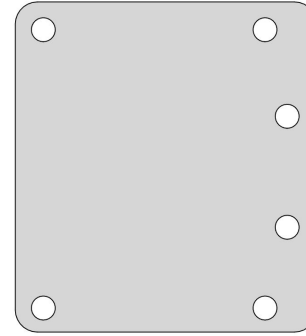


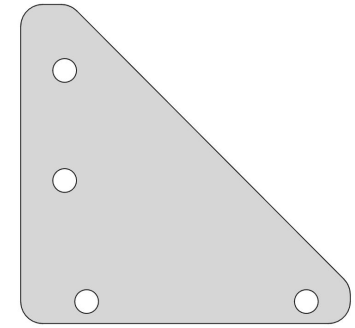
## Lift Mechanism

# Lift Mechanism Assembly

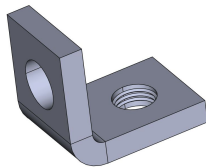
- Locate the acrylic pieces shown to the right.
- Locate the following parts
  - 4 nuts
  - 4 lock nuts
  - 4 1/2" screws
  - 4 3/8" screws



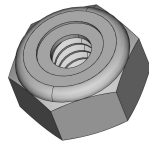
2 Square Brackets



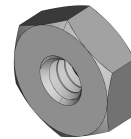
2 Triangle Brackets



Right Angle Bracket



Nylon Lock Nut



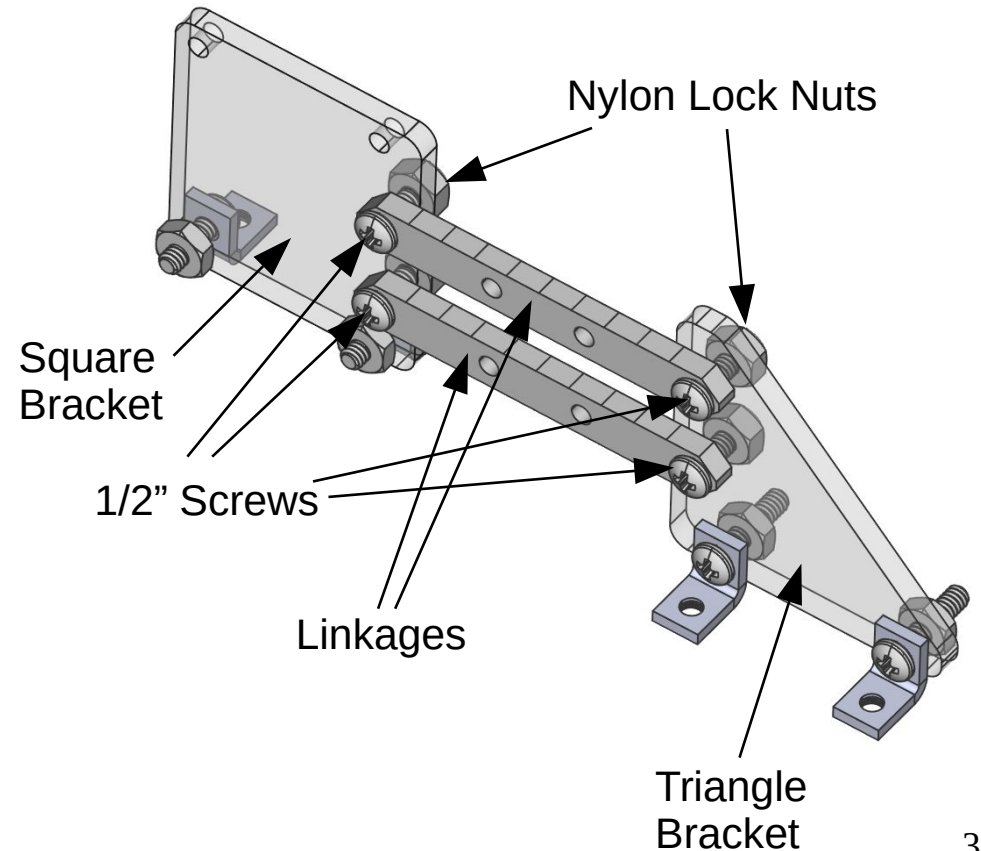
Nut



4 Linkages

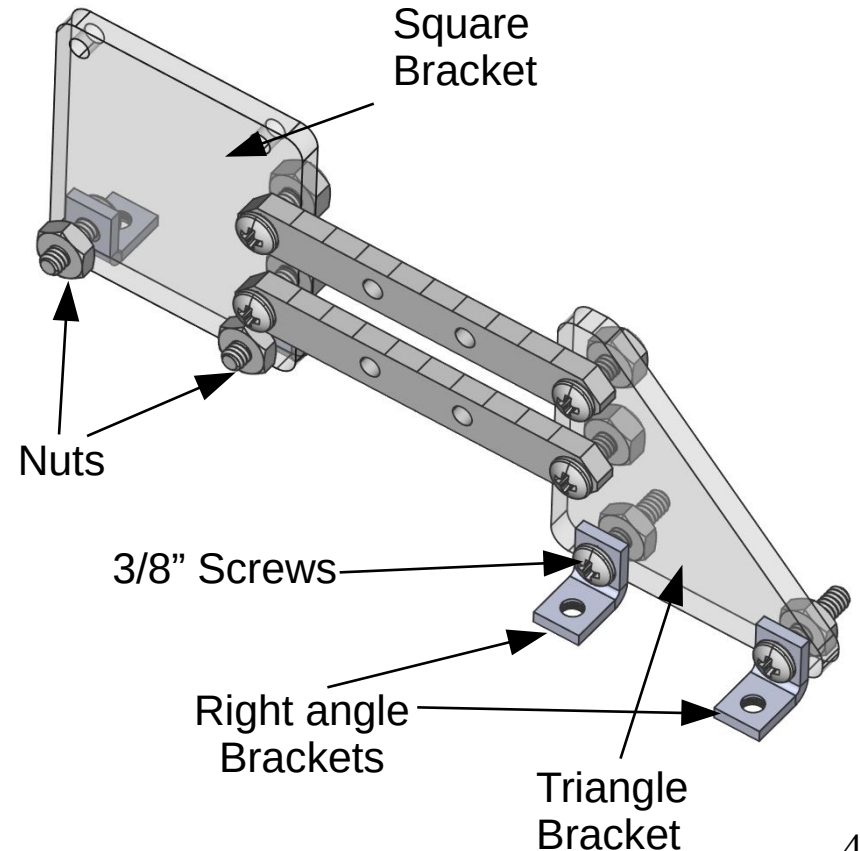
# Assembly

- Assemble the left side of the lift assembly as shown.
- Secure the two linkages to the square bracket and triangle bracket using 1/2" screws and nylon lock nuts.
- Do not tighten the nuts. Allow the pieces to freely rotate.



