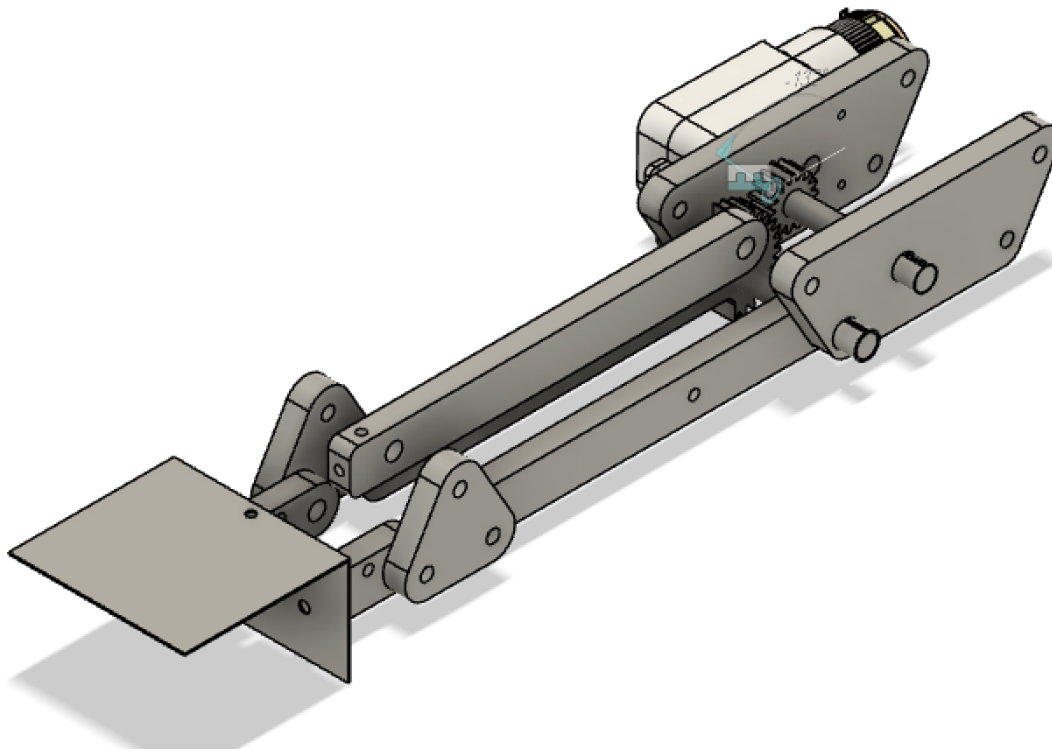


Upper Arm Design v2

Written By: Roger Nguyen



(isometric and left view)

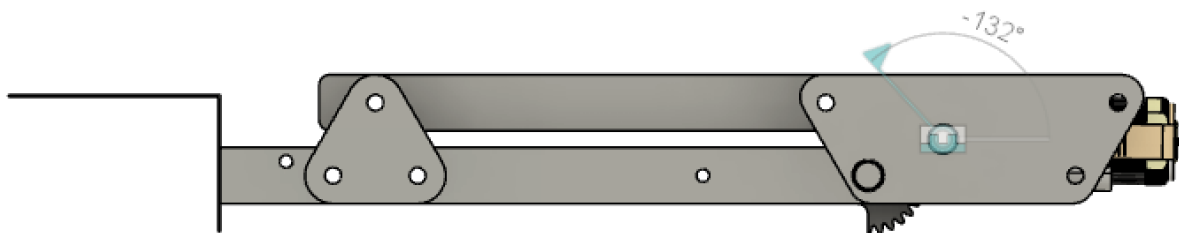


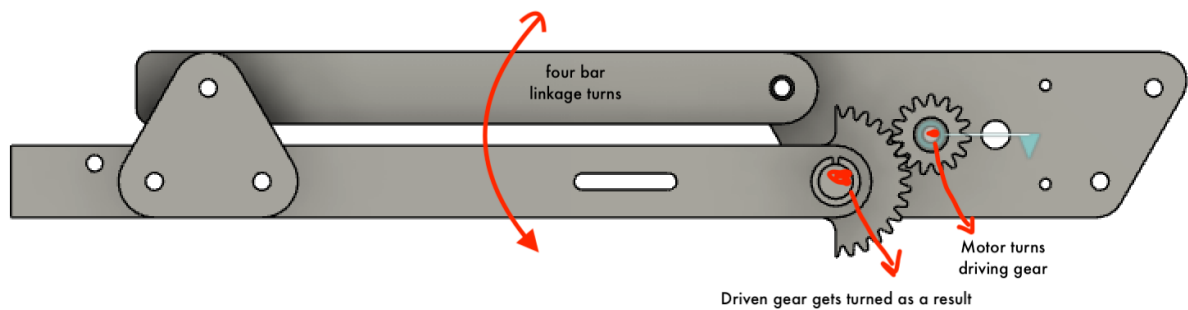
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[1] Abstract

