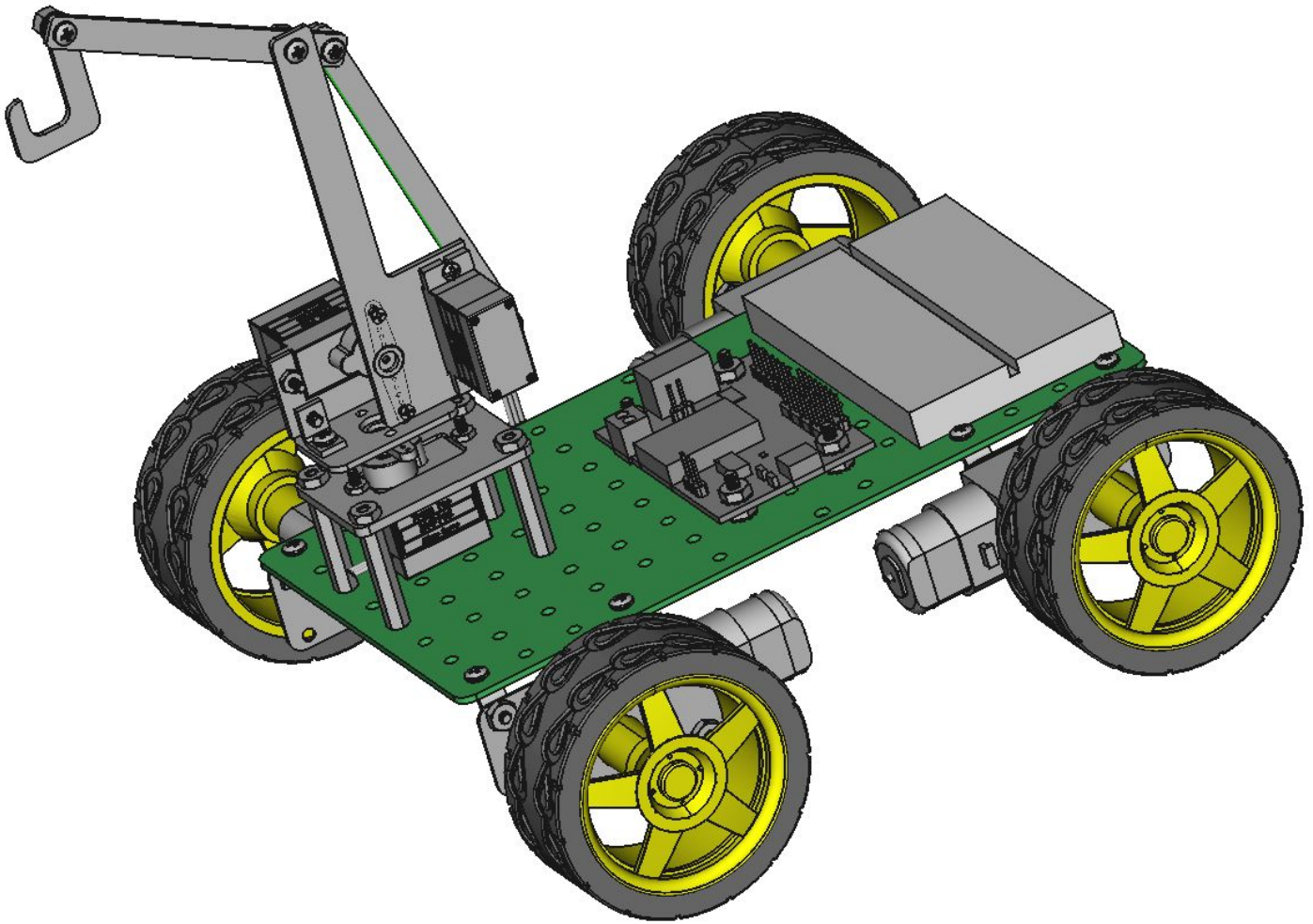
*Sten**BOT*** Robot Kit



Legal Stuff

- Stensat Group LLC assumes no responsibility and/or liability for the use of the kit and documentation.
- There is a 90 day warranty for the Quad-Bot kit against component defects. Damage caused by the user or owner is not covered.
    - Warranty does not cover such things as over tightening nuts on standoffs to the point of breaking off the standoff threads, breaking wires off the motors, causing shorts to damage components, powering the motor driver backwards, plugging the power input into an AC outlet, applying more than 9 volts to the power input, dropping the kit, kicking the kit, throwing the kit in fits of rage, unforeseen damage caused by the user/owner or any other method of destruction.
- If you do cause damage, we can sell you replacement parts or you can get most replacement parts from online hardware distributors.
- This document can be copied and printed and used by individuals who bought the kit, classroom use, summer camp use, and anywhere the kit is used. Stealing and using this document for profit is not allowed.
- If you need to contact us, go to www.stensat.org and click on contact us.

References

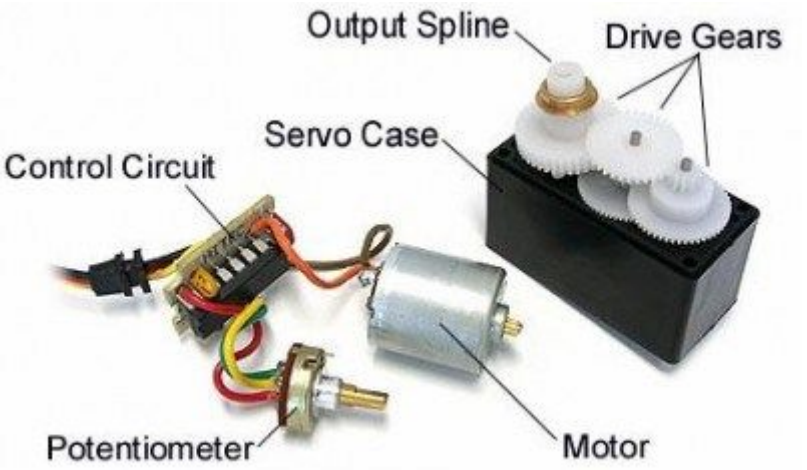
- www.arduino.cc
- http://esp8266.github.io/Arduino/versions/2.1.0/doc/reference.html

Robotic Arm Assembly

- This section will cover the assembly and testing of the robotic arm.

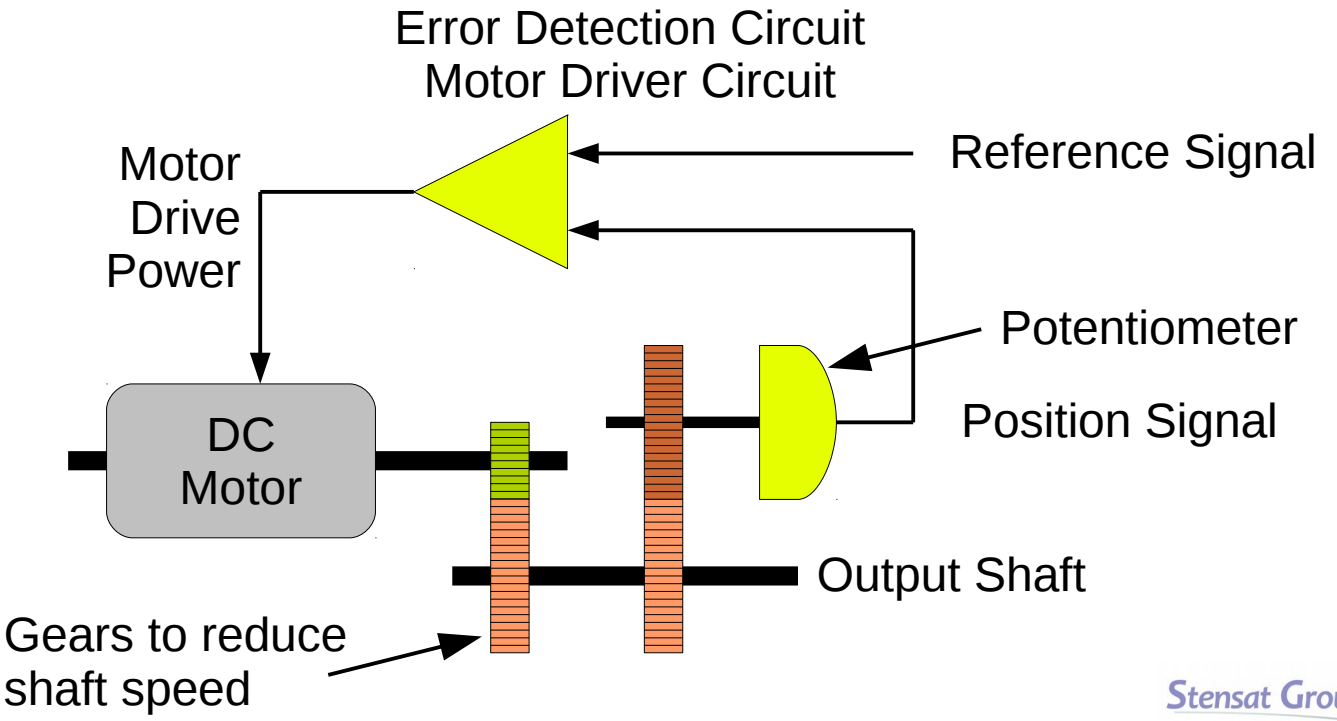
What is a Servo

- A servo is a geared motor with feedback used to control the position of the shaft of the motor.
- The servo consists of a motor that drives a bunch of gears to reduce the speed of the output spline or shaft. A potentiometer or variable resistor is connected to the output shaft and turns with the shaft. As it turns clockwise or counter clockwise, the resistance of the potentiometer changes. The resistance value indicates the angle of the shaft.



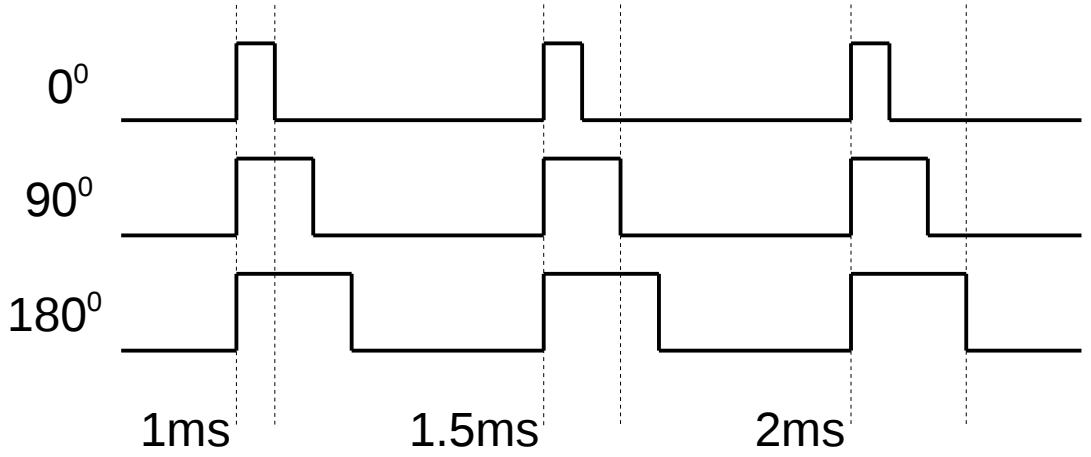
What is a Servo

- The potentiometer feeds a voltage signal based on the position of the shaft. A reference signal feeds a voltage signal for the desired position.
- The error detection circuit compares the two voltages and generates a voltage to power the DC motor in the desired direction until the position signal equals the reference signal.
- When the position signals equals the reference signal, the DC motor stops turning and the shaft is at the right angle.