# Assembly

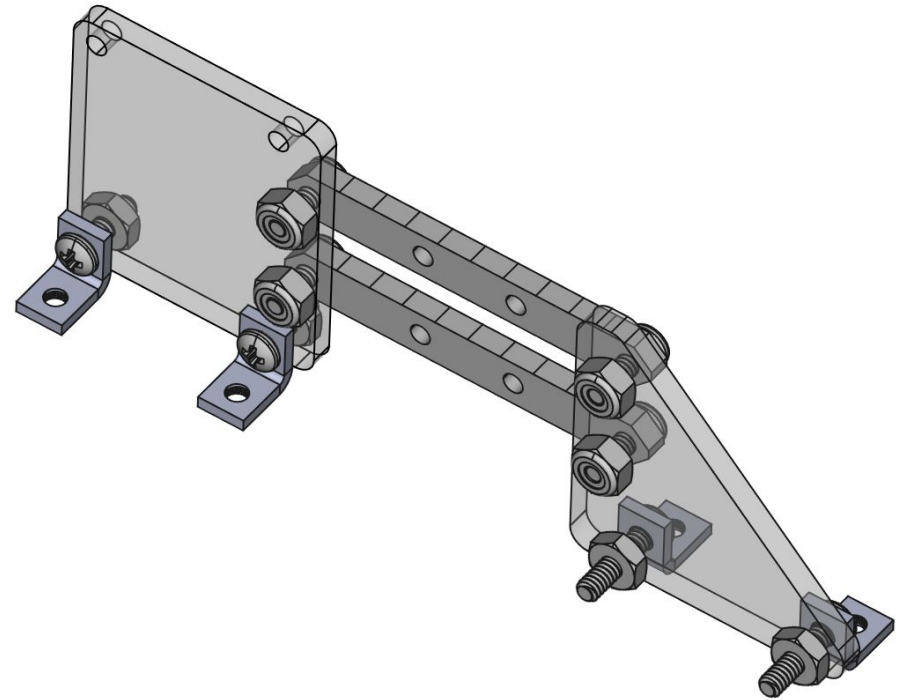
- Next, install the right angle brackets as shown. The larger hole side of the right angle bracket goes against the square and triangle brackets.
- The right angle brackets for the triangle bracket are mounted on the same side as the linkages.
- The right angle brackets for the square bracket is on the opposite side of the linkages.
- Secure the right angle brackets with 3/8" screws and regular nuts.



# Assembly

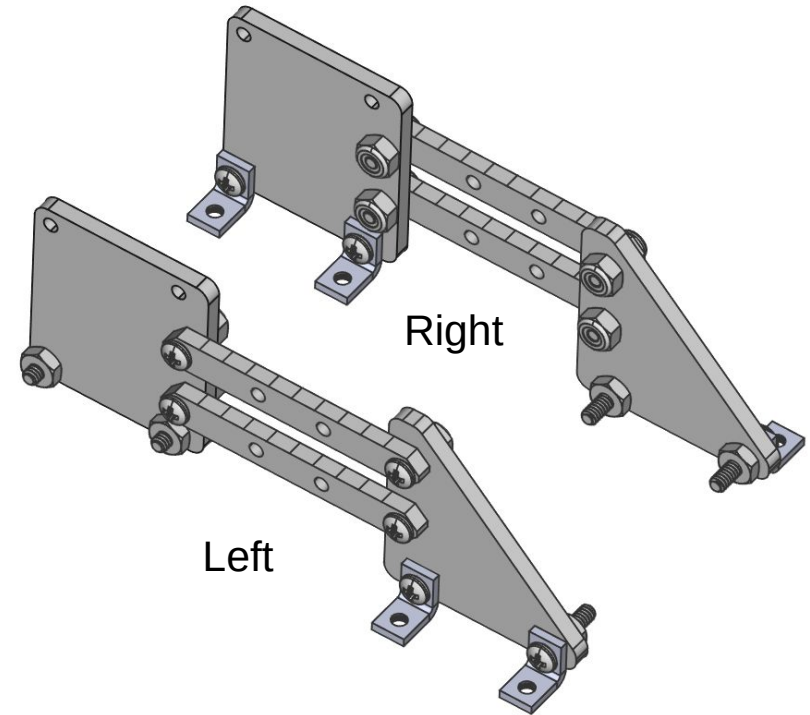
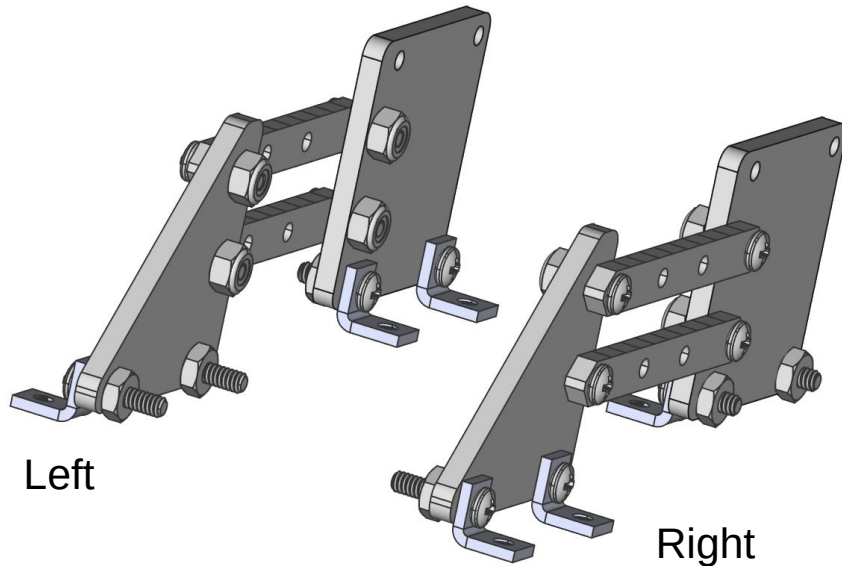
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- The right lift assembly gets assembled the opposite of the left assembly.
- Assemble the right assembly so it looks like the picture.



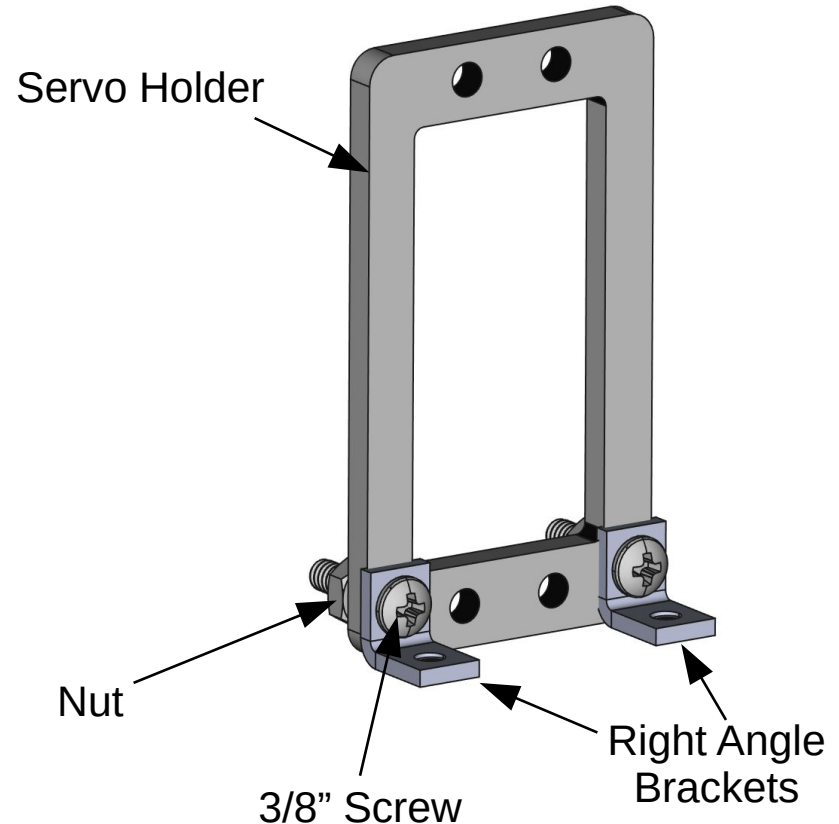
# Assembly

- Verify the left and right lift assemblies look like the picture.



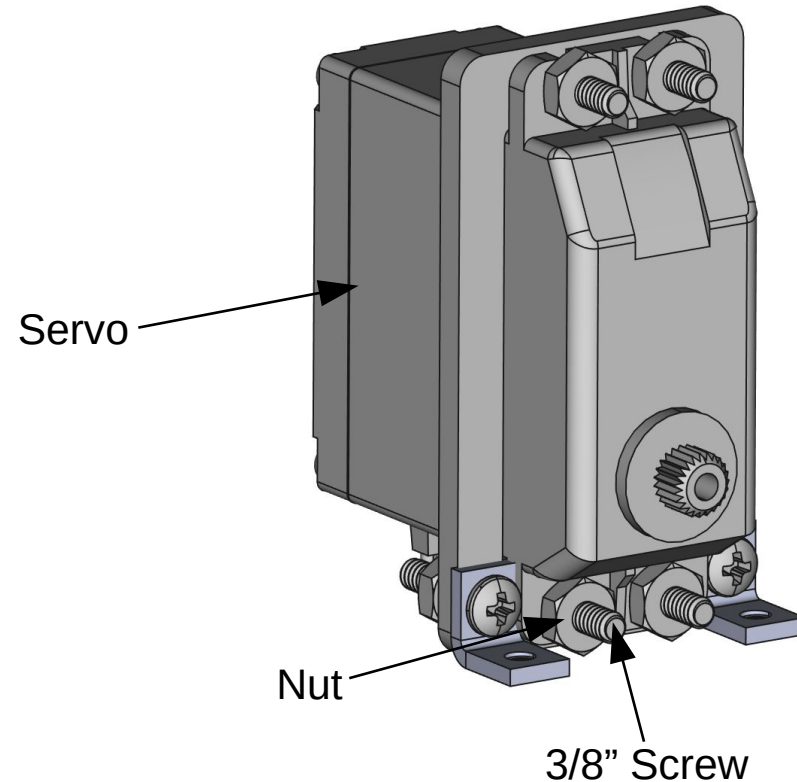
# Assembly

- Locate the servo holder acrylic part.
- Get two more right angle brackets, 2 3/8" screws and two nuts.
- Install the right angle brackets as shown. Make sure the larger hole is against the servo holder.



# Assembly

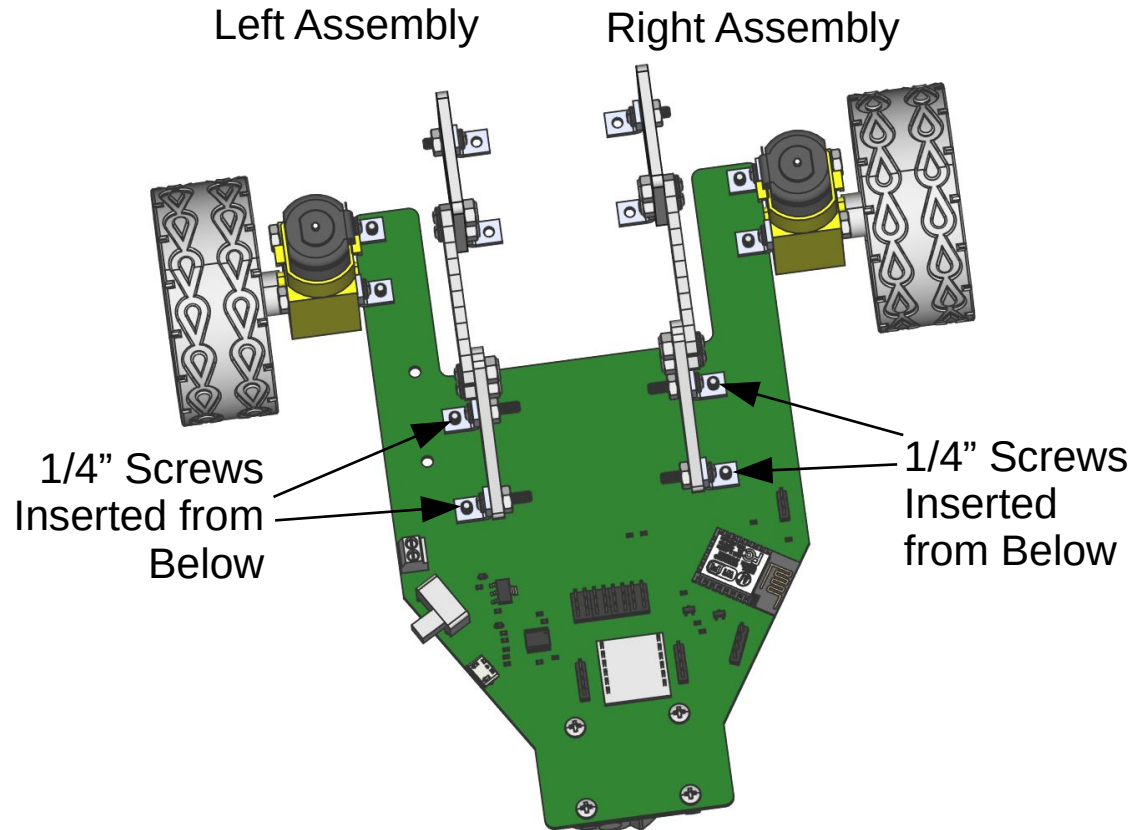
- Insert the servo from the front. Make sure the servo shaft is at the bottom.
- Secure the servo with four 3/8" screws and nuts. The screws are inserted from the rear and secured with nuts on the front side.





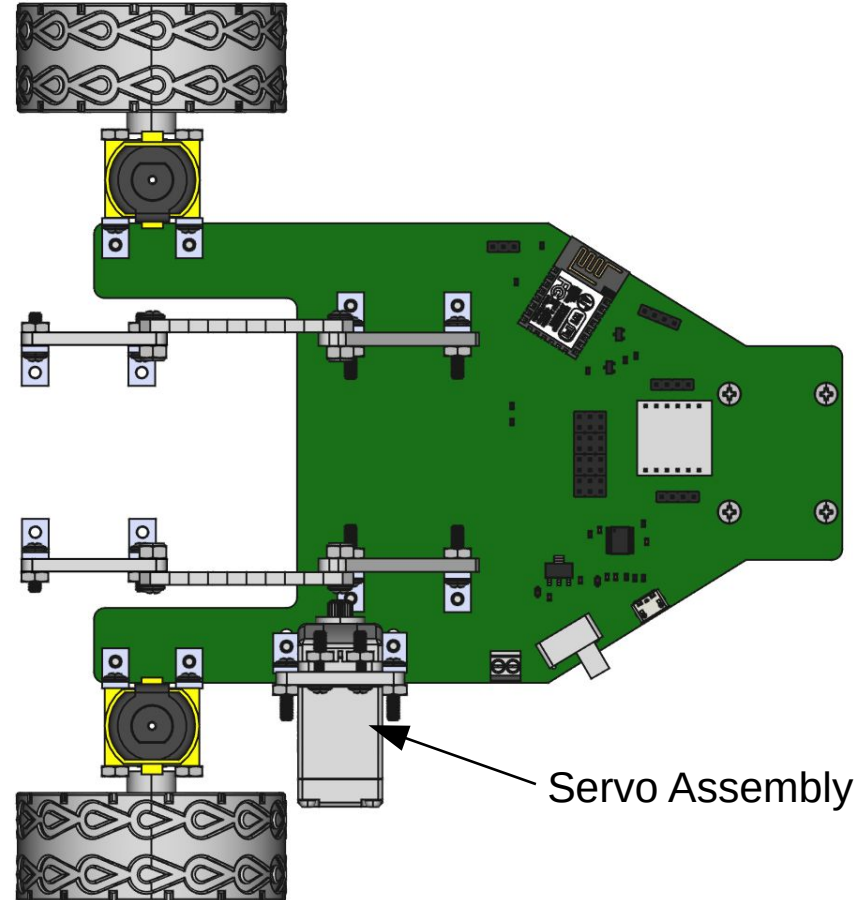
# Assembly

- Take the left assembly and align the right angle brackets on the triangle bracket with the holes on the robot structure. Secure with two 1/4" screws.
- Do the same for the right lift assembly.



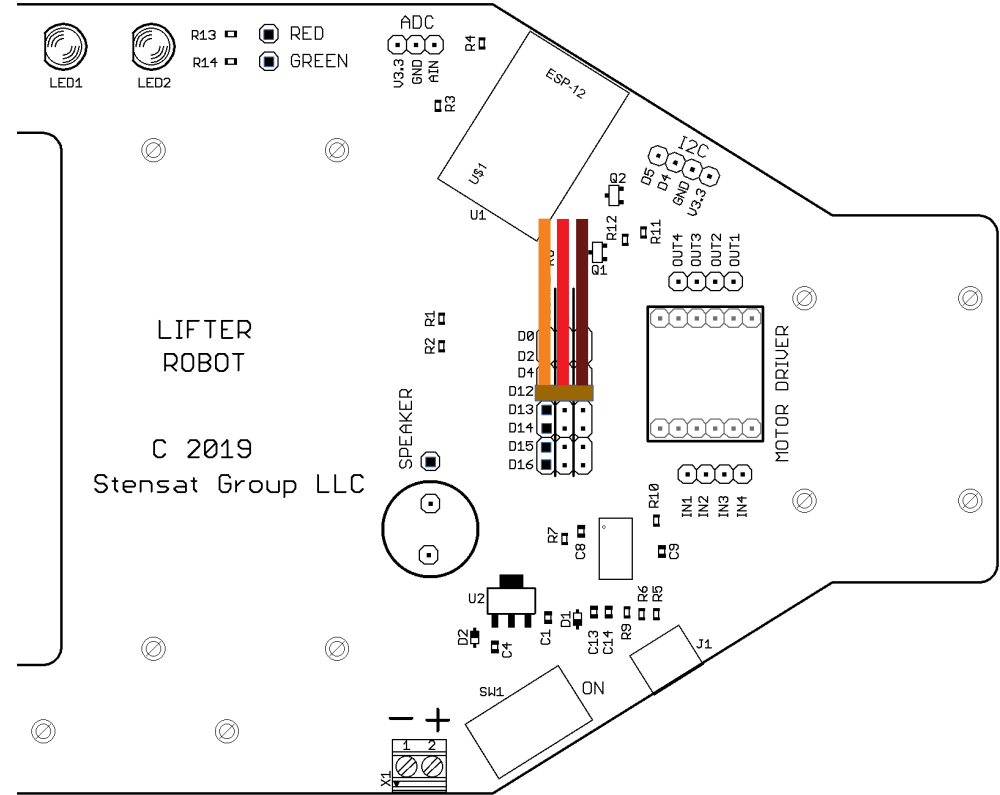
# Assembly

- Install the servo assembly onto the robot.
- Secure with  $\frac{1}{4}$  inch screws from the bottom.
- This will be temporary. The servo needs to be positioned.



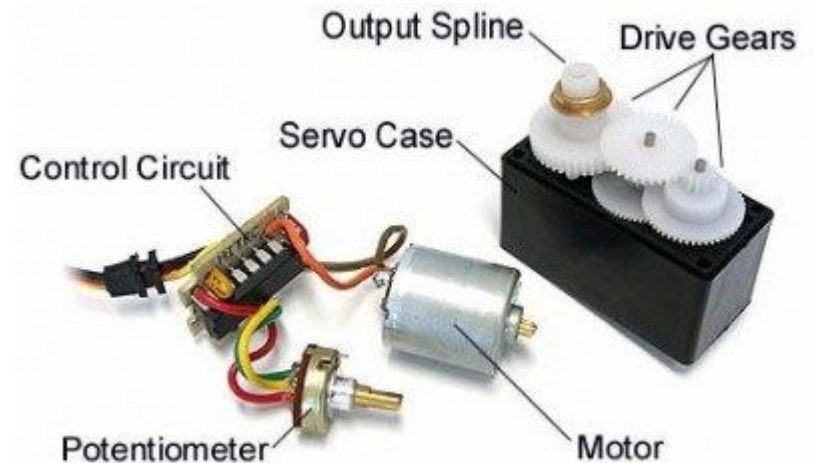
# Servo Programming

- Connect the servo cable to the robot digital port 12.
- Orientation of the cable is crucial. Make sure the orange wire is positioned closest to the D12 label.



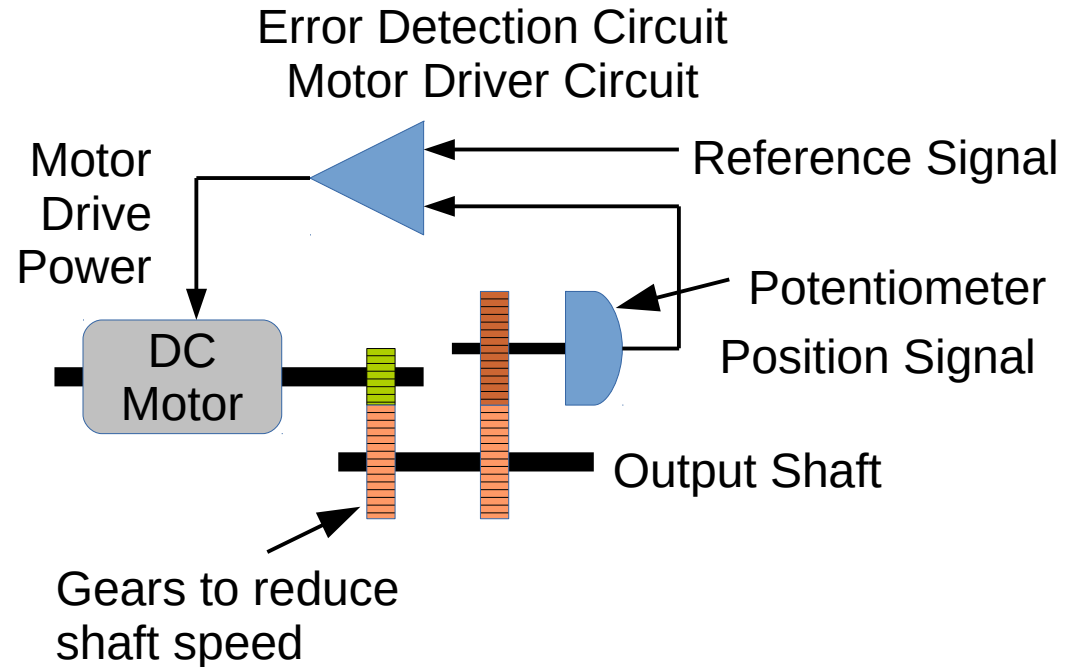
# Servos

- 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.



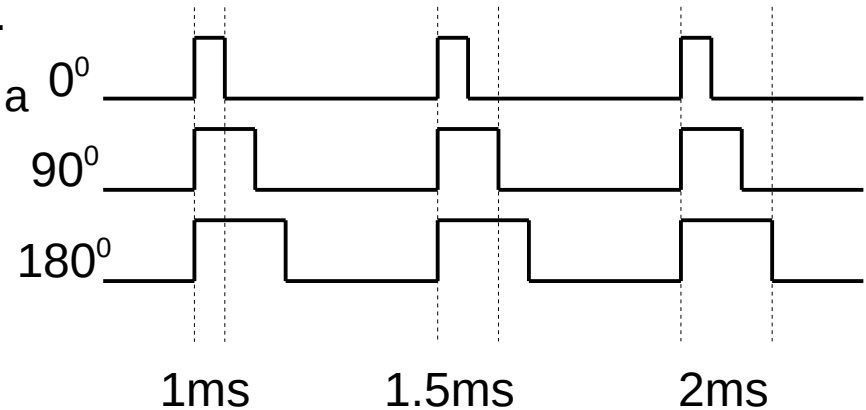
# Servo

- 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.



# 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.



Some servos have a wider range of 0.7ms to 2.3ms

# Servo Programming

- Enter the new program to the right.
- The first line tells the compiler to include functions from another file. These functions allow you to control servo motors.
- Next line creates a servo object called **lift**. There can be multiple servo objects.
- In **setup()**, **lift.attach(12)** tells the servo object base to control a servo connected to pin D12.
- In the loop, **lift.write()** moves the servo to the angle specified. The loop moves the servo from 0 to 180 degrees.

```
#include <servo.h>

Servo lift;

void setup() {
  Serial.begin(115200);
  lift.attach(12);
}

void loop() {
  lift.write(0);
  delay(2000);
  lift.write(180);
  delay(2000);
}
```

# Servo Control

- Compile and upload the program.
- When the program runs, the servo will start rotating back and forth.
- The delays are includes to give the servo time to move. The program will not wait for the servo to complete its movement.

```
#include <servo.h>

Servo base;

void setup() {
  Serial.begin(115200);
  base.attach(12);
}

void loop() {
  base.write(0);
  delay(2000);
  base.write(180);
  delay(2000);
}
```



# Servo Control

- Modify the program so that the lift can be secured to the servo horn.
- Run the program so the servo moves to the mid point at 90 degrees.
- Turn off the robot power.
- Next, the lift assembly will be attached to the servo.

```
#include <servo.h>

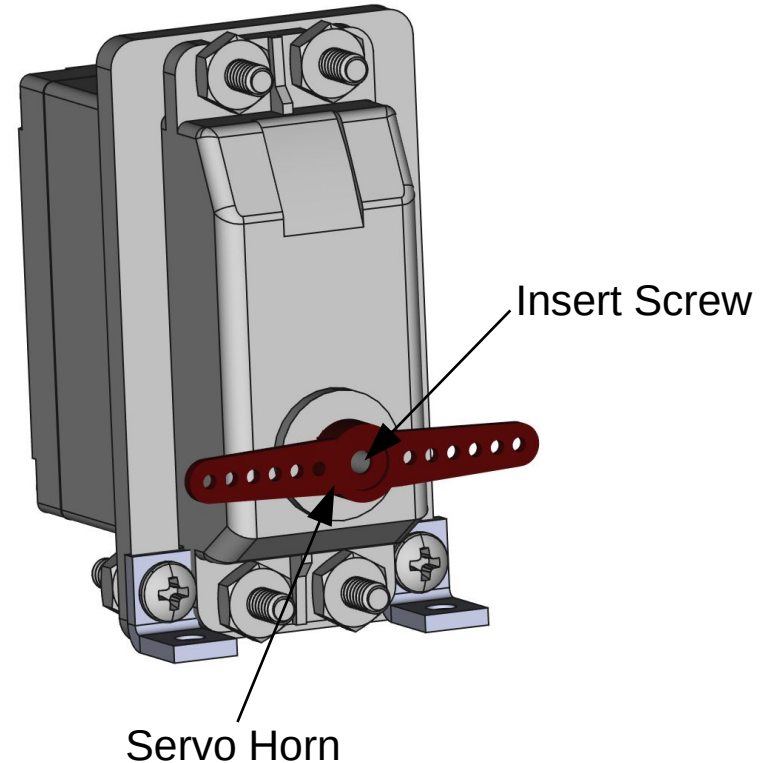
Servo base;

void setup() {
  Serial.begin(115200);
  base.attach(12);
  base.write(90);
}

void loop() {
}
```

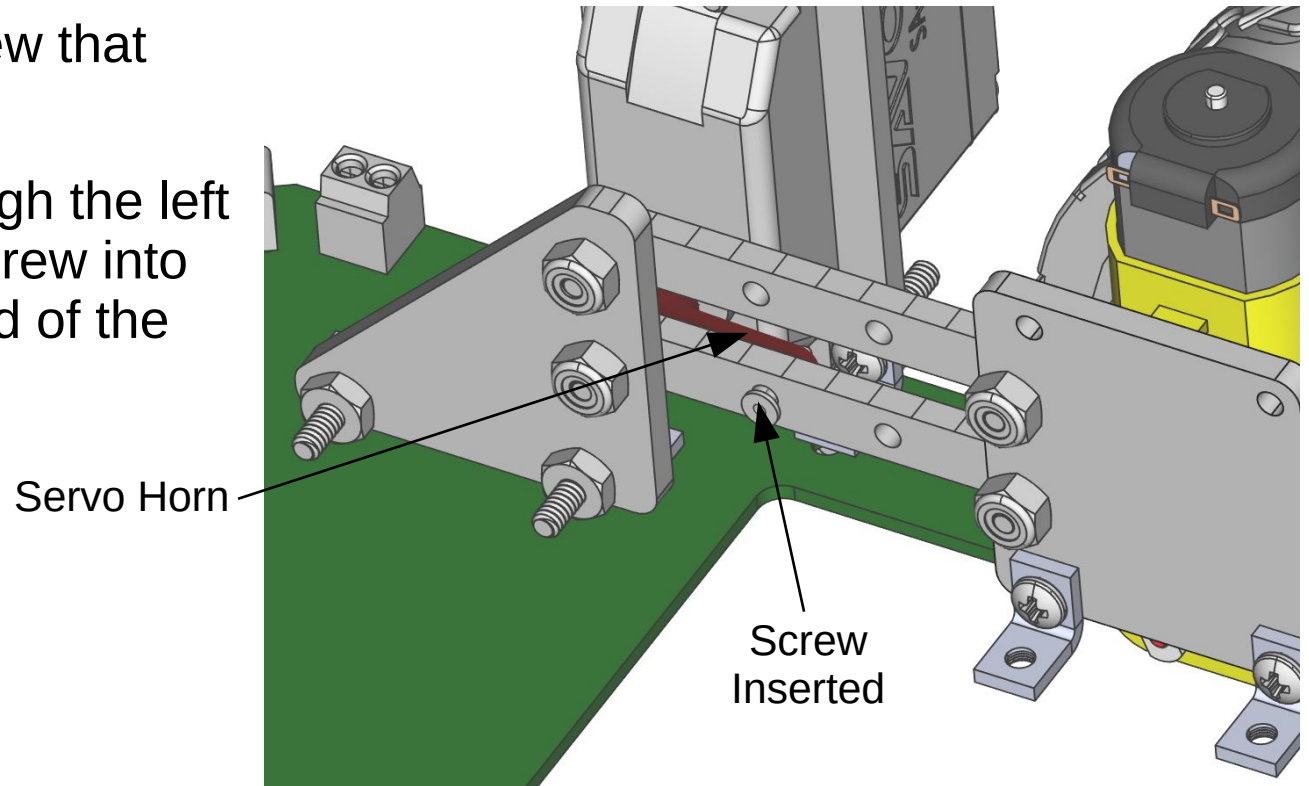
# Servo Horn

- Remove the servo assembly from the robot.
- Install the servo horn as shown so it is aligned horizontally.
- With the servo horn installed, reinstall the servo assembly to the robot.



