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Design and Control of UAV Gripping Mechanism

Introduction

The Dalhousie University Advanced Control and Mechatronics Laboratory has purchased two COEX clover Unmanned Aerial Vehicles (UAV) for research into the field of load transportation.

Load Transportation includes the expedient delivery of medical supplies, tooling, and raw materials.

The current gripping mechanism provided by COEX does not meet the Clients requirements, and they would like an alternative solution.

Figure 1: COEX Clover Drone

Design Requirements

The Mechanism must comply with the following design requirements and client preferences:

- Lift a maximum weight of 60g
- Add no more than 300g to the drone including payload
- Not exceed a budget of $1000
- Attach to the bottom plate of the drone
- Not exceed the height of the drone legs in open position
- Be compatible with Drone Raspberry Pi and ROS 1.6 driver
- Be designed so that it can operative cooperatively with another drone to lift long objects

Existing Options

- COEX currently produces a gripping mechanism that acts as a claw, though its design has many restraints that do not meet required characteristics
- The claw-like design limits the shape of objects that it can pick up
- The claws do not provide large surface area, limiting the amount of contact to the payload.
- Due to the claw's size, shape and construction, short or flat objects cannot be grasped while the extended drone feet are attached
- The mechanism involves the use of strings which tend to stretch or break

Figure 2: COEX Gripping Mechanism

Features

1. Dynamixel XL330-M288-T Servomotor. Raspberry Pi and ROS 1.6 Compatible. (Dynamixel SDK)
2. Mechanism attaches to bottom plate using available screw holes.
3. Actuating Centerpiece attaches to servomotor at center of rotation.
4. Two sets of Ball Joints allow Actuating arm 6 degrees of freedom for rotation and translation.
5. A four-bar mechanism allows for proper stability and actuation of gripping faces.
6. Mechanism does not interfere with the drone's ground-facing camera mounted on the plate.
7. Modular gripping faces allow for application of different, high friction materials, and allow for easy gripping face replacement.
8. Force sensors implemented between gripping face and gripping arm allow for force feedback control to prevent damage to payload.

Design Summary

The designed mechanism is shown in Figure 3. This design weighs under 150g and is able to lift payloads in excess of 250g. The total budget expended for this project was $339.71, well within the provided budget. The mechanism meets all compatibility requirements, and it is able to work in tandem with other mechanisms to lift larger and heavier objects.

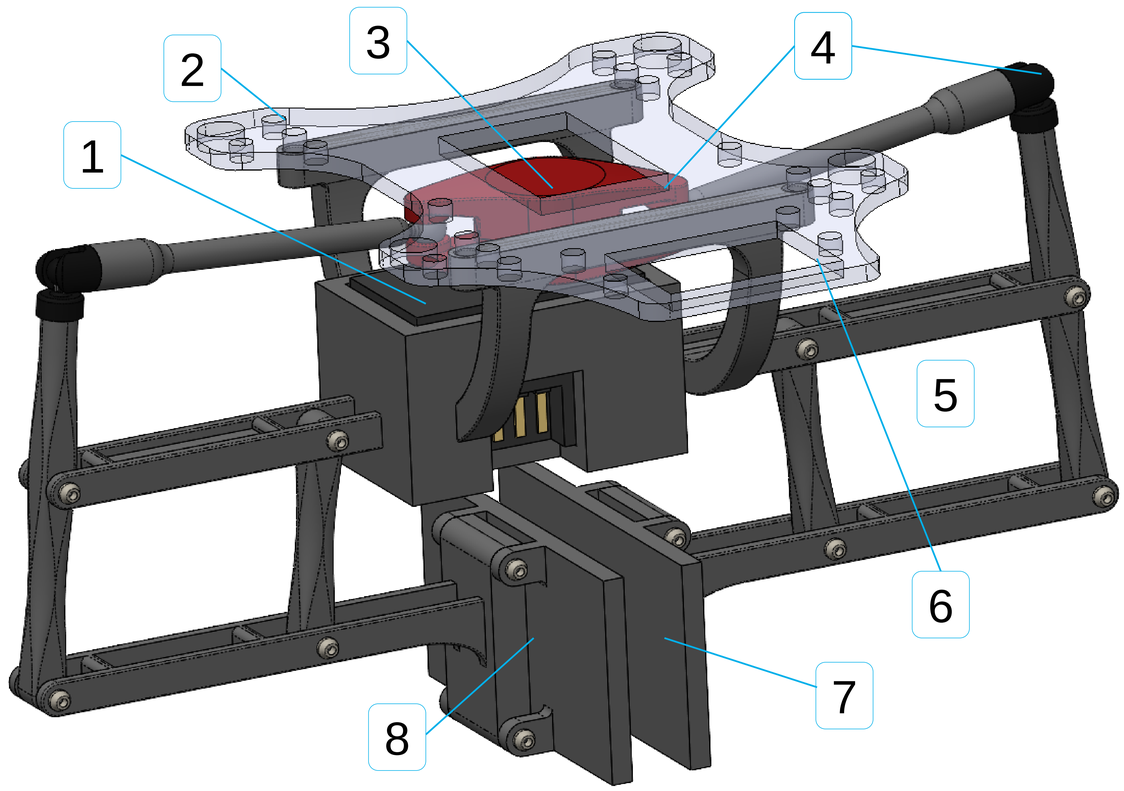

Figure 3: Gripping Mechanism 3D Model

Testing and Verification

To determine if the gripping mechanism would comply with the client's requests, preliminary tests have been conducted to assess various functions of the gripping mechanism.

- Testing shows that the gripping mechanism can pick up to 271g at less than 30% of the servomotor stall torque of 0.52 Nm at 5 V (XL33-M288-T)
- The Dynamixel motor successfully communicates with and can be controlled by the Raspberry Pi, enabling remote control of the mechanism
- The gripping mechanism operates within the designated area under the drone and does not exceed the height of the drone legs
- Testing has proven that the force sensors provide accurate and appropriate results for the given payload

The results of the preliminary tests confirm that the gripping mechanism has successfully met the requirements outlined by the client while consuming less than 40% of the allotted budget.

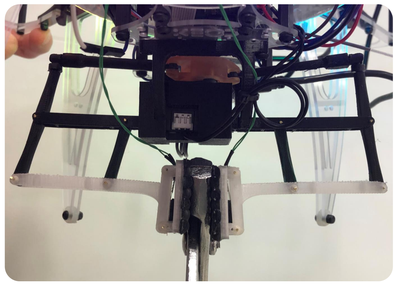

Figure 3: Design Testing

References

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- Figure 2: *Mechanical grip - Clover*. (n.d.). Assembling and setting up mechanical gripper. Retrieved March 27, 2022, from https://clover.coex.tech/en/mechanical_grip.html.
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