21st June

- We have gone through most of those urc videos for reference(**link**).
- Discussed about the basic design of the manipulator

Base

- Discussed about the Bearing shaft
- Have to decide on Bevel Gear vs Worm - Gear mechanism
- Motors vs Hydraulic actuators
    - Compare Price, Precision, and Weight

No. of Fingers

- 2 + static finger (In Built screwdriver) or 3 fingers
- 3 fingers - Complexity increases
- Inbuild Screwdriver - No need to pick up the driver, can also be used to type on the keyboard
- Make the screwdriver bit replaceable, so that it can be swapped with a new bit depending on the temperature
- Have to decide about the end factor mechanism, bevel gears or linear screw drive?
- Instead of going for 3 fingers, we can use an adapter gripping mechanism which mimics human finger and confirms the shape of the object thereby increasing the contact and hence gripping.(link)
- Basic structure of the Gripper is almost ready (From Shanmukh's task round)
    - Ref - https://youtu.be/9oDAP2ECbS8
    - Model - Gripper SW Model

General Doubts

- What manufacturing methods are available to us? Can we build Bevel gears?
- What is the budget of the manipulator?
- What is the weight of the manipulator? Depends on the weight of the Rover.
- Have to search for motors in the approximate torque range
- Decide the type of motors

22nd June

Linear actuators vs motors for rotation

- This article shares Advantages of linear actuators over using worm gear mechanism
    1. The loads on arms are reduced as it would ,now be shared with body where one end of one actuator rests, thus accounting for greater stability
    2. External gear usage for driving is not necessary
- This article states similar advantages for linear but elaborates advantages of rotator as follows
    1. They offer immediate feedback for diagnostic and maintenance(higher hand over control than linear where this effective feedback not possible(here we go with constant torque irrespective of speed..))
    2. But again the same article says for more precise motion we use linear actuators

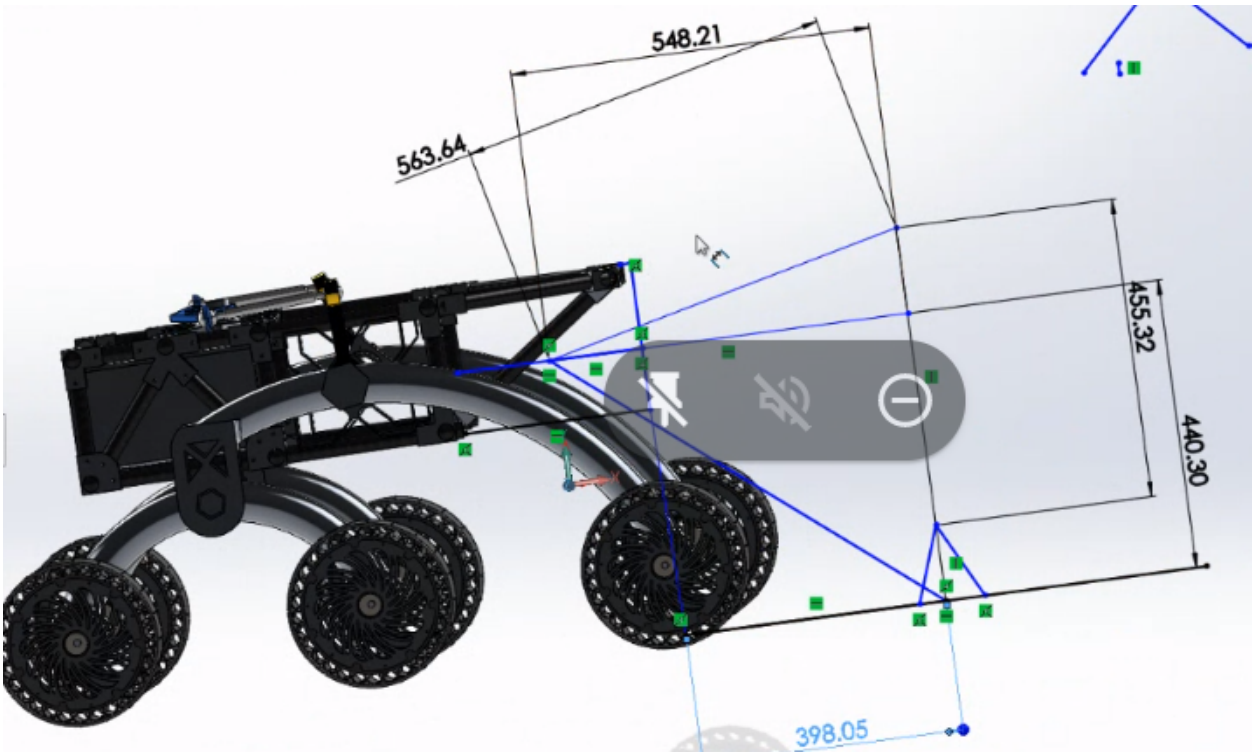
1. High-speed reduction: A speed reduction is as high as 100:1 can be obtained with a single pair of worm gear.

2. The worm gear is compact with small overall dimensions, compared with equivalent spur or helical gear drives having the same speed reduction.
3. The operation is smooth and silent.
4. Provision can be made for self-locking operation, where the motion is transmitted only from the worm to the worm wheel. This is advantageous in application like cranes and lifting device
5. The worm gear has good meshing effectiveness.
6. The worm gear used for reducing speed and increasing torque.

Refer to https://link.springer.com/content/pdf/10.1007%2F978-3-319-62533-1_16.pdf for inverse kinematic solutions for a simple robot manipulator

23rd June 2021

June 27

- 

- Torque Calculation
- l1=0.58, l2=0.46
- theta = 13.4deg
- mass of 1st arm =4kg
- mass of 2nd arm =3kg
- mass of gripper + load = 7+1 = 8kg
- torque2= 75N-m to 90N-m
- torque 1 =25N-m to 40N-m
- torque 3 =25N-m to 40N-m

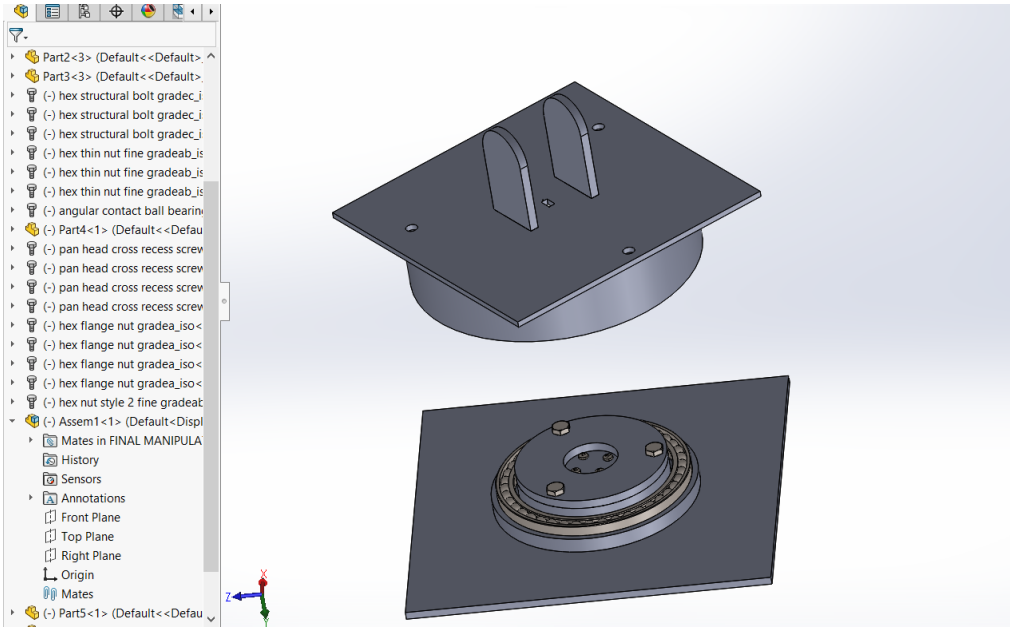
June 28 - July 9th: Not much work done due to end sems.

July-10th:

- We did some research work to start the designing of the manipulator and started with the base of the manipulator.
- We designed 5 parts for the base: the two bearings, a cylindrical body with a top, a shaft and used a gear which would be in contact with another gear , which would be connected to a motor to rotate the manipulator along the z-axis.

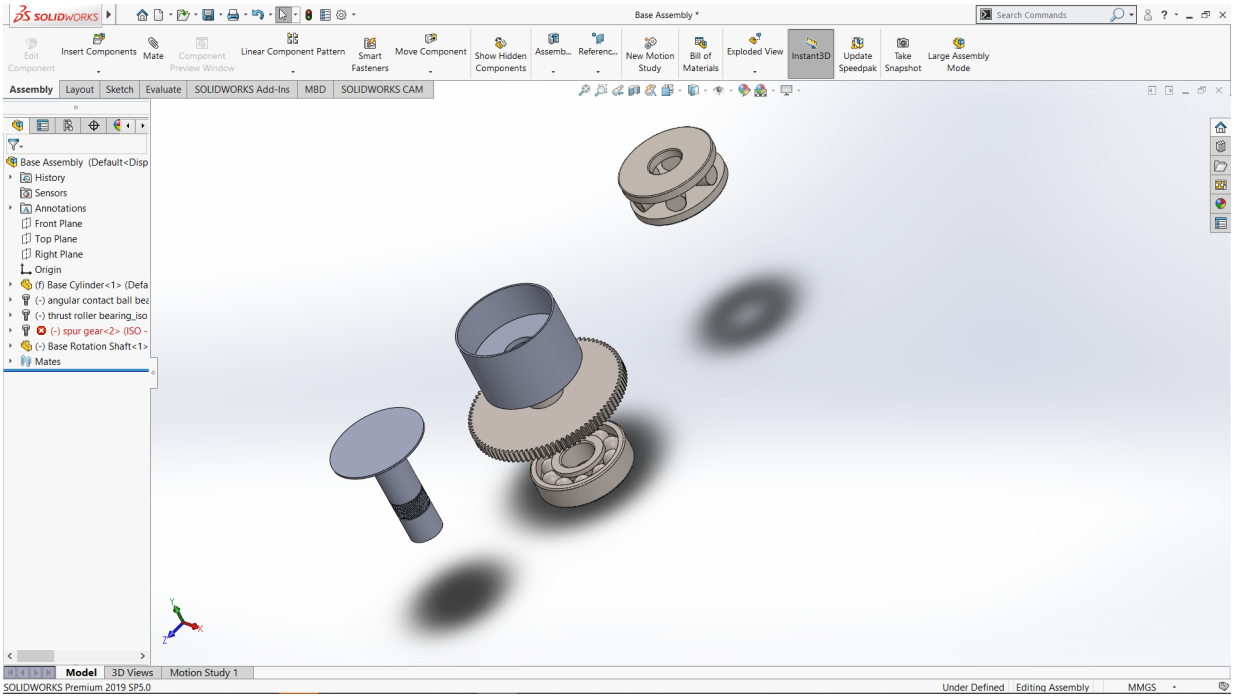
Base V1

- We failed to use it because connecting motor was issue as we had to make a hole through made base if we had to spur gear so we couldn't do this.
- If we were to connect the motor on top then we could have used a planetary gear system again balancing earth was difficult if it was the case and seems unnecessary.



