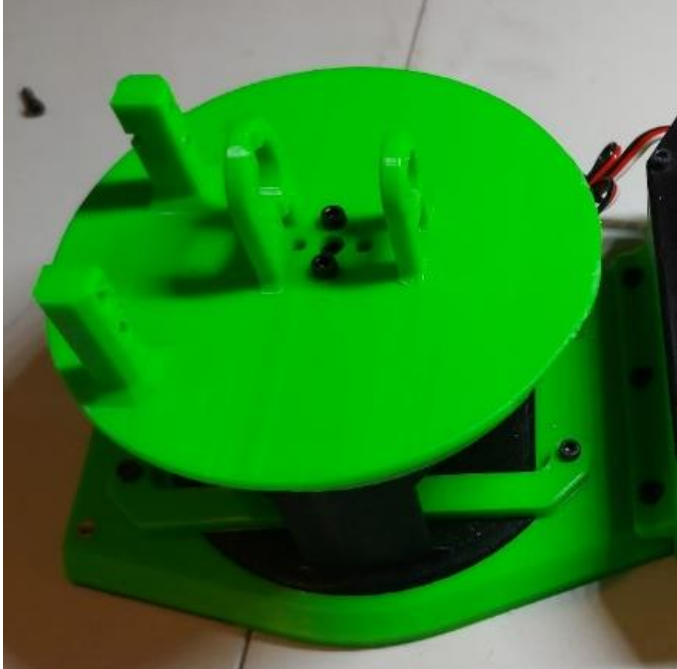
5	Use 3 medium screws to secure the main box cover to the main board box	
6	Use 3 long screws to secure the arm base to the main board box	

Turntable




1	<p>Parts list</p> <ol style="list-style-type: none"> 1. Main board box assembly 2. Lower swivel base 3. Upper swivel 4. 4 medium screws 5. 6 long screws 6. Aluminum servo bracket 7. Servo screw 8. 2 Swivel base supports 9. 25kg Servo 	
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2	Place the lower swivel base on the main board box assembly	
3	Secure both swivel base supports using 4 medium screws on the main board box assembly	
4	Place the 25kg servo on the lower swivel base, be sure to feed the servo wire through the hole in the lower swivel base	

5	Secure the servo using 4 medium screws	
6	Snap on the aluminum servo bracket onto the servo	
7	Snap on the upper swivel onto the lower swivel	

8	<p>Secure the upper swivel to the 25kg servo using the servo screw</p>	
9	<p>Secure the upper swivel base to the aluminum servo bracket using 2 medium screws</p>	

Shoulder Joint

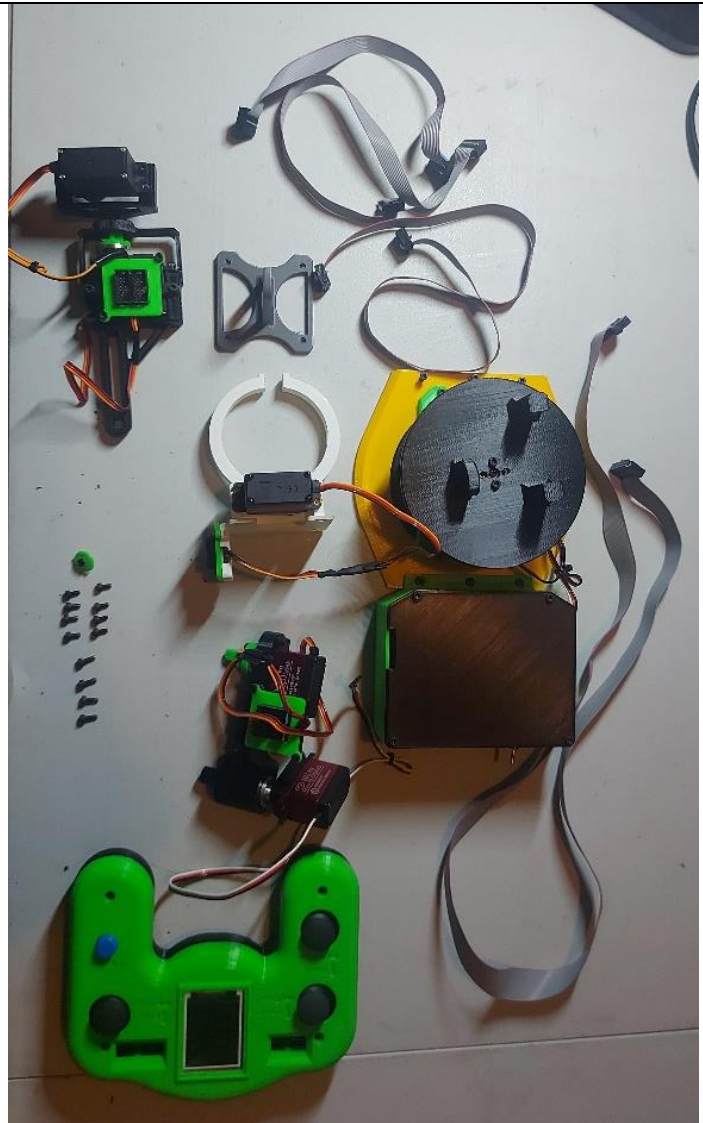
1	<p>Parts list</p> <ol style="list-style-type: none">1. 25kg servo2. 4 long screws3. 2 medium screws4. Aluminum servo bracket5. Bearing6. Servo screw7. Shoulder pin	 A photograph showing the components for the servo assembly. At the top is a DS3225MG Digital Servo. Below it are four long black screws, two medium black screws, a silver aluminum servo bracket, a silver bearing, a green shoulder pin, and a small black servo screw.
2	<p>Snap the aluminum servo bracket onto the 25kg servo and secure it with the servo screw</p>	 A photograph showing the silver aluminum servo bracket snapped onto the top of the DS3225MG Digital Servo. A small black servo screw is visible in the center of the bracket.
3	<p>Attach the shoulder pin to the servo and secure it with 4 medium screws</p>	 A photograph showing the green shoulder pin attached to the top of the servo. The pin is secured by four medium black screws. The servo is labeled DS3225MG Digital Servo.