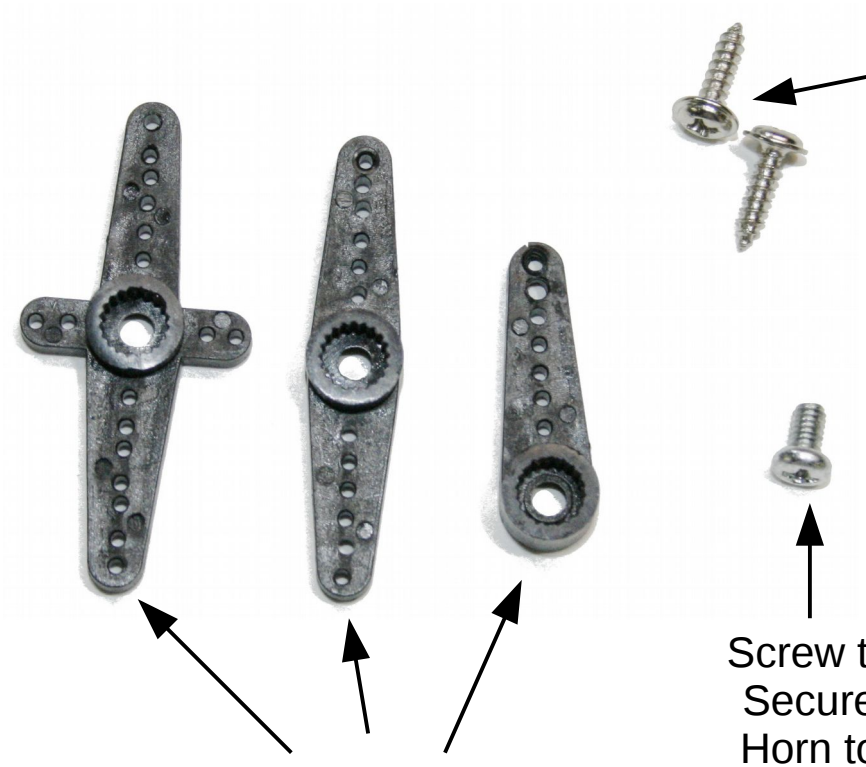
What is a Servo

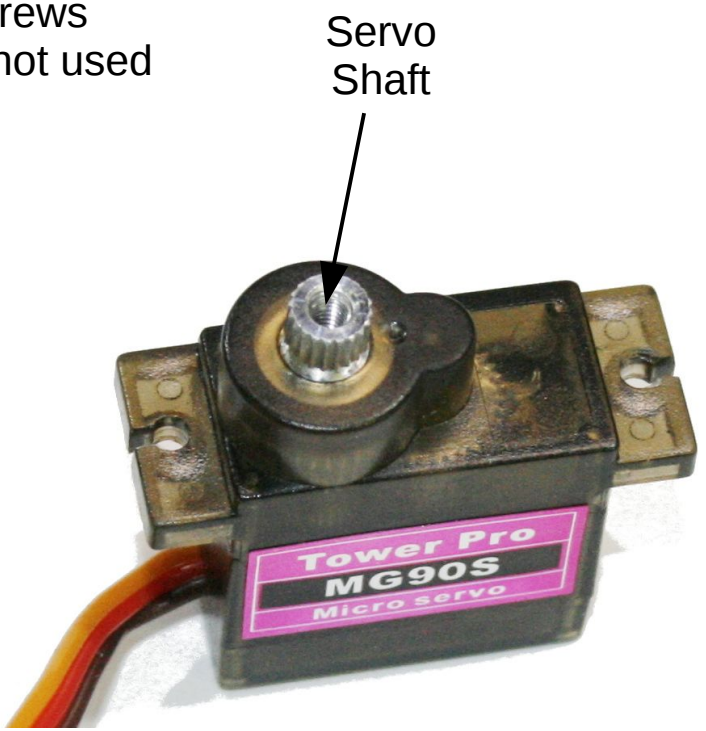
- The processor board uses pulses to control the position of the servo. The servo has an electronic circuit convert the pulse width to a position voltage.
- The processor board sends a pulse 50 to 60 times a second. The width of the pulse determines the position of the shaft which can range from 0 to 180 degrees.
- Neutral position is 90 degrees. The pulse width is 1.5 milliseconds (ms).
- 0 degree position is specified with a pulse width of 1 ms.
- 180 degree position is specified with a pulse width of 2 ms.
- The wave form below show what the signal looks like.



Servo Parts

- A servo is a geared motor that is used to rotate to specific angles. It is used in model airplanes to control the rudder, flaps and aeriolons.
- The servos come with parts. Most will be used.

