Autonomous Drone Swarm for Extended Payload Flight Time

• UAS @ UCLA, UCLA Department of Mechanical and Aerospace Engineering

Overview/Description

- Goal is to have a team of drones which can dock into an aerial apparatus to collectively lift a payload
- Drone team would have several advantages: (1) increased endurance compared to an individual drone, (2) redundancy to keep payload airborne in the case of a mechanical failure on any individual drone, (3) significantly lower price than a single drone which could accomplish the same task using exotic fuels or larger scale.
- The challenge of this project is linking a drone swarm together both physically with control software. Our main problem is the process of docking a drone into the apparatus.

Feasibility Assessment / Benefit

This method if fully realized, could lead to indefinite aerial suspension of a payload which applies to many cases: fast deployment of communications infrastructure in situations of natural disasters; semi-permanent surveillance of a region; or ...

Recent Results / Status

- Preliminary Design Review (Late November)
- Thrust tests to verify batteries + motors
- Simulation w/ ideal physics & simplified controls demonstrates dynamic cooperative control.

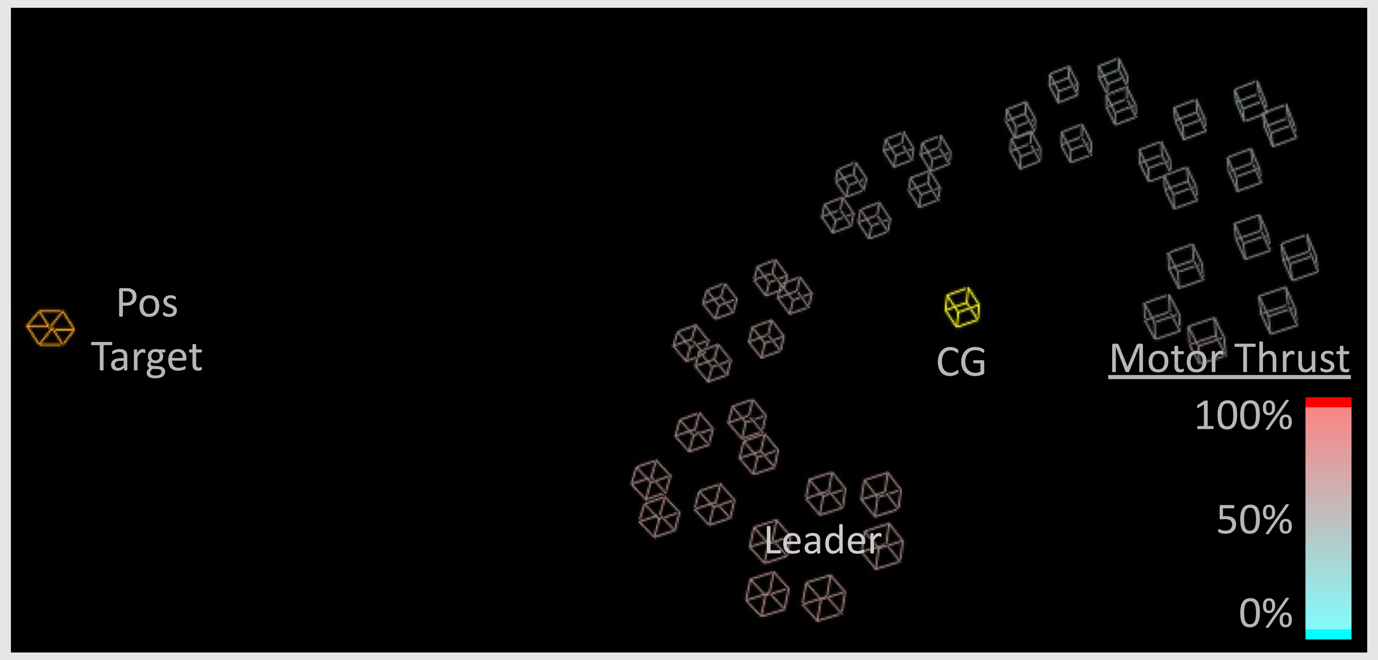
Next Steps

- Critical Design Review (Early February)
- Integrate subsystems
- Transition to physical testing from simulations

Partners

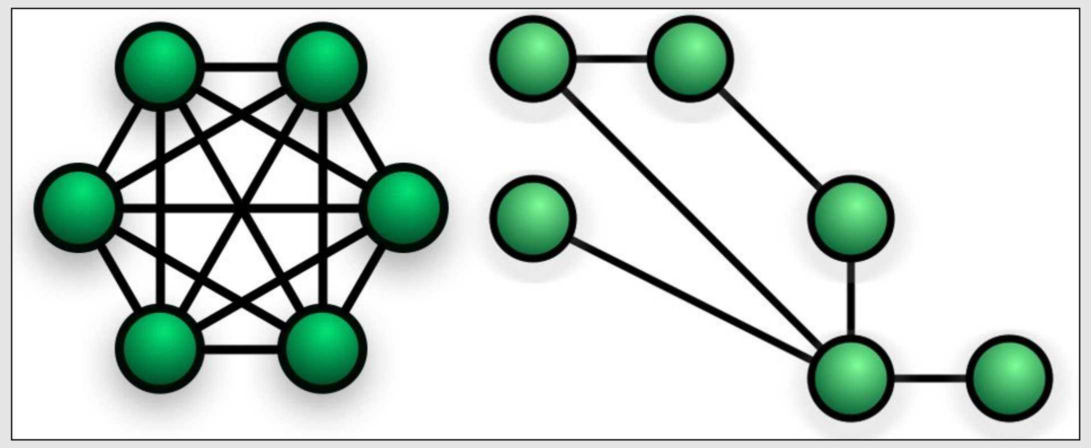
• UCLA Department of Mechanical and Aerospace Engineering