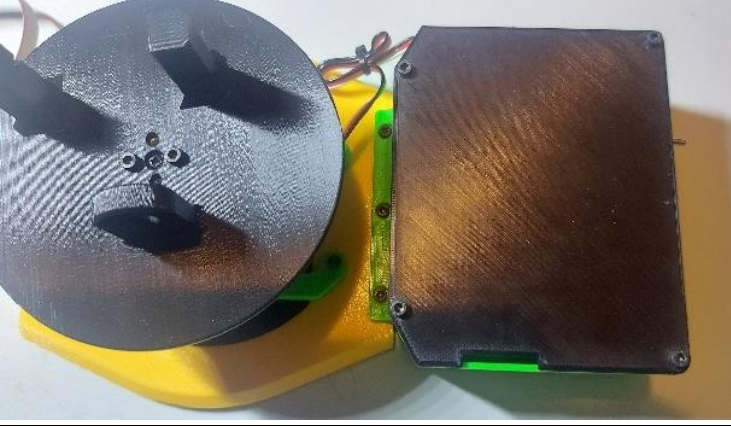
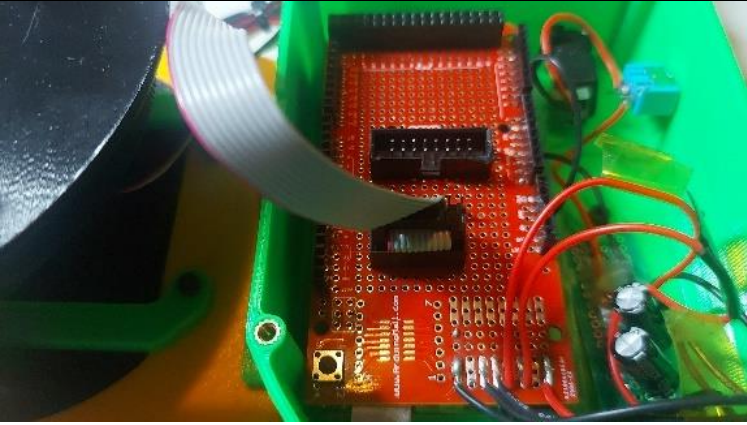
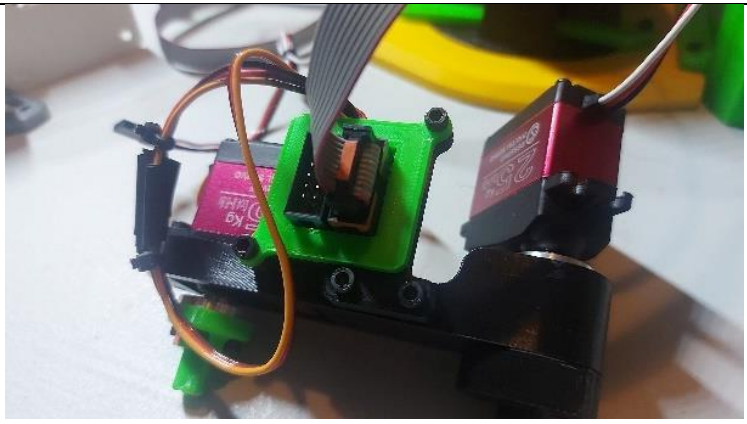
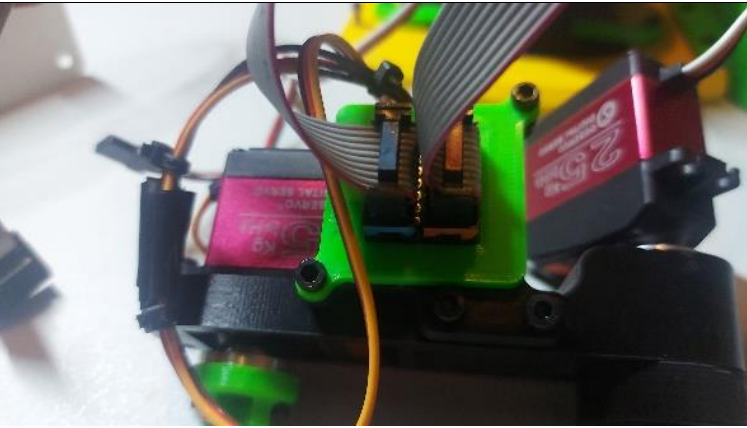
4	Place the bearing onto the shoulder pin	
5	Place the shoulder servo assembly on the upper swivel base Be sure to place the bearing into the upper swivel bearing brace	
6	Secure shoulder servo to the upper swivel using the 2 short screws	

