Ph.D. Defense

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(Advisor: Prof. Komerath)

"Experimental Study of Low Reynolds Number Multirotor Aerodynamic Interactions"

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Montgomery Knight Building 317

Abstract

In recent years, Vertical Take-off and Landing (VTOL) rotor Unmanned Aerial Vehicles (UAVs) have gained importance in various application suited to their small size and relatively cheap construction. Among rotor UAVs, multirotor UAVs are easier to control, and hence popular. Unfortunately, the small size rotor UAVs have poor aerodynamic performance due to viscosity dominated losses and the lack of understanding of rotor-rotor and rotor-airframe interactions. The existing tools developed for solving helicopter flows are inapplicable in this regime because of the invalidity of the underlying assumptions based on ignoring viscosity. Hence, there is an urgent need for characterizing the low Reynolds number multirotor flows which will enable UAV design optimization to make UAVs more capable.

The present work explored some prominent flow field and aerodynamic interaction phenomena typical to small size multirotor UAVs. This was done through performance measurements and flow diagnostics over five different setups: single rotor, coaxial rotor, quadrotor, modular bi-rotor, and a rotor-box. Various vortex-vortex, vortex-vortex sheet, blade-vortex, vortex-duct, and vortex-box interactions were observed and interpreted. The implications of such interactions on vehicle performance and noise were also studied. This work serves as a platform over which further detailed studies into specific aspects of the whole problem can find inspiration. Most of the current findings can be applied to the UAV design process in their present form too.

Committee

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