THE UNIVERSITY OF ALABAMA IN HUNTSVILLE | COLLEGE OF ENGINEERING

Honors Capstone Research (HCR)
Summer Program 2024

Designing a Test Stand to Study Multi-Propeller Aerodynamic Interactions

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Introduction

A test rig is needed to assess the aerodynamic and aeroacoustics behavior of Unmanned Aerial Vehicle (UAV) propeller interactions. The test rig can simulate various pitch angles of the UAV's propellers. Measurement techniques such as force sensors, Particle Image Velocimetry (PIV), and microphones can be integrated into the test rig for the quantitative study of the aerodynamics and aeroacoustics of UAV propellers. Additionally, wind tunnel testing can reveal propeller behavior when subjected to wind gusts.

Conceptual Framework

Georgia Tech, MOST (Italy), and NASA Ames were the research centers referenced when designing UAH's propeller testing setup [1][2][3].

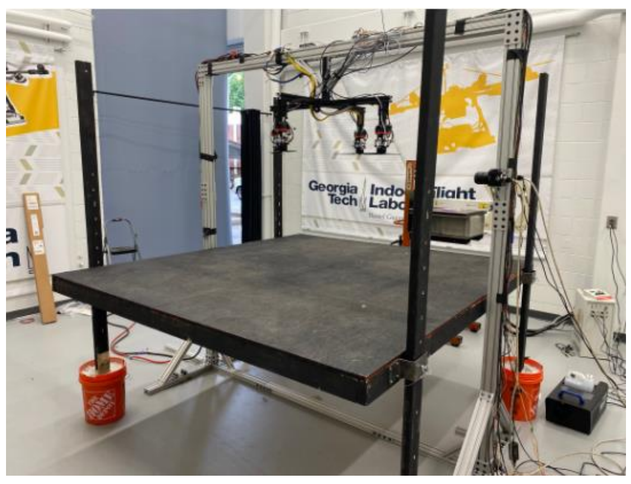

Fig 4. Georgia Tech's Indoor Flight Lab Test Platform [2]

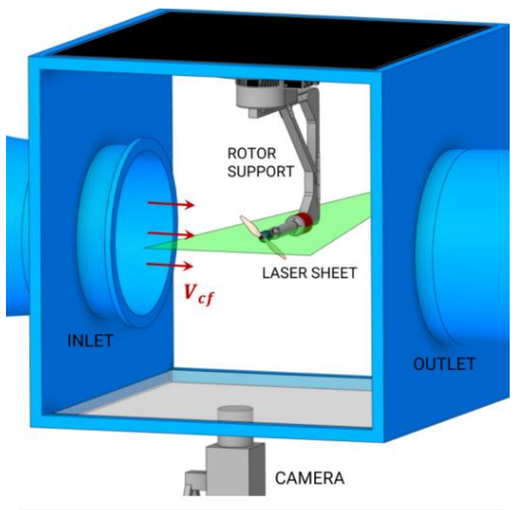

Fig 5. MOST - Centro Nazionale per la Mobilità Sostenibile (Italy) Propeller Testing Setup [3]

Results

The propeller test stand shown in figure 1 was constructed. An Arduino script was implemented to command the rotor to a desired RPM using PID control. Additionally, a Simulink model and user interface is currently being developed to improve data collection and usability as shown in figure 3.

Fig 1. UAH Propeller Test Stand Setup Completed During The Summer of 2024

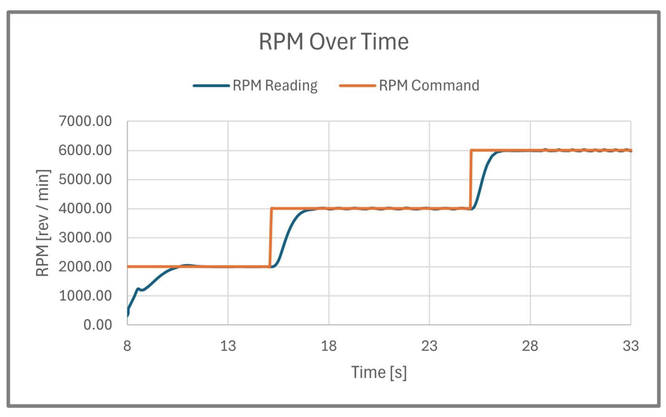

Fig 2. Example RPM Data Collected From The UAH Propeller Test Stand Shown in Figure 1.

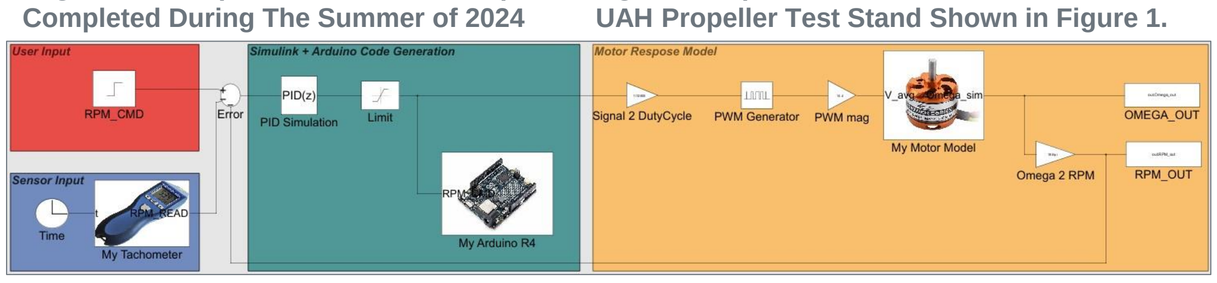

Fig 3. Simulink model block diagram illustrating how the electronic components work together

Impact

- Increased utility and interest in the commercial use of UAVs for urban transportation and package delivery.
- The military's utility of tight drone formations poses unique aerodynamic challenges due to the aerodynamic interactions of drones in close proximity.
- Novel lunar lander projects (Figure 6).
- Continued research and development in the aerodynamics of drones and UAVs is important to furthering relationships between UAH and the Huntsville aerospace industry.

Fig 6. Concept Rendering of NASA's Dragonfly Lander
Image Credit: Nasa/Johns Hopkins Apl/Steve Gribben

Acknowledgements

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References

[1] Marshal, M., "Performance of The Dragonfly Lander's Coaxial Motor in Vortex Ring State," AIAA SciTech Forum, Orlando, Florida, 2024.doi:https://doi.org/10.2514/6.2024-0247, AIAA 2024-0247.
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[3] Alesandro, G., "Aerodynamic investigation of a drone propeller in cross-flow," AIAA SciTech Forum, Orlando, Florida, 2024.doi:https://doi.org/10.2514/6.2024-0244, AIAA 2024-0244.

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