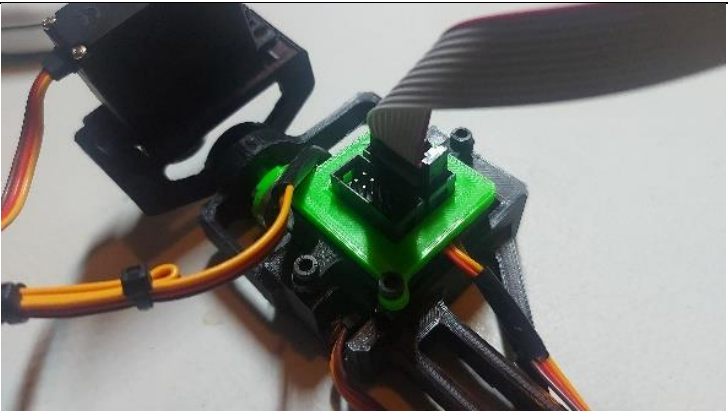
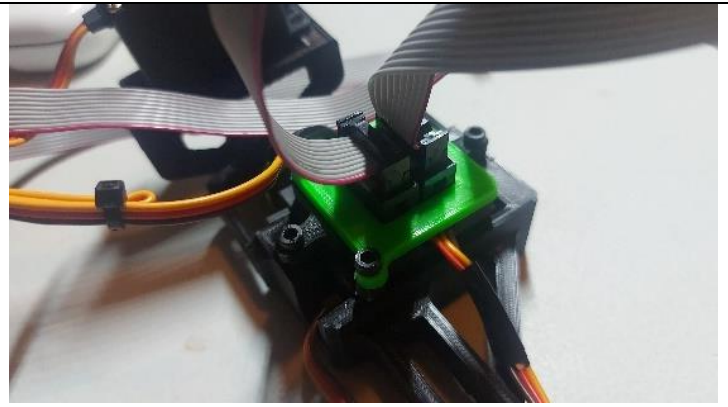
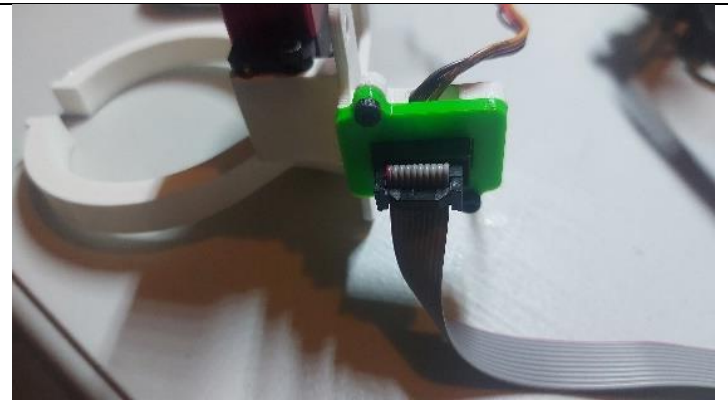
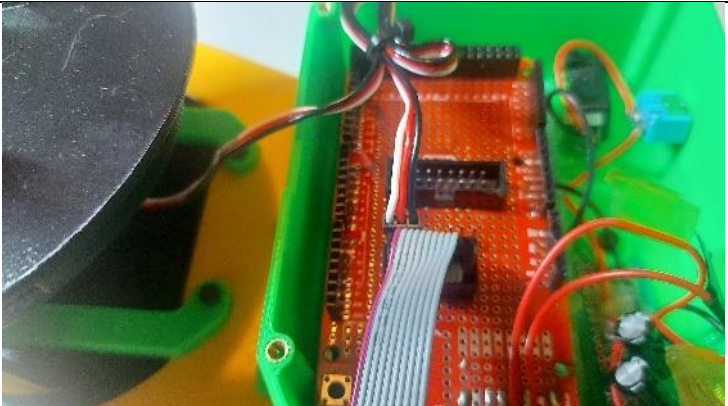
Final Assembly