This is the second design that was made for the upper arm of the robotic arm. This design fixes the problems that were associated with the initial design. The biggest problems were that the joint could not rotate and there was not enough torque as found using hand calculations. Some quality of life changes were also made to the design by reducing the amount of tapped holes and reducing the number of fasteners.

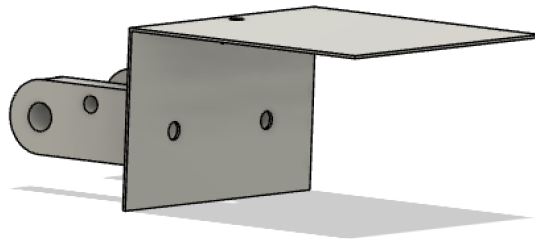
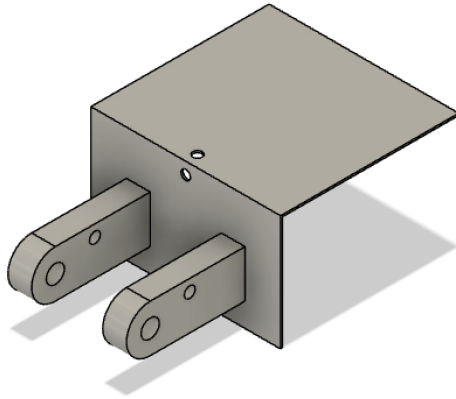
[2] How it works (Right to Left)



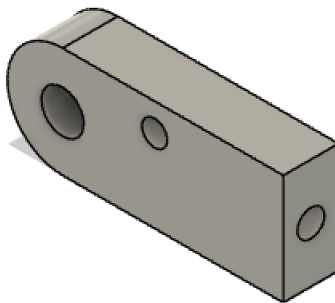
- The old design had the motor directly mounted to the trapezoid mount and the shaft was trying to rotate the mount about the motor. The problem was that the motor was mounted to the shaft; this meant that the motor's rotation relative to the mount was 0, so the arm could not rotate at all.
 - By moving the axis of rotation for the arm to a different position and having the trapezoid mount be stationary, the linkages were able to rotate correctly.
-

[3] Parts

[3.1] Gripper Linkage



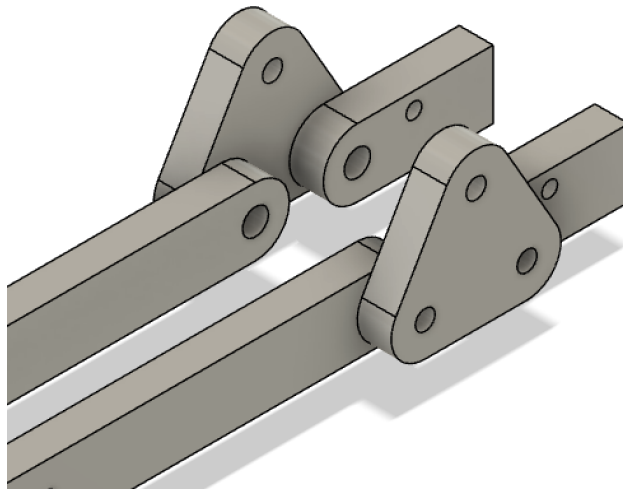
- The gripper linkage is how the upper arm is going to connect to the gripper.



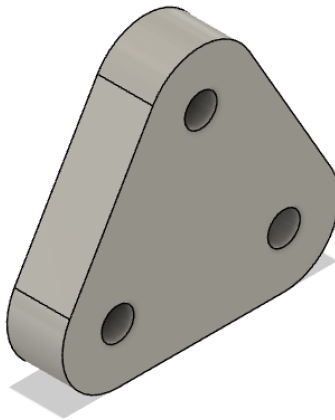
- The gripper linkage uses a 6-32 screw to connect to the gripper mount. This hole is tapped so no nut is needed and is on the rectangular face.