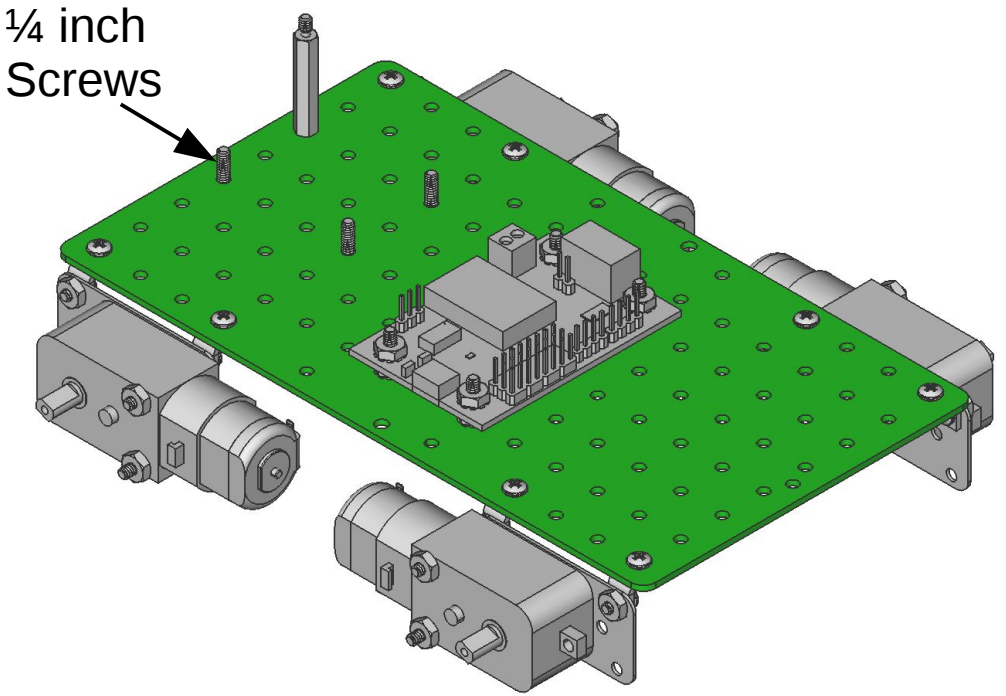


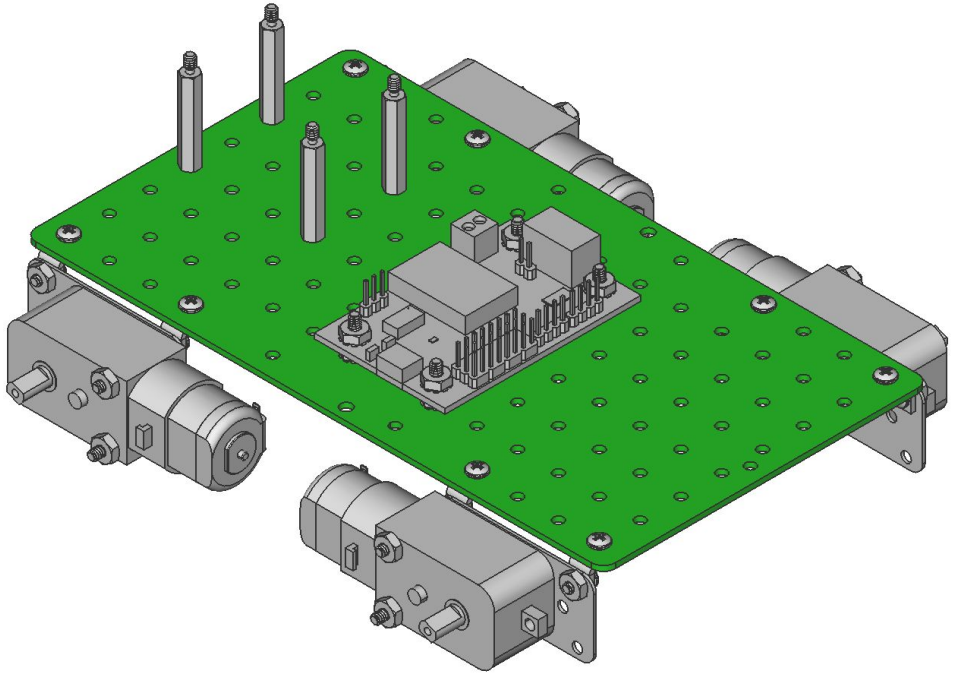


Servo

Robotic Arm Assembly

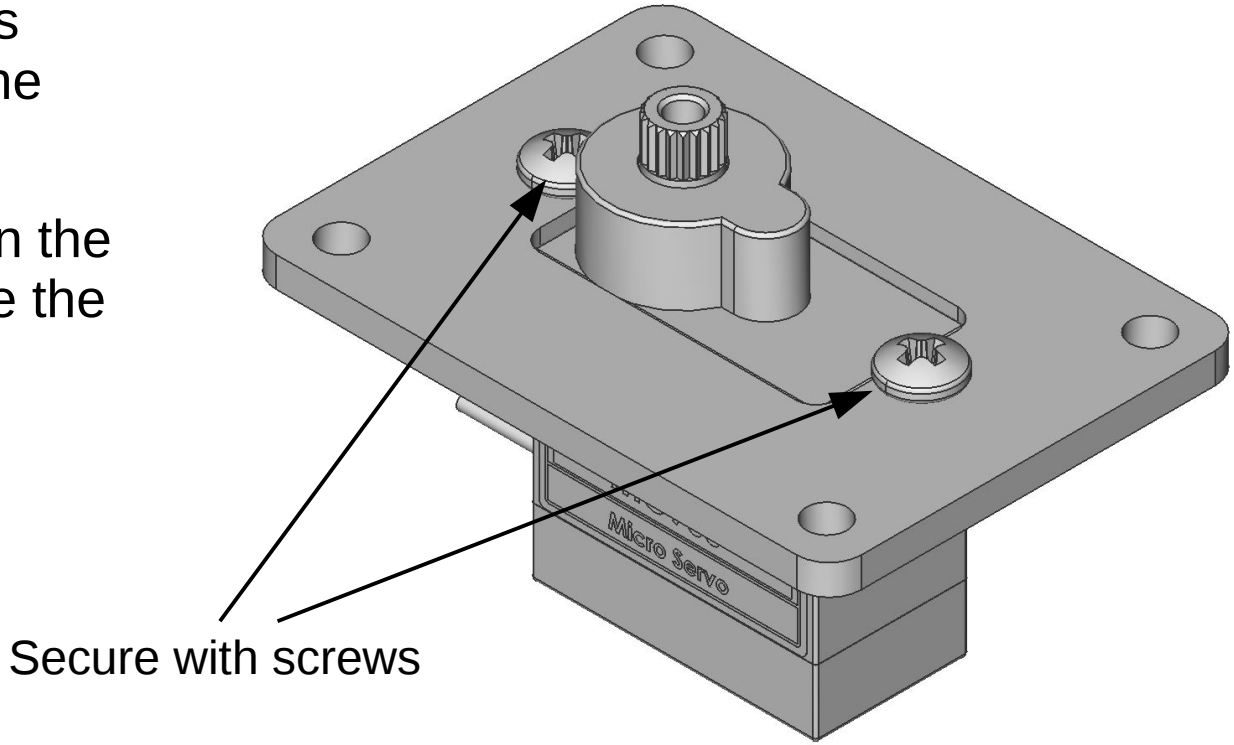
- Insert a ¼ inch screw from below the mounting plate and secure in place with the 1.5 inch long standoffs.
- Install all four standoffs in the holes shown.

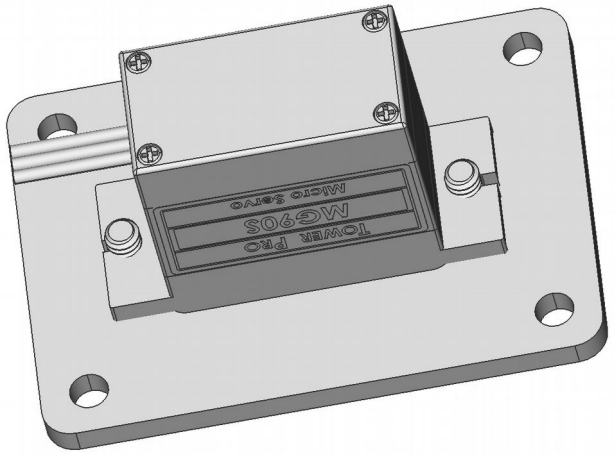




Azimuth Assembly

- Use two of the ¼ inch 4-40 screws and insert them as shown from the top into the servo.
- You need to push and turn the screw clockwise to secure the servo.

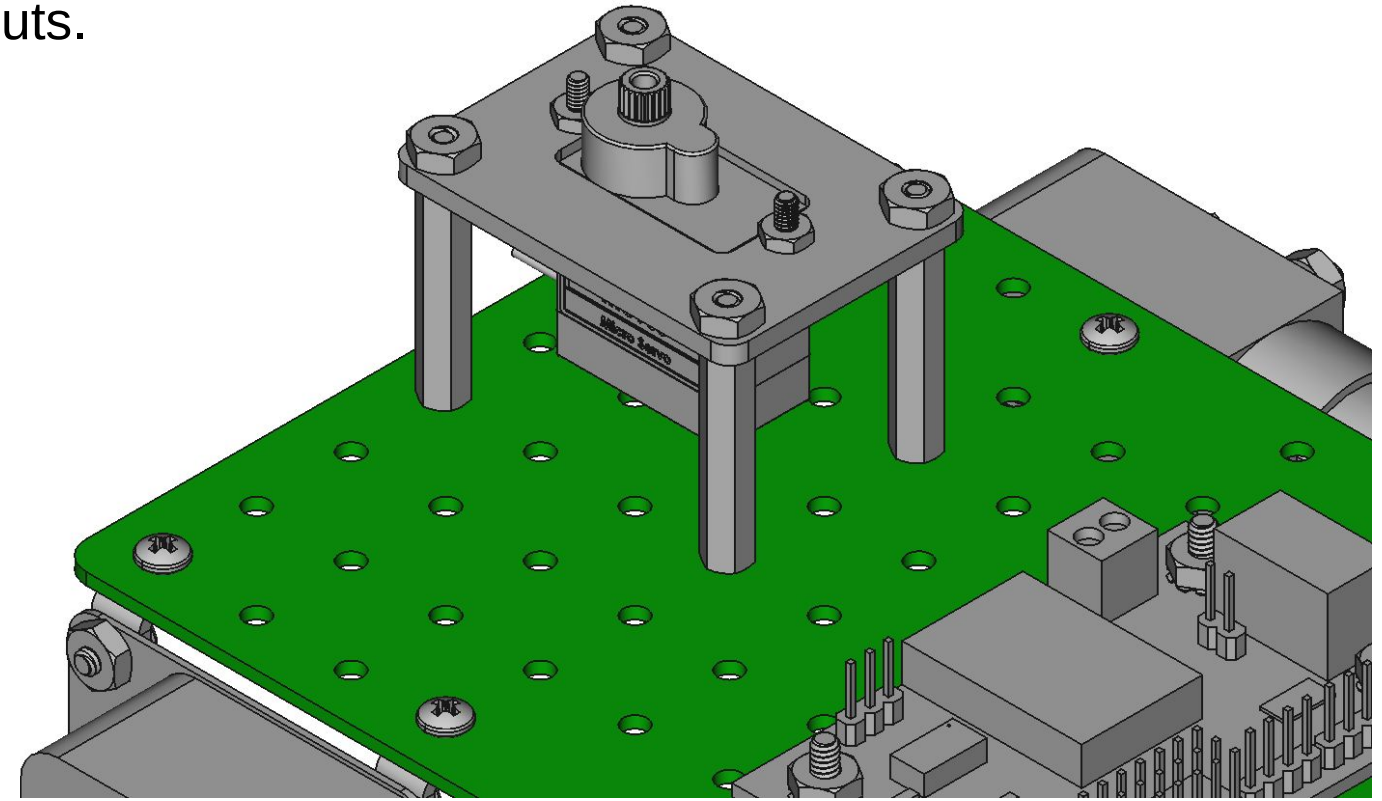




Bottom View

Robotic Arm Assembly

- Install the base servo plate as shown.
- Secure with four nuts.



Controlling the Servo

- To control the servo, the servo library needs to be installed.
- In the arduino software, click on the **Sketch** menu and select **Include Library**. Locate **Servo** and select it.
- At the beginning of the program will be a statement #include <Servo.h>
- This tells the compiler to include functions for controlling servos.

```
#include <Servo.h>
```

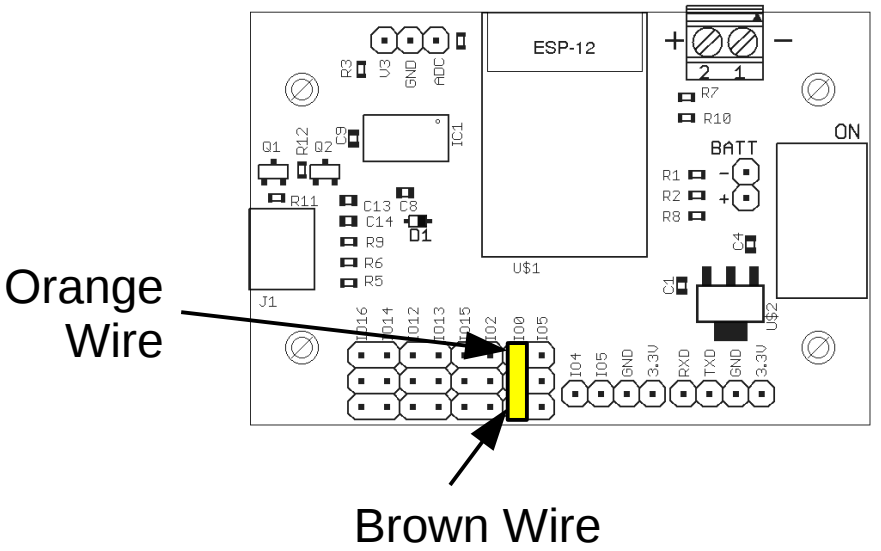
Controlling the Servo

- Next, create a servo object. It will be called **base**. **base** is an instance of the Servo object. Multiple instances can be created.
- In the **setup()** function, **base** is attached to digital pin 0.
- After base is attached, the servo position can be set with the **write()** function. The parameter is the angle in degrees.

```
#include <Servo.h>

Servo base;

void setup()
{
    base.attach(0);
    base.write(90);
}

void loop()
{
}
```

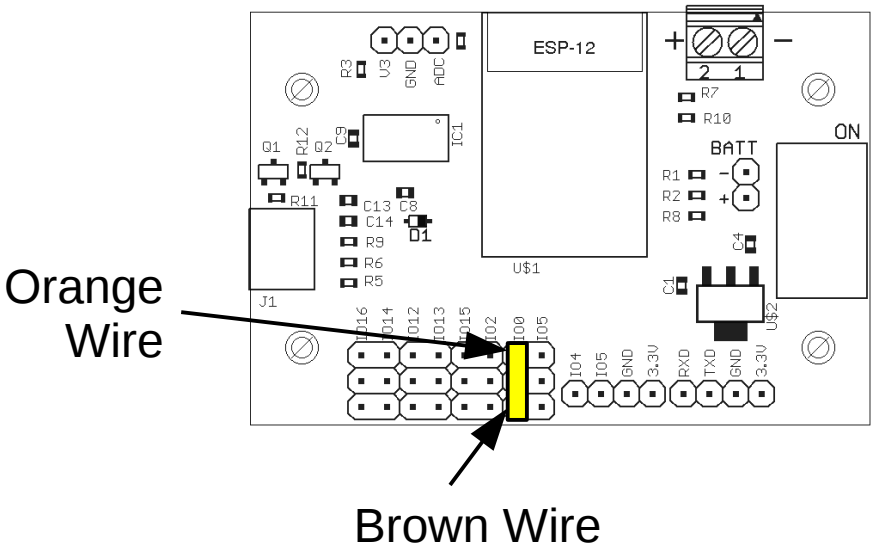
Operating The Servo

- Connect the servo to digital pin 0. The servo has a 3 pin socket connector.
- Orientation is critical. Installing it backwards can damage the servo.
- Insert the connector onto the pins with the brown wire closest to the edge of the processor board. The orange wire should be closest to the Pin 0 mark.



