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Sandia National Laboratories

Fundamentals of Airborne Manipulation (FAM)

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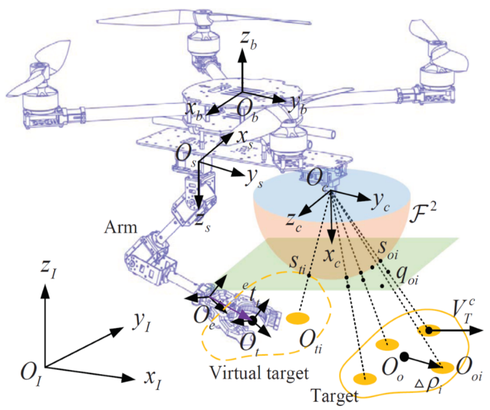
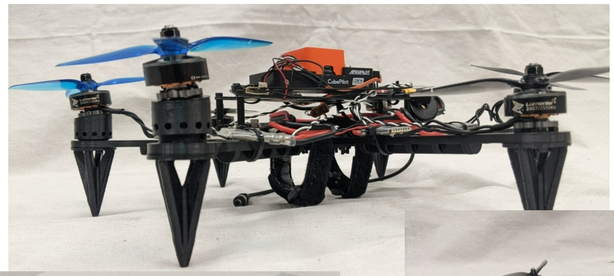
Introduction / Motivation

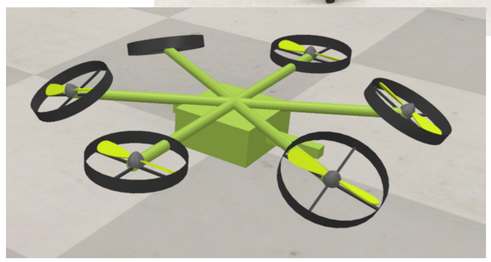
Q: How can we equip a drone to better interact with its environment?
A: Give it a multi degree of freedom robotic arm.
Q: How can we design the drone to exert the most force on the environment around it, without compromising mobility?
A: Change the propeller configuration.



Approach

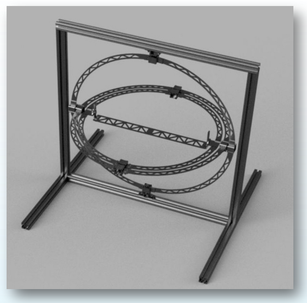
Instead of using a planar quadrotor, utilize a non-planar, fully-actuated vehicle. With tilted propellers, the system now has two extra degrees of freedom and is no longer restricted to using its pitch and roll exclusively to translate.
With two extras degrees of freedom, more force can be exerted in the desired directions, and the range of motion of the tool is greatly improved.





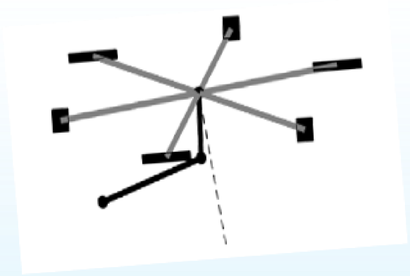
Challenges

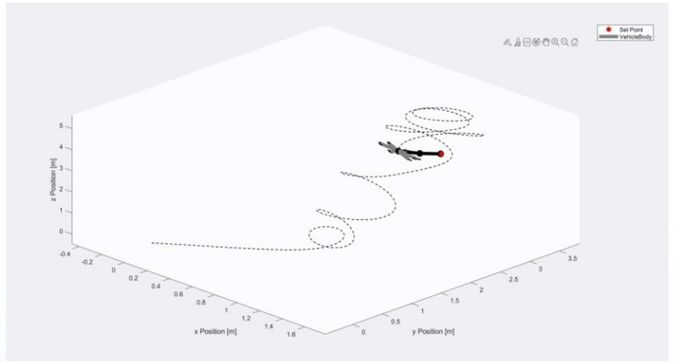
Physical Testing:
- New custom controllers need to be designed for the PX4 autopilot system.
- To safely test such a system, a unique apparatus is required. A gimbaled system, allowing for 3 rotational degrees of freedom.



Results

Simulation in MATLAB reveals that it is possible to use a tilted propeller design to achieve fully controllability of a drone built using a tilted propeller configuration. While having the tool track a trajectory.





Future Work / Partnerships

In the future, a new custom flight controller needs to be written on the PX4 architecture to make the system pilotable. After confirming the system is functioning as intended, a 3 D.O.F. robotic arm will be attached and used to test how much force the drone can exert on its surroundings and if the drone can recreate the trajectory tracking demonstrated in MATLAB.

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