- **Changed:**
 - The gripper linkage uses a 10-32 screw to connect to the triangle mount via a clearance hole.
 - The gripper linkage uses a 40-40 screw to hold the spring in place via a clearance hole.

[3.2] Triangle Mount

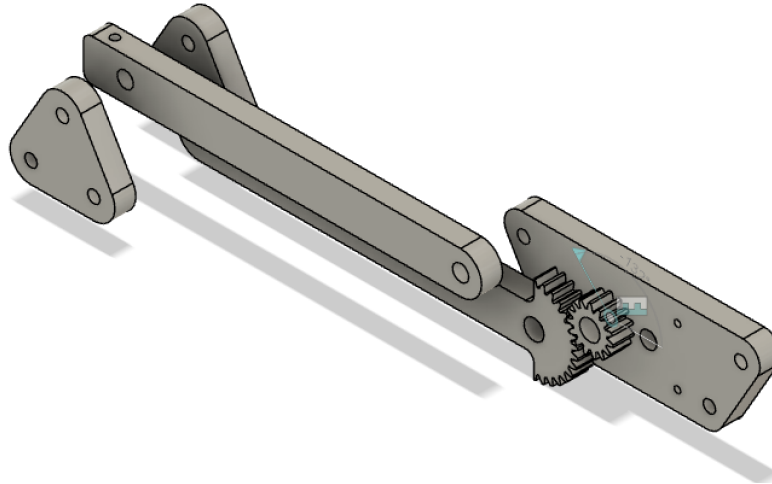


- The triangle mount is used to connect the grip linkages to the upper linkages. It acts as the wrist, albeit it is rigid.

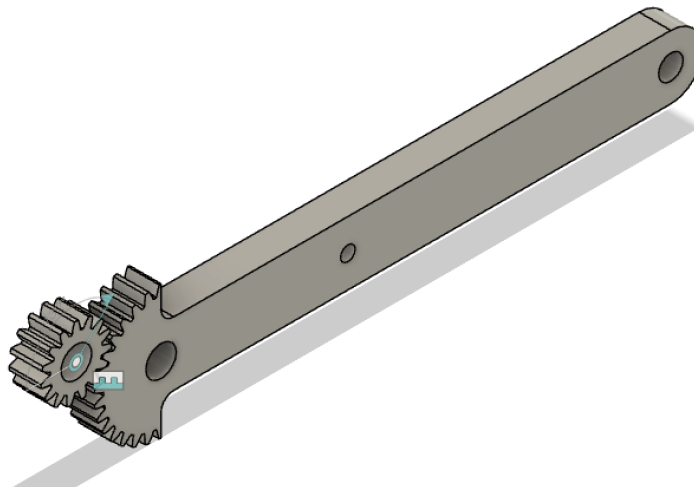


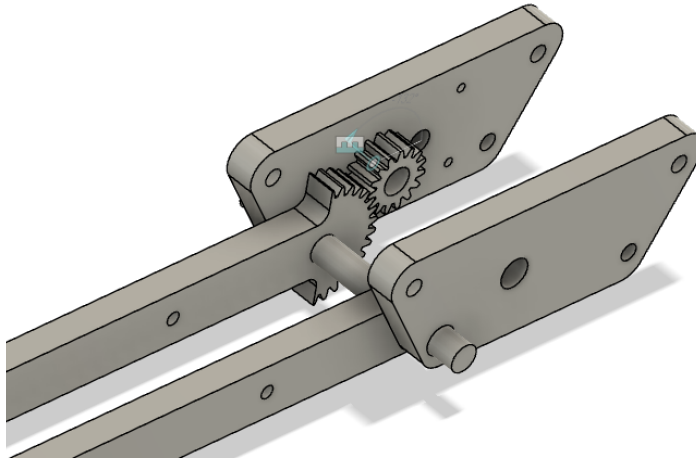
- **Changed:**
 - The triangle mount uses 10-32 screws to connect to the linkages and these holes are tapped holes.

