I became involved in research early in my undergraduate career and have four years of experience spanning three topics at two universities. These topics cover a broad range, all relating to the field of aerospace engineering. Starting out I conducted research in satellites. Yet after about a year I realized that my real passion lies in fluids and I began doing research in turbine blade flutter. The knowledge and skills I learned studying flutter carried over to my fellowship at Purdue University where I researched the aerodynamics of insect flight.

Accelerated Satellite Deorbiting Using a Deployable Gossamer Sail (Jan. 09 - Nov. 09)

My interest in aerospace led me to join a satellite design team as a sophomore. This project was part of the Air Force Research Labs University Nanosatellite Program (AFRL-UNP) and I was the Payload Subsystem Leader for the University of Central Florida's (UCF) entry, KnightSAT II, under the direction of Dr. Chan Ham. The goal of this project was to design a satellite payload that consisted of a deployable gossamer sail that would act to accelerate the deorbiting of a satellite. With this type of novel payload a satellite could be deorbited at the end of its lifetime freeing up orbits for future satellites to be launched. This project consisted of engineering students from many disciplines and as a leader I was in charge of five peers. My team was responsible for researching the effect that the solar cycle had on drag and the effect that an electrodynamic tether had on satellite stability. Using Matlab, I simulated deorbiting scenarios that calculated the time a satellite would take to deorbit based on the ballistic coefficient of different sized gossamer sails. I was also the primary liaison between UCF and the subcontractors who built our gossamer sail, with the responsibility of relaying requirements and also travelled across the country for a Preliminary Design Meeting. This project culminated with a presentation to industry professional judges at the Small Satellite Conference 2009 at Utah State University. The technical skills I gained in this project such as Computer Aided Design and Matlab applied directly to my research in turbine blade flutter and flapping wing flight. Additionally, I was introduced to the process of developing a requirements verification matrix and technical presentation, which served me both in my future research and senior design project to build a model airplane.

Computational and Experimental Comparison for the Prediction of Turbine Blade Flutter (Jan. 10 - April 11)

As a Young Entrepreneur and Scholar-Research and Mentoring Program(YES-RAMP) Fellow I carried out this research at the University of Central Florida under the direction of Dr. Seetha Raghavan of the Mechanical, Materials, and Aerospace Engineering Department. Turbine blade flutter is a dangerous instability in jet engines caused by fluid-structure interaction and aeroelastic forces. The goal of this research was to improve the prediction of this instability using Finite Element Modeling (FEM) and Computational Fluid Dynamics (CFD). As an original member I performed a literature search to obtain the important parameters for predicting turbine flutter and also devised a specific research problem. Using commercially available software I developed a simulation that incorporated a morphing mesh, fluid-structure interface, and various turbine blade geometries. The coupling of the CFD and FEM solvers made obtaining an accurate converged solution challenging. Extensive research went into setting appropriate initial and boundary conditions as well as using the correct mesh type. The results of this simulation demonstrated the structural response of a turbine blade under various operating conditions which is useful information to engineers who desire to design stable turbine cascades. These results were presented at the 2011 Showcase of Undergraduate Research Excellence in the form of a technical poster. Additionally, I designed a wind tunnel experiment to verify the results obtained in the simulation, but supplemental funds were required and the experiment could not be carried out. The skills I gained in fluids, aeroelasticity, experimental design and numerical methods carried into my future research endeavors and facilitated my selection for a summer research fellowship at Purdue University. Also the skills I gained in CFD allowed me to host a workshop for underclassmen at UCF to train them in the CFD software package Star-CCM+.

Vortex Tilting and the Enhancement of Spanwise Flow in Insect Flight (May 11 - Current)

The Purdue Summer Undergraduate Research Fellowship (SURF) is an 11 week intensive research program. Working under Dr. Xinyan Deng of the Mechanical Engineering Department I researched insect (or flapping wing) flight. The goal of this study was to investigate the stability of the leading edge vortex (LEV), which is the flow structure responsible for generating lift in flapping wing flight. Using dynamically scaled robots submerged in mineral oil, a novel three-dimensional (3D) Particle Image Velocimetry (PIV) system was employed to capture the the 3D flow structures that surround a flapping wing. TSI Inc. provided this 3D PIV system called Volumetric 3-Component Velocimetry (V3V). Because of the recent advent of this technology, there was no straightforward way of visualizing and analyzing the data, thus our research group had to develop an in-house visualization and analysis tool. Using the Matlab skills I gained in previous research I aided in the development of a code that allowed for the visualization of vorticity isosurfaces, the plotting of circulation vs. wing span, and the tracking of the LEV core. Using this experimentally obtained data I showed the correlation between vortex tilting and spanwise flow, which supported our hypothesis that vortex tilting induces spanwise flow and thus stabilizes the LEV. These results on LEV stability furthered the understanding of the aerodynamics of flapping wing flight and puts us closer to developing flapping wing Micro Aerial Vehicles (MAV). These MAVs can be used for surveillance indoors and in urban areas both for civilian and military application. The results were presented at the 2011 SURF Symposium and out of 150 students my presentation was selected as a "Top Research Talk." This study on vortex tilting became the basis of my undergraduate honors thesis which was successfully defended on November 7, 2011. Also it earned me a chance to present at The American Physics Society Division of Fluid Dynamics Conference in late November.

My high interest and great success while conducting this research convinced me to continue on in this field for my PhD. The Purdue Bio-Robotics Lab has all the necessary tools and resources I need to continue and thus is my desired location to carry out the future work that is outlined in my Technical Proposal.

Publications

- [redacted]

Conferences and Presentations

- [redacted]
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