Mini-project 2: Robot arm with hydraulic actuators

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Group 15 HIT

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1 Design

Figure 1 shows our design of a robot arm with syringe-based hydraulic actuation. Three sections of the arm are made of corrugated paper and toothpicks; each section is made of two parallel corrugated paper board connected by two toothpicks. Adjacent sections of the arm are connected by a syringe consisting a cylinder and a piston, which functions as a translating full slider joint. The bottom section of the arm is connected to the base through a used battery functioning as a revolute joint, and the battery is fixed to the base. The bottom section is also connected to the base through a syringe, which would rotate the whole arm when the piston was pushed out. The gripper is made of corrugated paper and steel wires. Two arms of the gripper are connected to the gripper base using toothpicks as revolute joints. The ends of two gripper arm are connected to the piston of a syringe, and all joint among them are revolute joints; this syringe is fixed to the top section of the arm, as well as the gripper base.

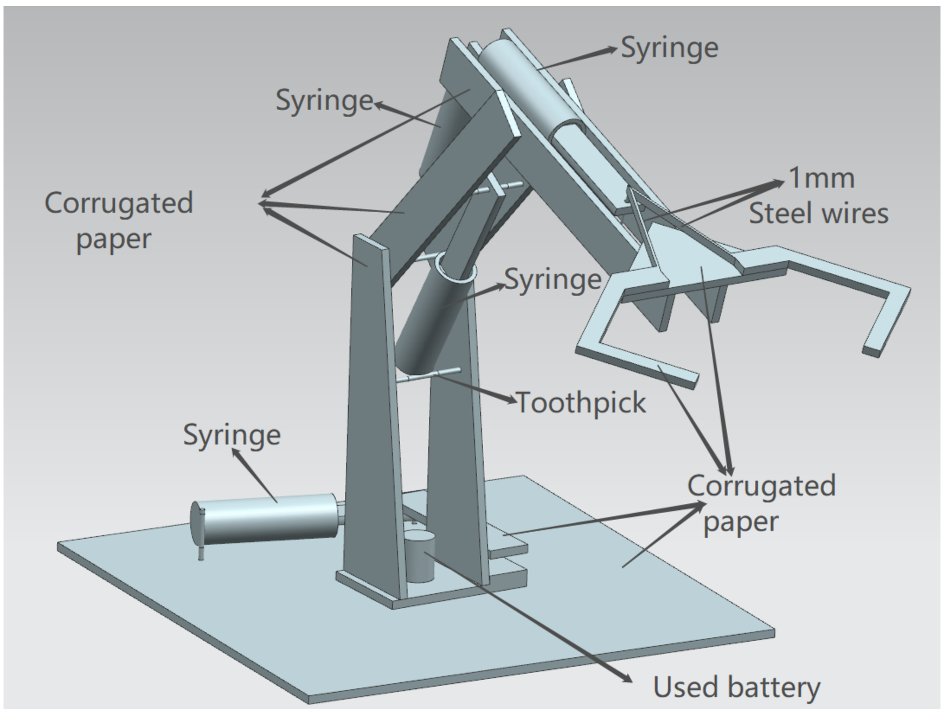

Figure 1: Design of a robot arm with syringe-based hydraulic actuation.

Figure 2 shows the major dimensions of our robot arm. The measurement are made among the connected revolute joints.