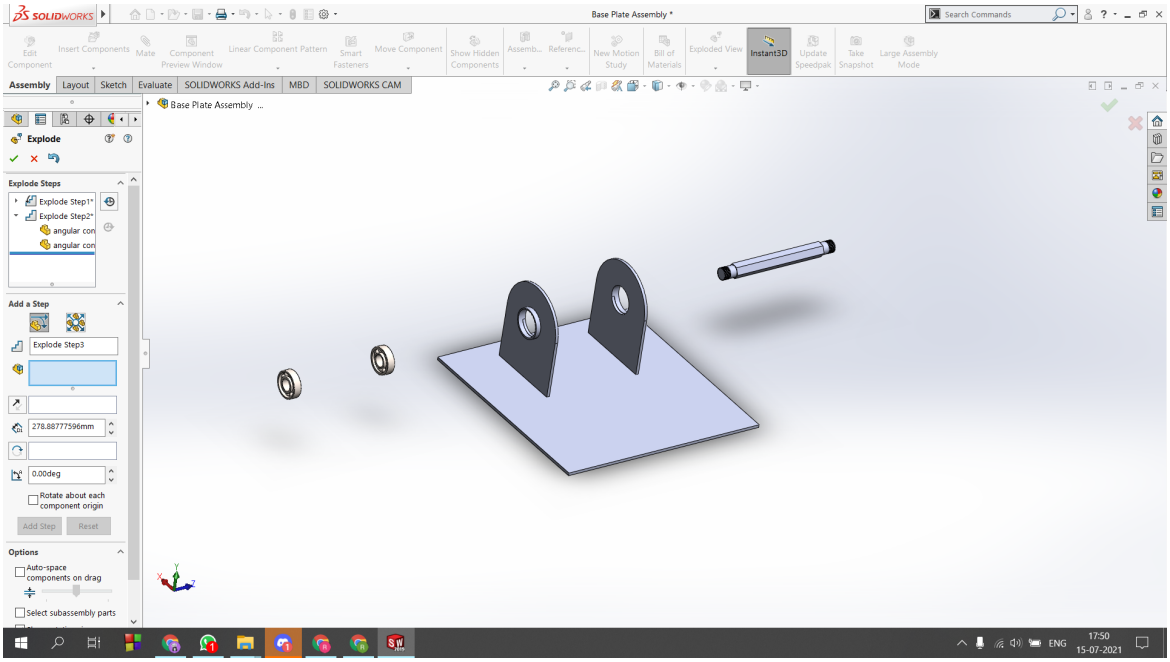
Base V2:

- We faced some difficulty in understanding how to restrict the axial motion of a shaft at the same time allowing rotation, finally went with a surface thrust bearing and added nuts to lock the axial movement. Alternatively locknuts can also be used.
- We decided to go with a nut with a screw which allows us to tighten it before locking it with some perpendicular screws.



July-11th:

- We modelled the base plate of the manipulator and in this we connected a hexagonal shaft on which the arm links of the manipulator will be connected.
- It will be mounted on the top of the base assembly.
- We are planning to use a worm gear connected with a motor to move the manipulator in the xy plane.
- Looking for plausible motor options and figuring out the required gear ratio will be approximately 100 if we go with Nema series stepper motors which is quite difficult considering the fact that on average spur gear will be able to give a gear ratio of 5-10 and Worm gear will achieve 20-25.
- Alternatively DC motors are light, small, high torque and cheap as well but we are not sure how much precision we can achieve with an optical encoder.
- Need to do more research on Motors and have to decide on the Gear boxes after motor selection.



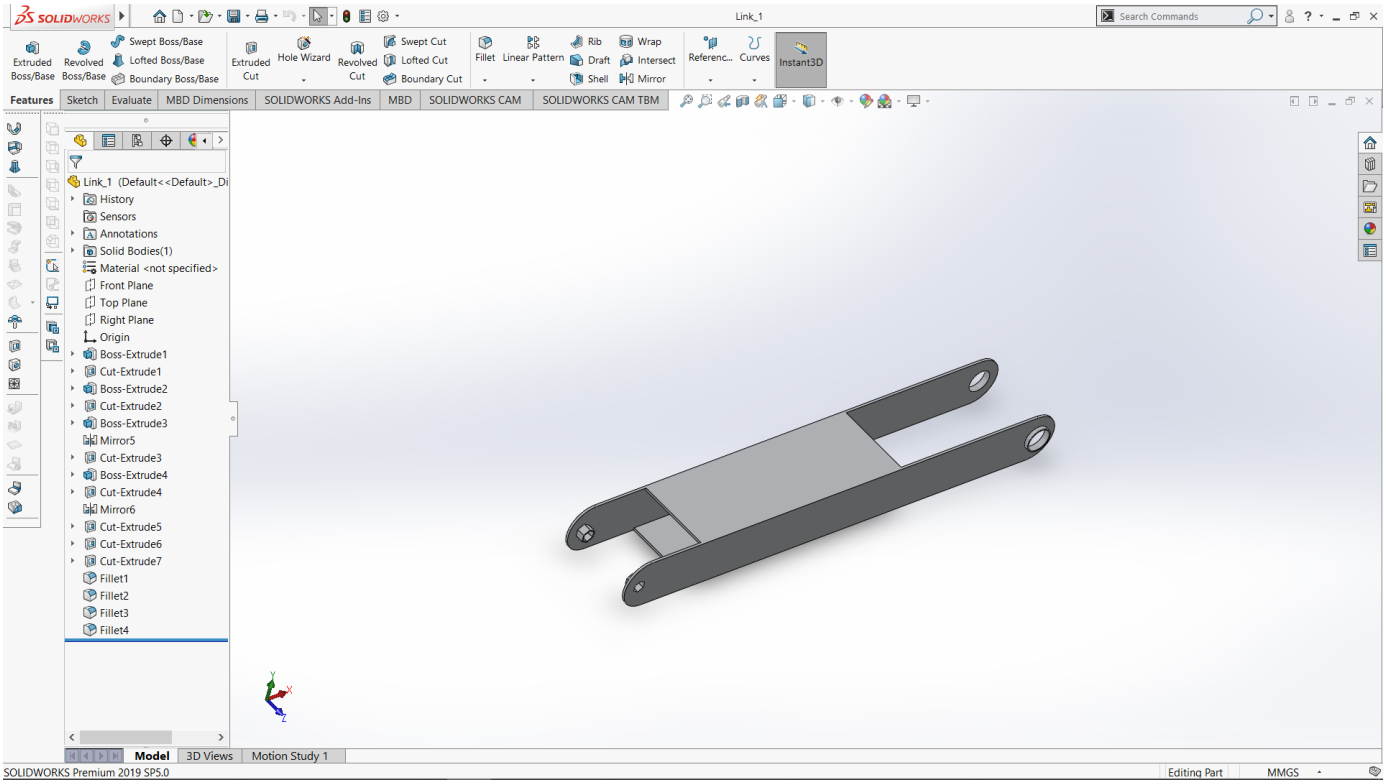
July12th:

Initially we approximated the link lengths using the original rover model, but as the steering team updated the rocker-bogie mechanism and installed ackerman steering, we decided to check make a dummy to test out on the updated rover and decided upon the new lengths

(Add Photos)

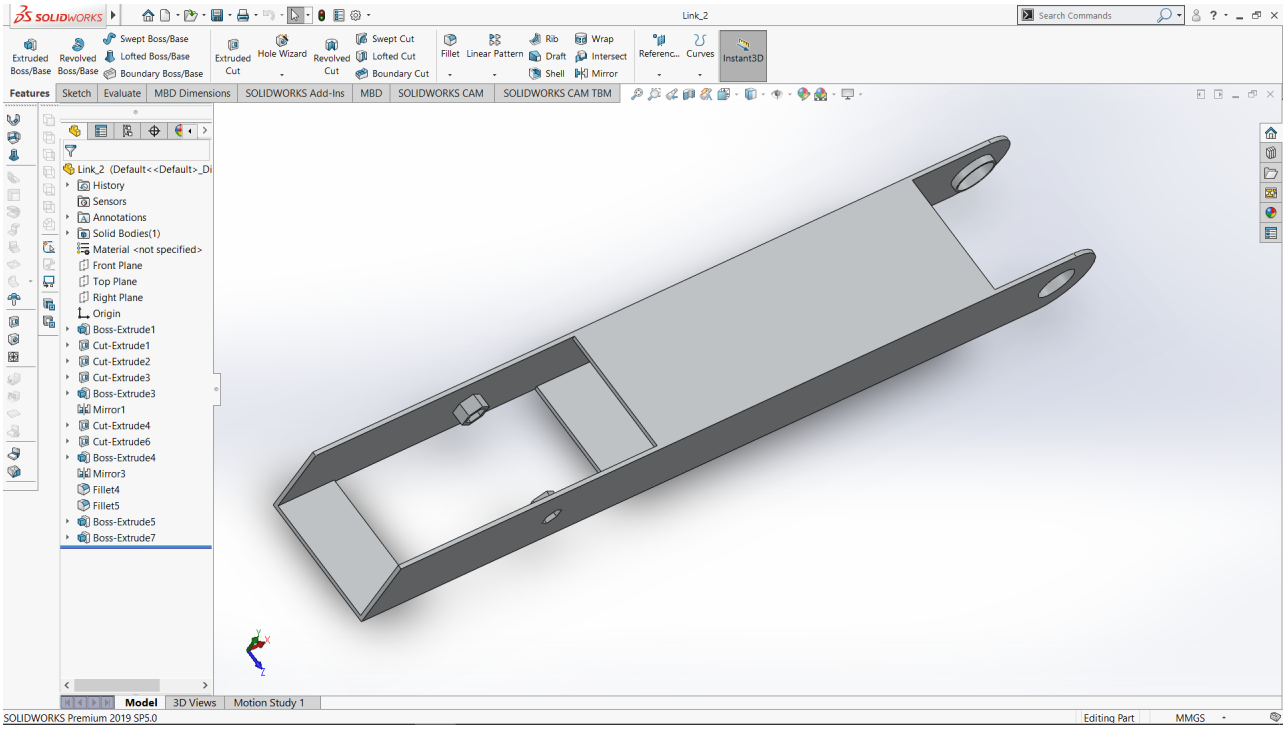
Arm Link-1:

- For the link 1 we decided on a truss like design.
- We are currently not sure of what is the optimal thickness, just randomly picked 3mm, have to do Ansys analysis to decide on the correct thickness of the sheet metal.
- The length of this link is 600mm.
- Also looked at multiple truss designs to be extruded, though needs analysis before delving into that.
- Currently the link came out to be approximately 1000 grams using the Aluminum 6061 Alloy.
- Again this is true only if that 3mm guess turns out to be a correct one.



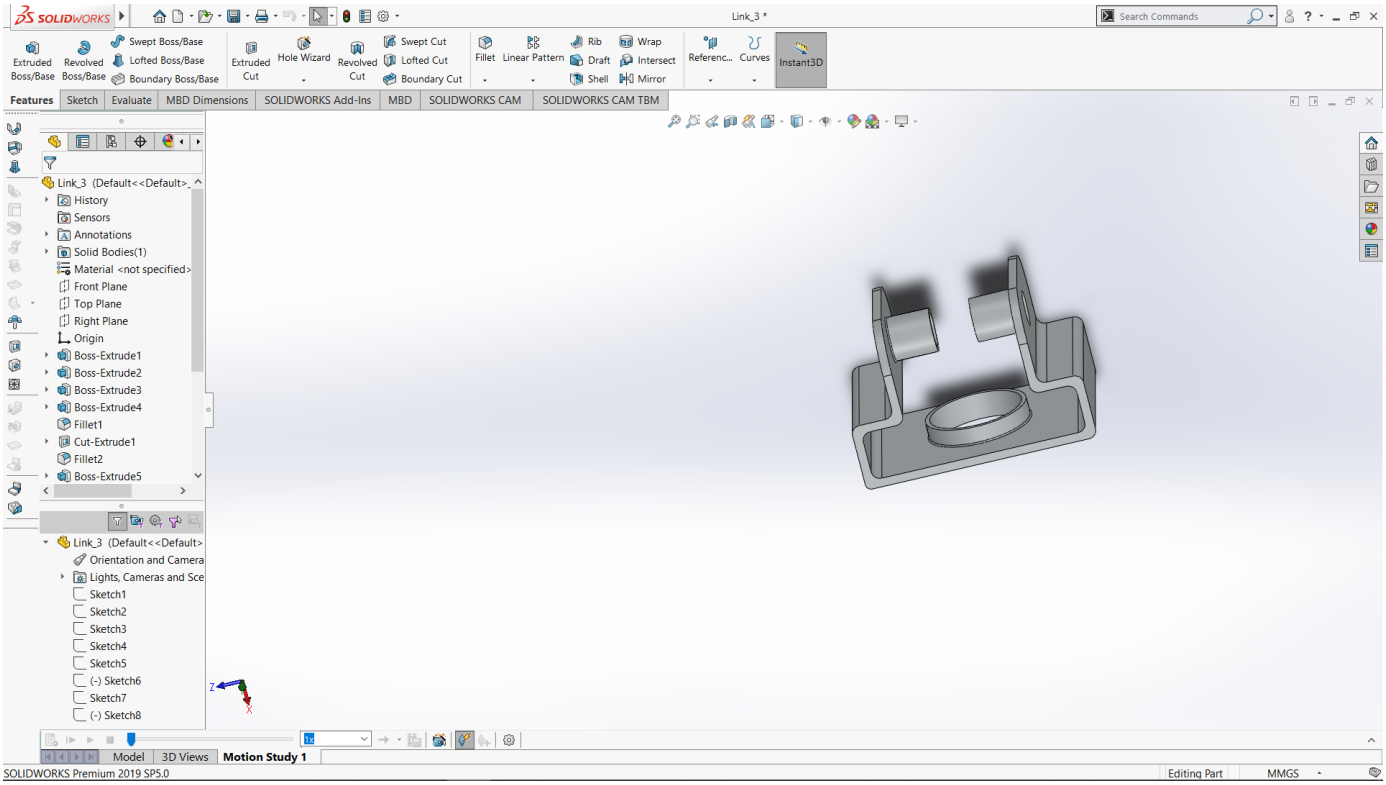
Arm Link-2:

- The design is similar to the 1st link and length is 500mm.
- For the movement of link-2 we will use worm gear.
- Although have to be decided depending on the motors.

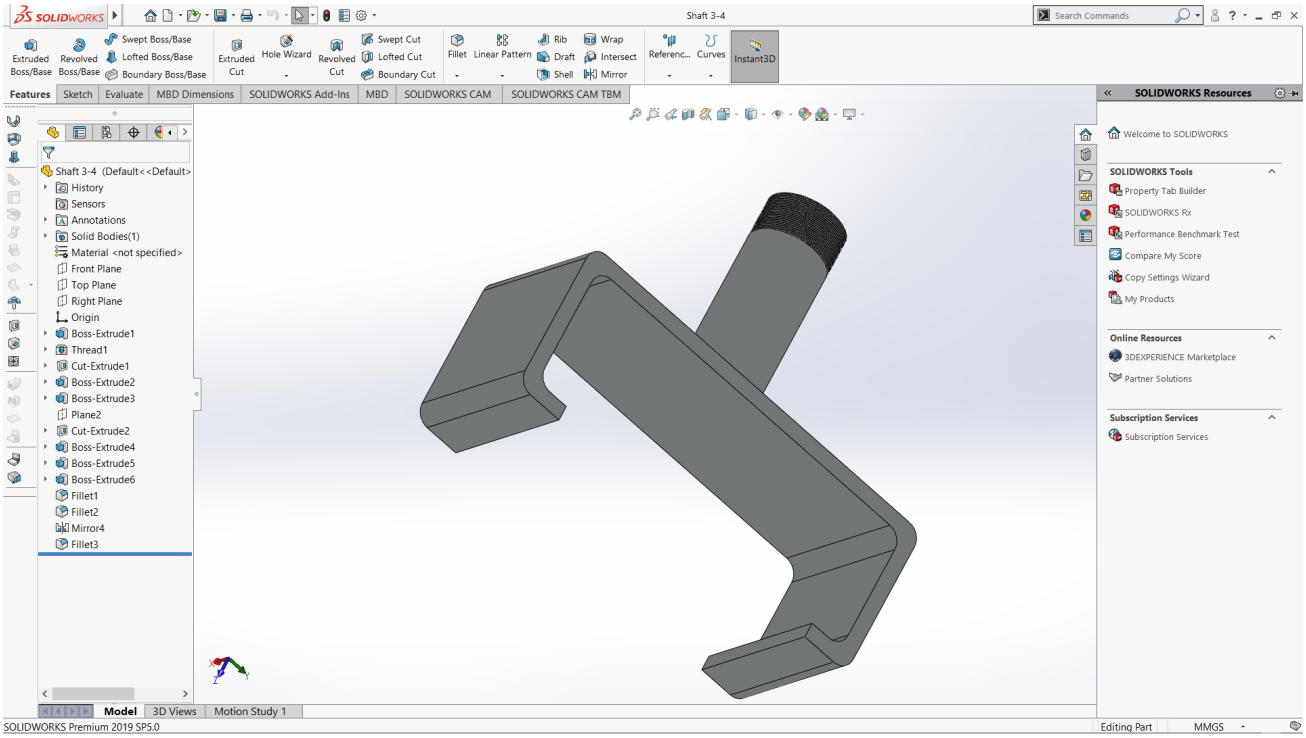


July 13th:

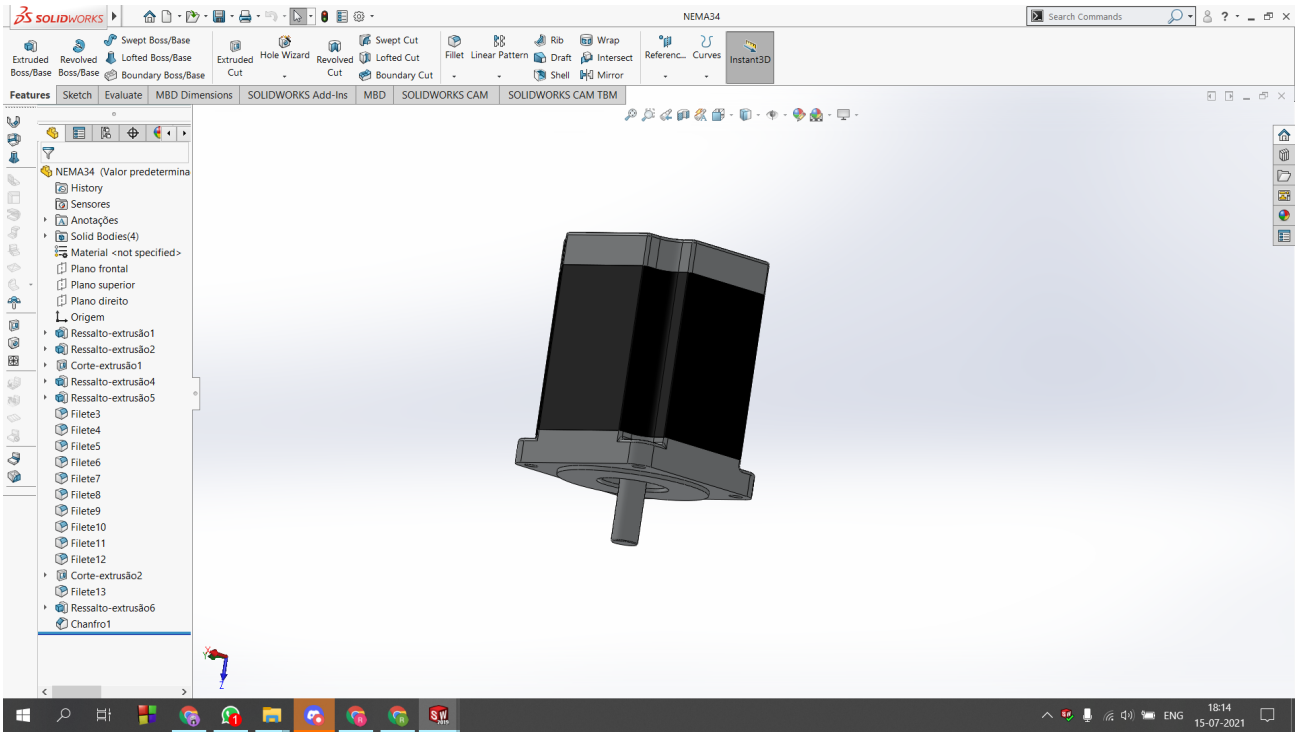
- We designed the Link 3 for the gripper.
- This is attach the gripper.