Controls



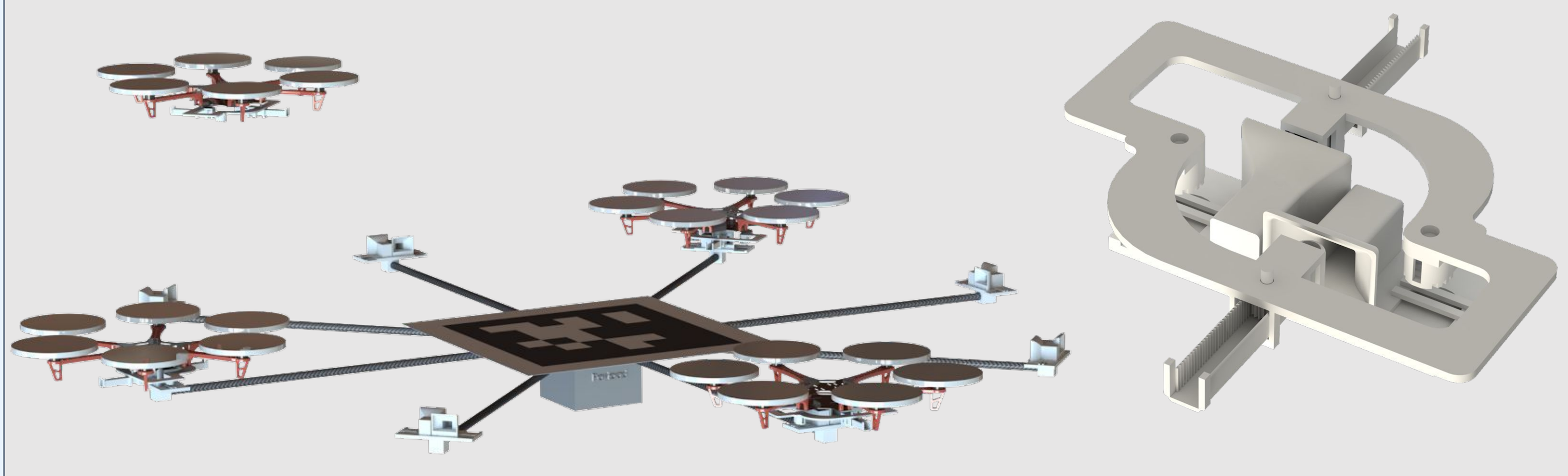
- Treated as a rigid structure, a motor control allocation scheme for all the rotors is determined.
- Control allocation optimization is being investigated.
- Leader/follower system for sending control setpoints, with handling of docking/undocking transitions.
- Simulations have demonstrated basic functionality; real-world tests are planned to verify and revise the methods used, most importantly distributed control.

Communications



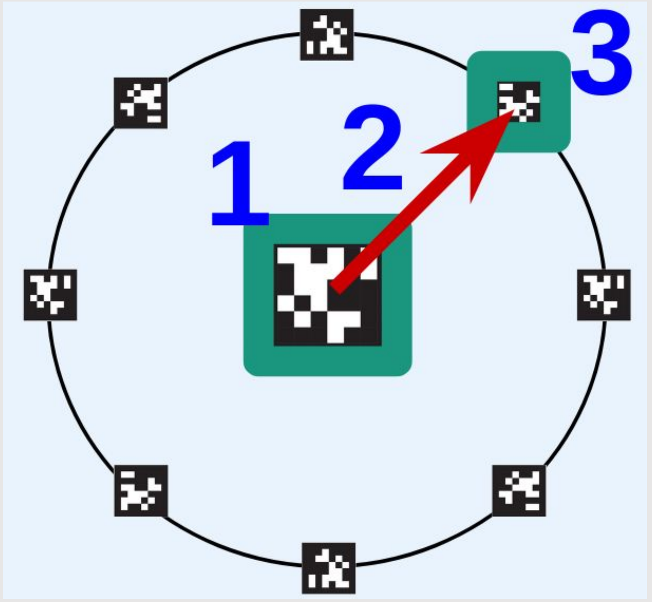
- Use OLSRV2/OONF framework to build a mesh network that allows drones to have direct intercommunications.
- Challenge: integrating with other parts of the system; the lack of documentation means the only way to find usable APIs is through reading the code.
- Upon drones joining and leaving, network topology recovers too slowly. Need to develop a new mechanism.

Airframe



- 8 booms extend from a central payload mount to provide landing sites for up to 8 hexacopters to dock to the frame
- At the end of each boom is a docking site with two mirrored guide funnels that, in conjunction with rack-and-pinion inserts on each drone and magnets for alignment, allow for rigid attachment to the frame in the proper orientation
- Each funnel provides 2” of horizontal and 1” of vertical tolerance for the alignment of each hexacopter; design changes that increase this tolerance are being investigated.

Docking



- Use GPS to get drones to and from the system.
- Once we make it to the system, autonomous docking is accomplished using computer vision.
- Challenge: need to have targets small enough to stay in frame when we get close, but be detectable from far away.
- 3 stage docking: drones use the big central target on their initial approach, use it to orient themselves, then can fly to their assigned location for actual docking using the smaller peripheral target.