REPORT for 3/4 DOF Arm plus gripper

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Team members: 3

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3. Bhargav Varshney

Targets Achieved:

1) Design Finalization : Used four bar mechanism to actuate the shoulders efficiently

2) CAD Model : Designed the CAD model in Autodesk Inventor and Fusion 360

3) Simulation : Created an animation of the robot to test the design

4) Manufacturing (Mechanically) : Laser cut and 3D printed the parts

5) Electrical circuiting : Used stepper motor to rotate the turntable and servo motor to actuate the legs and gripper of the arm

6) PS3 control : Controlled the robotic arm with a PS3 controller via an USB cable

7) Mechanical Model : Good working condition

8) Testing : All three servo motors are working individually

List of Components:

- Stepper and Servo motors, X-Channels, Acrylic Sheet, Nuts-Bolts, Arduino Mega ADK, PS3 controller

Timeline

17th May to 10th June

- Designed various models and discussed the pros and cons of each model with the mentors.
    - Rejected ball and socket joint due to tough actuation.
    - Rejected linear robotic arm links due to more need of actuators and inefficient design
- Finalised the CAD model and made the assembly in Autodesk Inventor and collaborated using Autodesk Fusion 360

11th June to 20th June

- Prepared the mathematical model
- Decided the motors for actuation
- Calculated the stall torque of servo motors required

20th June to 1st July

- Laser cut all the parts and assembled the arm using nuts and bolts
- Faced problem of finding proper sized nuts and bolts
- Faced design problem while assembling due to increased thickness of arm

1st July to 11th July

- Controlled Servo motors using arduino
- Integrated it with PS3 controller
- Soldered the nuts and bolts to prevent loosening of nuts
- Laser cut some parts again according to the actual dimensions of servo motors
- Laser cut the (2 x)acrylic part joining the connecting shaft to the plastic fan on the motor

12th July to 23rd July

- 3D printed the connecting shaft
- Assembled the stepper motor on base, faced issue of cavity size in base
- Failed to run stepper motor using stepper motor driver A4988
- Brainstormed for the design of the turntable, having two layers to support the stepper motor.
- Laser cut new gears according to the design of the turntable