[3.3] Upper Linkage 1 (Motor-Side)



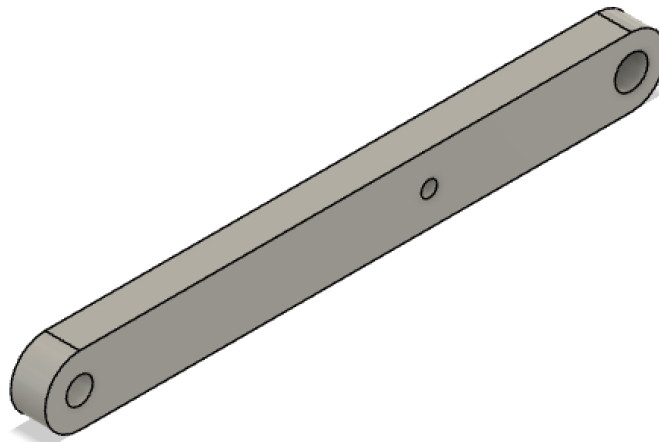
- The upper linkage 1 connects to the triangle and trapezoid mount.
- **Changed:**
 - Gear teeth were added to this linkage in a ratio of 2:3.





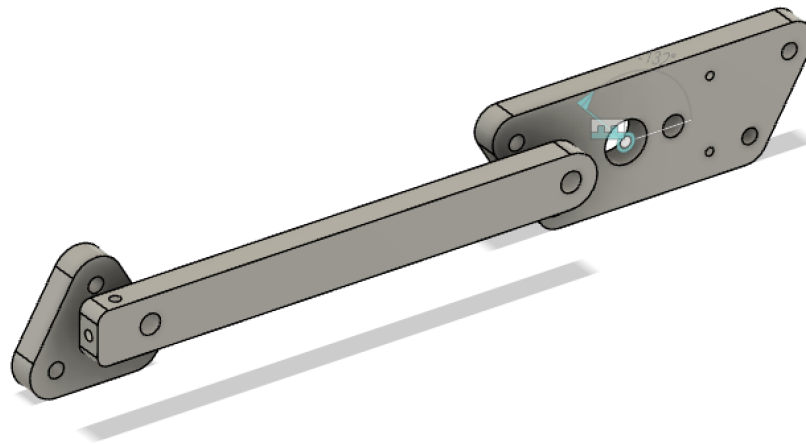
- **Changed:**
 - The upper linkage 1 uses a 10-32 screw to connect to the triangle mount via a clearance hole.
 - A 0.24 inch aluminum shaft is press-fit into the linkages to connect it to the opposing non-motor side linkage and the trapezoid mounts.
 - It uses a 4-40 screw to hold the spring in place via a clearance hole.

[3.4] Upper Linkage 1 (Non-Motor Side)

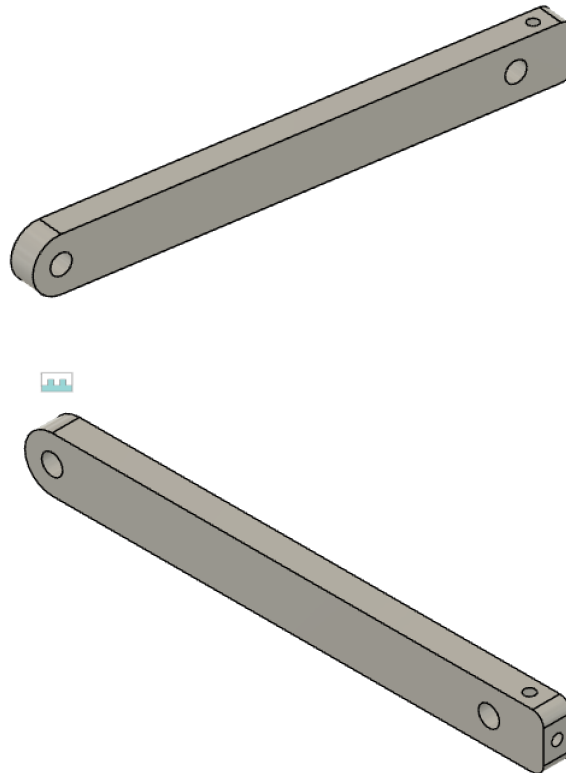


- The non-motor side linkage functions similar to the motor-side linkage but acts as support to ensure the sides of the four-bar linkage move.
- It uses a 10-32 clearance hole at the end to connect to the triangle mount and a 0.24 inch shaft is press-fit into the other end to connect it to the other upper linkage.