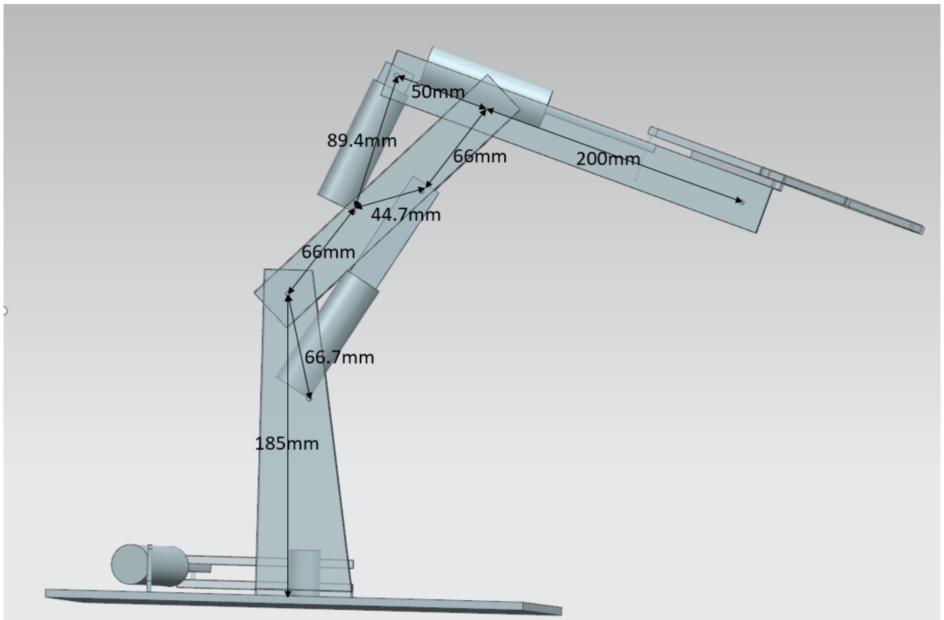

Figure 2: Dimensions of the three section of the arm.

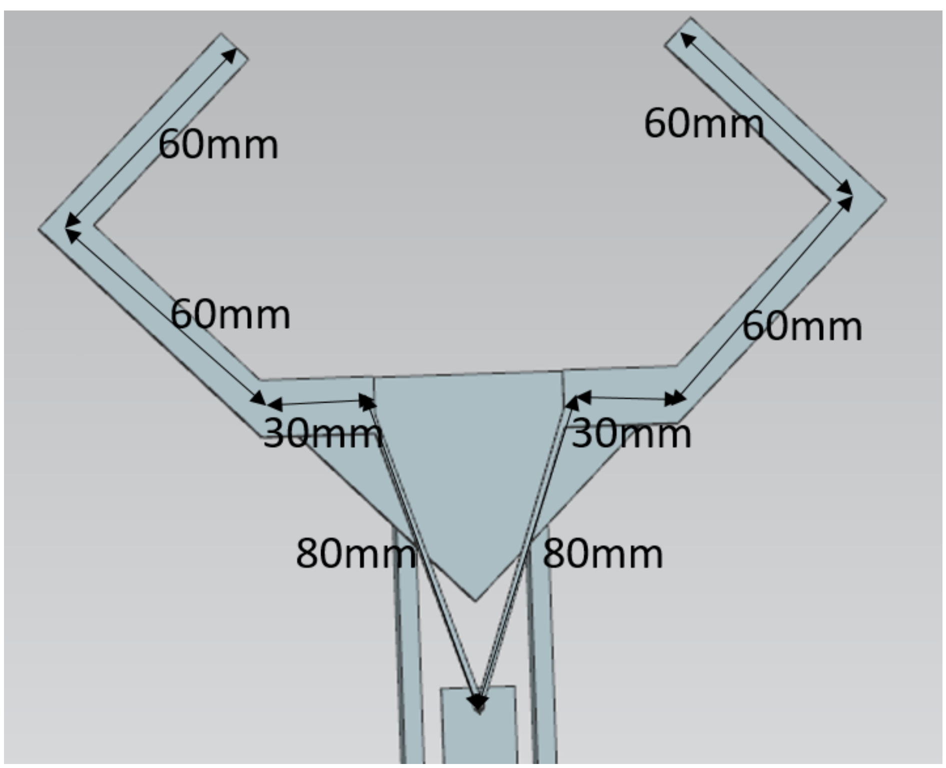

Figure 3: Dimensions of the gripper.

2 Mobility analysis

2.1 Gripper

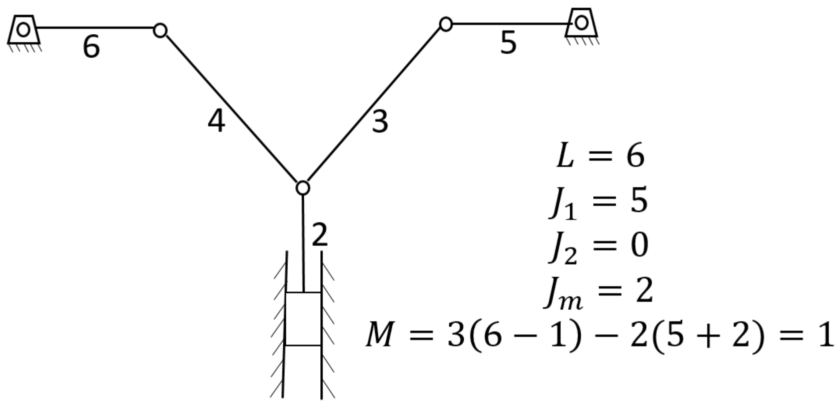

Figure 4: Mobility of the gripper.