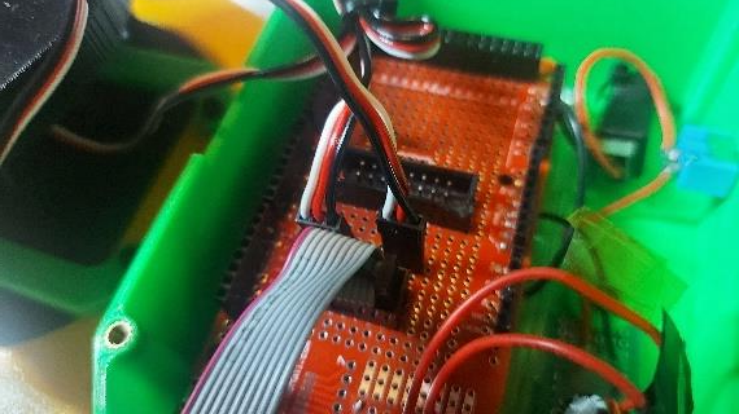



During final assembly the robot will need to be turned on before attaching all of the finished joints together. To prevent electrical shock or damage to your components be sure all wires are free from entanglement prior to turning the robot on. Also make sure the electrical box is closed so the power cables inside are not accidentally touched.



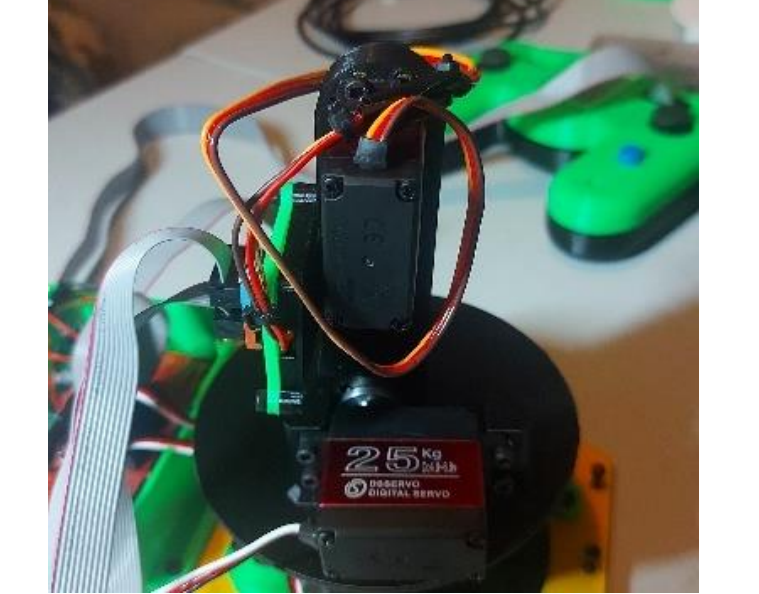
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|---|---|
| 1 | <p>Parts List:</p> <ol style="list-style-type: none">1. Base2. Link 13. Link 24. Connector Bracket5. Gripper6. 3, 8 pin Cables7. 1, 20 pin Cable8. Controller9. 12 screws10. 1 screw with washer |
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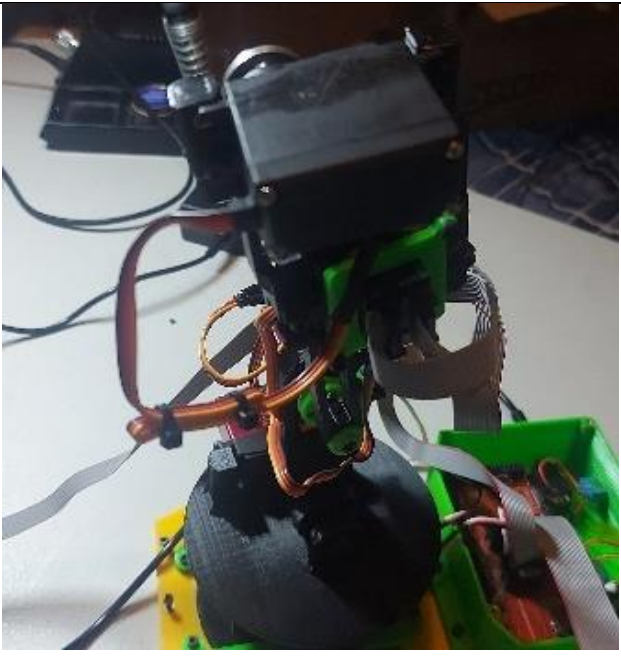