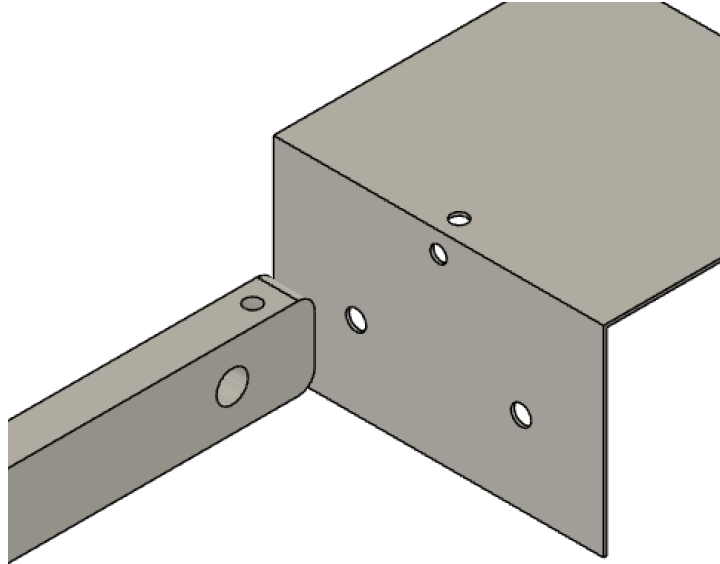
[3.5] Upper Linkage 2



- The upper linkage 2 connects to the trapezoid and the triangle mount as well.

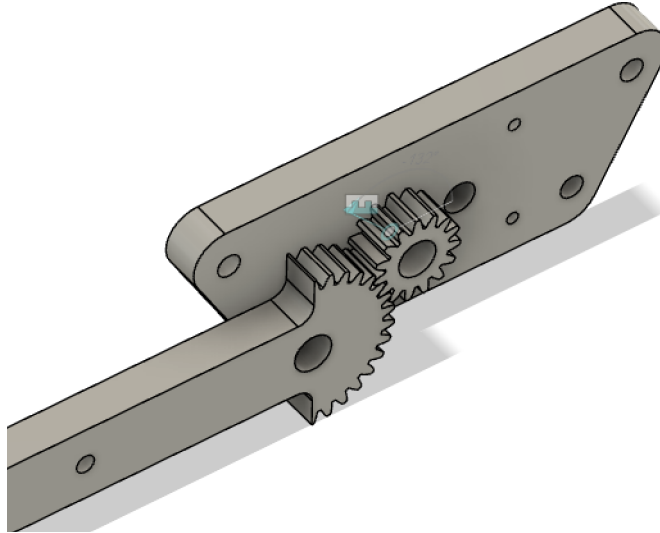


- **Changes:**
 - The upper linkage uses 10-32 screws to mount to both the mounts via a clearance hole.

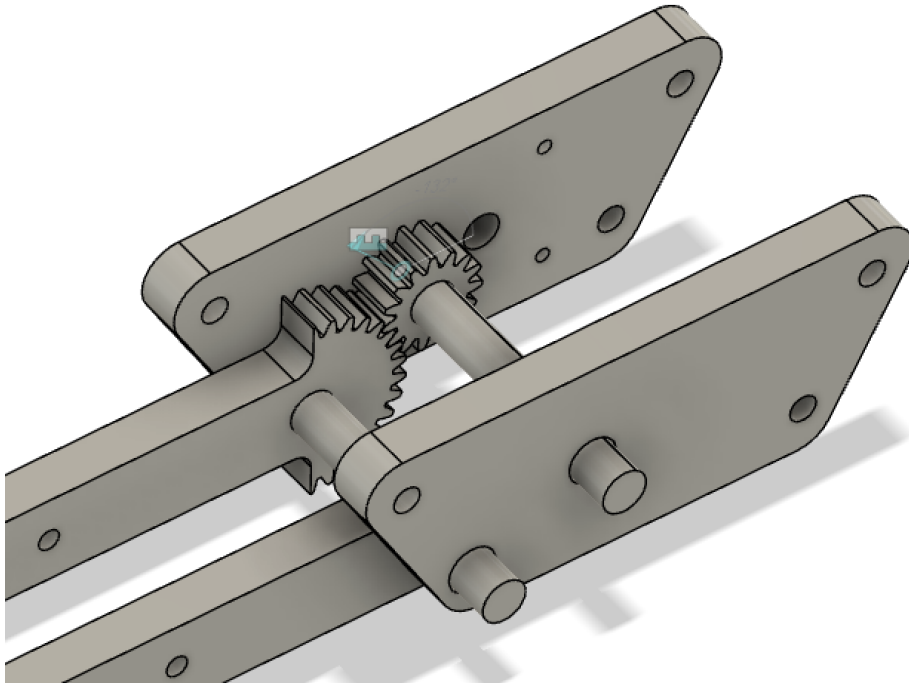


- In order to offer extra support for the gripper linkages, holes are cut out of the upper linkage 2 and sheet metal to allow a fishing line to connect these two parts to reduce load on gripper linkages.