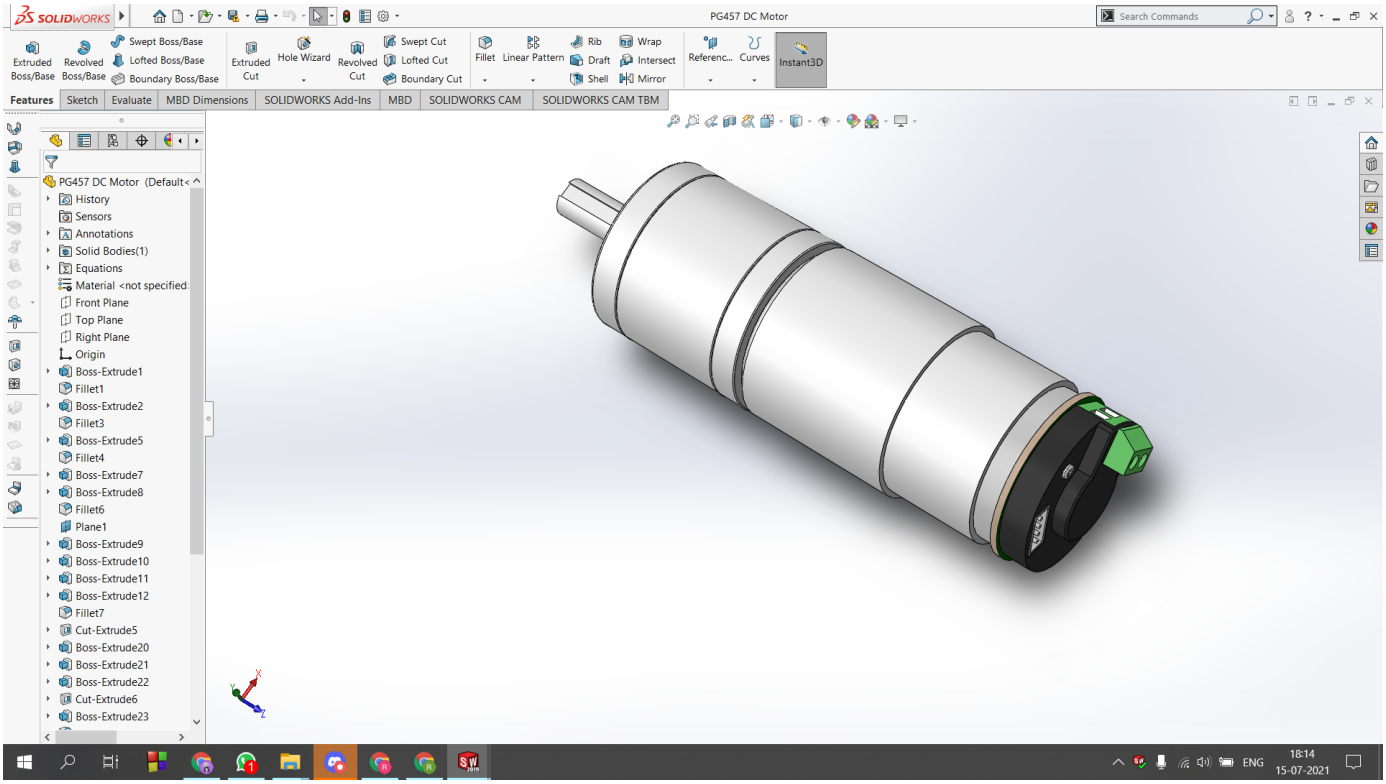
- A shaft was also designed to connect the link 3 and the gripper.