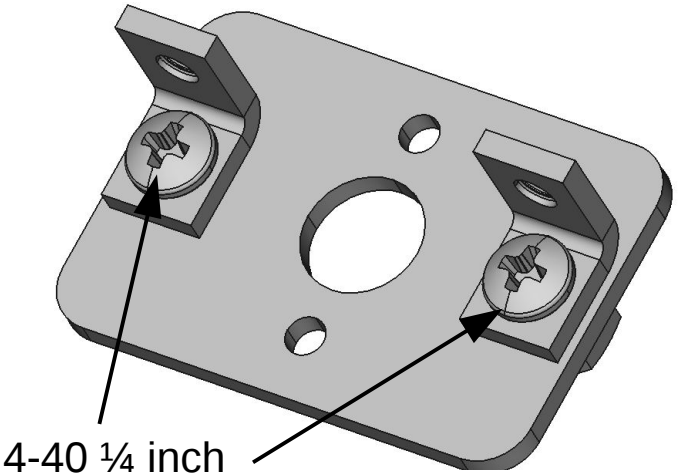
Operating The Servo

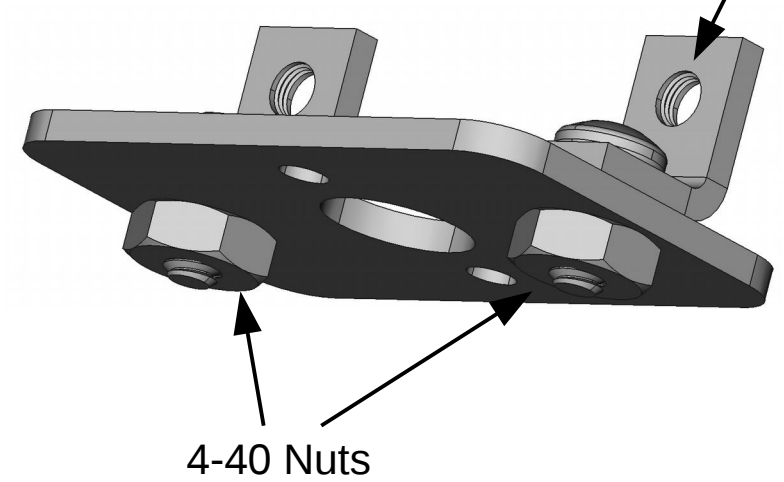
- Turn on the processor board and upload the code from the previous page.
- When the upload is complete, the servo should make a sound and the shaft should rotate.
- The servo will positioned so the robotic arm faces straight out when assembled.
- When complete, turn the processor off.

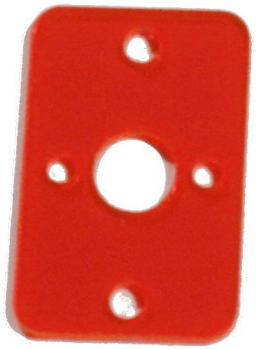


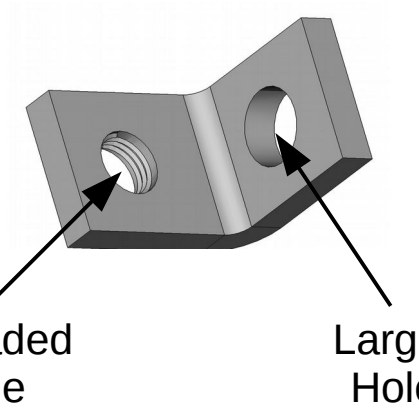
Azimuth Assembly

- Locate the azimuth plate like the one shown and the right angle brackets.
- Install the right angle brackets on to the azimuth plate and secure with the supplied screws and nuts.
- Use the larger hole on the right angle bracket to secure to the azimuth plate. It's the holes in the bracket that the screws can freely enter.



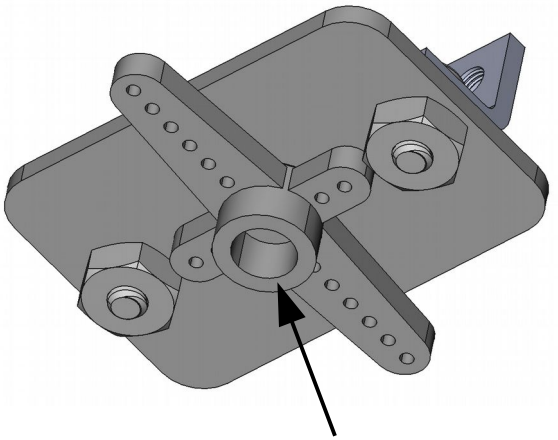




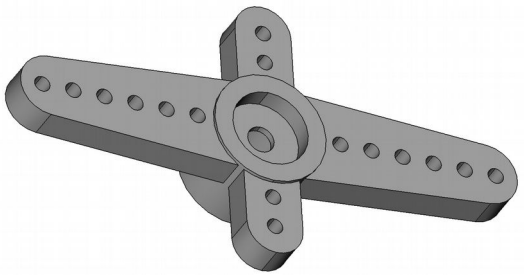


Azimuth Assembly

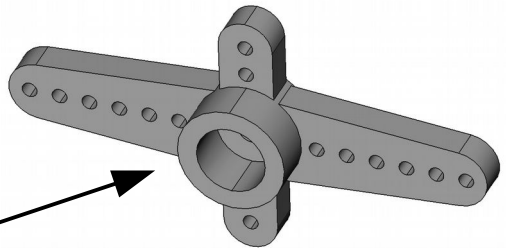
- Use the servo horn from the servo package like the one below.
- Place it on the opposite side of the plate as the right angle connectors. Make sure the larger cylinder on the horn is facing away from the plate.



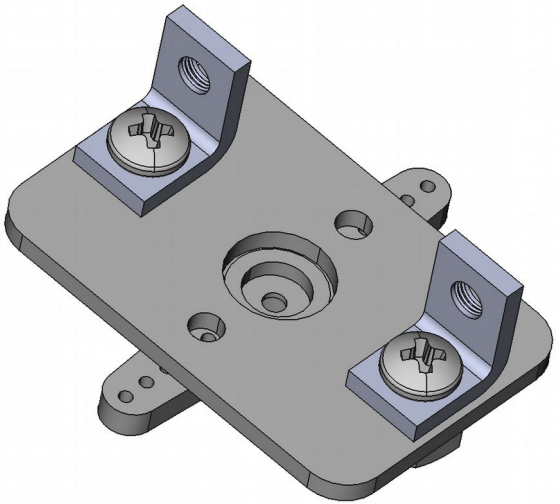
Bottom side of Servo Horn



Servo Horn Top Side



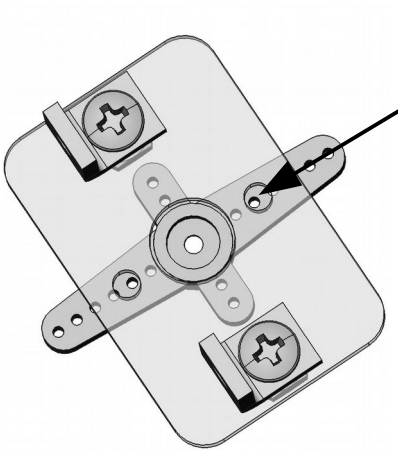
Servo Horn Bottom Side

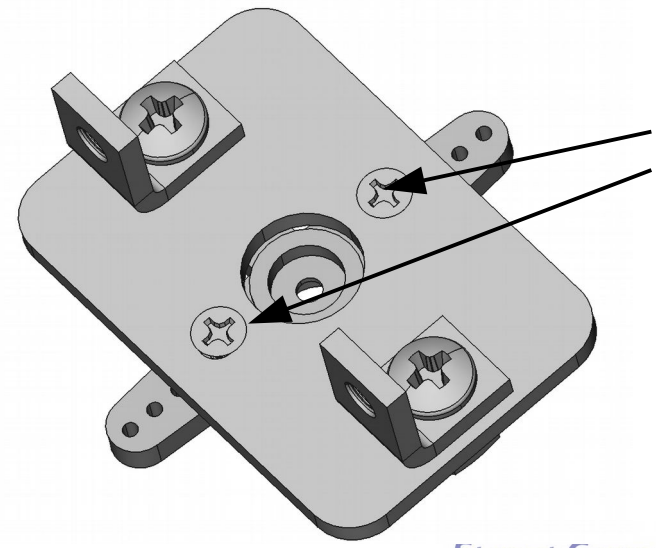


Servo Horn Opposite Side of Brackets

Azimuth Assembly

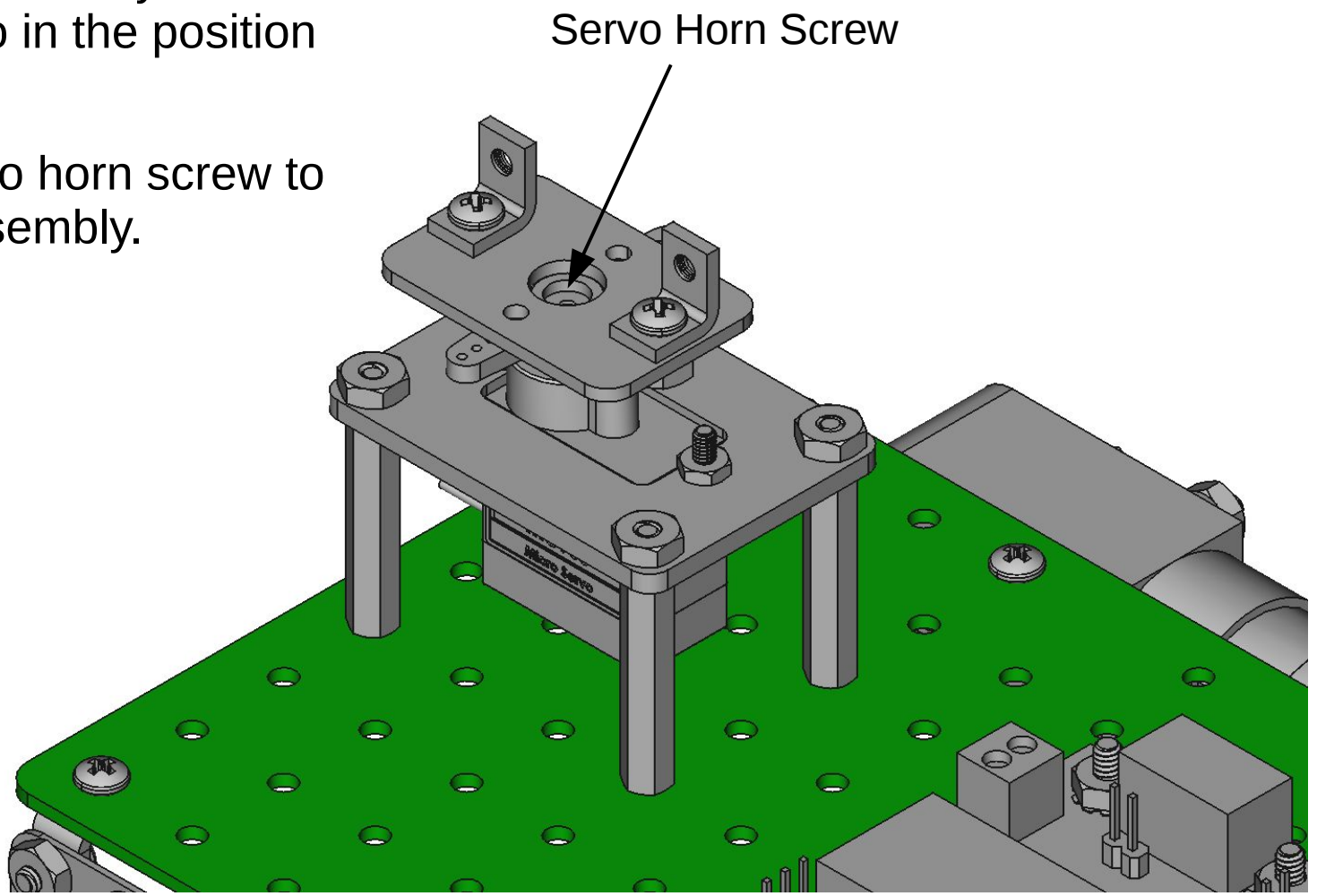
- Secure with the two small pointy screws that came with the servo.
- The holes on the servo horn will not line up quite right.