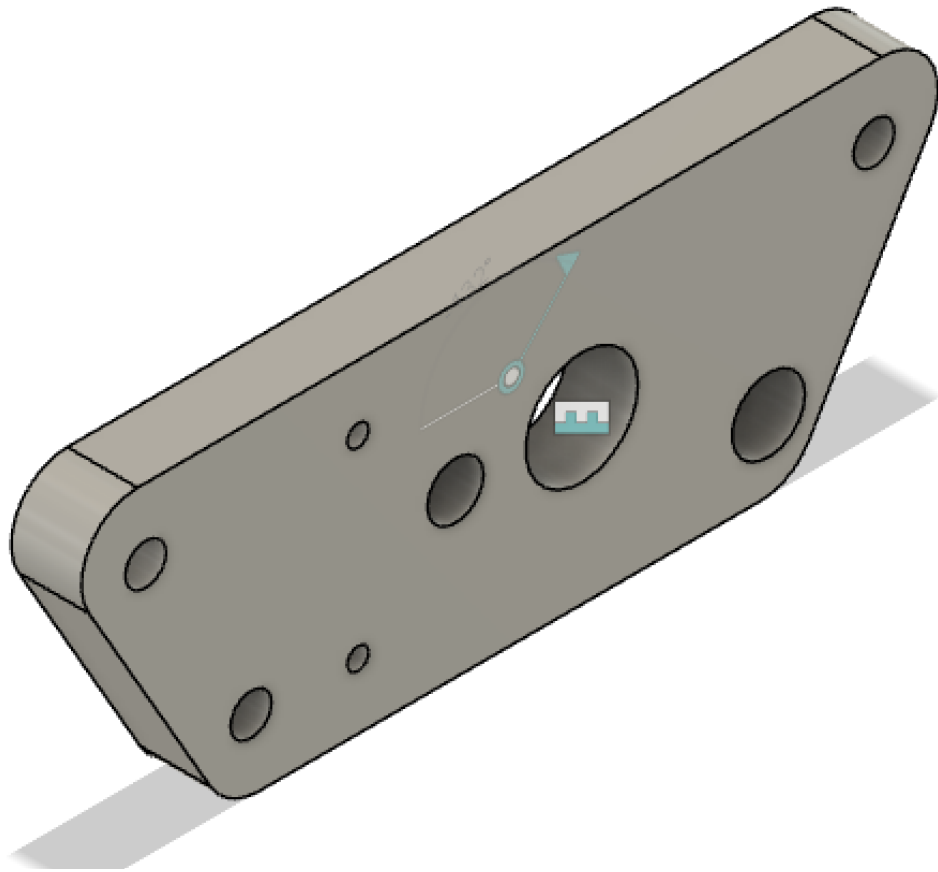
[3.6] Trapezoid Mount (Motor Side)



- This trapezoid mount for the motor side mounts the motor and connects the upper arm to the lower arm. It acts as the elbow of the robotic arm.

