

AEROSPACE ENGINEERING AND ENGINEERING MECHANICS  
COLLEGE OF ENGINEERING AND APPLIED SCIENCE

SUMMER RESEARCH OPPORTUNITIES FOR UNDERGRADUATE WOMEN

APPLICATION DEADLINE: 03/01/2020

PROJECT TITLE: Aeroacoustics of Electrically Propelled Air Vehicles

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**Project Description**

A transformational era in flight is upon us with the increased ubiquity of Unmanned Aerial Systems (UAS), in particular, the burgeoning interest in Unmanned Aerial Mobility (UAM) for mobilizing cargo and passengers. While the precise application and market for these vehicles is still developing, there will definitely be more of these UAM vehicles flying in and around populated areas. One of the key enabling factors for realizing the quantity and frequency of flights that are envisioned will be the noise levels produced by UAM as they operate in populated areas. In order to develop low noise UAM, air vehicle designers need data, design tools, and technology to enable the development of quiet vehicles from conceptual design stage all of the way through detailed design. Currently, there is a dearth of data and capability for predicting the noise produced by UAM until millions of dollars have been spent to design, fabricate, and fly the vehicle. After fabrication of a vehicle, the only method of controlling noise is through retrofitting the system with noise control technology that is usually very limited in achievable noise reduction. This is why acoustics needs to be factored into the earliest stages of conceptual design in order to develop a vehicle that achieve the quietest design possible.

This project will be the first step in developing a state-of-the-art research and development program at the University of Cincinnati focused on measuring and predicting noise from UAM vehicles and operations. The long-term vision for this program is to create a Center of Excellence (CoE) for UAM aeroacoustics. This CoE will involve sub-scale to full-scale testing of the aeroacoustics and performance of propulsors (electrically driven propellers and rotors), flight testing of UAM systems (in collaboration with other UAV research groups at UC), development of design and prediction tools for UAM aeroacoustics prediction, and contributions to the development for noise regulation methods and procedures.

In order to execute this multidisciplinary research program, we need to develop capability for advanced measurement techniques to further the

understanding of the noise source mechanisms, fluid dynamics involved with noise generation, the impact of propulsor-airframe integration, and to generate the data needed to build low-order acoustic prediction tools.

Research projects may include:

- 1) Design, purchase, and assemble a mobile acoustics data acquisition platform for anechoic facility and outdoor measurements. This platform will include microphones, measurement arrays, data acquisition equipment, and software for acquiring and processing acoustic data
- 2) Develop a test stand for operating electric motor and rotor configurations in our anechoic facility
- 3) Develop an experimental setup for measuring the velocity field (velocity and turbulence) of various propulsor configurations. This task will utilize a high-speed Particle Image Velocimetry (PIV) system consisting of a high-speed laser, high-speed camera, and flow-seeding mechanism.
- 4) Develop data processing software to synthesize acoustics and flowfield data to provide data-driven insights into the dominant noise mechanisms to be addressed for UAM applications