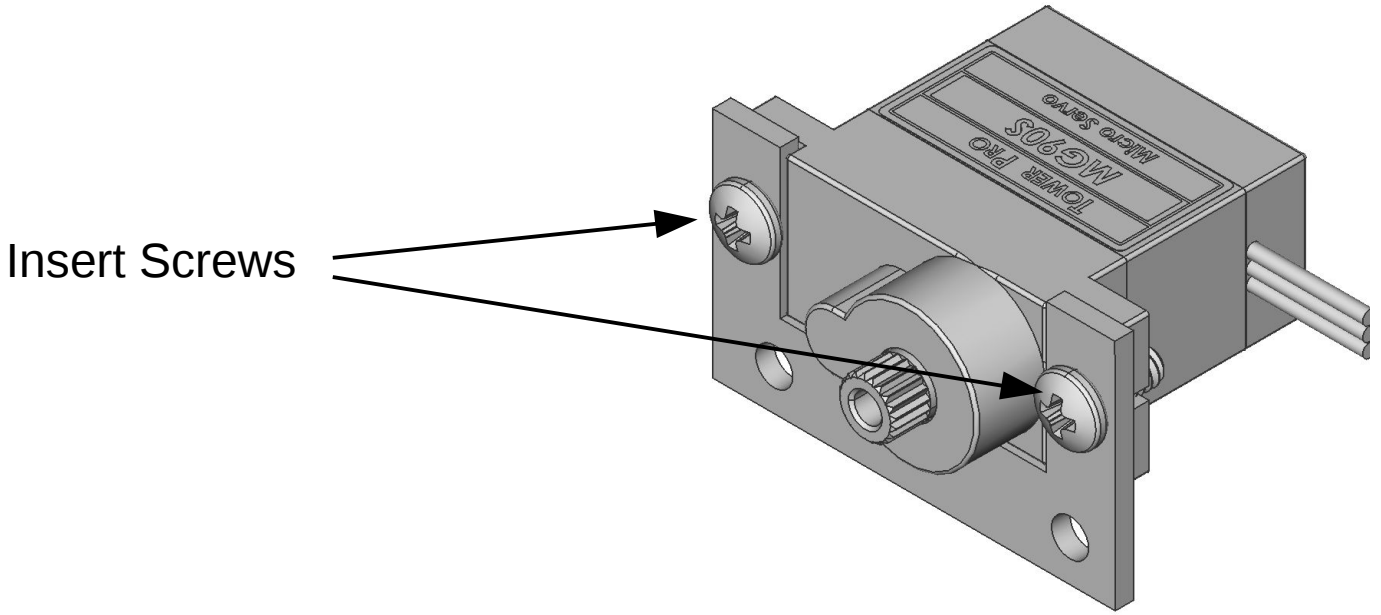
Robotic Arm Assembly

- Position the assembly onto the base servo in the position as shown.
- Insert the servo horn screw to secure the assembly.



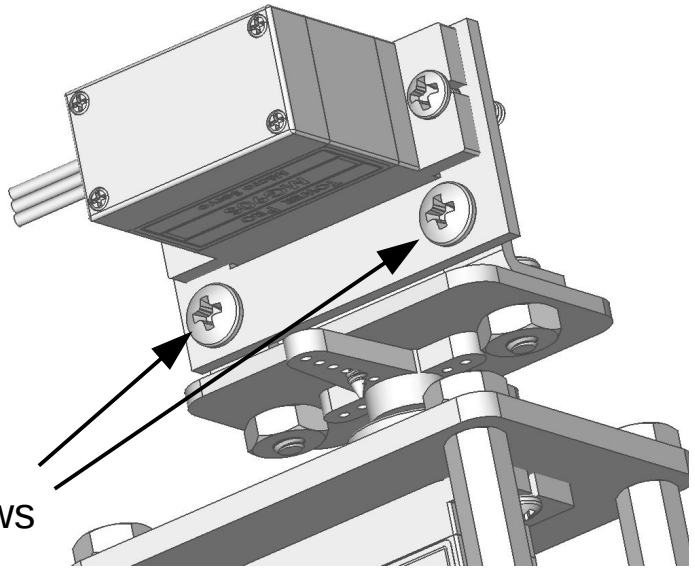
Arm Assembly

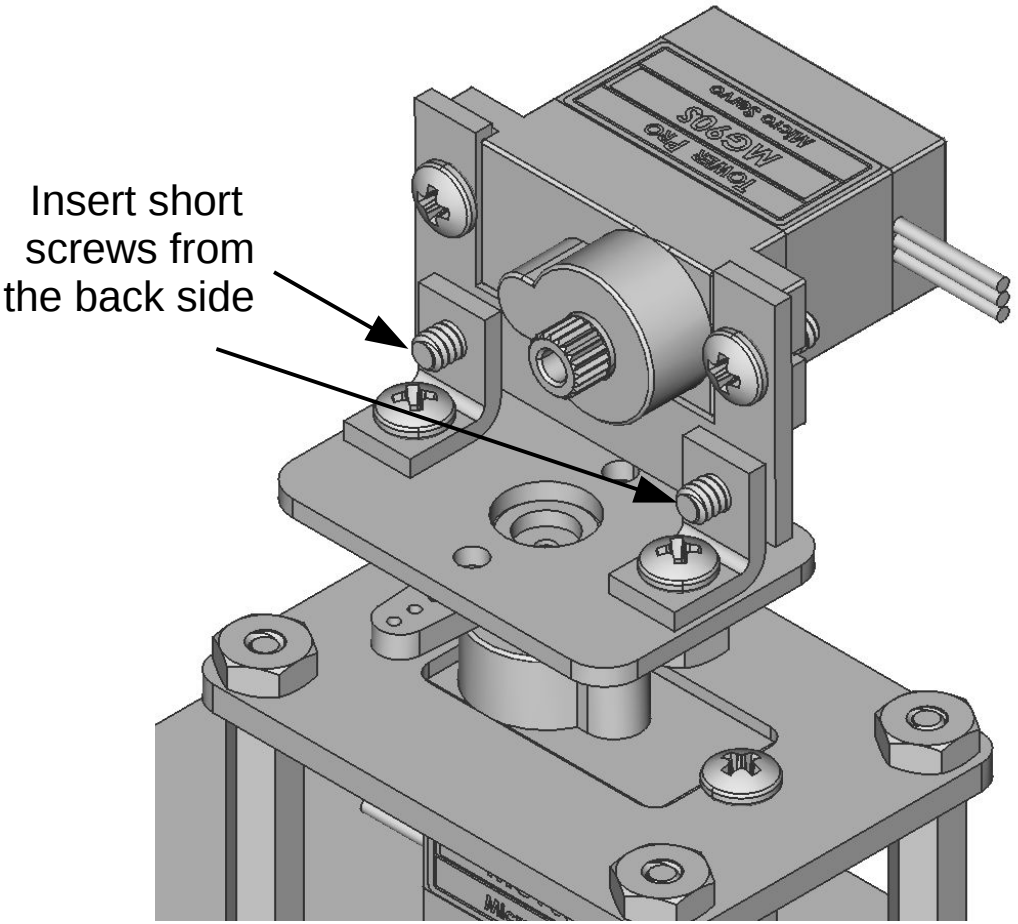
- Take another servo and the bracket as shown.
- Mount the bracket on top of the servo as shown.
- Use two ¼ inch 4-40 screws and insert from the top and screw into the servo.
- Do not overtighten as the bracket may crack.



Arm Assembly

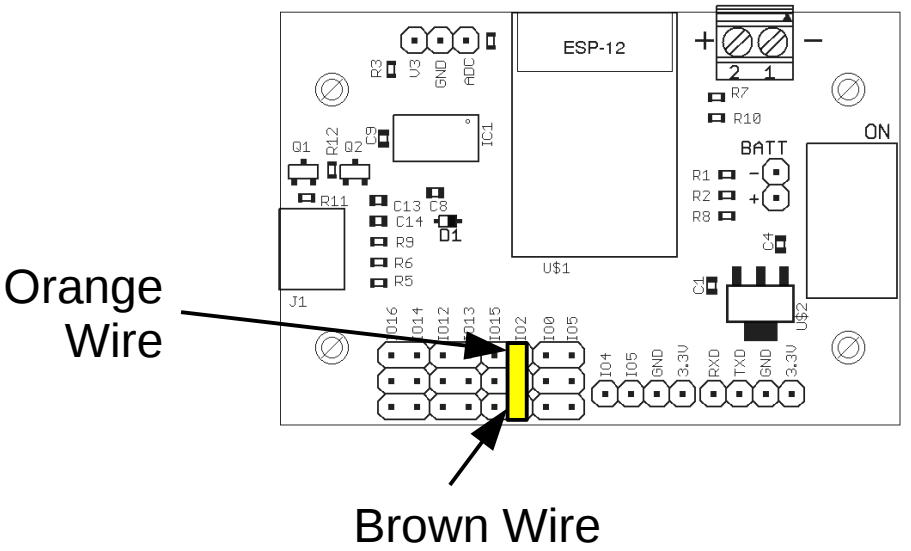
- Attach the servo and bracket assembly to the base mount.
- Secure the
- Use two short #4 screws and screw in from behind the bracket into the metal right angle bracket on the base.





Adjusting the Servo

- Plug the second servo into digital pin 2. It is to the left of digital pin 0.
- Make sure the connector is in the proper orientation.



Adjusting the Servo

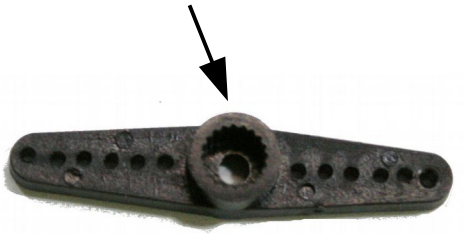
- Modify the servo code to add a second servo. It will be called arm.
- A second servo object is created called arm. It will be attached to digital pin 2.
- The position is set to 179 degrees which is the arm pointing straight up.

```
#include <Servo.h>

Servo base;
Servo arm;

void setup()
{
    base.attach(0);
    arm.attach(2);
    base.write(90);
    arm.write(179);
}

void loop()
{
}
```

Arm Assembly

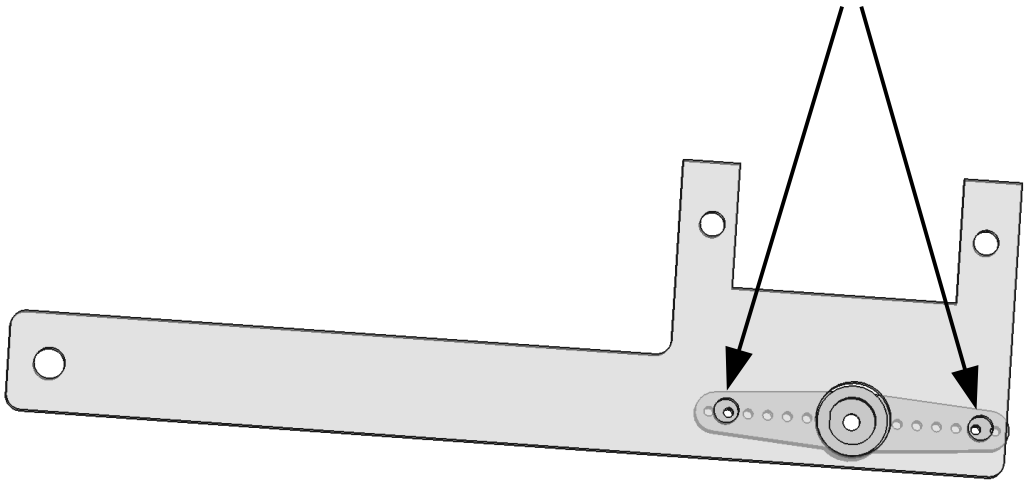
- Locate the second servo and get the servo horn that is shown.
- Locate the arm segment as shown.
- Position the servo horn under the arm segment as shown in the upper right.

Spline Hole to Mount on Servo

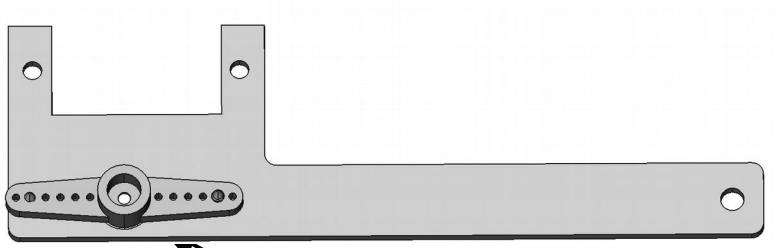


Servo Horn

Align servo horn holes to holes in arm.
They will not be exactly centered.



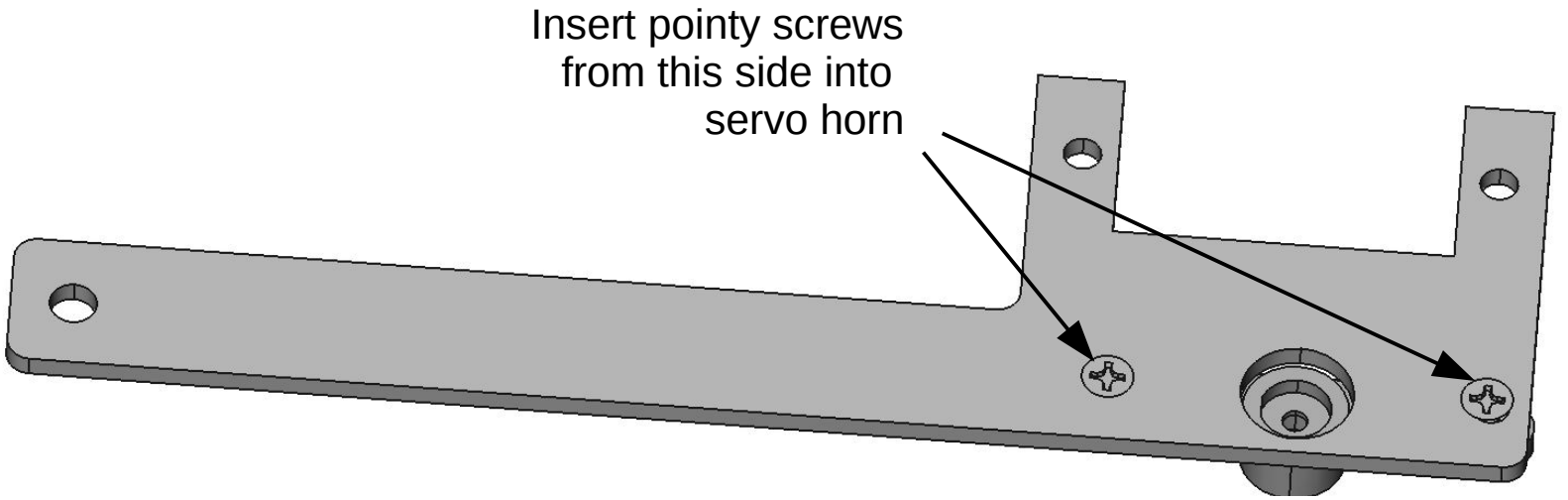
Back Side



Note Orientation of Servo Horn

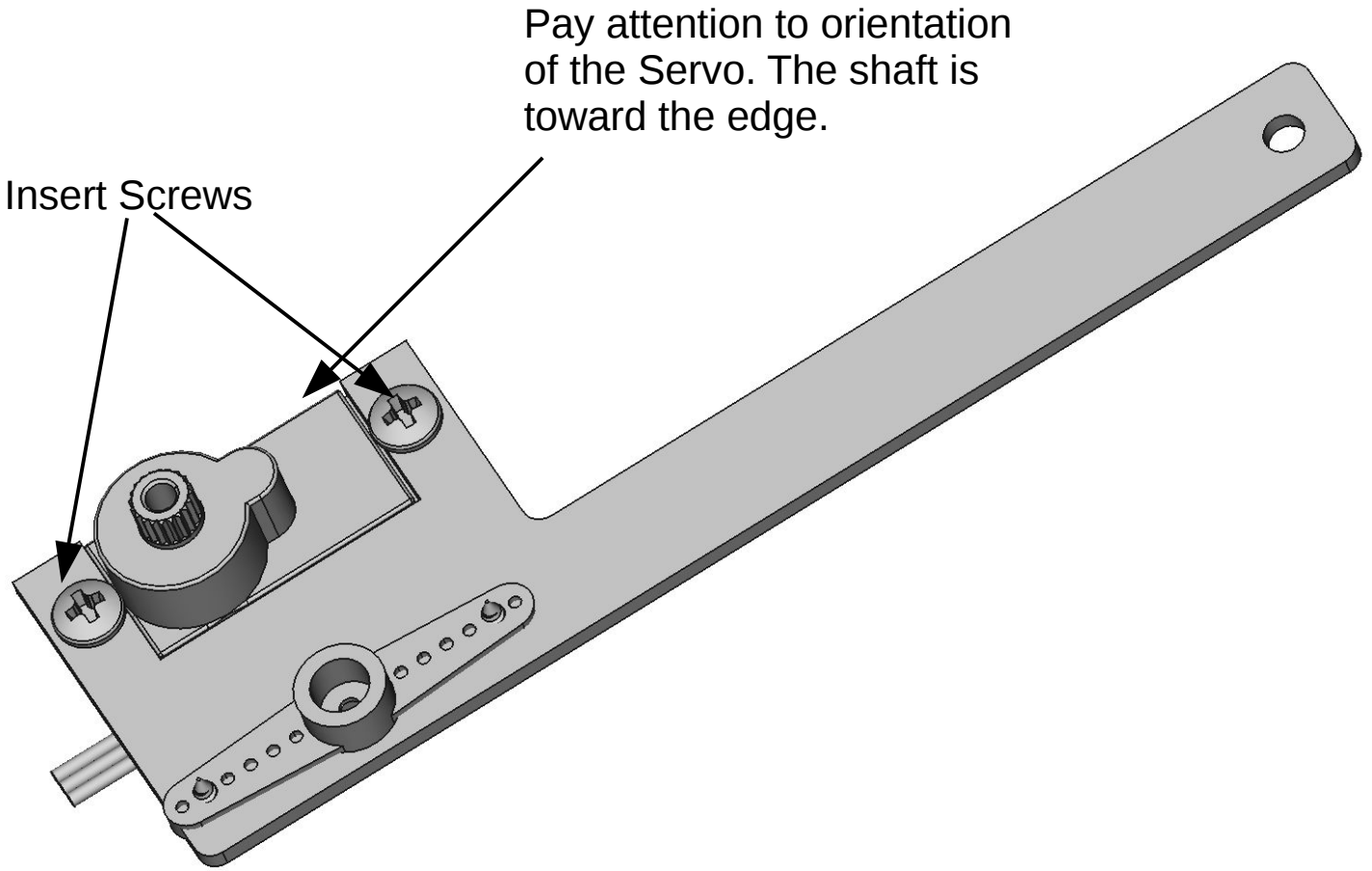
Arm Assembly

- From the top side, use the two pointy screws from the servo and screw from the arm segment into the servo horn. Use the holes that line up with the arm holes.