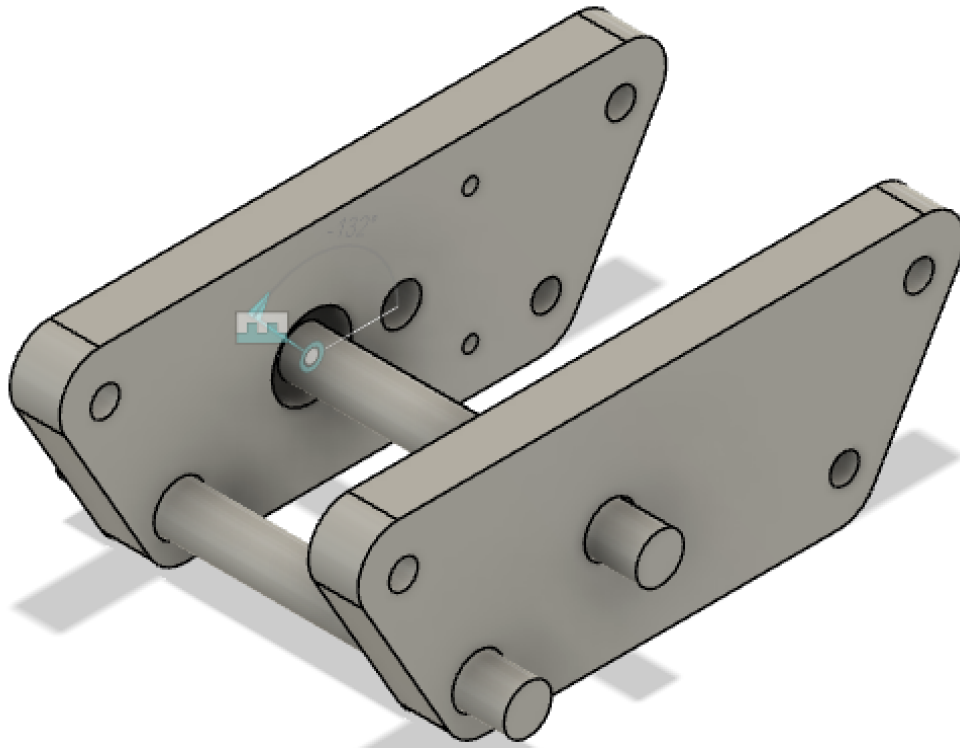


- The motor-side trapezoid mount connects to the other trapezoid using a shaft.



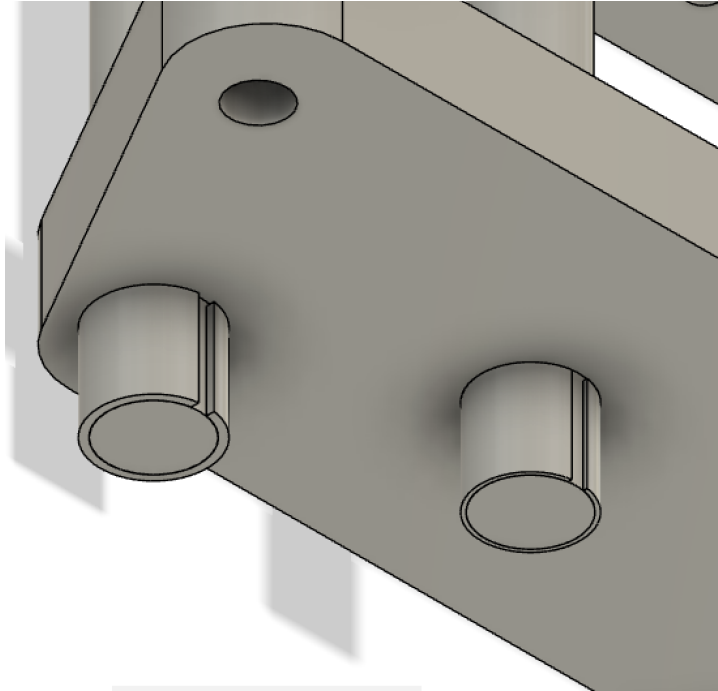
- **Changes:**
 - The motor side trapezoid mount uses 10-32 screws to connect the upper arm and lower arm together. These holes are tapped since there is not enough space for nuts.
 - For the shaft connecting to the driven gear, a 0.26 inch clearance hole was used to connect the trapezoid mounts together (in the bottom right corner).
 - To mount the motor, 4-40 tapped holes were used.
 - The motor-side trapezoid mount also has other holes near the center to allow a correct mounting and transmission of the motor shaft.

[3.7] Trapezoid Mount (Non-Motor Side)

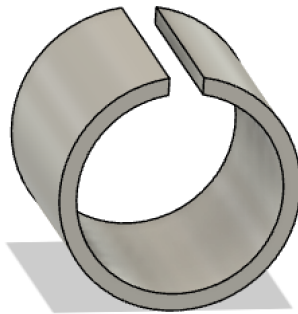


- The non-motor side trapezoid mount is connected to the other mount with a shaft.
- **Changes:**
 - It uses a 10-32 screw to connect the linkages and is tapped at the corners
 - At the center of the mount is a 0.26 inch clearance hole to allow the shaft to pass through.

[3.7] Shaft Collar



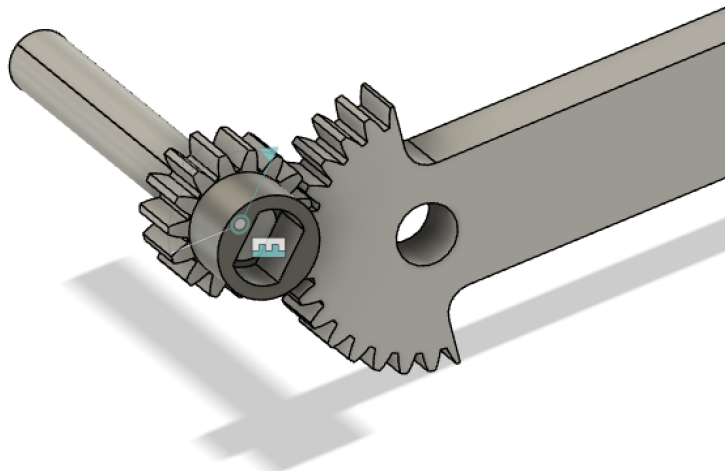
- In order to prevent the shaft from translating linearly, shaft collars were used.



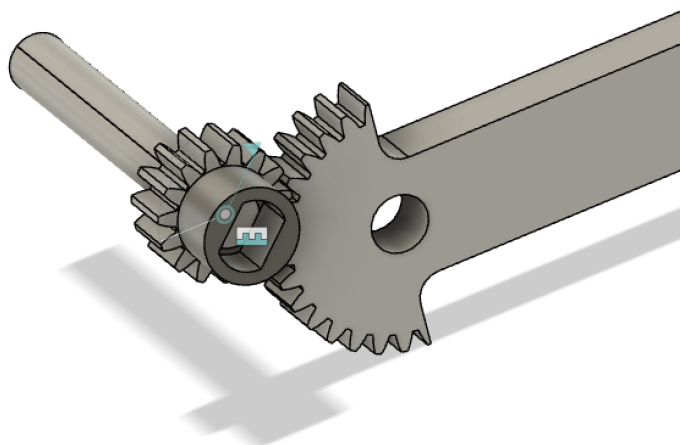
[3.8] Aluminum Shafts

- One shaft is 2.25 inches in length and is used to connect the upper linkages together.
- The other shaft is 1.80 inches in length and is used to connect the trapezoid mounts together.
 - These are the minimum lengths and should be manufactured to be slightly larger to allow for correct press-fits .

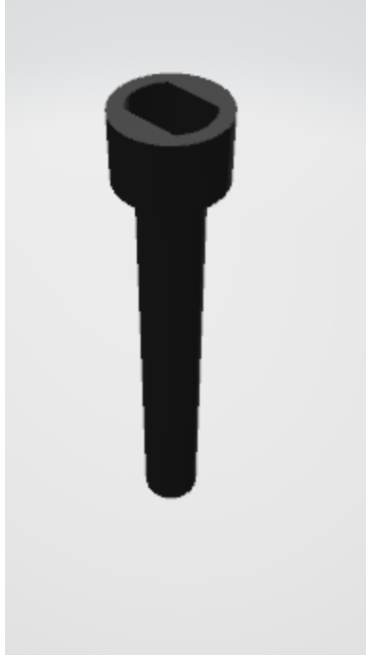
[3.9] Motor Hub



- A motor hub is used to better transfer torque from the motor shaft to the driving gear. This part will be 3d printed.



- The shaft will be press-fit into both the driving gear and the motor hub. This allows both objects to rotate when the motor rotates the hub.



- An alternate version of the motor hub was made that included the shaft itself.

[4] Future Changes

[4.1] Hole Size

- 10-32 screws work well but 8-32 screws could also be used in order to reduce the weight. Further testing is needed to determine if 8-32 can withstand the weight of the gripper.

[4.2] Linkage Lengths

- Due to the four-bar linkage, the upper arm can fold really easily and could be as long or even longer than the linkages used in the lower arm.

[4.3] Alternate Design for Motor Hub

- The alternate design was used and it worked really well. The problem is that the motor hub part is a bit too long since it was designed in mind that a shaft would be press-fit into it. This can be fixed by reducing the hub length by 0.05 inches.
- Another problem is that the shaft part is about 0.25 inches too short, but this can also be easily fixed by increasing the length.

[4.4] Shaft Collars

- Shaft collars can be used in order to reduce the number of press-fit parts. The upper linkage 1 (non-motor side) was accidentally made with a clearance hole, but shaft collars were used and the part worked fine.

[4.5] Springs

- The usage of springs in the elbow is not needed with the current design since it actually reduces the range of motion and the part is already rigid. If we want to use the springs, a slot hole should be used instead of a singular hole. Springs can still be used in the wrist to ensure the part doesn't move.