PhD Dissertation Defense Announcement
Mechanical and Aerospace Engineering Department
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Optimal Aggressive Constrained Trajectory Synthesis and Control for Multi-Copters

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Abstract

Multi-copters have become increasingly popular in recent years due to their availability, mobility, agility, and flexibility. They serve as excellent platforms for control experiments and various applications. Their characteristics also make them an attractive choice for high-speed aerial navigation in complex environments. Numerous studies have been conducted on aggressive trajectory generation and maneuver tracking. However, the level of aggressiveness achievable depends on the optimality of the trajectory plan and the dynamic capabilities of the vehicle. It would be valuable if one can generate a trajectory that fully utilizes the dynamic capabilities of the multi-copter while accommodating specific maneuvers at predetermined locations. Therefore, in this research we assume that the multi-copter's dynamic capability is limited by its maximum rotor thrust and address the problem as "**Given waypoint coordinates, heading and vehicle velocity and attitude constraints at these waypoints, how to find a feasible trajectory that fully utilizes the dynamic capability of a multi-copter to achieve the optimal aggressiveness and perform precise trajectory tracking control?** ". We divide this research into three phases. In the first phase, we adopt a simplified quadcopter dynamic model and develop a synthesis framework to generate a multi-segment polynomial trajectory that fully utilizes the available rotor thrust of a quadcopter when performing the most aggressive maneuver. Next to be more realistic, we further develop the compensation for rotor aerodynamic, gyroscopic, and rolling effects in phase two and perform high fidelity Gazebo/RotorS simulation. In the final phase, we develop a SITL (Software in the Loop) test environment for realistic simulation and conduct real quadcopter flight experiments to identify the actual parameters in our dynamic model and verify the aggressive trajectory optimization and the trajectory tracking control we developed