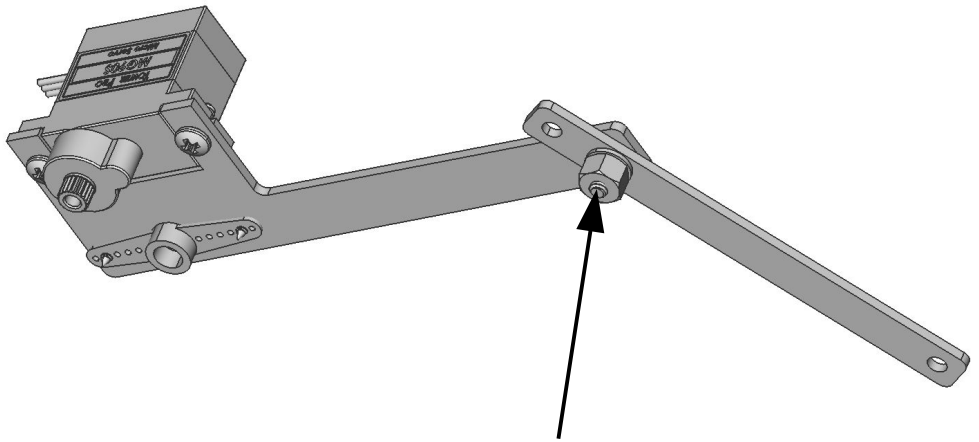
Arm Assembly

- Install the third servo onto the arm segment as shown. Pay attention to the orientation.
- Secure the servo with two ¼ imch 4-40 screws. Do not over tighten.

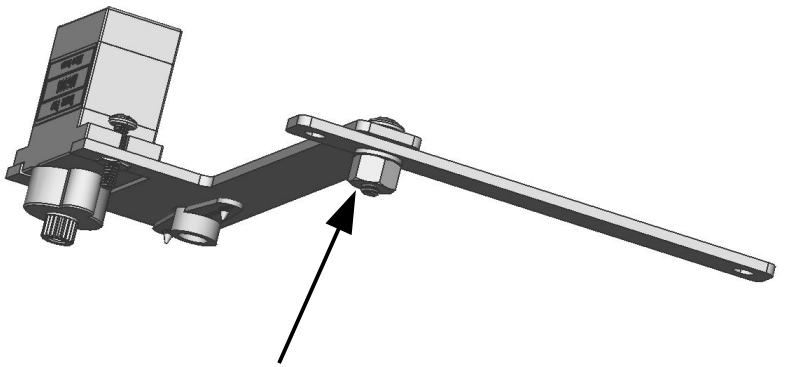


Arm Assembly

- Locate the second segment with the three holes.
- Attach it to the arm segment using a 4-40 3/8 inch screw and a lock nut as shown. Pay attention to which side the second segment is relative to the arm segment.
- Tighten the screw and nut using a screw driver and nut driver. Keep screwing until it gets a little tight then **unscrew by a ¼ turn to loosen it so the second segment moves freely**.
- **Do not over tighten as you can break the plastic material.**



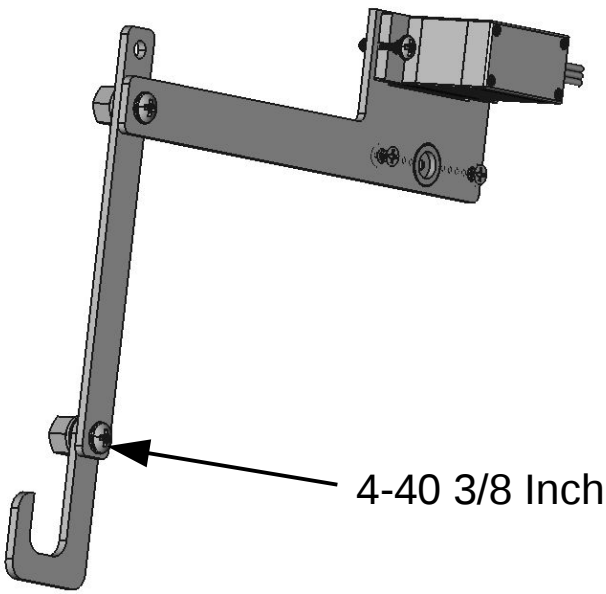
Second Segment placed on this side

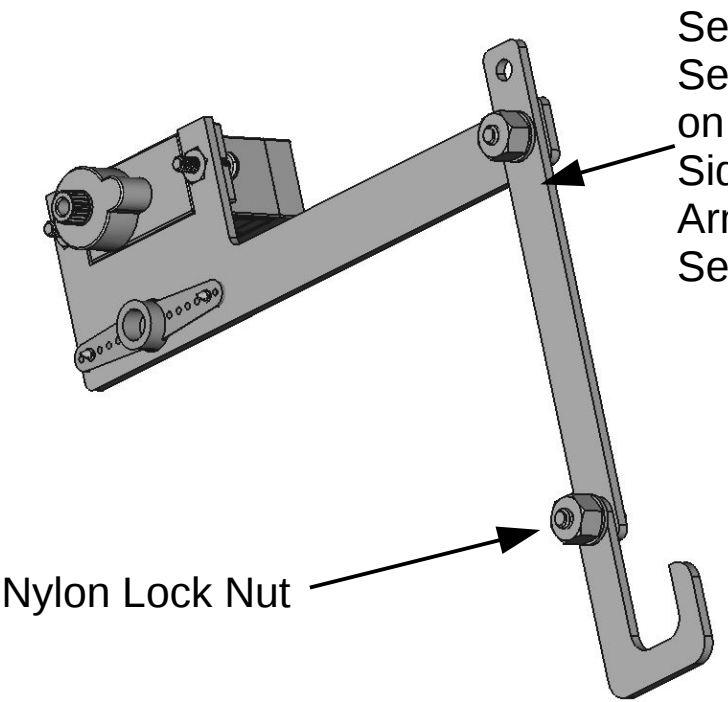


Use Nylon Lock Nut

Arm Assembly

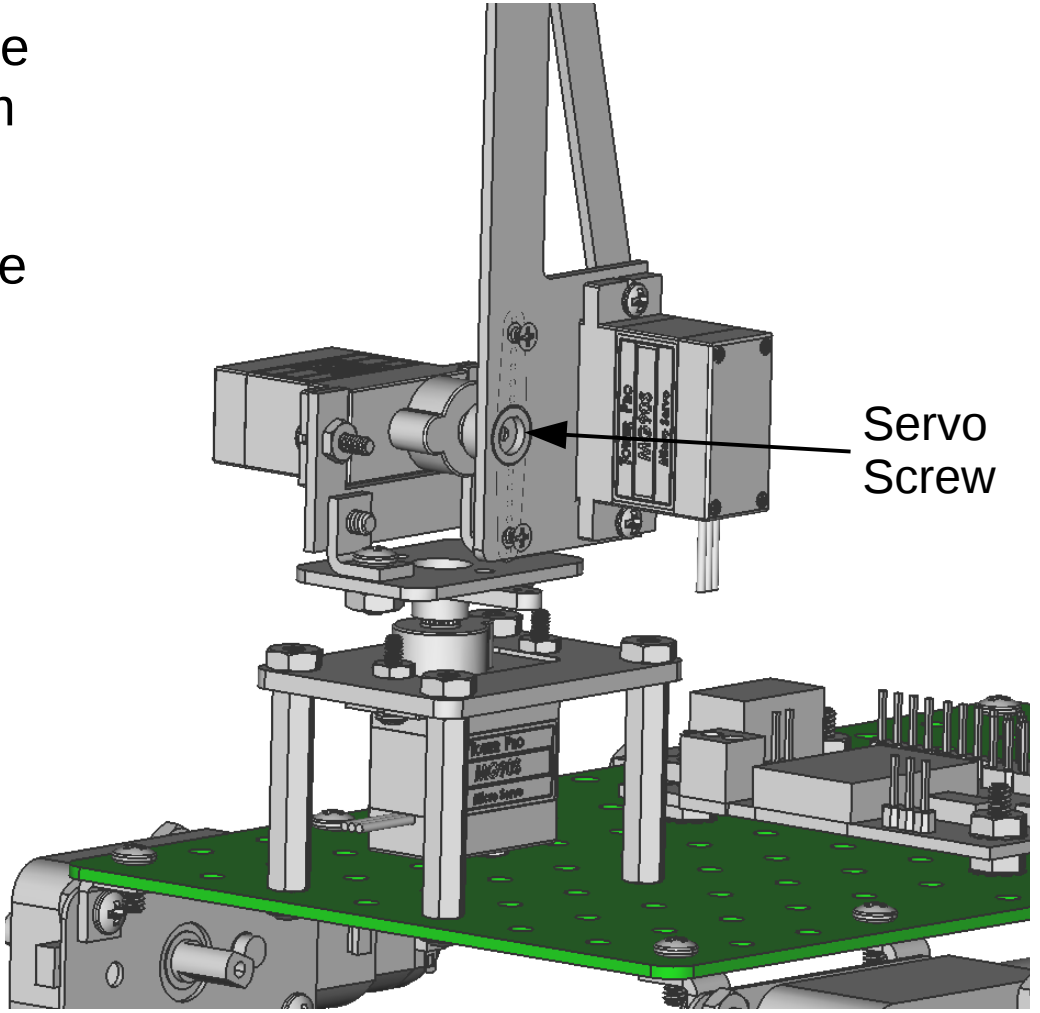
- Attach the hook to the end of the segment as shown.
- Secure with a 3/8 inch 4-40 screw and lock nut.
- Keep the screw and nut **loose** like the previous step so the hook can freely move.





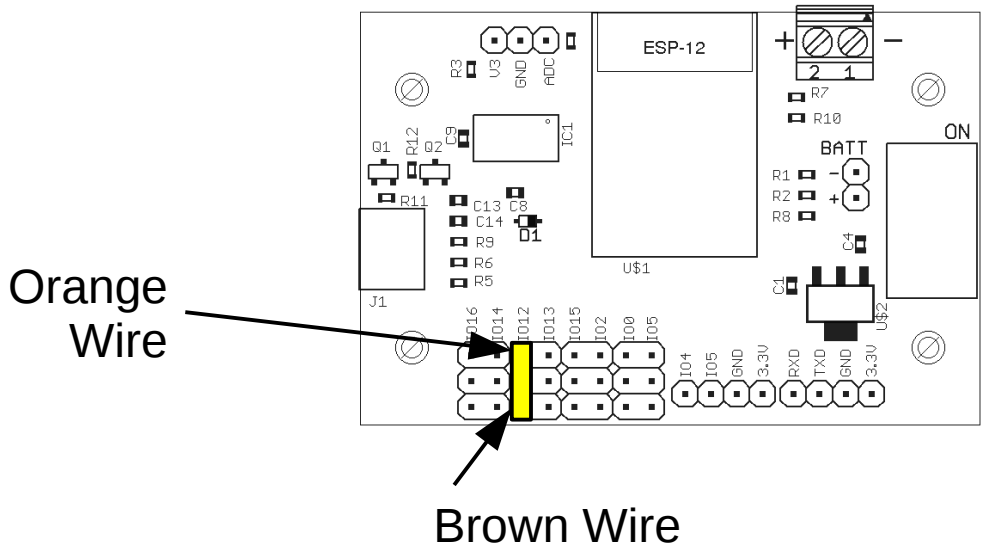
Robotic Arm Assembly

- Mount the arm assembly on to the second servo. Make sure the arm points straight up.
- Secure the arm assembly with the servo screw.