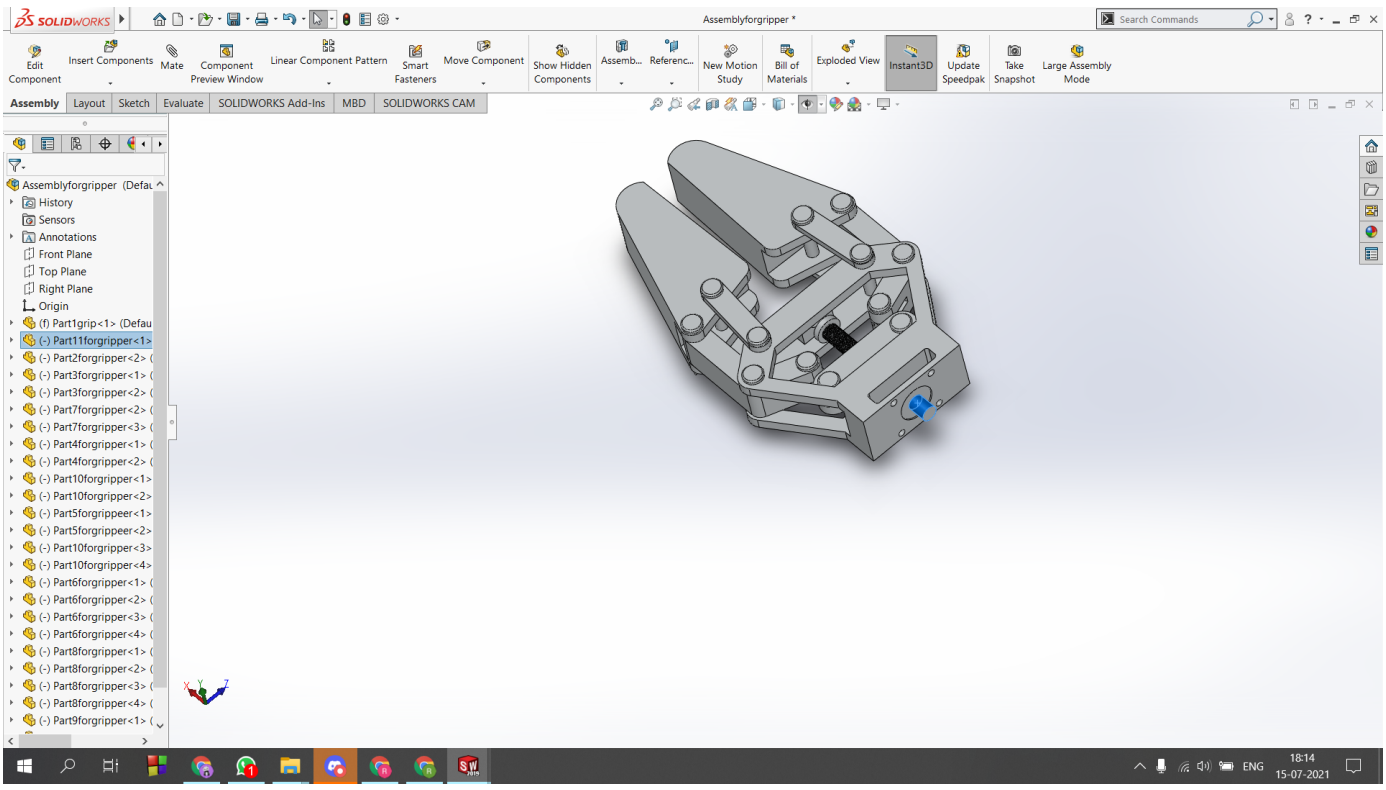


July14th:

- We used the same [gripper]as designed by Shanmukh in his task round and did some modifications in that.
- 

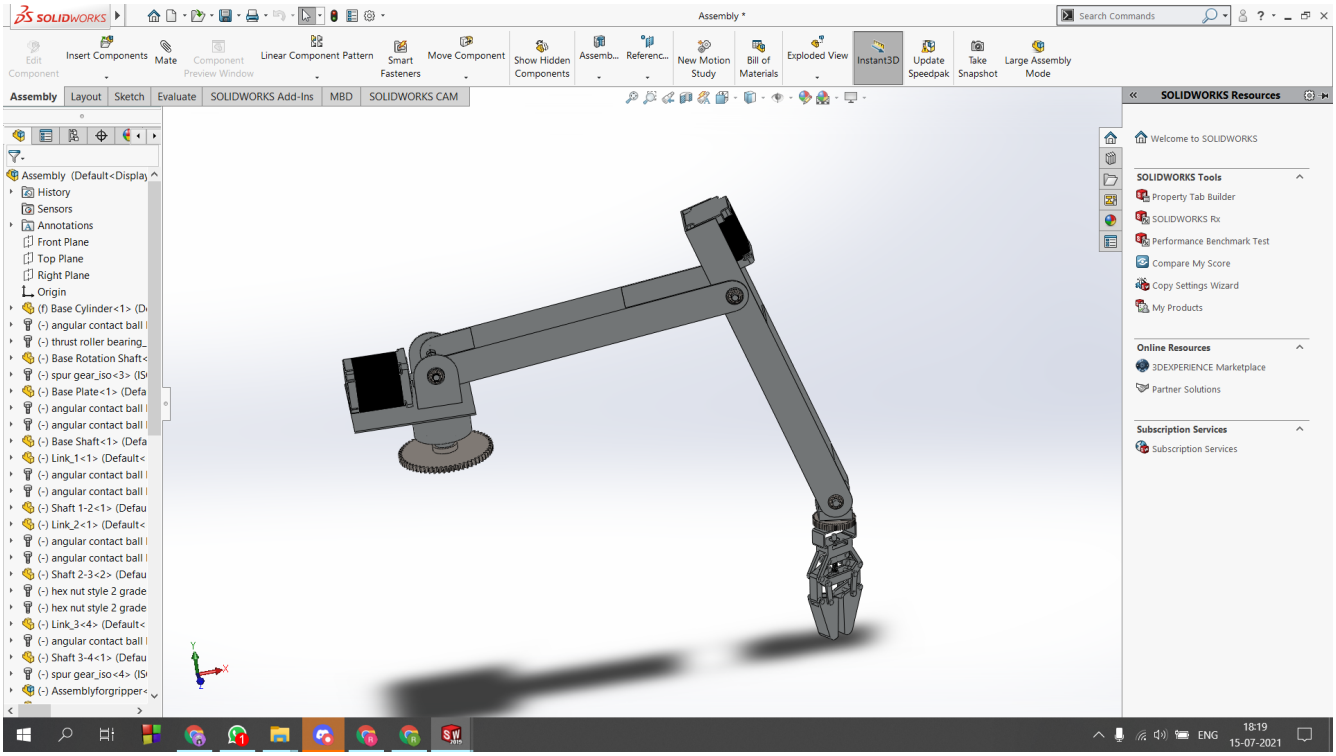
- We also decided to use some motors and we extracted their CAD models from www.grabcad.com.





July15th:

- We did some modifications and assembled the manipulator.



Final [link] to download all the files for the manipulator.

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