Project Scope and Plan

EML 4552C – Senior Design – Spring 2012 Deliverable

Team # 4

William Ehlers, Daryl Montooth, Redan Reyes, Manuel Santos

Department of Mechanical Engineering, Florida State University, Tallahassee, FL

Project Sponsor(s)

Dr. Ben Dickinson

Eglin Air Force Base

Project Advisor(s)

Dr. William Oates

Department of Mechanical Engineering

<u>Table of Contents</u>

Problem Statement…………………………………………………………………………………………………… page 3

Background/Justification……………………………………………………………………………………… page 4

Methodology…………………………………………………………………………………………………........ page 5

Constraints……….. page 6

Project Schedule……………………………………………………………………………………………………. page 7

Problem Statement

The reliability of micro-air vehicles is relatively low considering they are fairly new. Proper research and steps are being taken to better understand their performance/stability during flight and to increase the feasibility of application. Implementations of electro-active membranes are being used to control the shape of the wing during flight. The effectiveness of electro-active membranes can be determined by measuring time response. Through the implementation of electro-active membranes, we want to improve the flight characteristics, frequency modes, and time response. The flight characteristics include lift and drag while the frequency determines our stability. Time response is crucial in determining how long the wing takes to fully deform as well as go back to steady state.

Background / Justification

Micro aerial vehicles (MAV) are size restricted, unmanned aerial vehicles (UAV) that are used by the military for emergency response applications that include, and are not limited to, surveillance, reconnaissance and recovery operations. MAVs allow the military to have a better understanding of the environment they plan to encounter while reducing the risk of their location being detected by the enemy. Recently, the idea of placing electro active membranes on the wings of MAVs has been of great interest to increase the agility, lift-to-drag ratio and overall flight control. The purpose of the electro active membranes is to distort the shape of the wing by running an electric potential across it while it is approaching stall, which will allow for an increase in lift when it normally would not. Carbon grease will be used to accept the electric potential. While the benefits of MAVs are plenty, it is also important to address certain aspects which could potentially alter the outcome. One major problem to MAVs is the small size which directly affects its maneuverability and stability. Our solution will be to do tests on the MAV using strain variation. Through strain variation, we will be able to ensure a change in our frequency and flight characteristics. Through research, analyzation, and data, we concluded our best option to achieve our goals was through this technique of varying the strain. When speaking of varying the strain, we mean the strain of the VHB 4910 before application onto the frame. Typically, when conducting similar experiments, we see that most experiments were ran with approximately the same pre-strain. MAVs with the application of electro active membranes are still in design and testing stages, and we plan to further our knowledge of effective characteristics of this field through testing at Eglin Air Force Research Laboratory.

Methodology

The objective of using electro-active membranes in micro-air vehicle applications is to see if these membranes may truly enhance the existing aerodynamic properties of MAVs. The first step is to study the behavior of the membrane itself. Using a bench-top approach of experimentation, the time-response of the material behavior to an imposed voltage will be studied. In addition, the structure will undergo a vibration simulation to observe changes in modal frequency due to the imposed voltage. These experiments will be conducted using our predecessors' original idea of 300% strain as well as our varied strain concept to establish control and unknown variables. After these tests have been conducted, testing will shift over to wind tunnel testing at Eglin scheduled for early March during spring break. The wind tunnel tests will simulate the membrane under flight conditions in which an air flow of 6 and 10 m/s will be induced. The flight properties such as lift, drag, and etc. will be measured before and after voltage application to the electro-active membrane infused wing. The final test will be under gust alleviation conditions, also in the wind tunnel. A bluff body will be placed in front of the wing to simulate the existence of vortices generated within air flow. The wing's behavior under these conditions will be observed as well. Afterwards, an analysis of the recorded observations will be conducted before final preparations for the end of the semester. The analysis ideally will be done through means of finite element techniques.

Constraints

For each variation in strain value a large number of trials will be required to obtain a sufficient amount of parameter data. This will increase the accuracy of our parameter trending; however, it too will require the membrane to sustain cycled application of the high voltage. The optimization of parameter values for this dynamic system will require higher level finite element analysis, and the extent of optimization will be constrained by time available for this aspect of testing.

Effectively integrating our methods of gust alleviation prior to wind tunnel testing will be difficult, as each must prove viable to ensure the time available at REEF is not wasted on concept analysis. Available time for testing at the REEF facility will occur between March 3rd and 11th, and although the exact dates are not yet solidified, benchtop testing and the majority of preliminary analysis will need to be completed and approved by our faculty advisor before then.

The projection of costs for required materials this semester is still well within our allotted budget at just under $200 (travel expense to REEF facility not included) so the boundary conditions (i.e. for breakdown, etc.) of our setup may be determined without the overhanging concern of material availability.

Project Schedule

ID		Task Name	Duration	Start	Finish
1		Order Materials	22 days	Fri 1/13/1:	Mon 2/13/1
2		Benchtop Testing	10 days	Mon 1/16/1	Fri 1/27/1:
3		Benchtop Analysis	11 days	Fri 1/27/1:	Fri 2/10/1:
4		Receive Materials	1 day	Mon 2/13/1	Mon 2/13/1
5		Prototype Build	6 days	Thu 2/16/1	Thu 2/23/1
6		Final Build	6 days	Thu 2/23/1	Thu 3/1/1
7		Final Testing & Analysis	7 days	Sat 3/3/1:	Sun 3/11/1
8		Final Report & Presentation	23 days	Mon 3/19/1	Wed 4/18/1: