Underwater Continuum Manipulator V2 Assembly Guide

Autonomous Robotic Manipulator Lab

Stevens Institute of Technology

Updated 6/19/23

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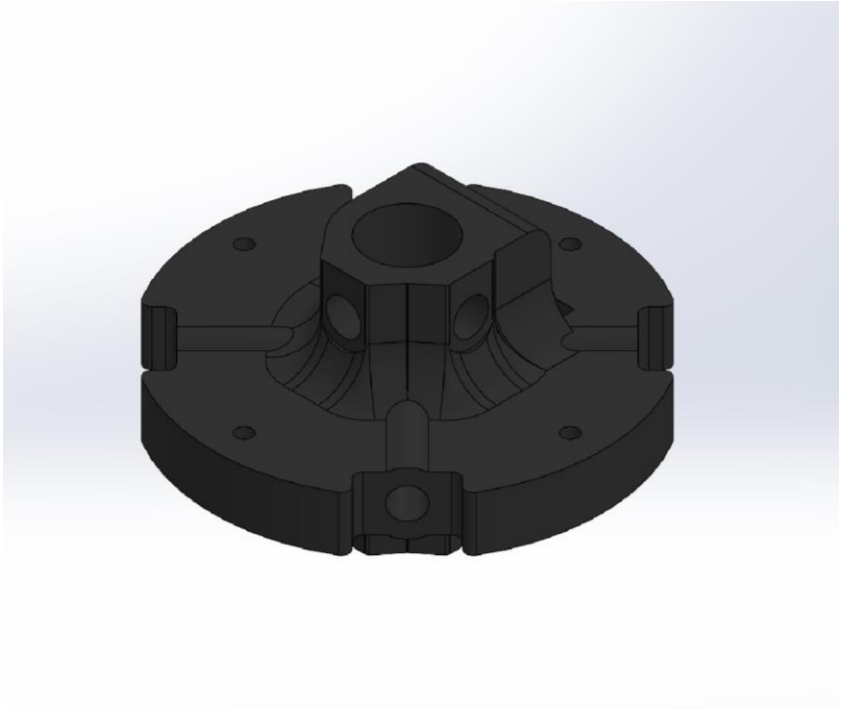
1870

Arm Assembly

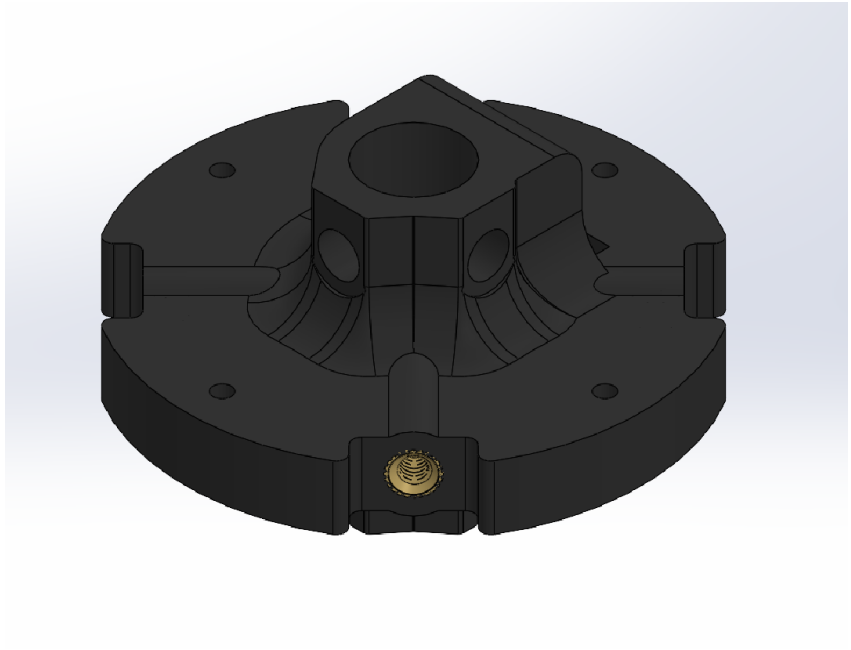
Updated 6/19/23

Link Assembly



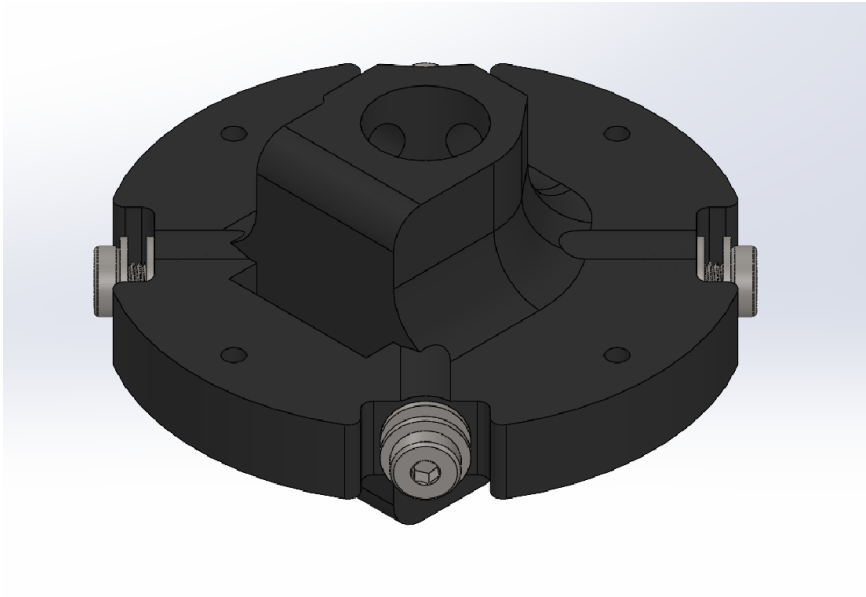
- Start with the arm link

Link Assembly



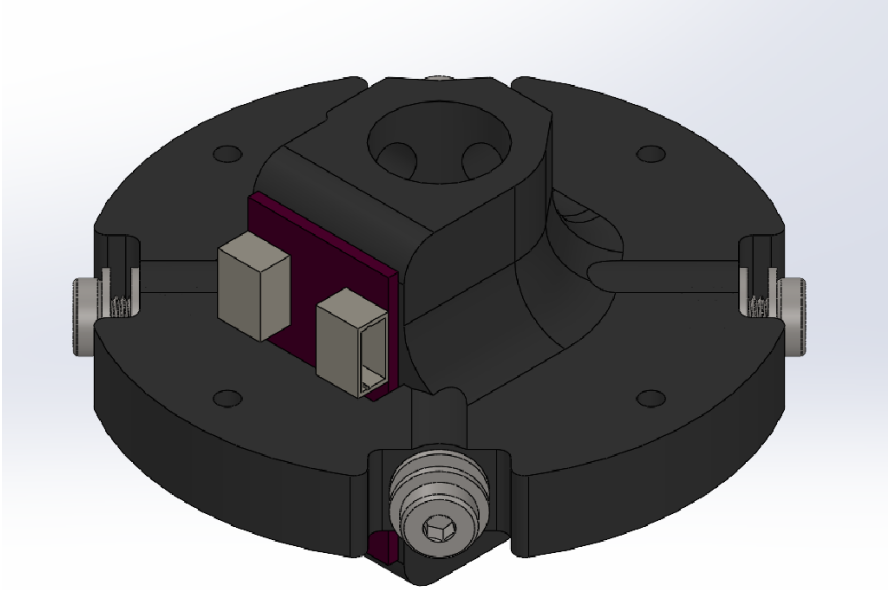
- Insert M3 x 5.7mm heat set insert into each side hole
- Note: A soldering iron or heat application tool with a similar end can be used to easily insert the heat set insert

Link Assembly



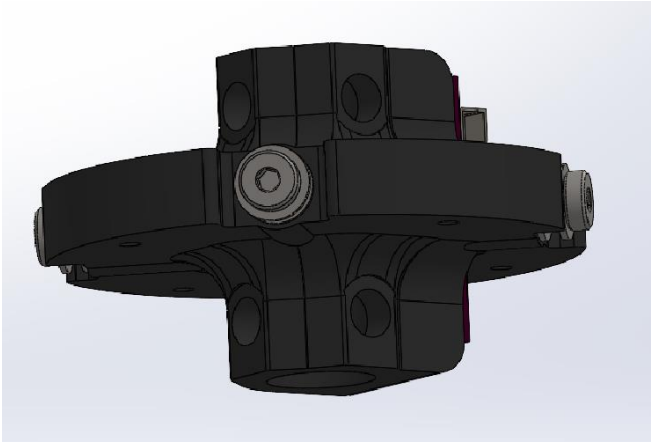
- Screw in M3x0.5 10mm size machine screws with two M3 size washers into each heat set insert

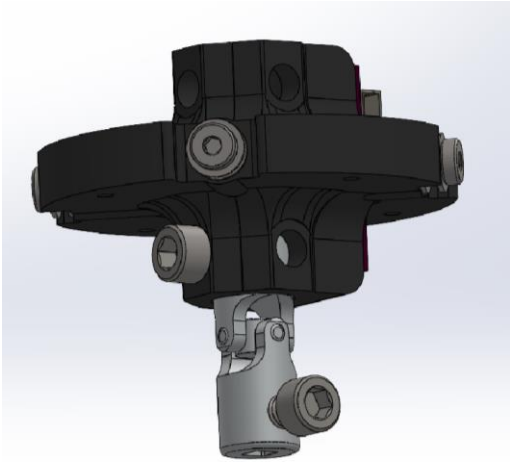
Link Assembly



- Attach an IMU board to the link via hot glue in the slot on the inside of the link

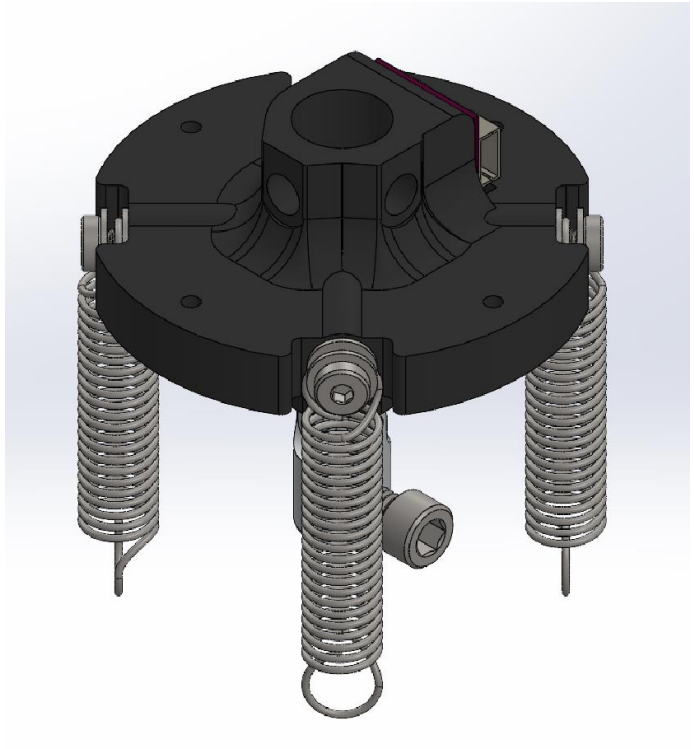
Link Assembly





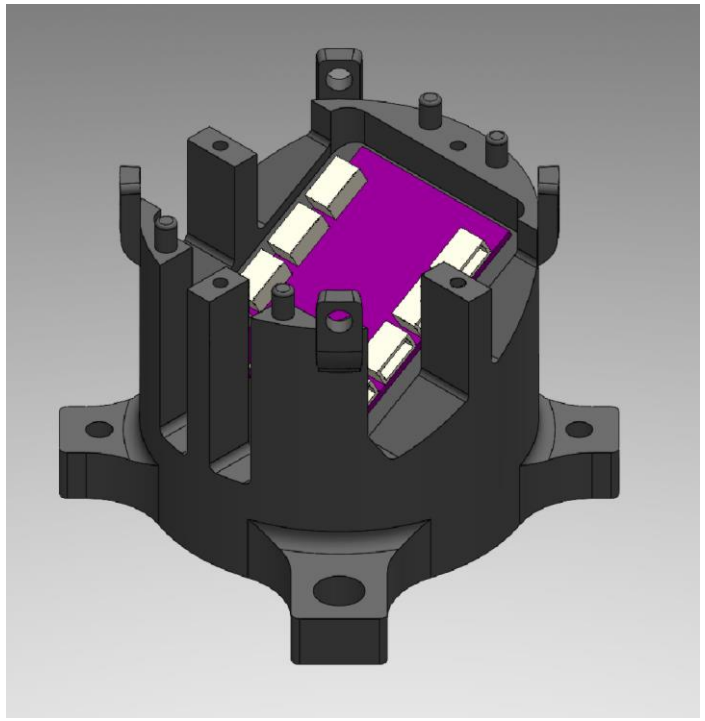
- On the bottom of each link, screw in a VEX universal joint to one of the two holes
- Note: By aligning each of the two holes on the VEX joint to be in line with the holes will lead to easier assembly of the full arm

Link Assembly



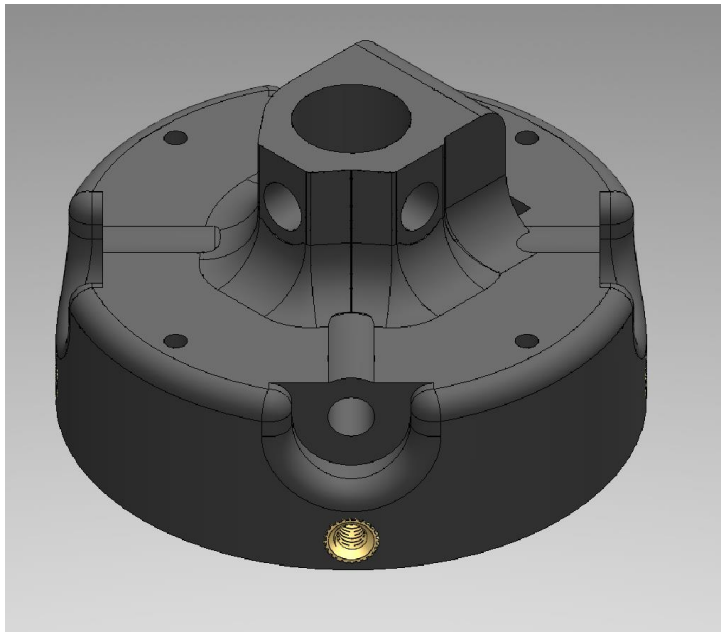
- On each screw attach a spring and screw in the screw to clamp the end of the spring to the link

Arm Assembly



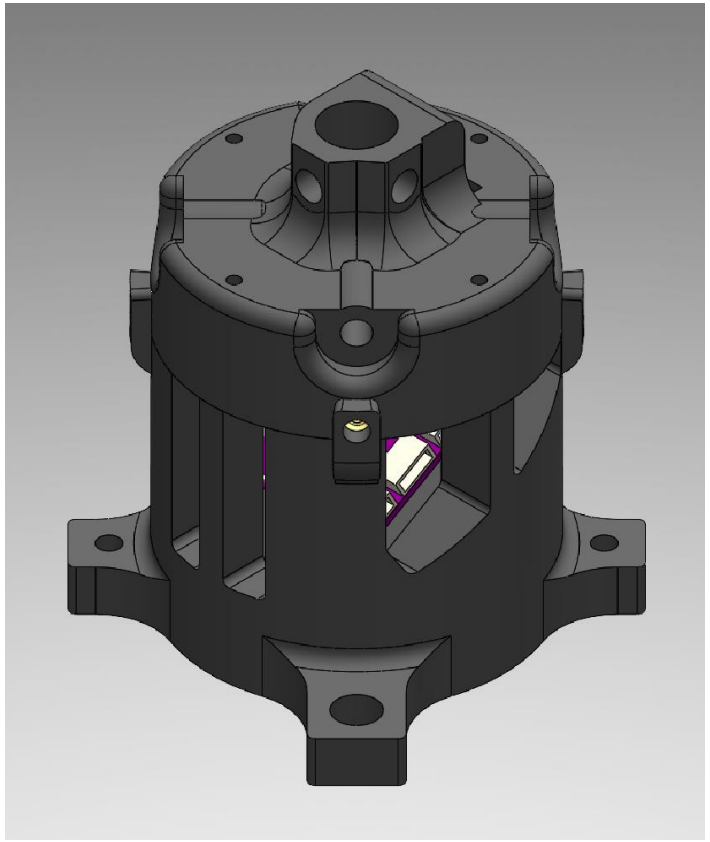
- On the lower half of the base of the arm, insert the IMU mux

Arm Assembly



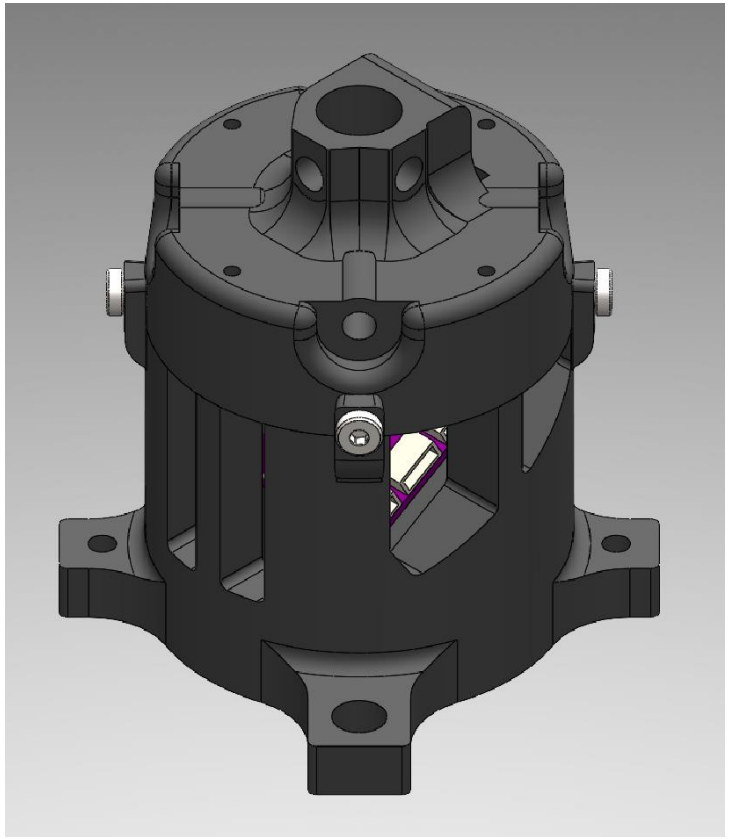
- On the upper half of the arm base, insert M3 x 5.7mm heat set inserts into each of the lowest side holes

Arm Assembly



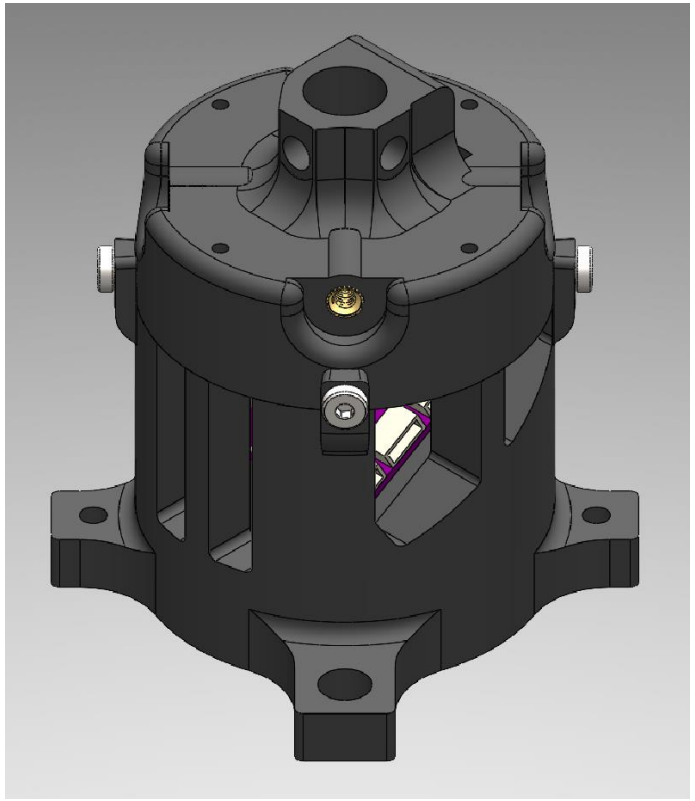
- Set the upper half of arm base onto the lower half with the heat set inserts lined up with the extensions on the base

Arm Assembly



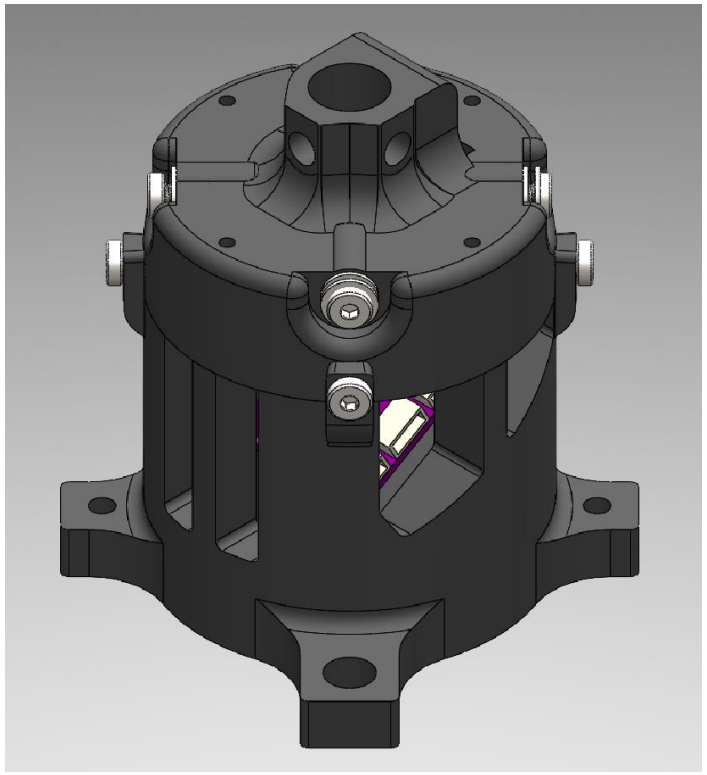
- Insert an M3x0.5 10mm screw into each of the heat set inserts through the attachment holes of the upper half of base

Arm Assembly



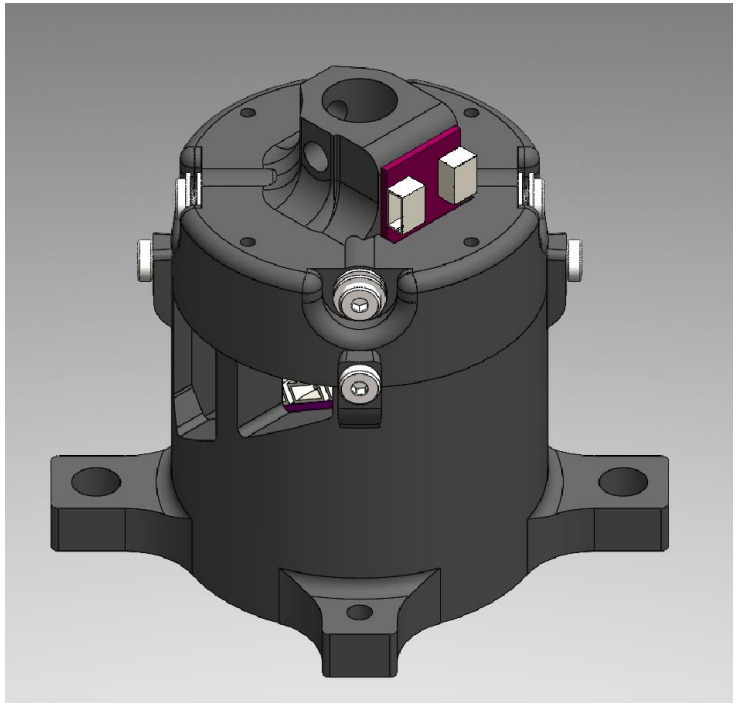
- Insert M3 x 5.7mm heat set insert into each of the upper side holes on the upper half of the base

Arm Assembly



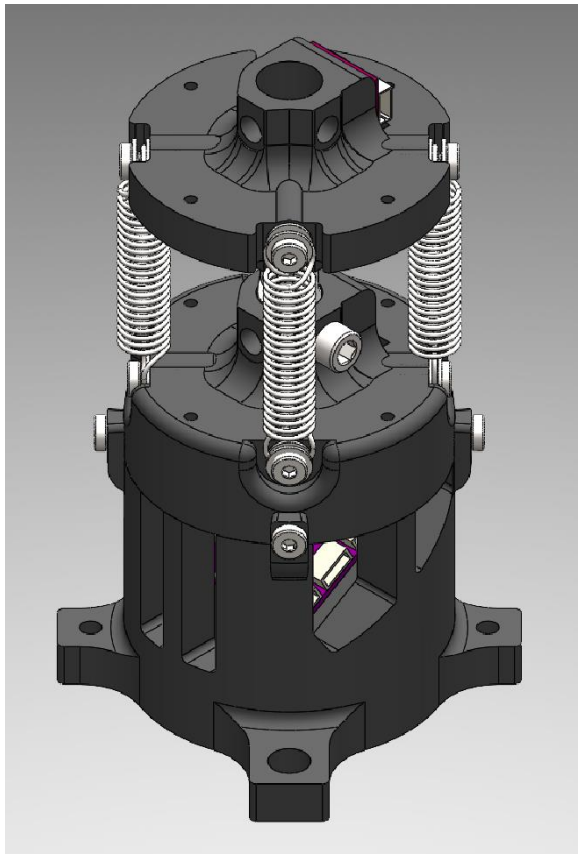
- Insert M3x0.5 10mm screws with two washers into heat set inserts on the upper half of the base

Arm Assembly



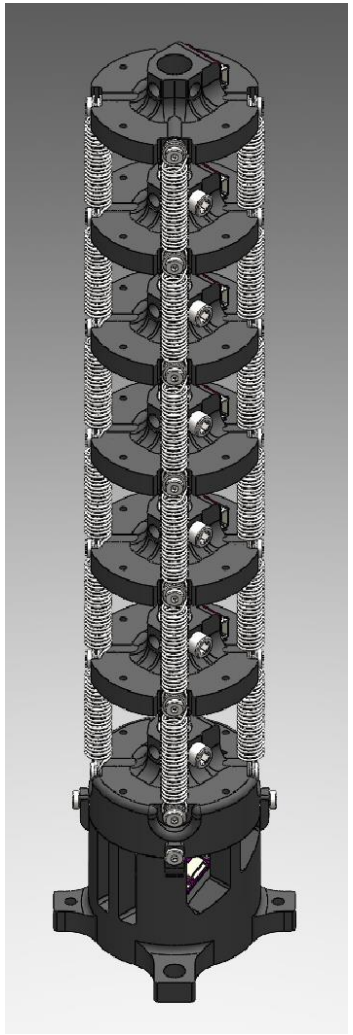
- Attach IMU to the upper half of the base in slot on the inside of the base

Arm Assembly



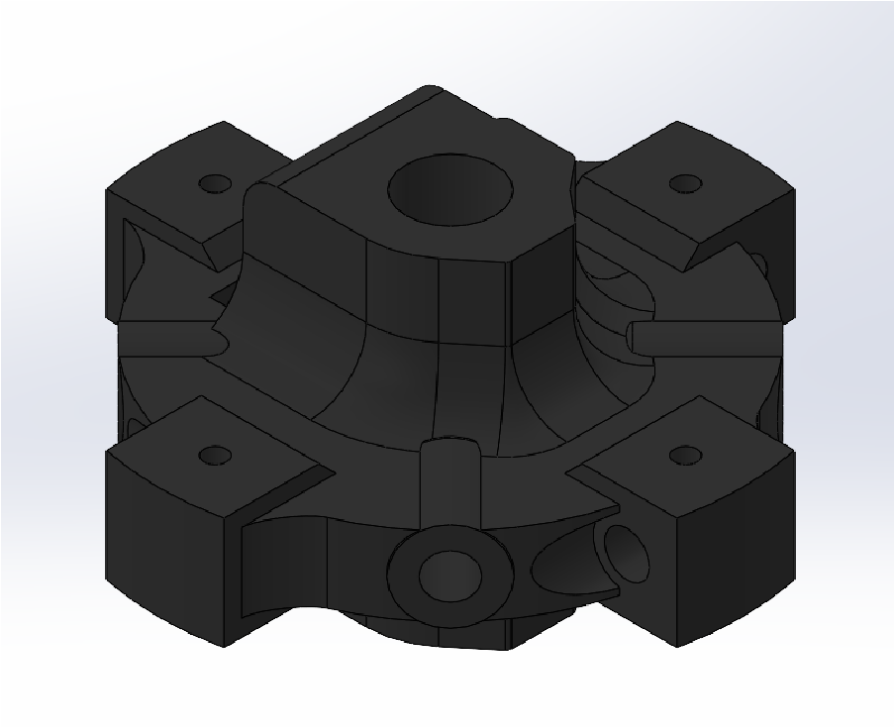
- Screw on the other end of the VEX universal joint of a completed link to the arm base
- Attach the bottom of the springs to the screws and washers of the base

Arm Assembly



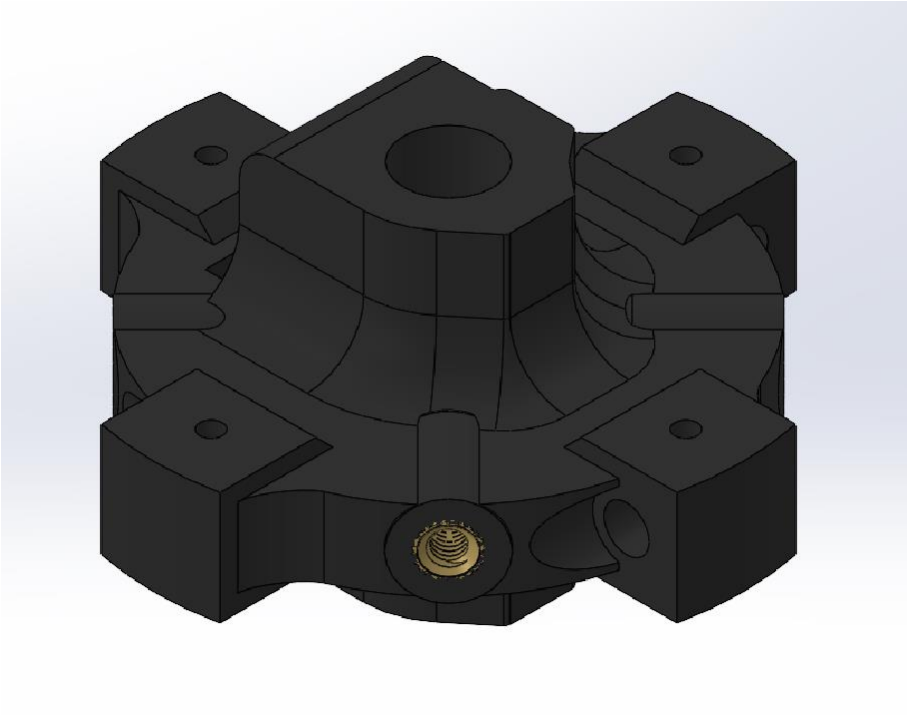
- In the same way as the first link, add each link to the arm
- Attach the springs of each link to the screws of the below link, clamping them down with the washers in same fashion as before

End Link Assembly



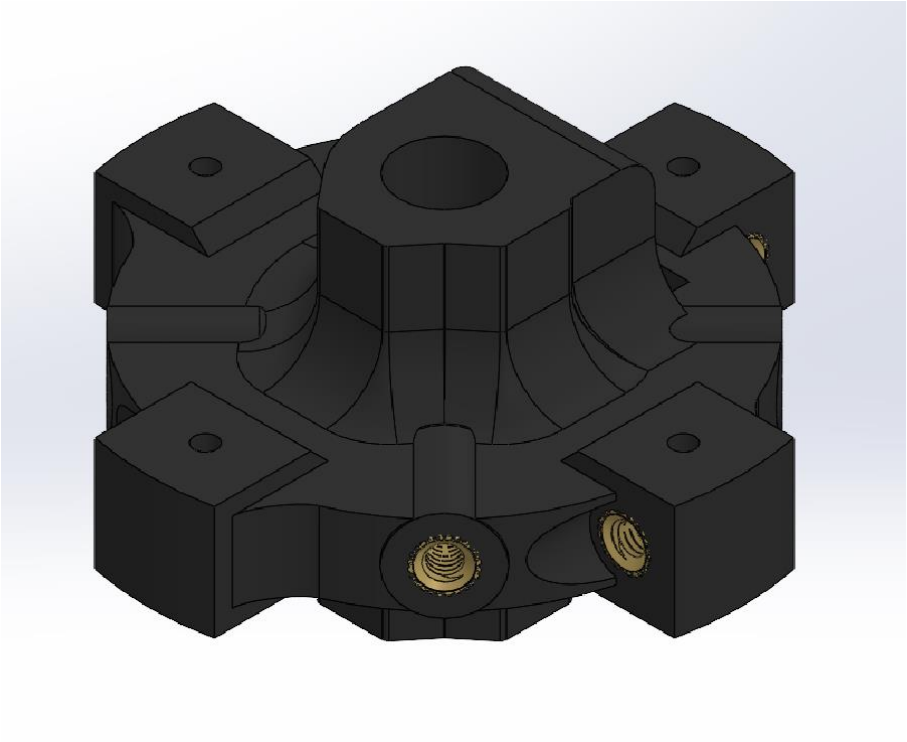
- In the same fashion as a standard arm link, start with the end link

End Link Assembly



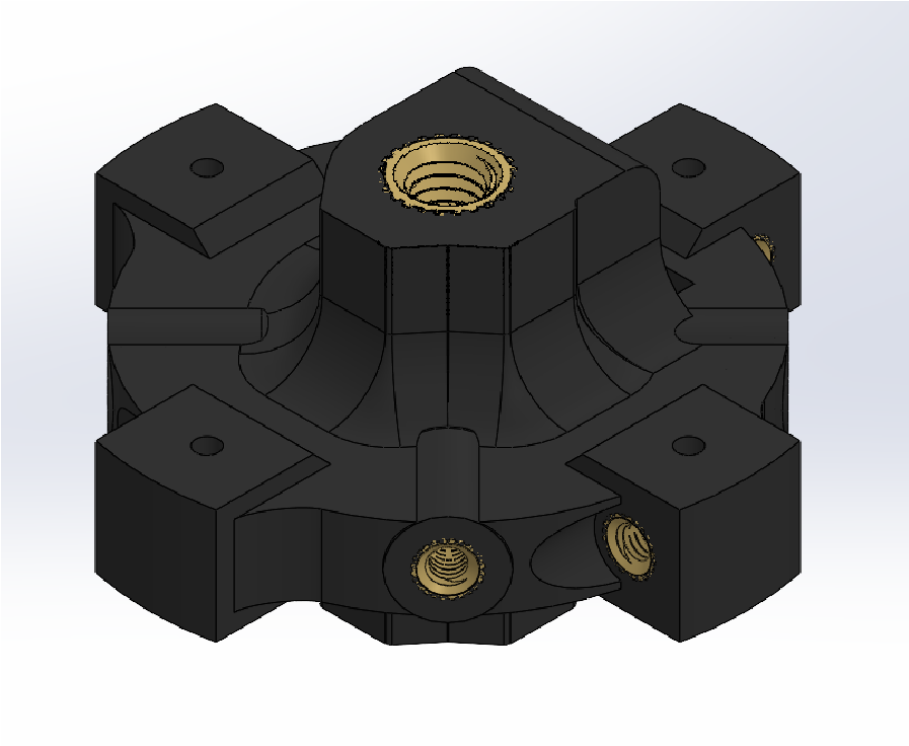
- First, inert M3 x 5.7mm heat set inserts into each of the holes on the side of the main circle of the link

End Link Assembly



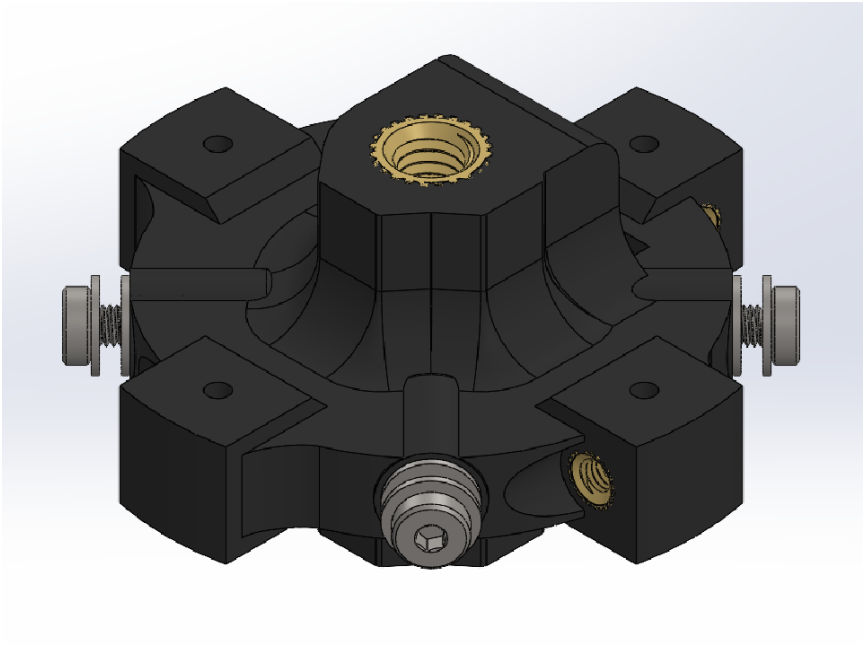
- On each of the protrusions of the link, insert a M3 x 4.3mm heat set insert into the hole on the side.
- Note: Inserting a nitinol rod into the small perpendicular hole before inserting the heat set insert helps prevent it from being pushed too far into the hole

End Link Assembly



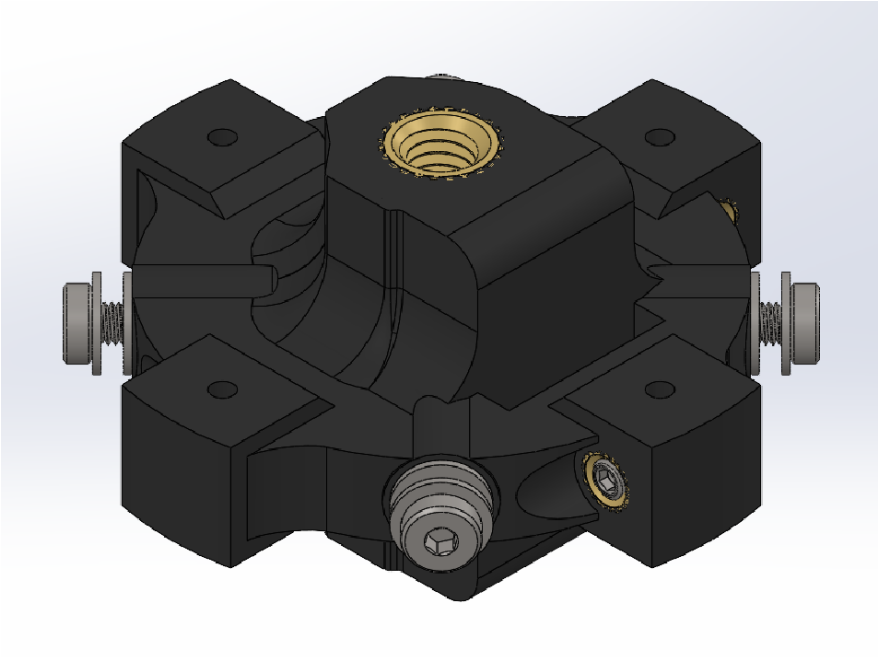
- On the top end of the end link (the side of the link without screw holes for the VEX universal joint), insert a M6 x 7.9mm heat set insert

End Link Assembly



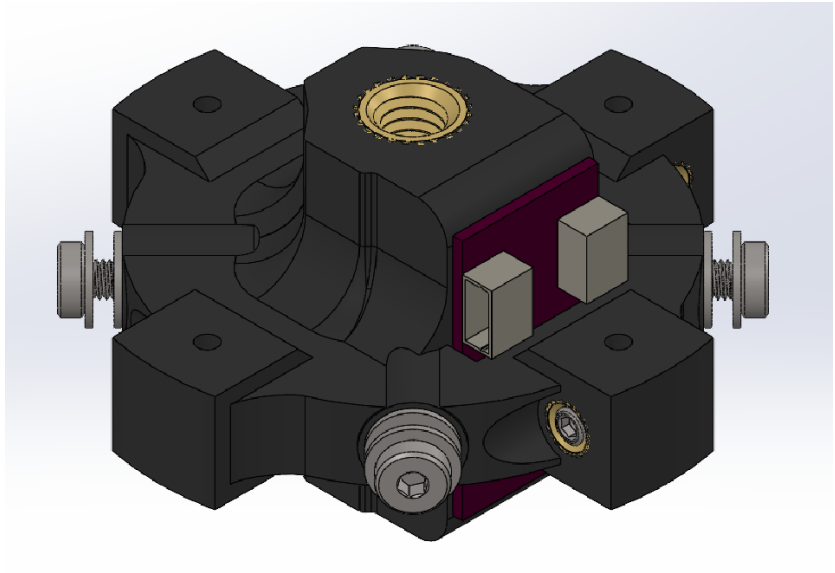
- In each of the side heat set inserts that are on the main circle of the link, insert a M3x0.5 10mm screw with two M3 washers

End Link Assembly



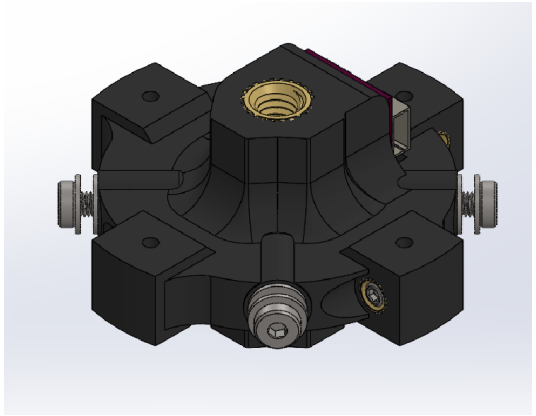
- In each of the heat set inserts on the protrusions, insert a M3x0.5 4mm set screw for use of locking the nitinol rods once inserted

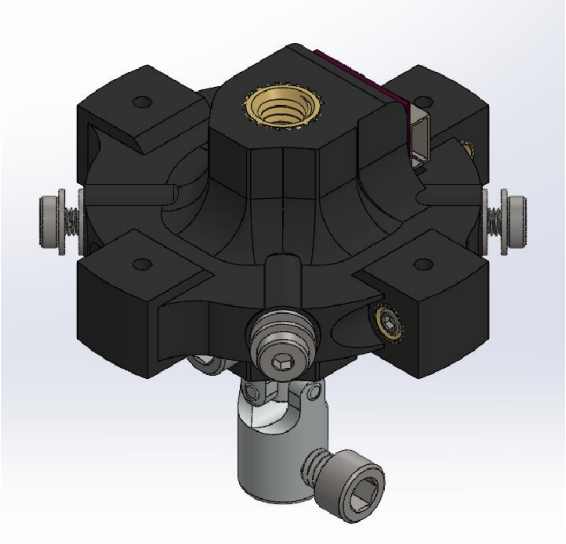
End Link Assembly



- Attach IMU board to the end link the inner slot of the link via hot glue

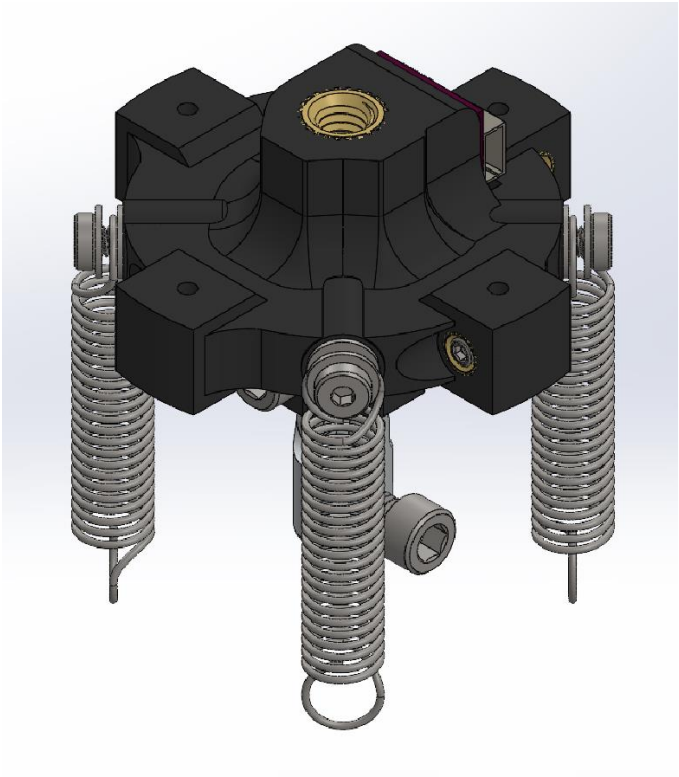
End Link Assembly





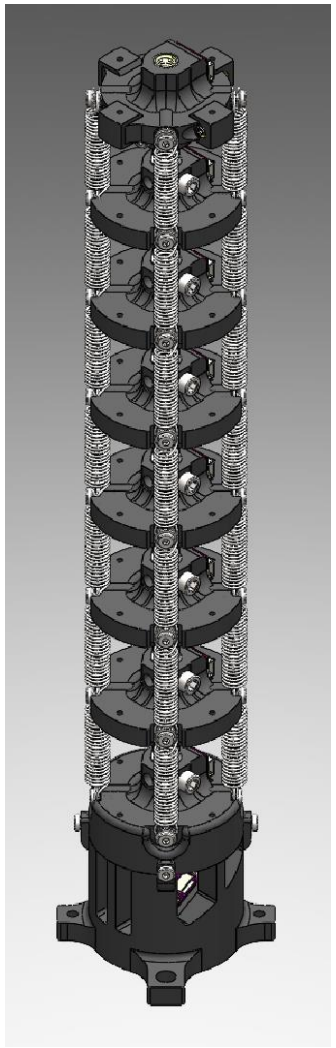
- Attach VEX universal joint by inserting joint into the large hole on the lower half of the link and inserting the screw into the joint through the side holes on the connection

End Link Assembly



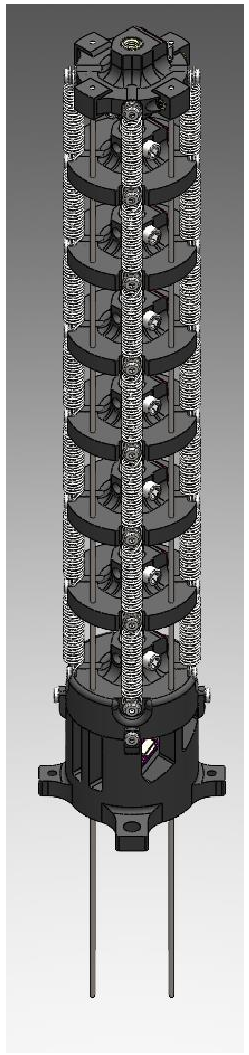
- On each screw attach a spring and screw in the screw to clamp the end of the spring to the link

Arm Assembly



- Attach the end link to the top of the arm in the same way that the other links were attached

Arm Assembly



- Insert nitinol rods through the small holes on the face of each link and fasten the end of the rod in the end link using the set screw in each protrusion

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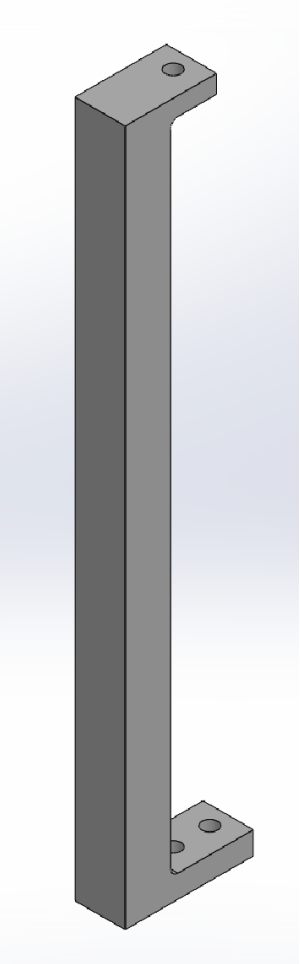
Actuation Unit Assembly

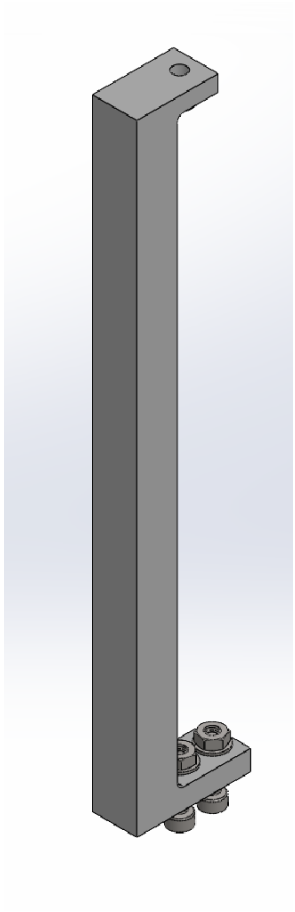
Updated 6/19/23

Potentiometer Mount Assembly



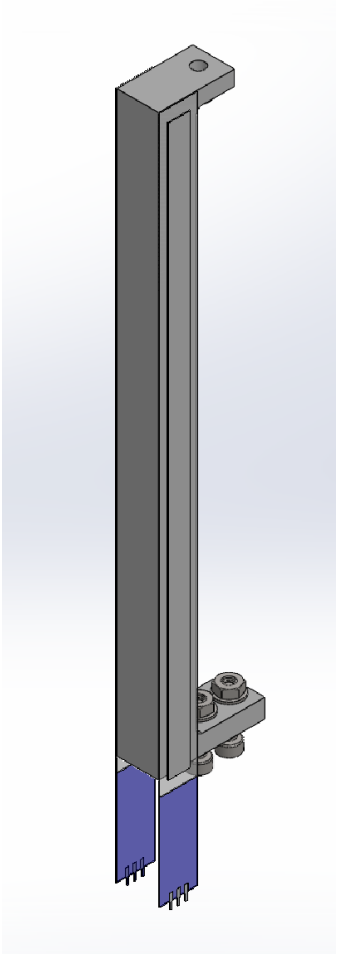
- Start with the 3D printed potentiometer mount standoff

Potentiometer Mount Assembly



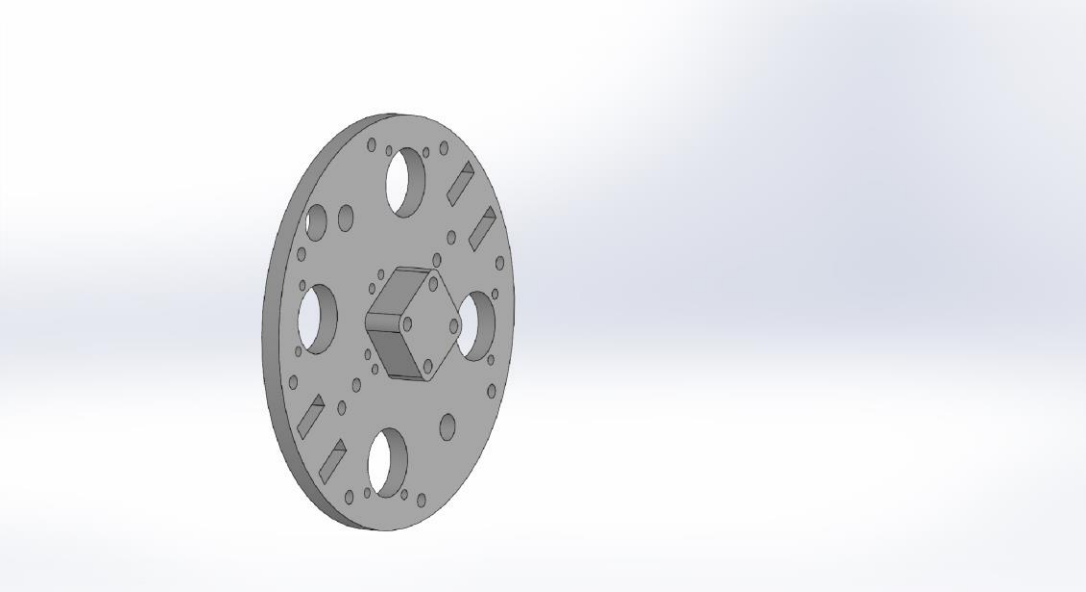
- When mounting the assembly to the base plate, the screws used will be M3x0.5 12mm screws with M3 nuts and washers

Potentiometer Mount Assembly



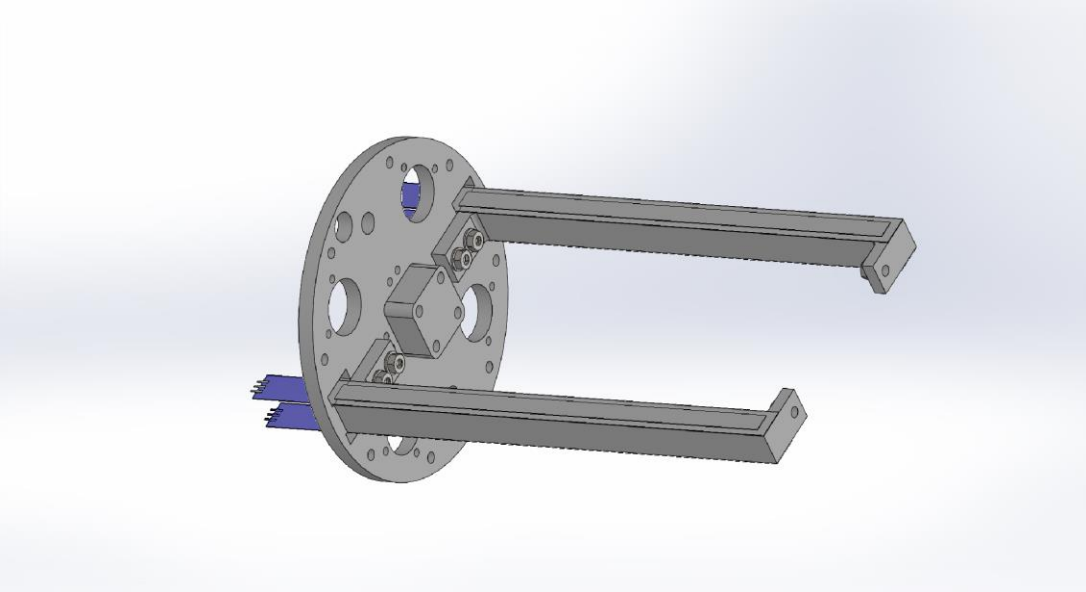
- On either side of the standoff, stick the linear potentiometers with the wire connections towards the bottom (where the two screws are)

Actuator Assembly



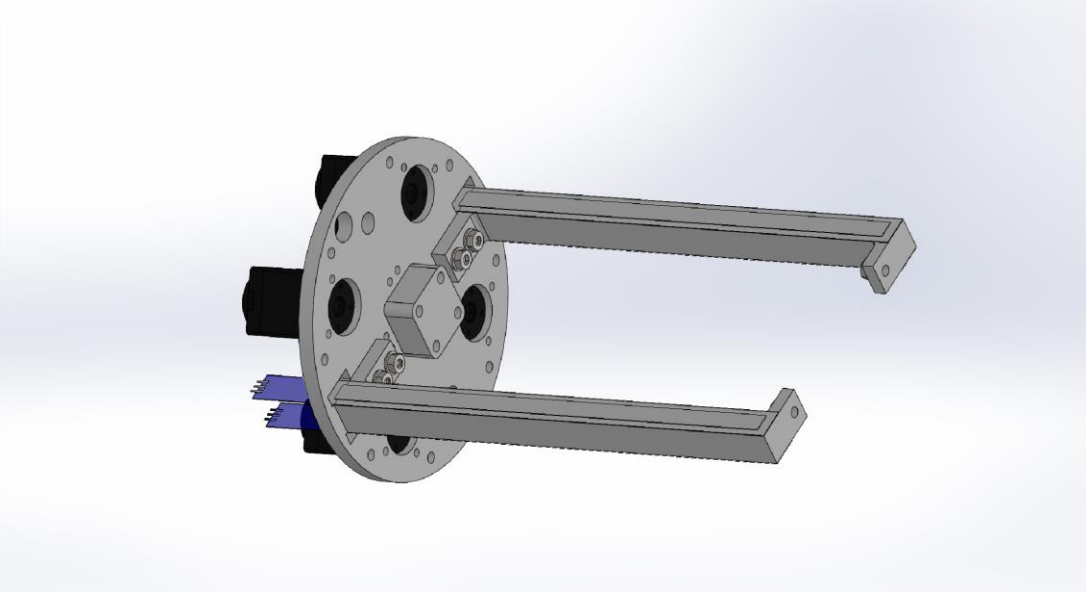
- To assemble the actuator, start with the base plate

Actuator Assembly



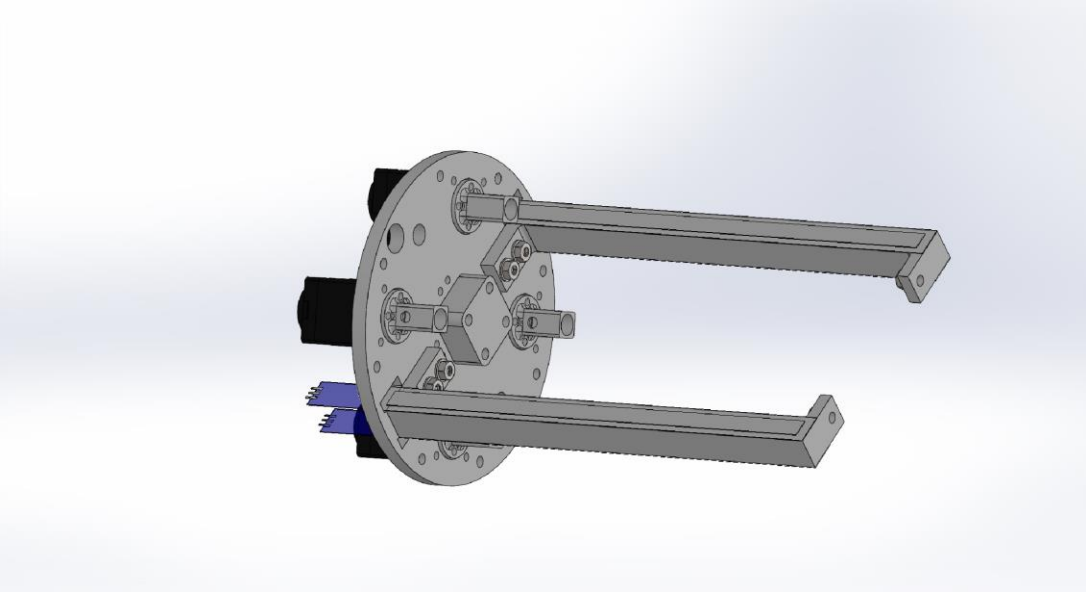
- Screw on potentiometer mounts assembled prior to opposite sides of the base with the bottom end of the potentiometer sticking through the slots on either end of the mount base
- Thread the screws from the base plate to the mounts with the washers and nuts being on the inside of the mount

Actuator Assembly



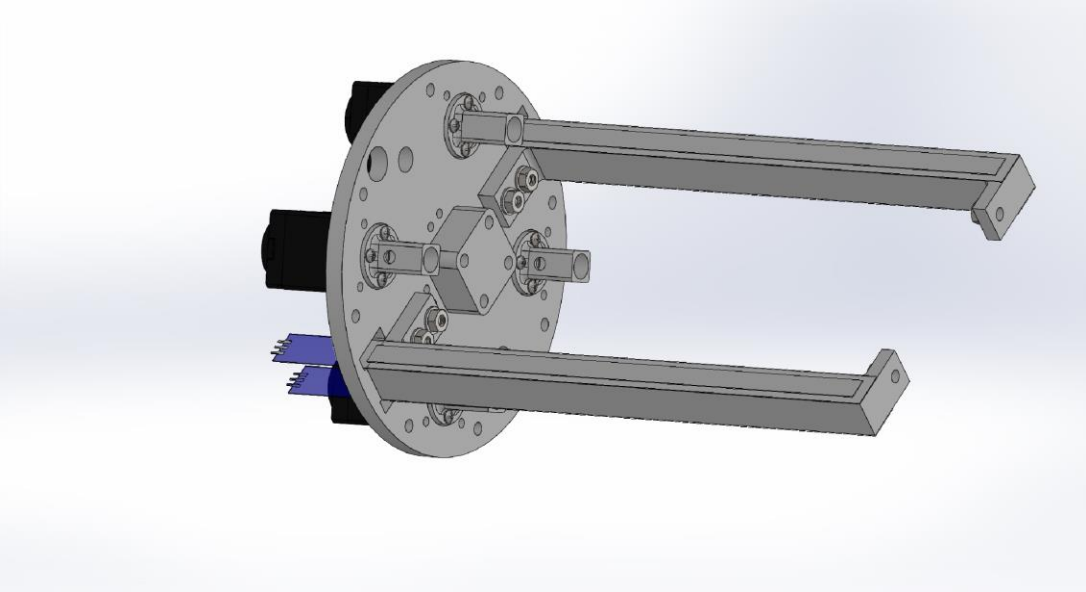
- Position Dynamixel XL430-W250-T motors at each large hole on the base with the longer end of the motor pointed towards the center of the base
- Connect motors in a chain using 3-wire cable

Actuator Assembly



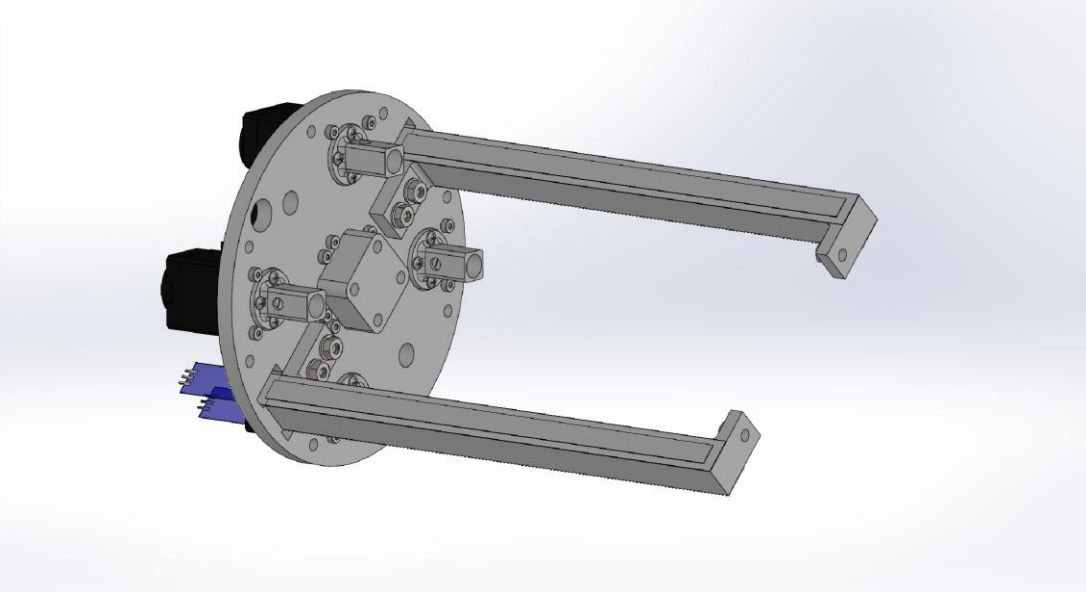
- Position each threaded rod mount at in each of the motor holes with the screw holes aligned with the mounting holes on the face of the motors

Actuator Assembly



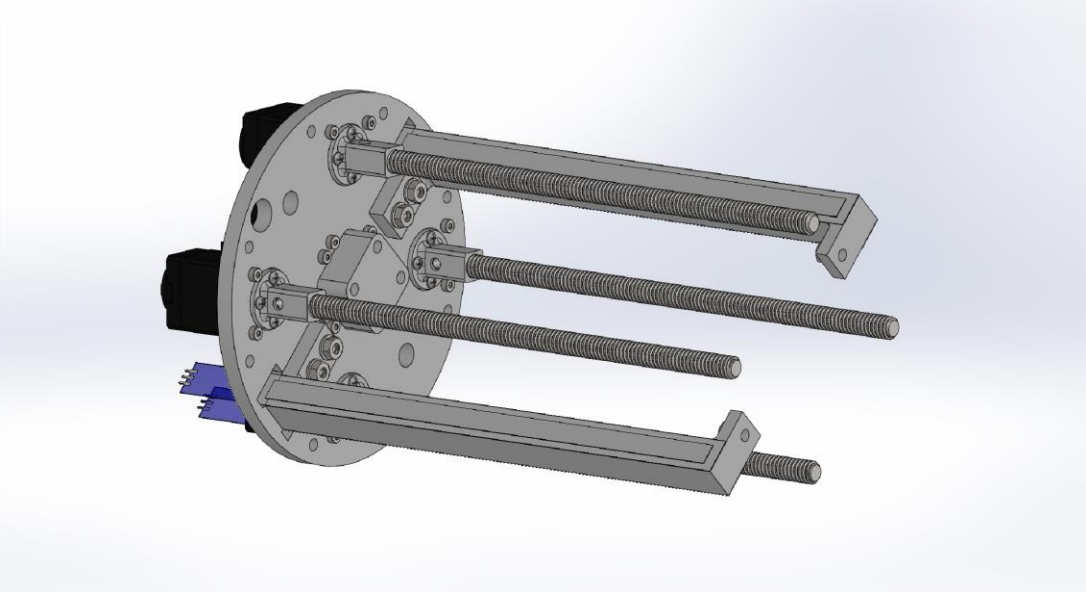
- Using 6mm long M2 size screws, attach the threaded rod mounts to the motors

Actuator Assembly



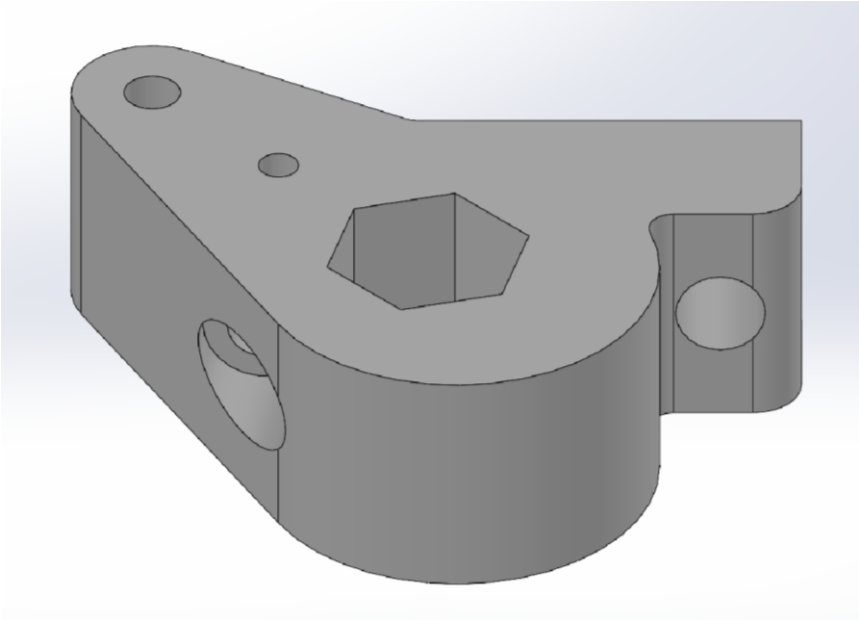
- Using 16mm long M2 size screws, attach each of the motors to the base plate

Actuator Assembly



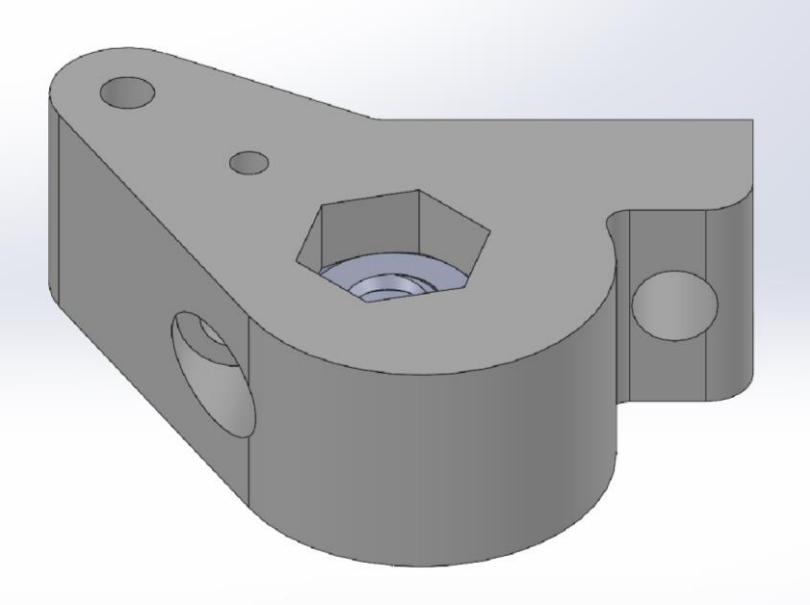
- Insert threaded rods into the mounts on the motors, aligning the side hole at the base with the side hole of each mount

Nitinol Mount Assembly



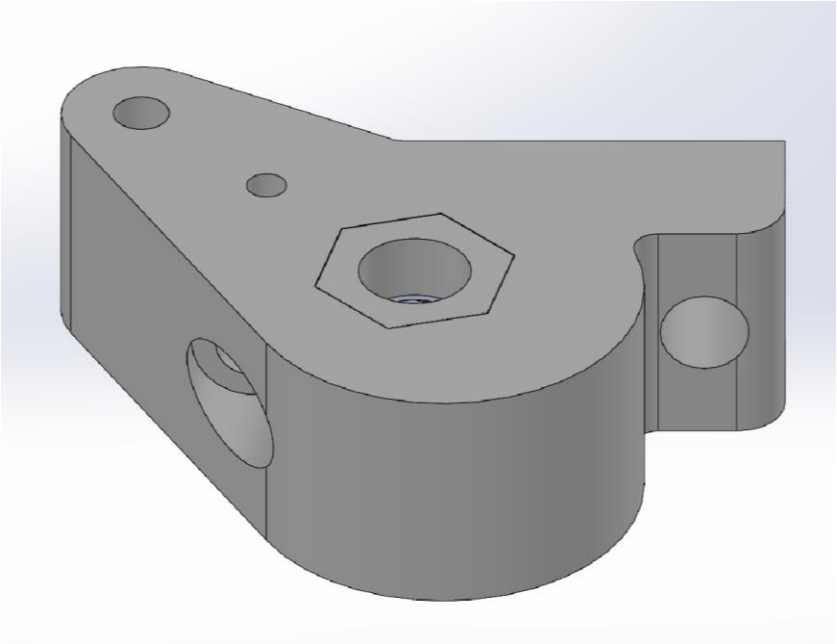
- To assemble the nitinol cable mounts, start with the bracket

Nitinol Mount Assembly



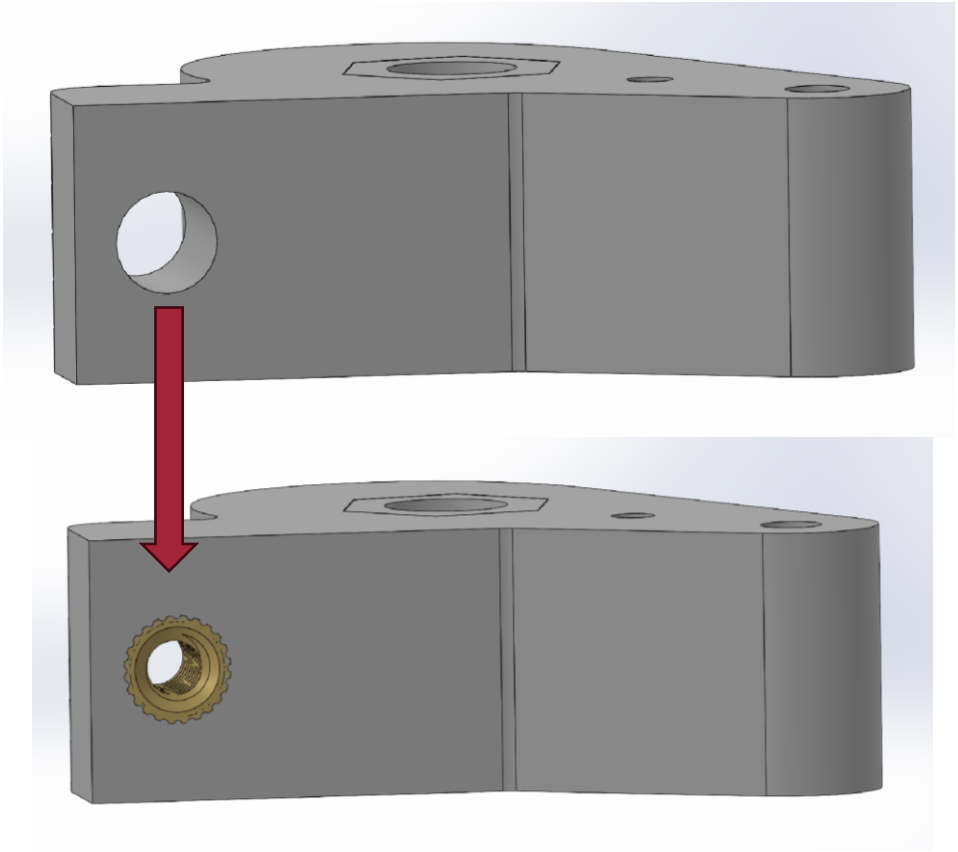
- Push a ¼-20 thread hex nut into the center hexagonal hole until it reaches the bottom

Nitinol Mount Assembly



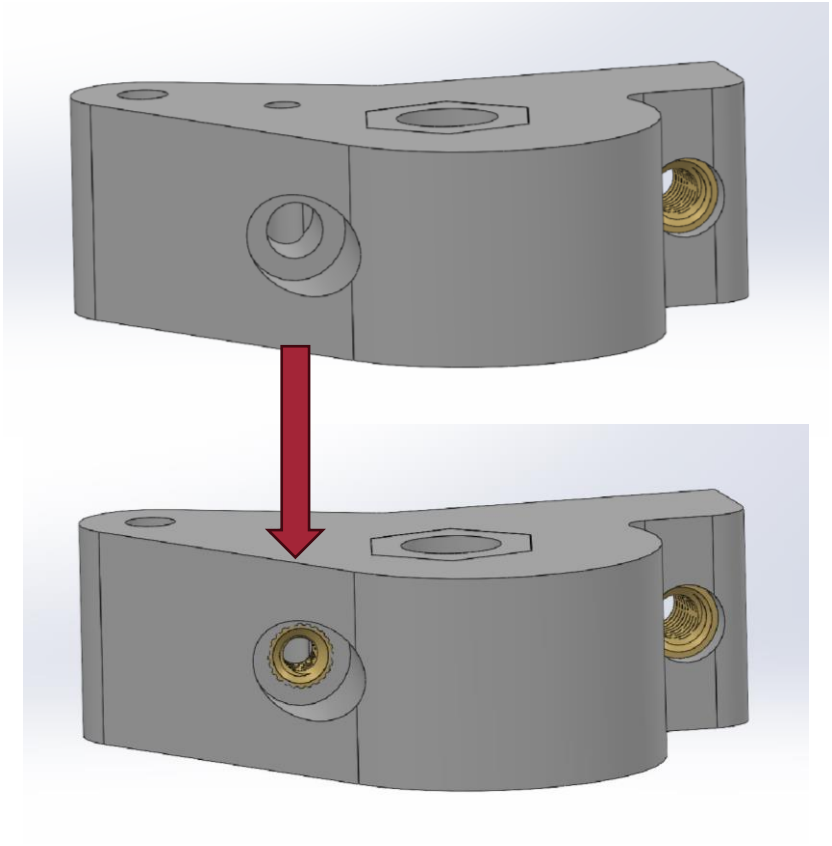
- Push the hex nut mount cap into the hole on top of the nut and use a soldering iron or similar heat application tool to melt and fuse the PLA around the edges of the cap to the bracket

Nitinol Mount Assembly



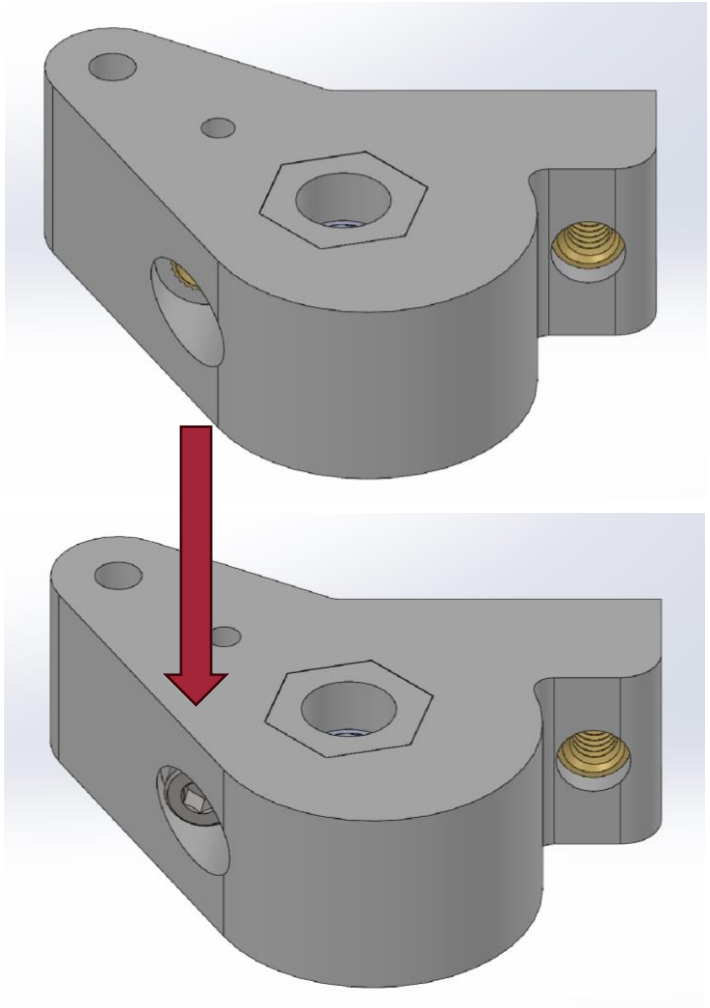
- Inserting from the larger flat side of the hole, insert a M4 8.2mm heat set insert until it is flush with the brakcet

Nitinol Mount Assembly



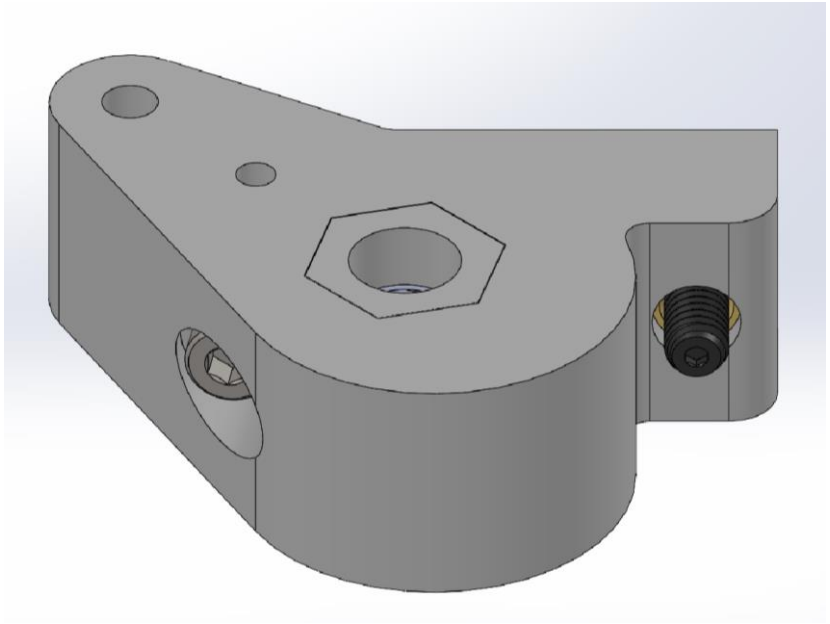
- Insert a M3 4.3mm heat set insert into hole located towards the center of the side of the bracket
- Note: similar to the nitinol holes on the end link of the arm, it makes it easier to set the insert to the correct depth by feeding a nitinol rod through the top hole before inserting the heat set insert

Nitinol Mount Assembly



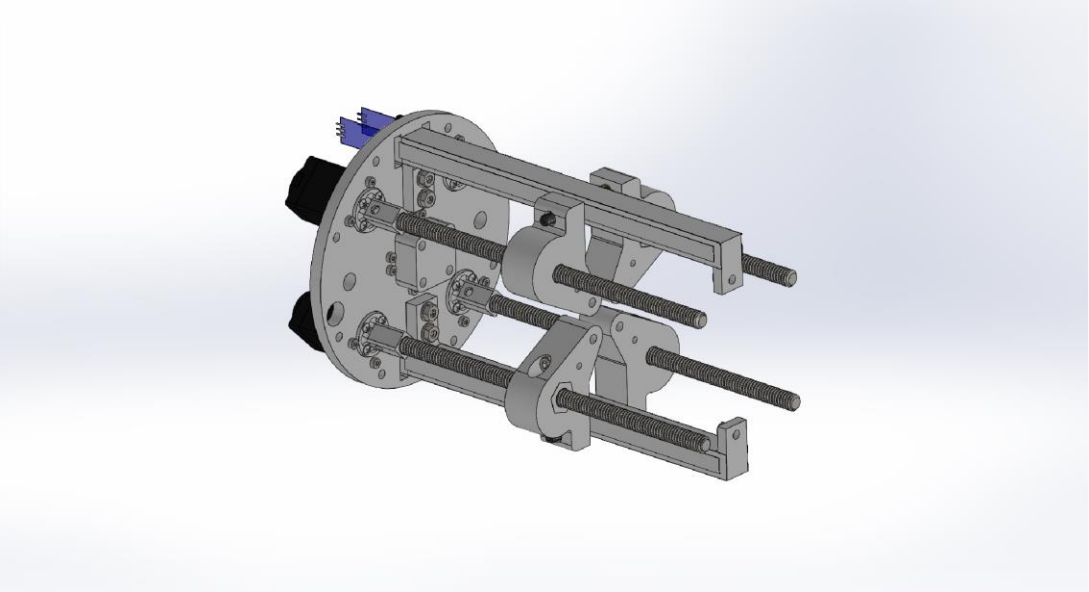
- Thread a M3x0.5 8mm screw into the heat set insert to help lock the nitinol when positioned in the actuator

Nitinol Mount Assembly



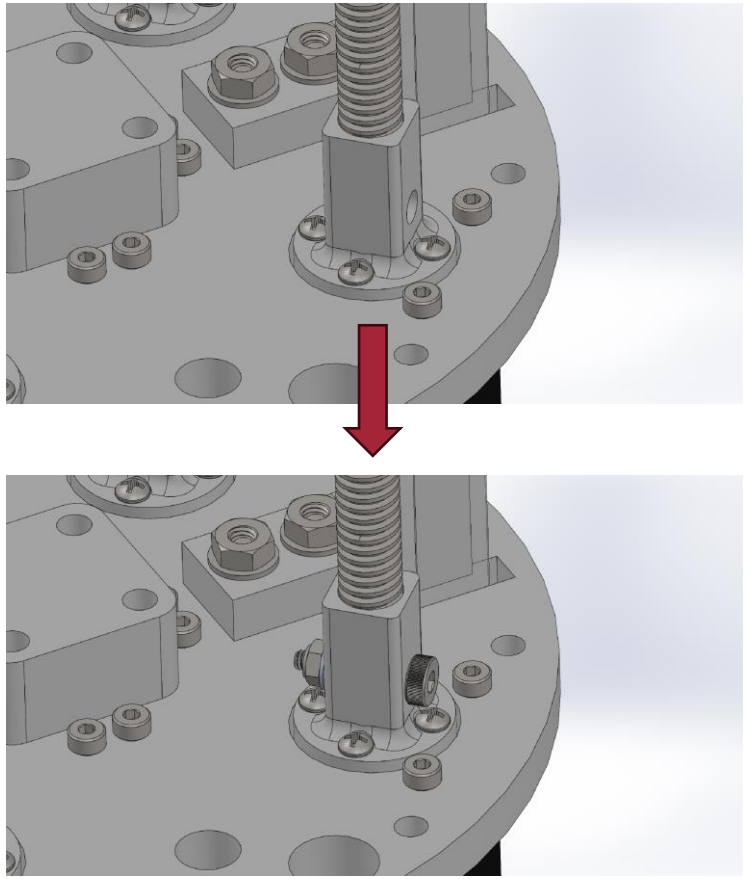
- Thread a M4x0.7 long nose spring plunger screw into the side heat set insert that will actuate the potentiometer in the final actuator

Actuator Assembly



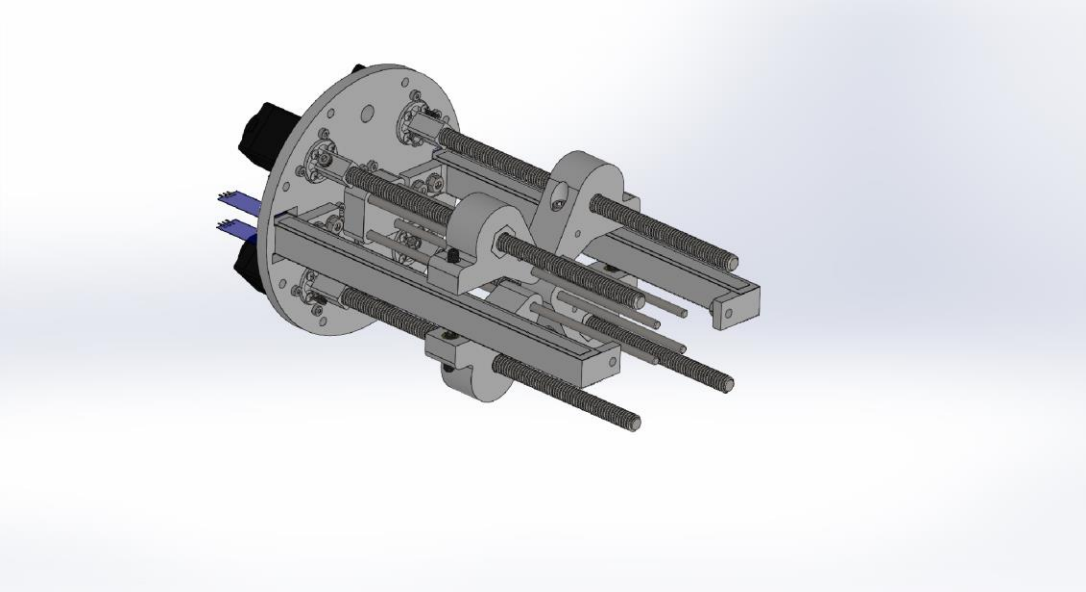
- Thread the nitinol mounts onto each threaded rod, it may be easier to rotate the threaded rod to position the mounts
- Note: the exact position of each mount does not explicitly matter at this point as the homing program can move them to the final position after the finished assembly

Actuator Assembly



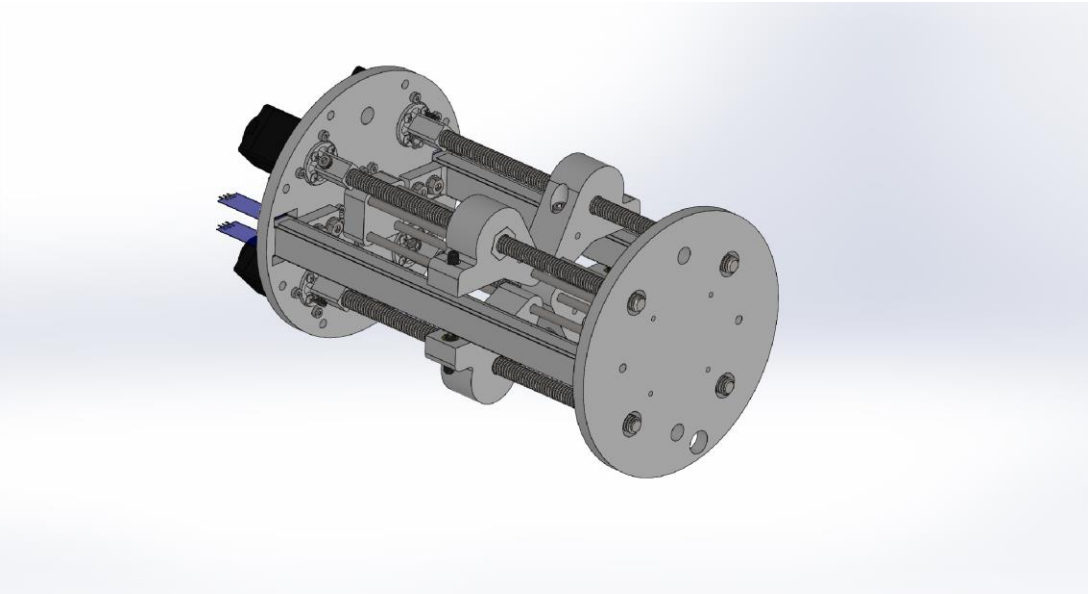
- Insert a 3mm x 8mm M2 shoulder screw through the side hole on the mount
- Thread on two M2 size washers and a M2 nut to secure the screw and threaded rod

Actuator Assembly



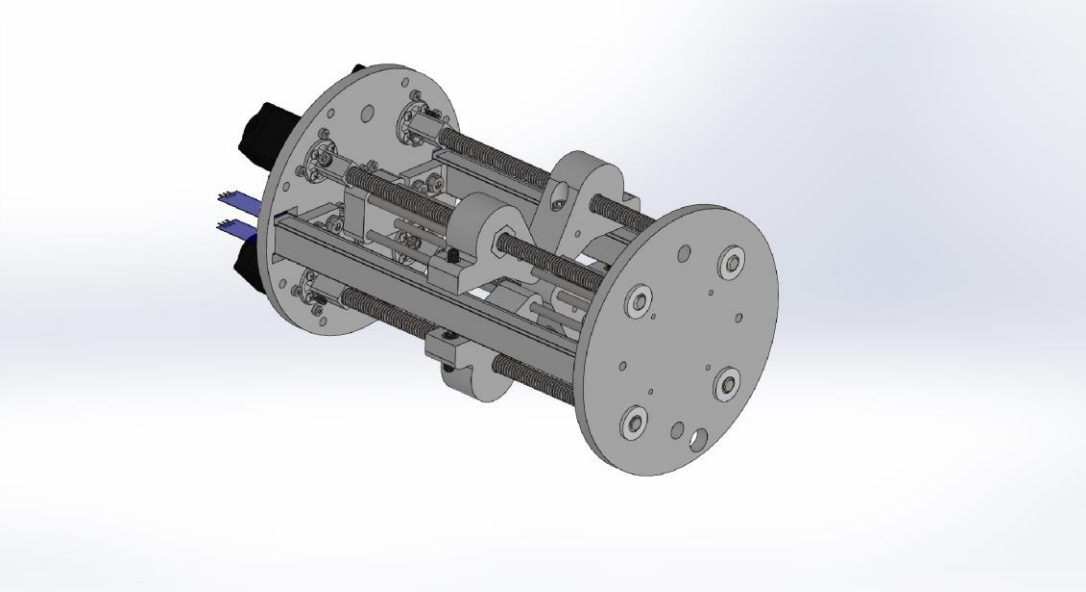
- Insert linear motion shafts through the end hole of each nitinol mount and into the corresponding base hole

Actuator Assembly



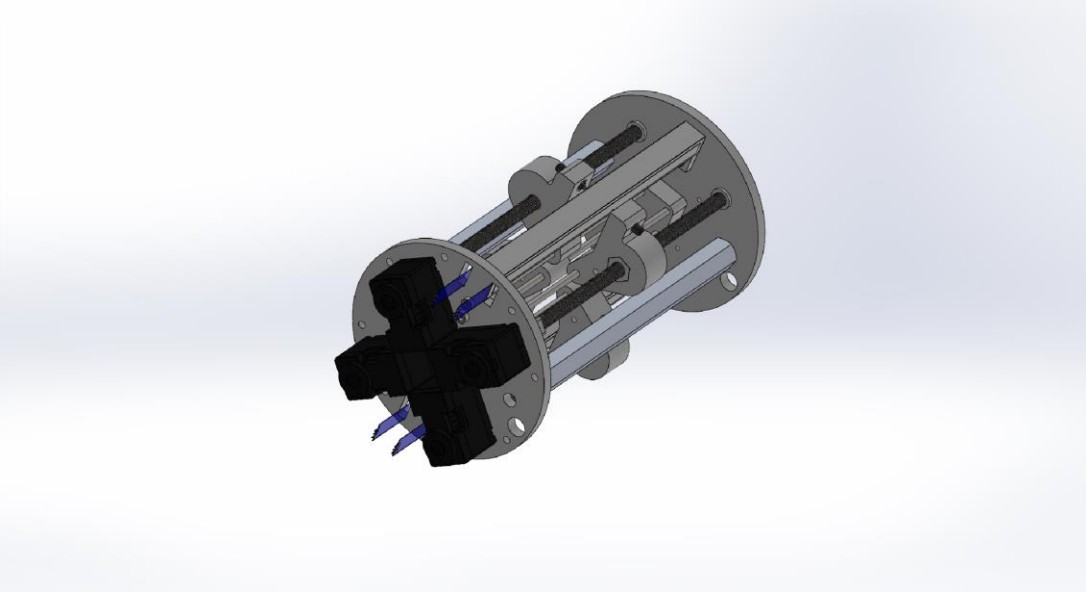
- Position actuator top with using the linear shaft holes and threaded rod holes as a guide
- Note: Make sure the proper mounting screw holes are lined up with the potentiometer mounts

Actuator Assembly



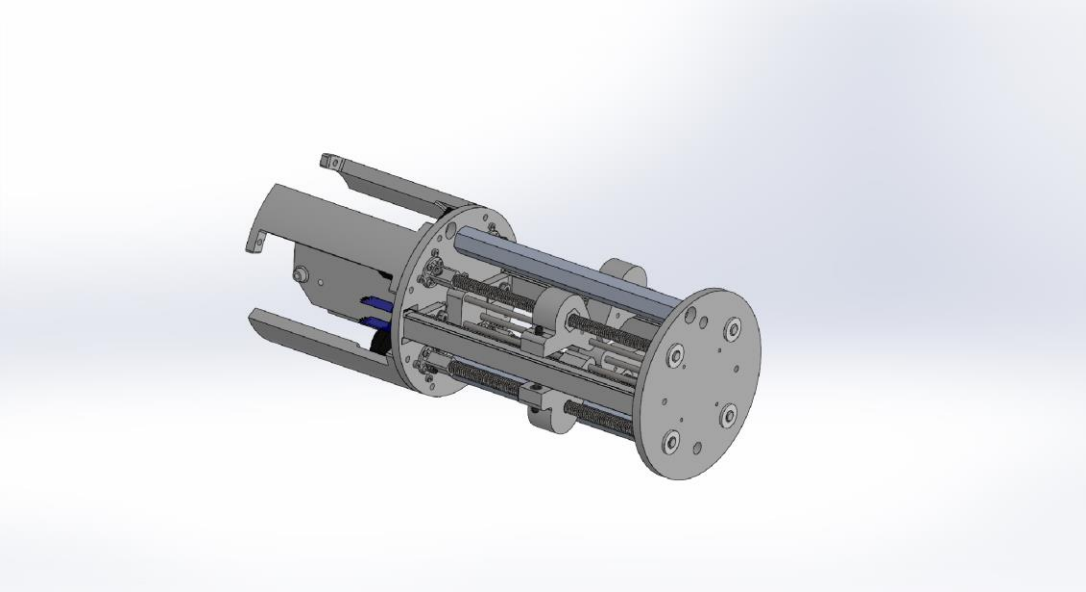
- Insert nylon sleeve bearings into each threaded rod hole to secure translational movement of the threaded rods

Actuator Assembly



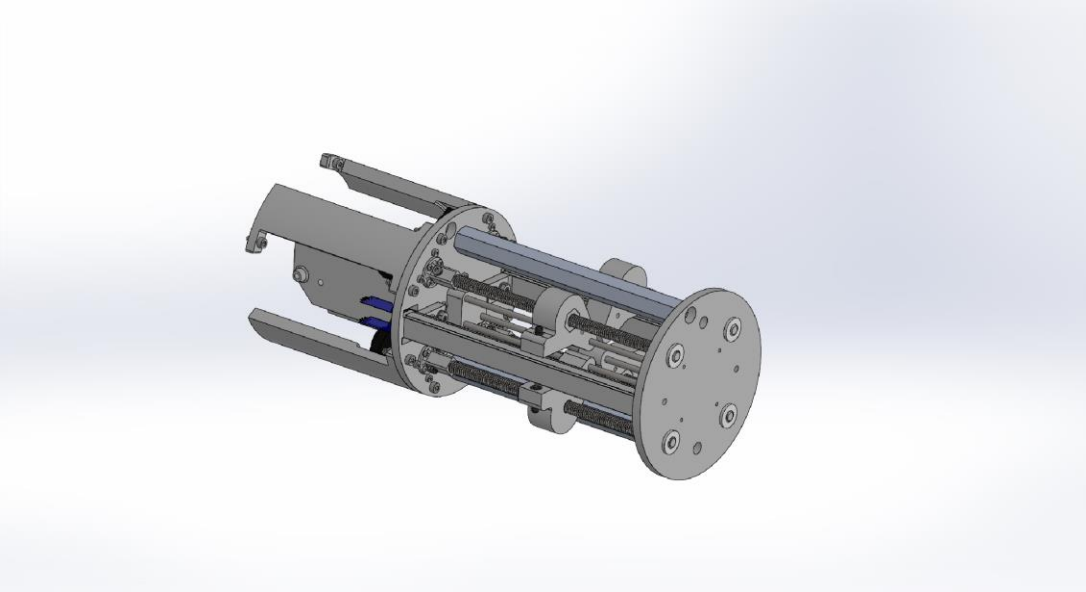
- Attach ¼-20 threaded 6 in long aluminum standoffs to the sides of the actuator for stability and strength of the system.
- Fasten the bottom of the standoffs to the base using ¼-20 thread 1 in long screws

Actuator Assembly



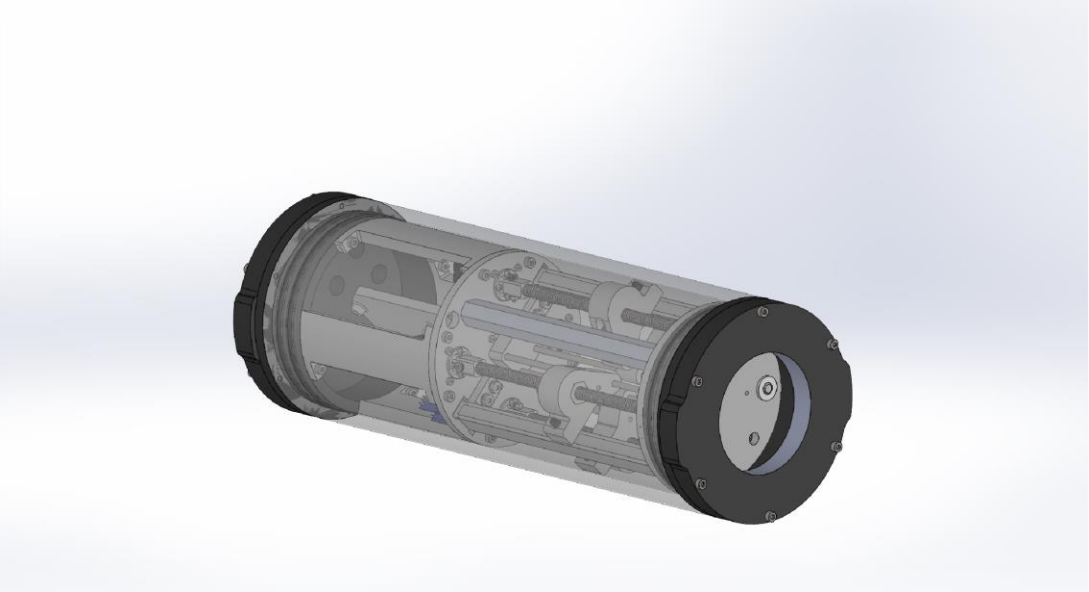
- When mounting the aluminum standoffs, use the mounting screws to also fasten the electronics mounting plate to the base plate
- Position enclosure mounts to the base plate holes for mounting
- Note: Not pictured, it is best to mount circuits to the electronics mounting plate before assembly

Actuator Assembly



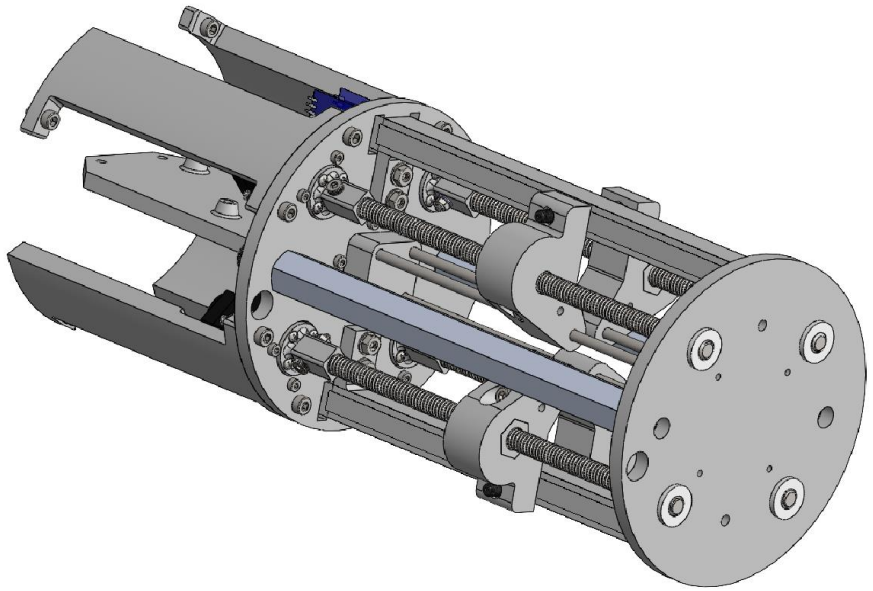
- Using M3x0.5 16mm screws threaded through the base plate and M3 nuts on to secure the fastener, attach the enclosure mounts to the base of the actuator

Actuator Assembly



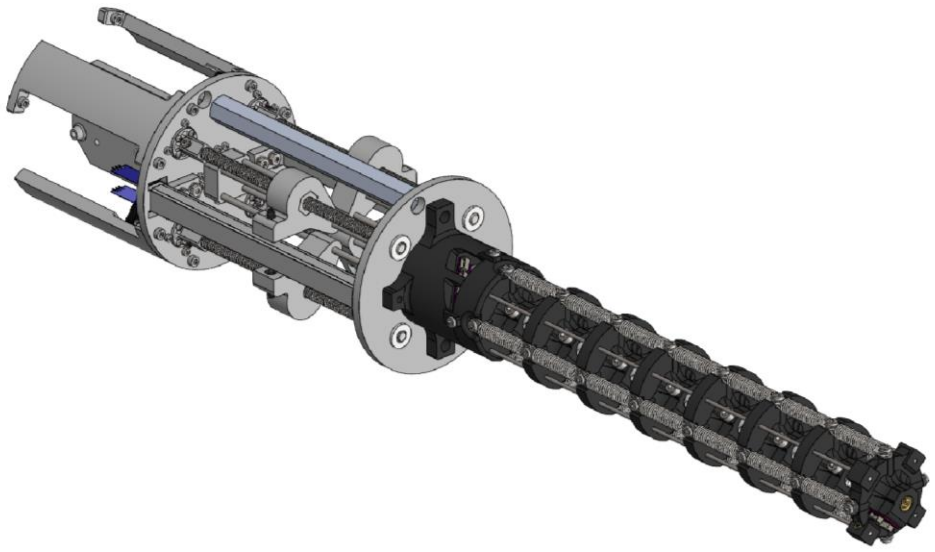
- Mount the enclosure my first screwing the enclosure mounts to the bottom O-Ring flange and then insert system into the tube

Full Assembly



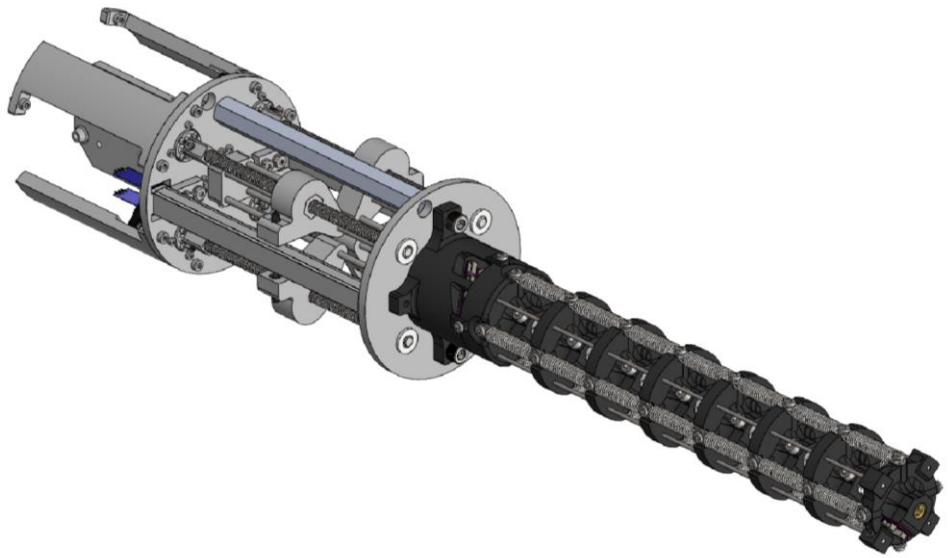
- Start with the actuation unit assembly

Full Assembly



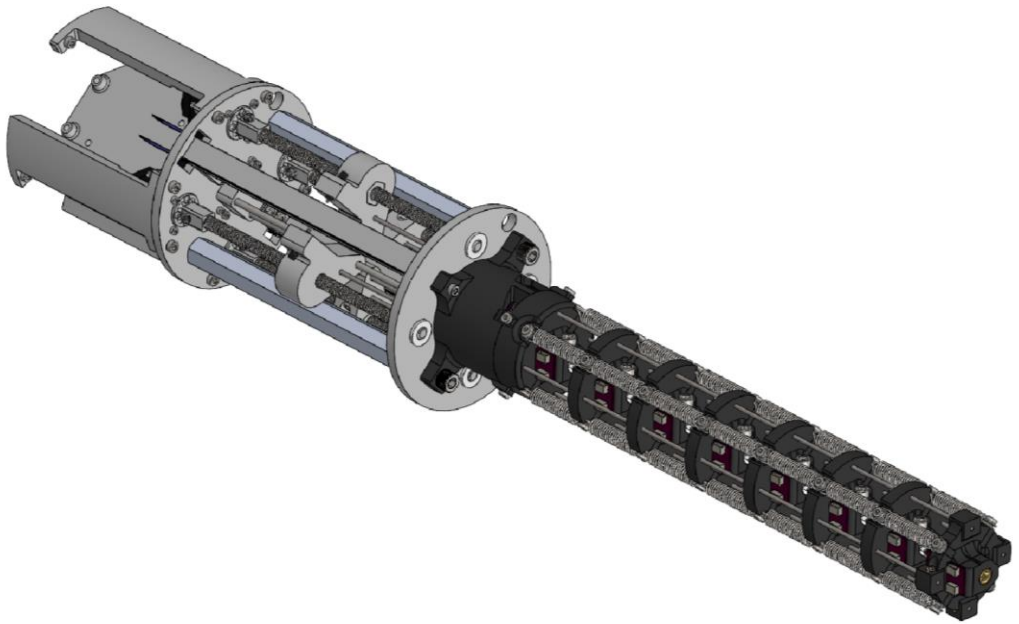
- Lining up the mounting holes of the base of the arm and the top of the actuation unit, thread the nitinol cables through the center holes until the arm base and the actuation unit are touching
- Note: Make sure to also thread the nitinol cables into the nitinol mounts in the center of the actuation unit

Full Assembly



- Through the base of the arm to the aluminum standoffs, thread a 1 in long ¼-20 screw to fasten the arm to the actuation unit

Full Assembly



- Thread M3x0.5 20mm screw into the remaining two mounting holes on the base of the arm
- Use an M3 nut and washer to secure the screws on the underside of the top of the actuation unit

Full Assembly

- With the arm and actuation unit assembled, the waterproof enclosure and bellows can be fitted onto the arm to complete the seal
- The enclosure should be fitted first with the bellows fit over the arm to seal with the enclosure