AN EXPERIMENTAL STUDY ON THE PERFORMANCE OF EXISTING AND CUSTOM QUIET PROPELLER DESIGNS FOR UNMANNED AIRCRAFT SYSTEMS

A Thesis
IN
Mechanical Engineering

Presented to the Faculty of the University
of Missouri–Kansas City in partial fulfillment of
the requirements for the degree

MASTER OF SCIENCE

by
SETH A. SEAGRAVES

B. S. Physics, University of Missouri - Columbia, 2021

Kansas City, Missouri
2023

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Seth A. Seagraves

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ABSTRACT

Unmanned Aircraft Systems (UAS), or drones, are being employed in a myriad of civilian and military applications including: aerial photographs of houses for real estate photography, videos of car chases, or package delivery. Package delivery provides unique challenges as the vehicle must be capable of carrying and delivering a payload in an (often) urban environment near non-participating bystanders. These larger UAS can produce significant acoustic signatures, which can deter operations in populated areas. The UAS propulsion system is the dominate acoustic source, and there is a need to reduce the acoustic signature of the propeller-motor system without dramatically reducing propulsion system performance. Several propeller design techniques were considered including: reducing the thickness of the propeller blade, increasing the sweep angle, and increasing the number of blades on the propeller. Further modification to the propeller

design such as a boundary layer trip on the leading edge top surface or serrations to the trailing edge has been shown to reduce the sound radiated by the propeller. In total, 37 quiet propeller designs were created and simulated using SolidWorks Flow Simulation. From the simulaiton results, the three best performing designs were chosen to move on to manufacturing. Bringing these designs to life, a manufacturing process was devised and outlined which results in a carbon fiber composite prototype propeller. A custom semi-anechoic chamber testing environment was constructed which allowed for adequate airflow reducing the performance reducing effects of local pressure regions from the inlet and exhaust of the propeller while absorbing almost all sound radiated by the propulsion system. Custom propeller design, modification, manufacturing, and testing was done ultimately reducing the acoustic signature of a UAV propulsion system by up to 50% at a constant thrust and a minimum increase in consumed power by only 8.5%.

The full version of this thesis will be uploaded onto the Defense Technical Information Center (DTIC). For more information please contact Dr. Travis Fields at fieldstd@umkc.edu.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the School of Science and Engineering, have examined a thesis titled "An Experimental Study on the Performance of Existing and Custom Quiet Propeller Designs For Unmanned Aircraft Systems," presented by Seth A. Seagraves, candidate for the Master of Science degree, and hereby certify that in their opinion it is worthy of acceptance.

Supervisory Committee

Travis D. Fields , Ph.D., Committee Chair
Department of Mechanical Engineering

Mujahhid Abdulrahim, Ph.D.
Department of Mechanical Engineering

Roy Allen, Ph.D.
Department of Mechanical Engineering