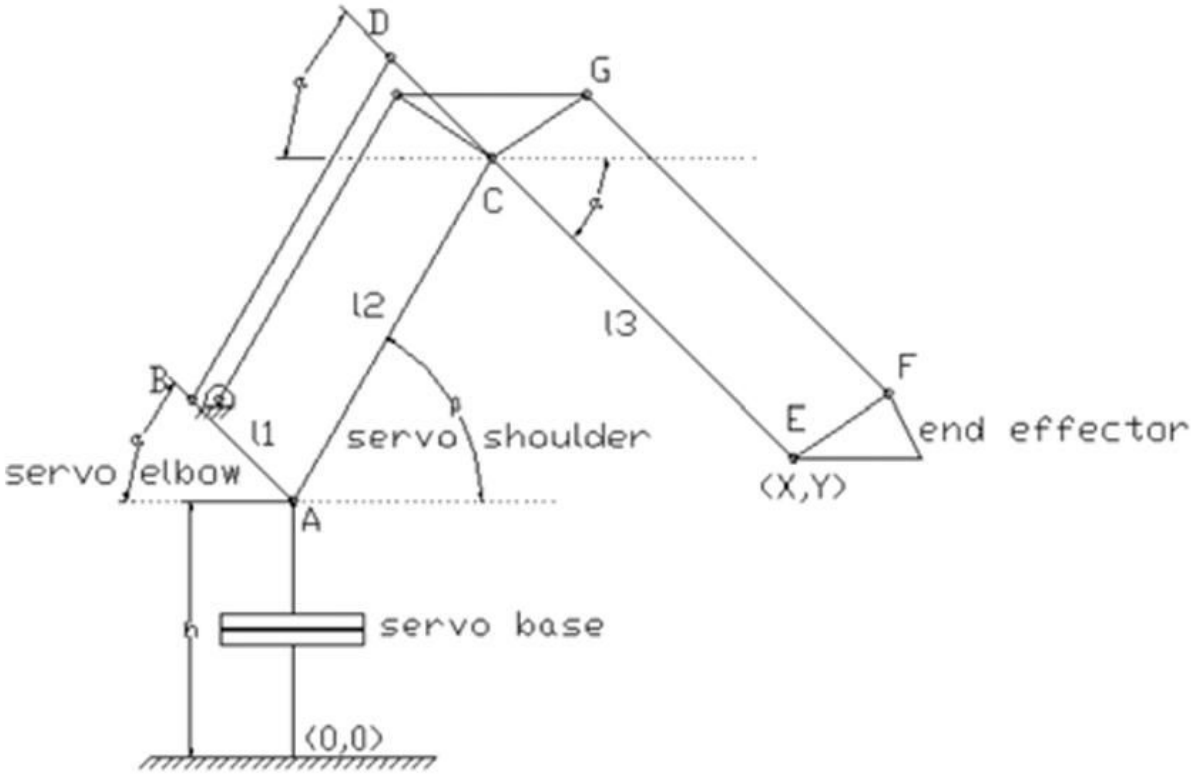
24th July to 7th August

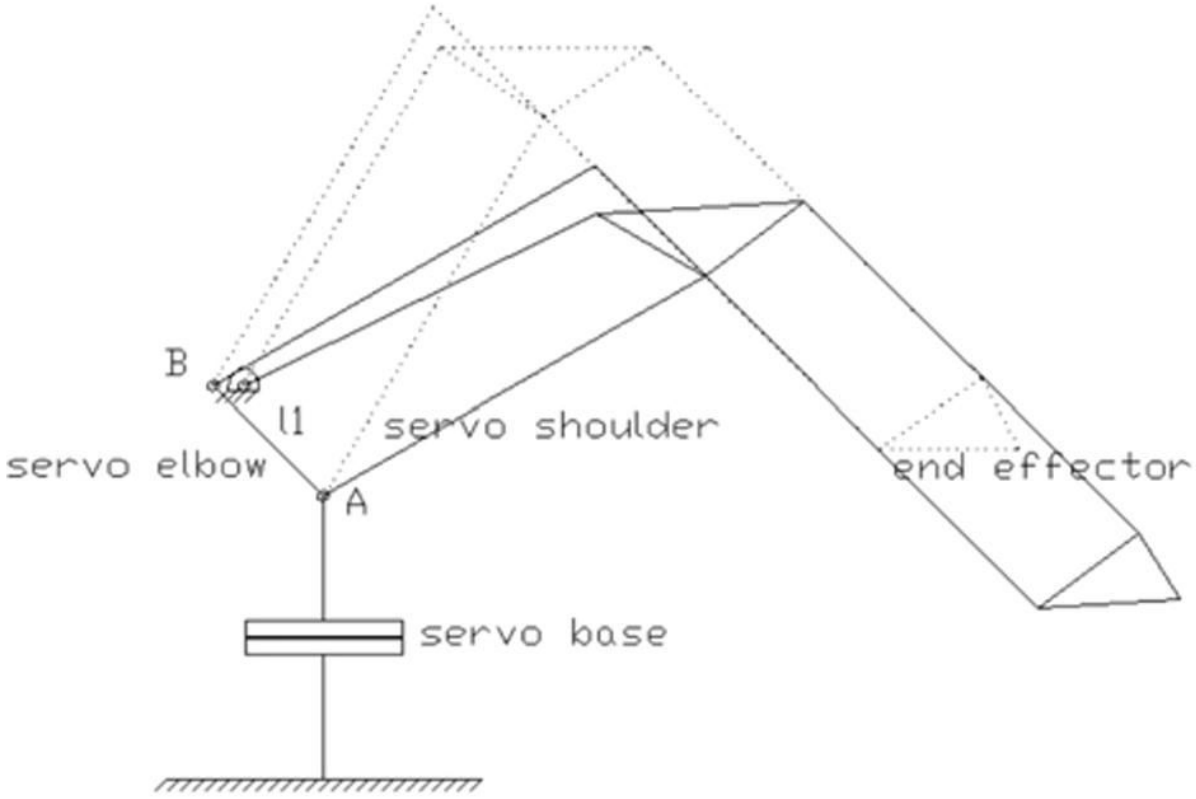
- Laser cut and 3D printed new parts according to the design of the turntable
- Completed assembling the mechanical model
- Observed significant wobbling of the arm
- Consulted with seniors and designed a CAD for a new design for the turntable with a third level of the base
- The third base was laser cut in Makerspace, the shaft was reprinted using the 3D printer in the club, since the new design required a longer shaft