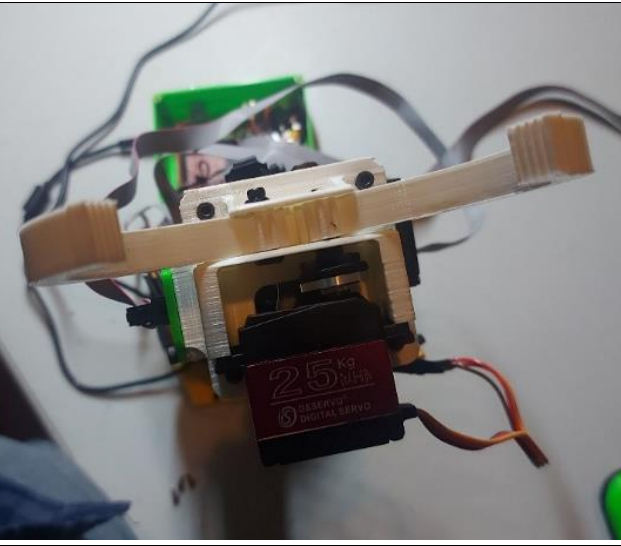


2	Remove the BP_EBox_Lid from the BP_EBox	
3	Connect a 8 rib cable to the 8 rib connector	
4	Connect the other end of the 8 rib cable to the lower connector on Link 1	
5	Connect another 8 rib cable to the upper connector on link 1	

6	Connect the other end of this 8 rib cable to the lower connector of link 2	
7	Connect another 8 rib connector to the upper connector of link 2	
8	Connect the other end of this 8 rib cable to the connector on the Gripper	
9	Connect the turntable servo connector to the 3 pins closest to the turntable	

10	Connect the shoulder servo connector to the 3 pins furthest from the turntable	
11	Connect the 20 rib connector to the Arduino board and then the controller	
12	Be sure the switch on the side of the BP_EBox is switched to the off position	
13	Plug in the power supply to the BP_EBox and plug the power supply into the wall	

14	<p>Make sure all cables and parts are free to move before switching the switch to the on position</p>	
15	<p>Move the switch to the on position</p>	
16	<p>Now the final assembly of the robot can begin</p> <p>When the robot is first switched on all of the servos will move to their middle position and this will make sure that during assembly the connected positions will be correct</p>	
17	<p>Attach link 1 to the base</p> <p>Make sure link 1 is pointing straight up</p> <p>Connect Link 1 by first sliding the shaft into the turntable hole and then securing the servo to the mounts using 4 screws.</p>	

18	<p>Attach link 2 to link 1 Make sure link 2 is pointing straight up</p> <p>Attach link 2 by sliding the lower portion onto the axle and then securing it with the washer and screw</p>	
19	<p>Attach the connector bracket to Link 1 using 4 screws Be sure it is pointing straight up</p>	
20	<p>Attach the gripper to link 1 Be sure the gripper is pointing straight up</p> <p>Attach it to the connector bracket using 4 screws</p>	
21	<p>The robot is now fully functional and can be controlled using the controller</p>	

Using the Robot

After you have finished building the robot it is ready to be operated. You can use the controller to move the robot around and the gripper can be replaced with a marker that allow the user to write. There is also 2 main functions that the robot can do based on certain inputs you can find below

Controller:

- Joysticks
 - J1
 - Up and down controls the Shoulder joint
 - Left and Right controls the turntable
 - Pushing down the joystick performs the wave
 - J2
 - Up and Down controls the Elbow
 - Left and right controls the wrist
 - Pushing down the joy stick makes the robot draw UC
 - J3
 - Up and down controls the gripper swivel
 - Left and right controls the gripper arms
- Other
 - Home Button
 - Returns the robot arm back to the home position
 - Screen
 - Once the camera is connected the screen shows the camera feed

Troubleshooting Tips