2.2 Arm

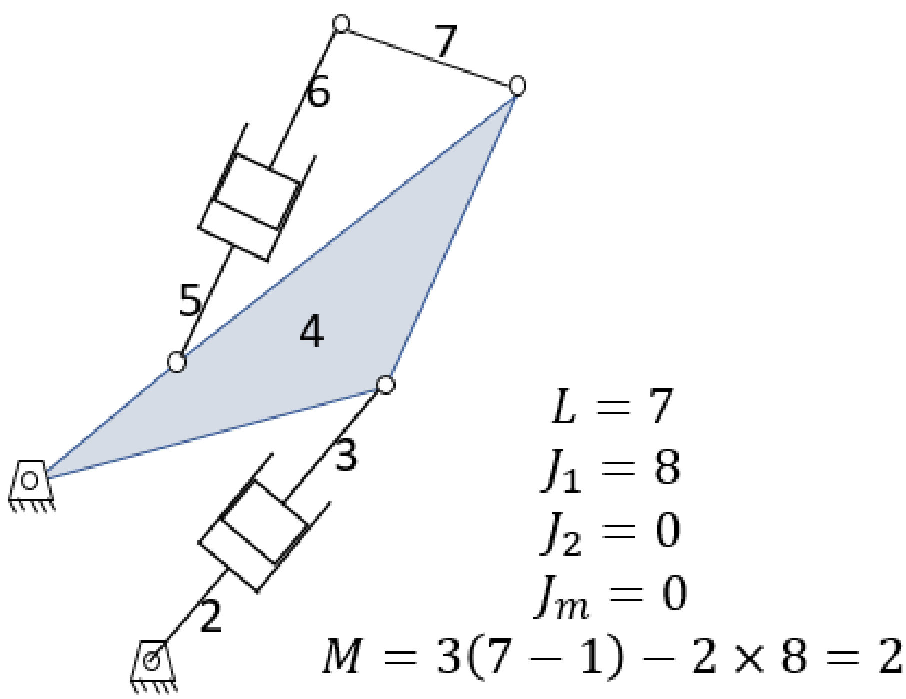

Figure 5: Mobility of the arm.

2.3 Rotator

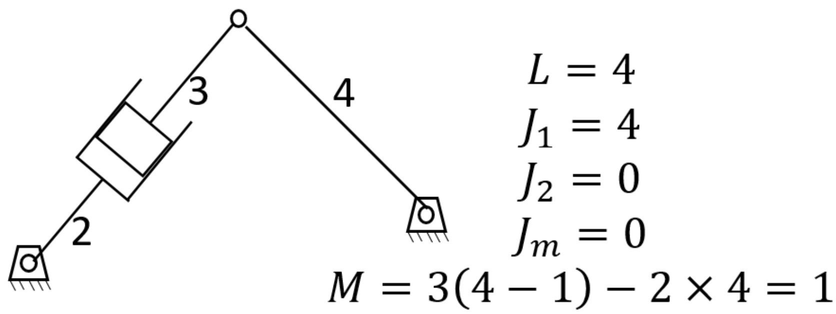

Figure 6: Mobility of the rotator.

3 Discussions and improvements

3.1 Discussions

One problem we encountered during the building process was that the length of the toothpick was not long enough to go though the two pair of parallel corrugated paper boards. A possible solution of this problem is to use longer wood rod instead of toothpick.

Another problem was that there was some air inside the syringes, so that the device cannot respond immediately to the hydraulic sliding input. This is because the air can be compressed, and the piston of the syringes would not move until the pressure of air instead is large enough after compression. One possible solution is that first assembly tubes to the syringes on the arm, and make the syringes at maximum length, and add liquid through the tubes until it is full, and then assembly syringe on the control panel to the tubes. We added liquid to the tube and the syringes first, which might be the reason of the existence of air in the syringes.

3.2 Improvements

1. Use the same base for the robot arm and the control panel, which makes the whole device more compact and easy to move.
2. Use wood board to build the holder of syringes on the control panel, which can fix syringes more firmly than corrugated paper boards.
3. Use smaller and longer syringes to avoid conflict among syringes on the arm, which can also extent the reach of the robot arm.

4 Team member's contribution

Tongxing Shen: building control panel; analysis

Xucheng Ma: building arm; CAD

Yuhan Chen: building gripper; writing report

Zhifan Ma: building rotator; adding colored liquid to syringes