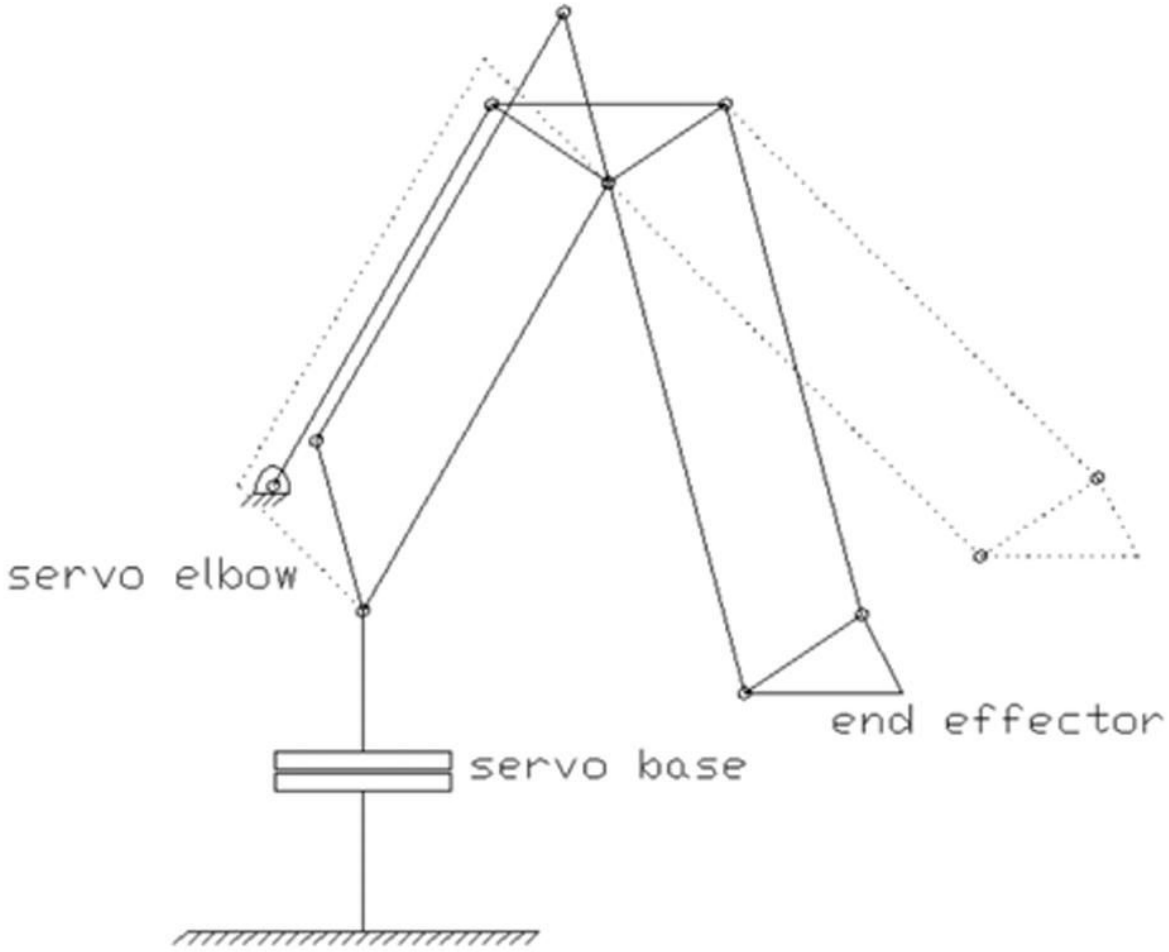
8th August to 14th August

- This design of the turntable was assembled as in the CAD using L connectors, X channels and two ball bearings, instead of one like in the previous model
- The wobbling was assumed to have decreased significantly
- The mechanical model was completed
- The electrical part included running the three servo motors and the stepper motor
- The team quickly made the circuits for each individual motor
- The three servo motors were successfully controlled individually using a PS4 controller
- It was observed that the stepper rotated individually while testing, but had a very low torque, and would be stopped using even a light touch to the gear with a finger
- The stepper was found to be unable to rotate the turntable

Mathematical model :




B
l1
servo shoulder
servo elbow
A
end effector
servo base



$$X = l_2.\cos(\beta) + l_3.\cos(\alpha) \qquad (1)$$

$$Y = h + l_2.\sin(\beta) - l_3.\sin(\alpha) \qquad (2)$$

Initial report as on 10th June:

Our team had proposed two solutions for the given problem both of which had 4 DOF(Degrees of Freedom). One was based on linear links with 5 actuators and the other one was based on a 4R-4 Bar Mechanism connected in series with another 4R-4 Bar mechanism. After a thorough discussion we finalised the second solution, as it had less number of actuators so the control was easy, further, the payload capacity is more in the latter. We decided all actuators: Using stepper motor for base which consists of a turntable having a stepper motor and servo motors for all other links.
We finished the CAD model of the same, and the initial version is displayed below :