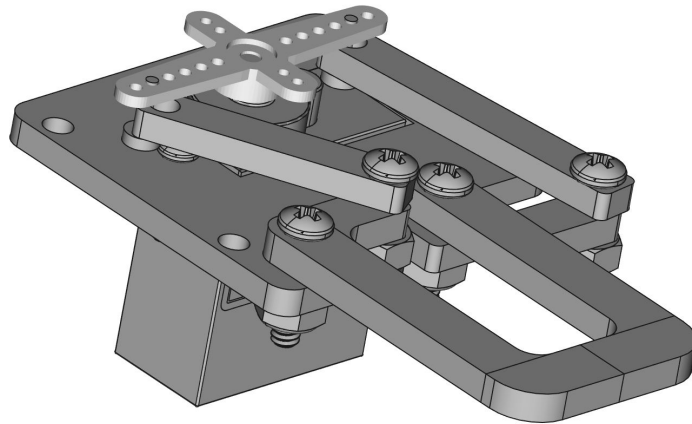
# Assembly

- Locate the pointy screw that came with the servo.
- Insert the screw through the left bottom linkage and screw into the last hole at the end of the servo horn.

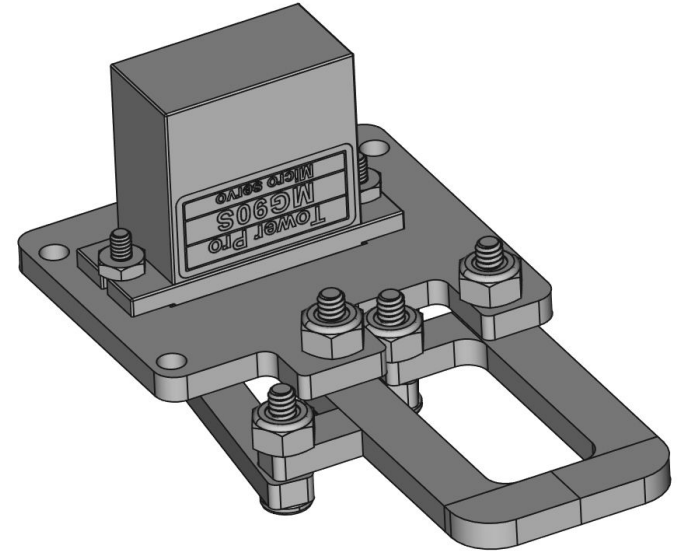


# Gripper Assembly

- The gripper assembly uses a small servo to operate the fingers.



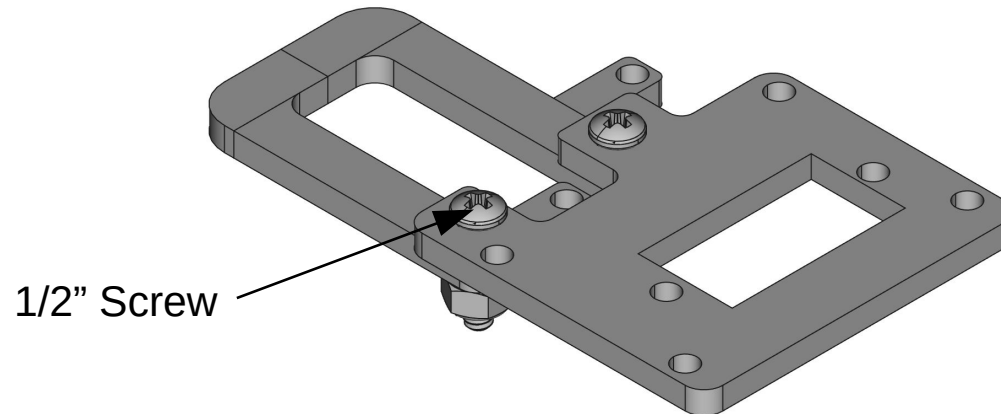
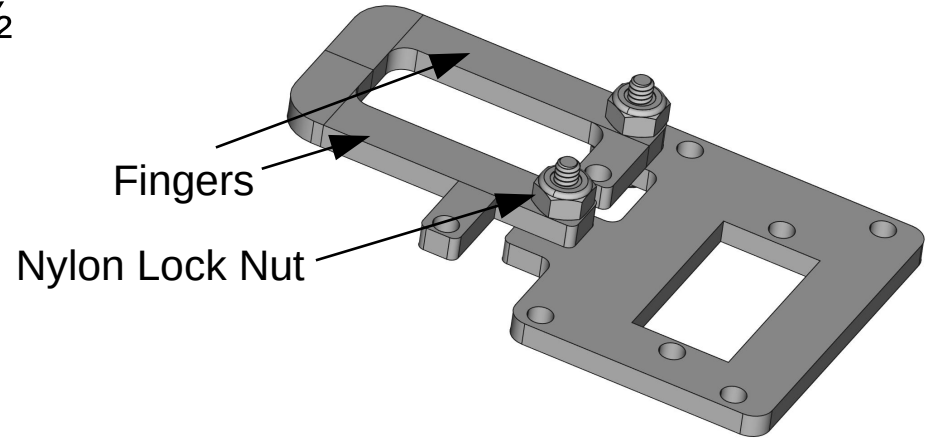
Bottom Side



Top Side

# Gripper Assembly

- Install the gripper fingers using  $\frac{1}{2}$  inch screws and nylon lock nuts.
- Do not tighten the nuts. let the fingers rotate freely.



# Gripper Assembly

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- Take the servo horn shown from the small servo packaging.
- Locate the two linkages. Secure the linkages to the servo horns using the two pointy screws that came with the servo.
- Insert the screws into the second to the last holes on the servo horn. The screws are too large for the last holes.

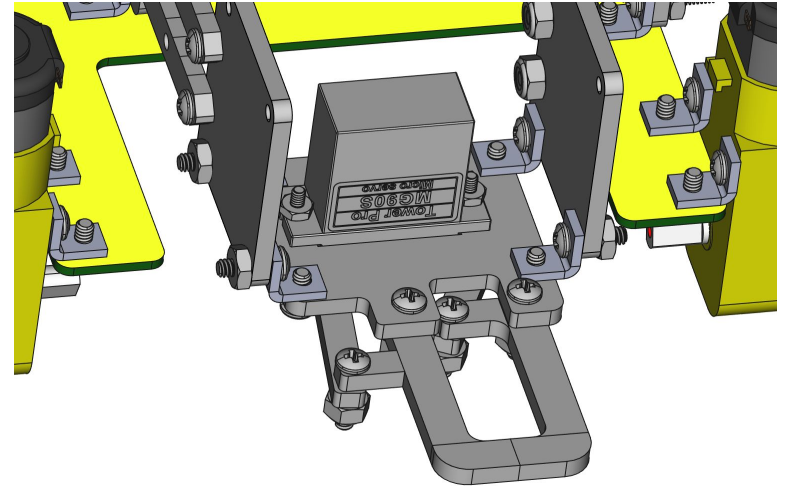
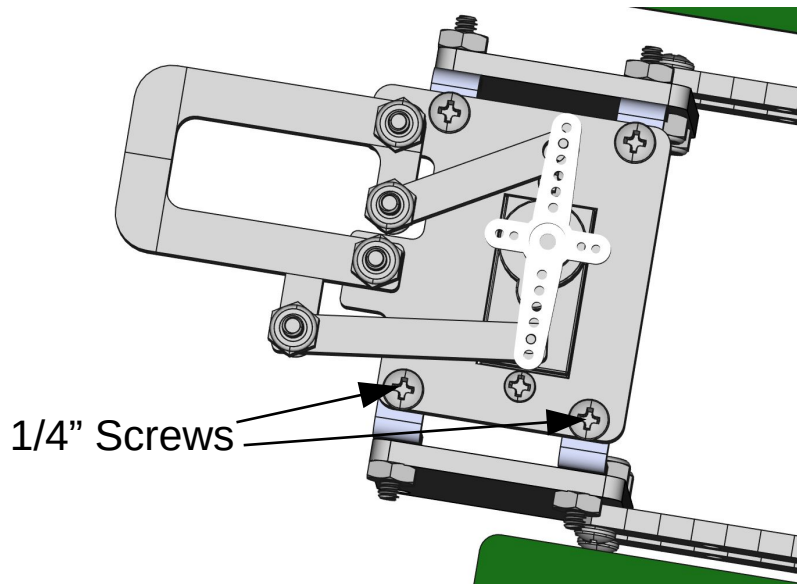
# Gripper Assembly

---

- Mount the servo horn onto the servo so the two linkages align with the fingers.
- Secure the linkages to fingers with 1/2" screws and nylon lock nuts.

# Gripper Assembly

- Install the gripper assembly onto the lift assembly.
- Use 1/4" screws to secure the gripper assembly to the lift assembly.

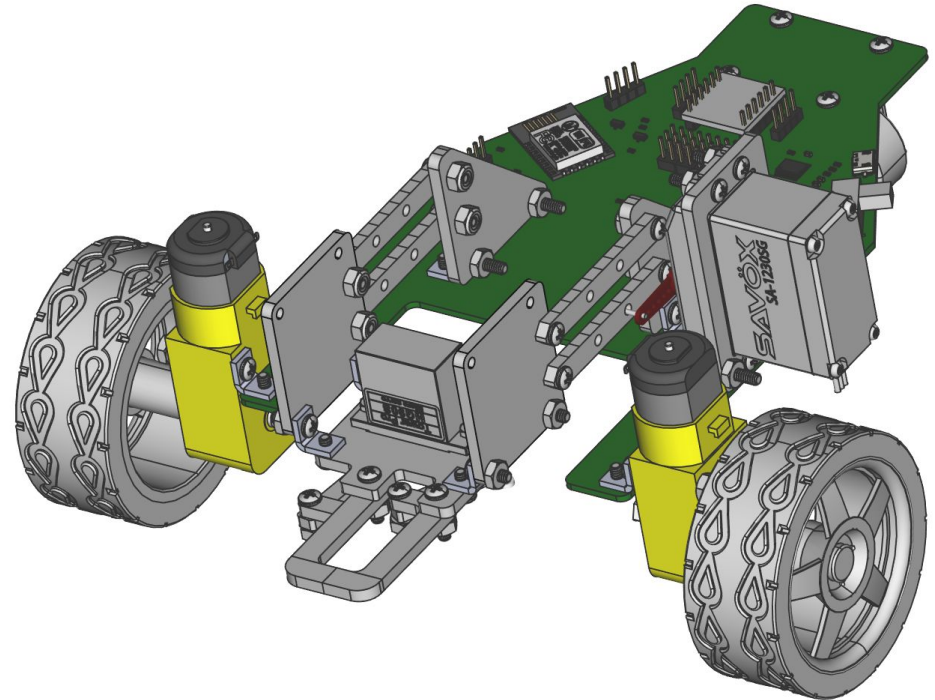




# Gripper Assembly

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- The robot assembly is complete.
- Connect the servo cable to digital port 0. Make sure the cable is oriented the same way as the servo cable.



# Gripper Adjustment

- Pull the servo horn off of the servo. This will let the servo get adjusted.
- Enter the program to the right. This will set the gripper servo to 90 degrees.
- After the program runs and servo rotates into position, reattach the servo horn with the fingers closed as best as possible. It is fine if the fingers cannot touch each other. The servo can be adjusted later.

```
#include <servo.h>

Servo grip;

void setup() {
  Serial.begin(115200);
  grip.attach(0);
  grip.write(90);
}

void loop() {
}
```

End