Adjusting Last Servo

- With the last servo installed, connect it to digital port 12.
- Make sure the orientation of the connector is the same as the others.



Adjusting Last Servo

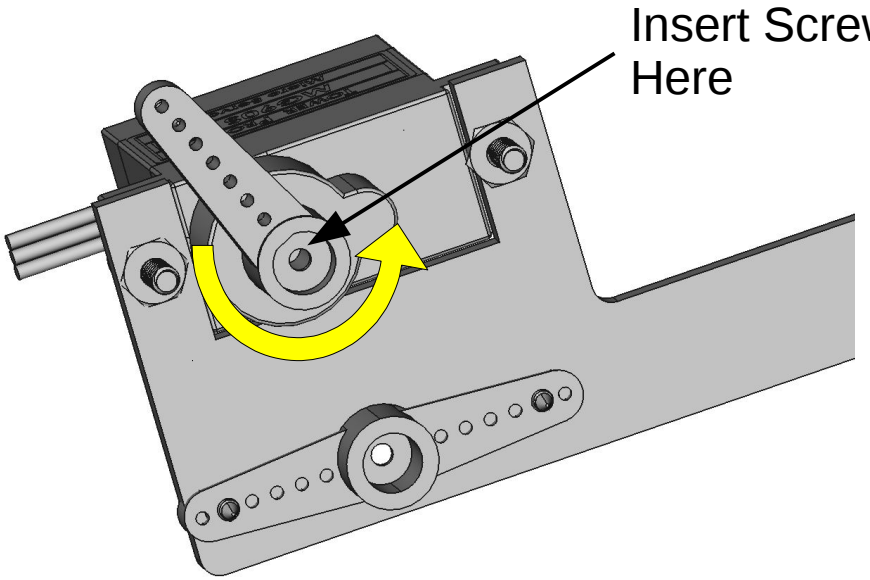
- Add one more servo to the servo program.
- The third servo object will be called elbow.
- It will be set to the fully extended position.
- Run the program and let the servos move to their positions.
- Turn off power.

```
#include <Servo.h>

Servo base;
Servo arm;
Servo elbow;

void setup()
{
    base.attach(0);
    arm.attach(2);
    elbow.attach(12);
    base.write(90);
    arm.write(179);
    elbow.write(179);
}

void loop()
{
}
```

Arm Assembly

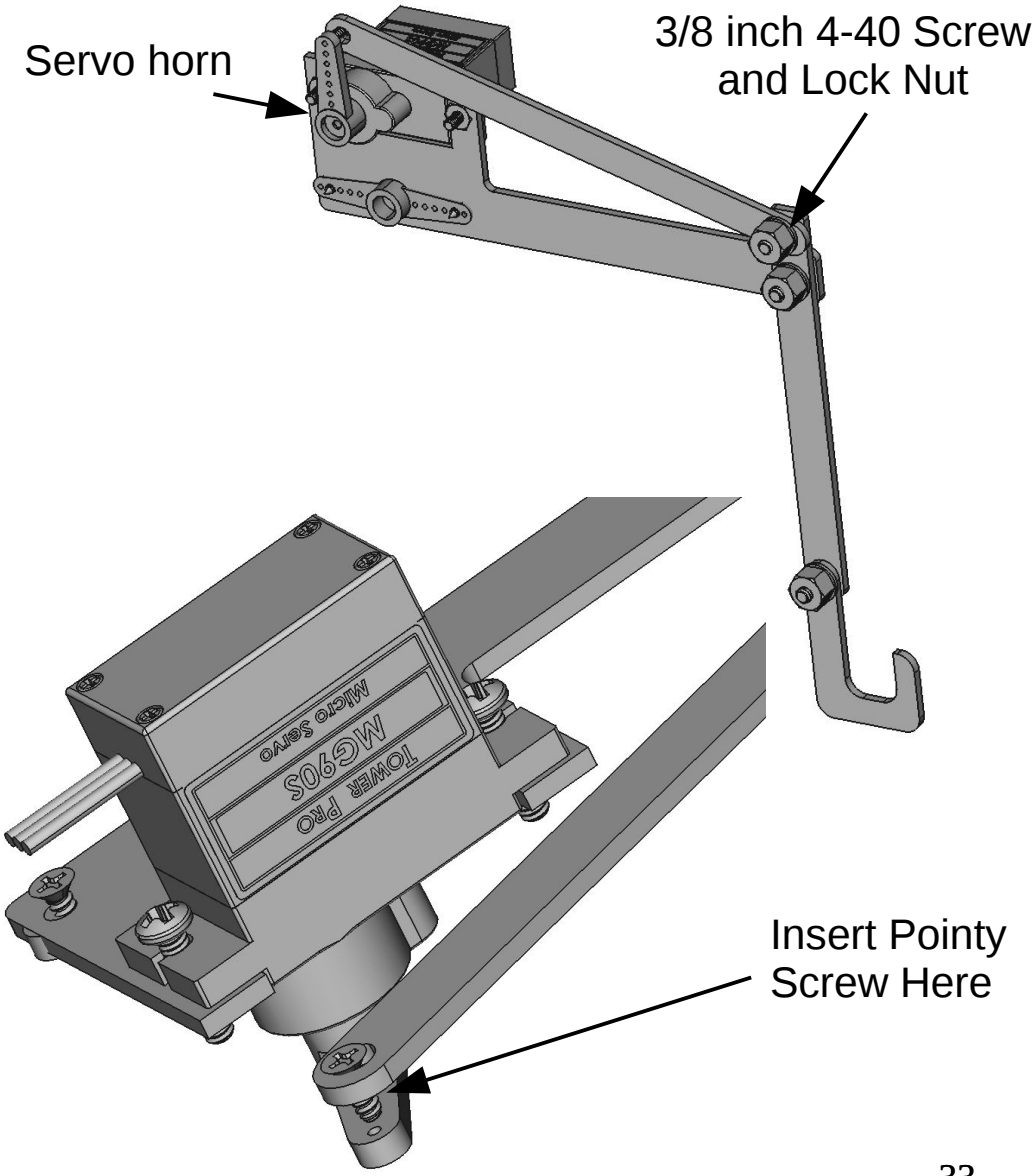
- Locate the horn shown to the right from one of the servo packages.
- Install the horn onto the servo as shown pointing back a bit. This is the fully extended position.

Servo Horn



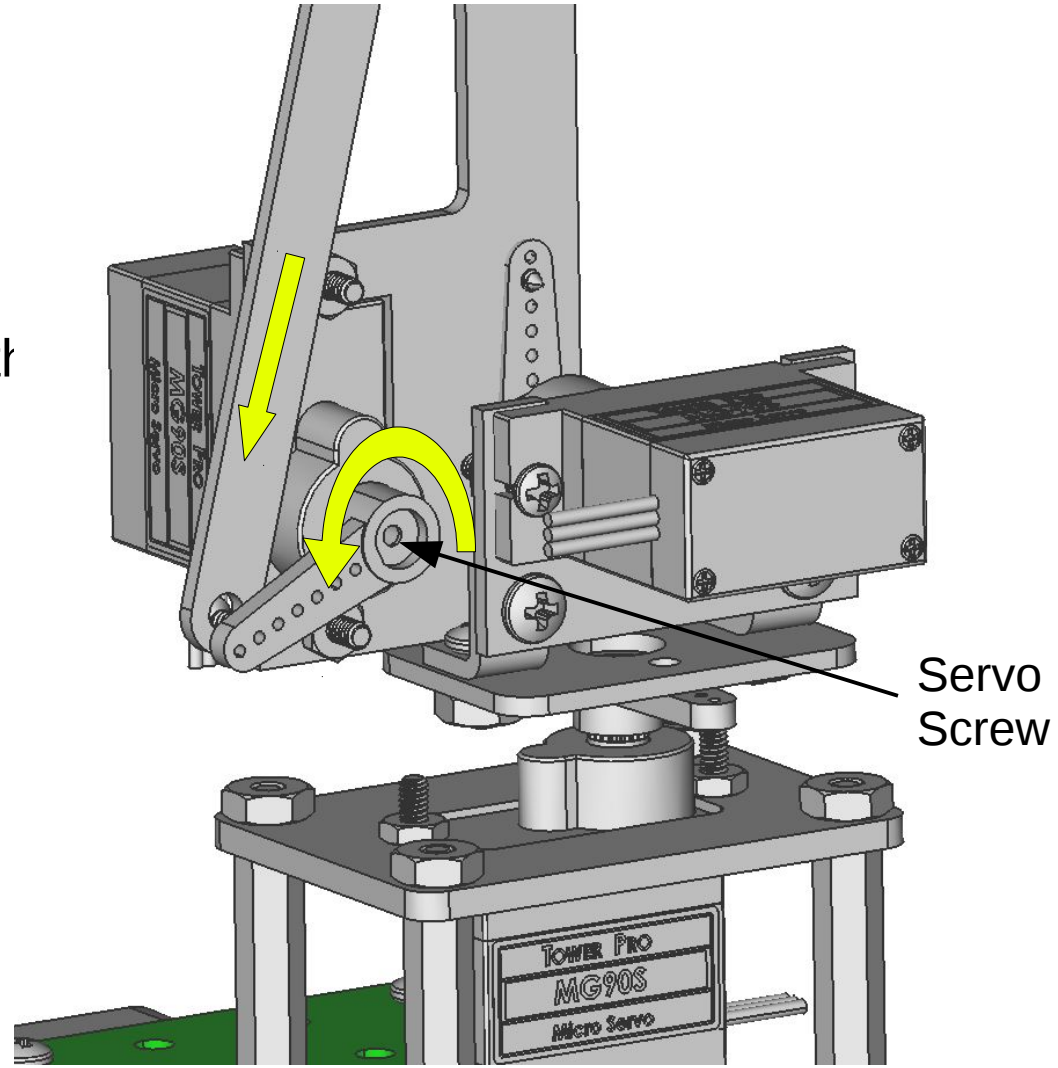
Arm Assembly

- Connect the linkage to the second segment with a 3/8 inch 4-40 screw and lock nut. Do not tighten the lock nut. Let the linkage move freely.
- Using the pointy screw from the servo, insert the screw through the linkage into the second to last hole on the servo horn.
- Screw the pointy screw into the servo horn just enough so it just starts coming out of the other side. Do not tighten the screw. It needs to be very loose.



Robotic Arm Assembly

- With the linkage attached to the horn, remove the horn from the servo and rotate the horn so the arm is as straight as possible.
- Reinsert the horn and secure with a servo screw.



End

- This completes the assembly of the robotic arm.