

Group 5
Enhanced Agility of MAV's Using
Adaptive Structures

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Overview

Introduction

Background

Design Concept

Testing

Cost Analysis

Future Work



Introduction

Motivation:

- Unmanned Aerial Vehicle (UAV) operating limitations

Project Focus:

- Implementation and Testing of adaptive structures in Micro-Air Vehicle (MAV)



Figure 1



Figure 2



Introduction

Project Specifications:

- Compatible with test equipment
- Reconfigurable
- Operating Range: $Re < 10^5$
- Largest Airfoil Dimension: ≤ 20 cm



Introduction: Previous Work

Dr. Dickinson and Dr. Oates summer 2010

- Elliptical Membrane Wing
- Dielectric Elastomer VHB 4910

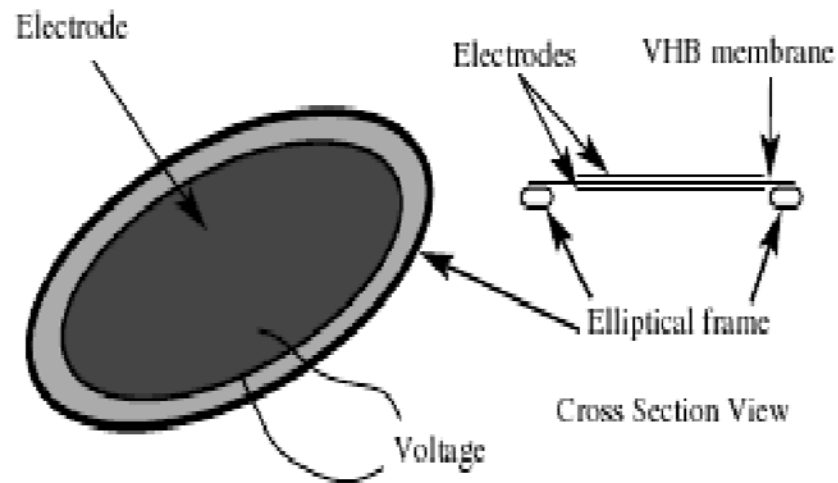


Figure 3



Background

Dielectric Elastomer

- Two Electrodes
- Membrane

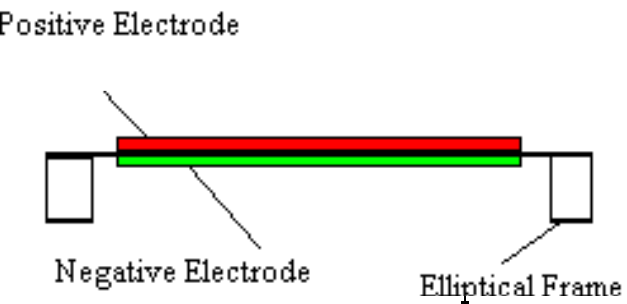


Figure 4

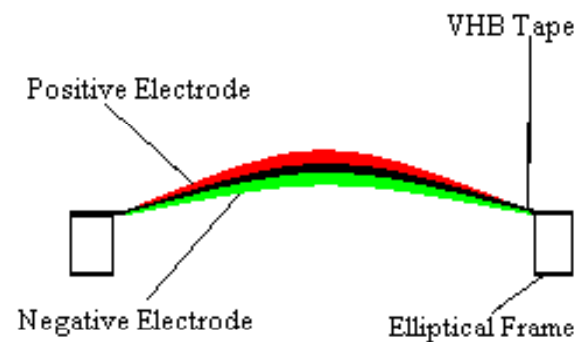


Figure 5

Design Concept

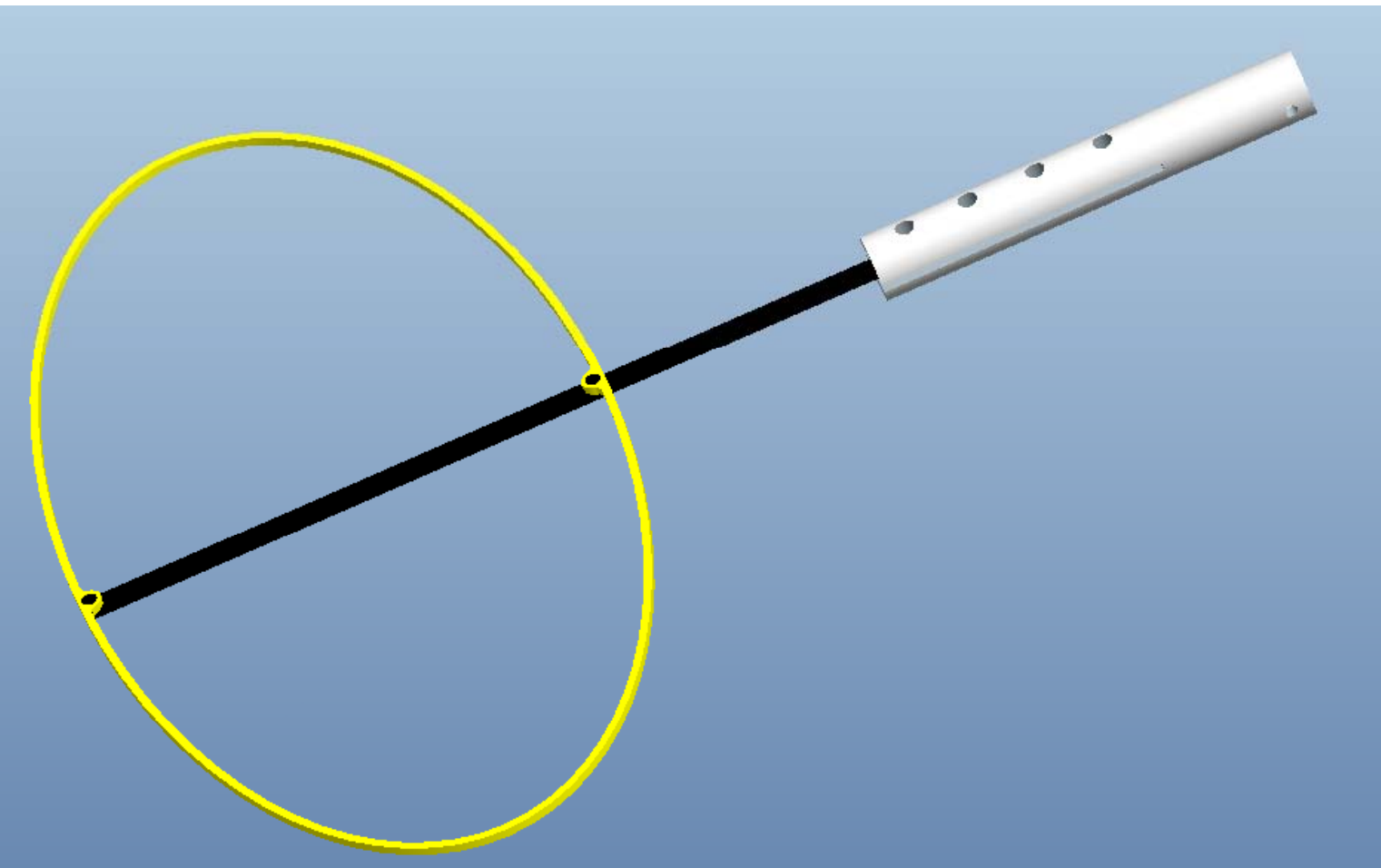


Figure 6



Design Concept: Elliptical Wing

Ellipse

- Major Axis: 20cm
- Minor Axis: 10cm
- 1/16" thickness

Material:

- Al 6061

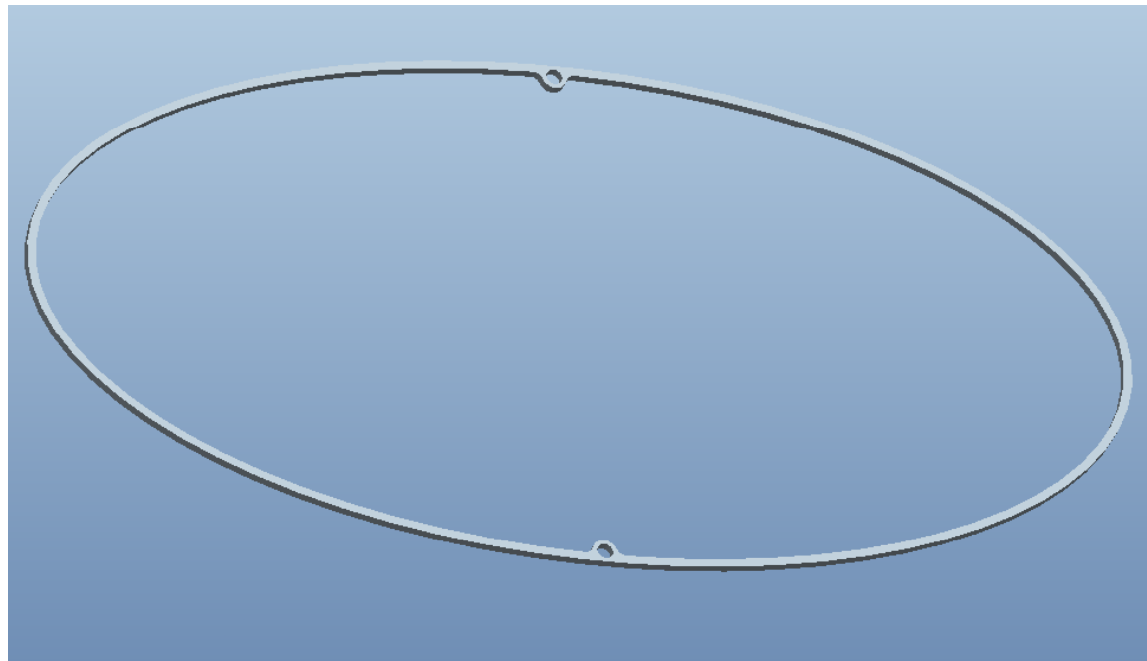


Figure 7: Elliptical Wing



Design Concept: Frame Connector

Minimal Affect on
Flow

Press Fit

Zero Deflection

Material:

- Al 6061

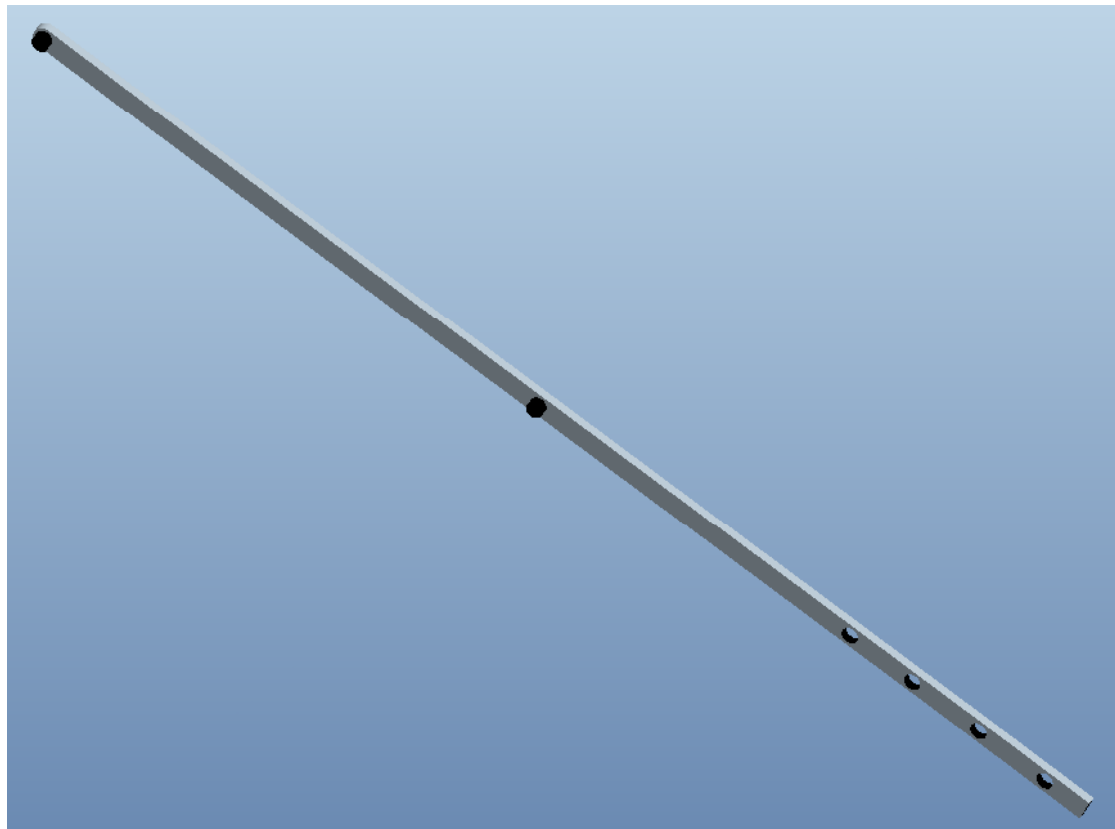


Figure 8: Elliptical Wing



Design Concept: Sting Connector

Non Conductive

Rigid

Material:

- Delrin

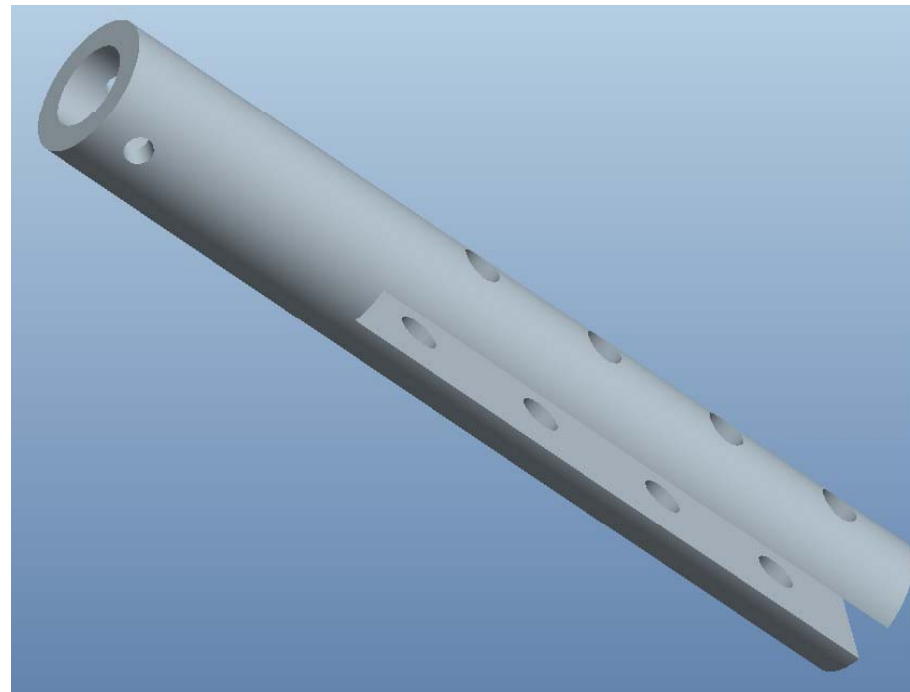


Figure 9: Sting balance connector

Design Concept: Wing Membrane

Materials:

- High strength bonding (VHB) tape
- Carbon Grease

Preparation:

- 300% Strain



Figure 10: VHB Tape 4910



Testing

Electrode Configuration

- Leading Edge
- Roll

Force Measurement

Flow Visualization



Electrode Configuration: Leading Edge

Vary Electrode Thickness

- 0.4 in
- 0.8 in
- 1.2 in

Focus:

- Increase Lift
- Increase Critical Attack Angle

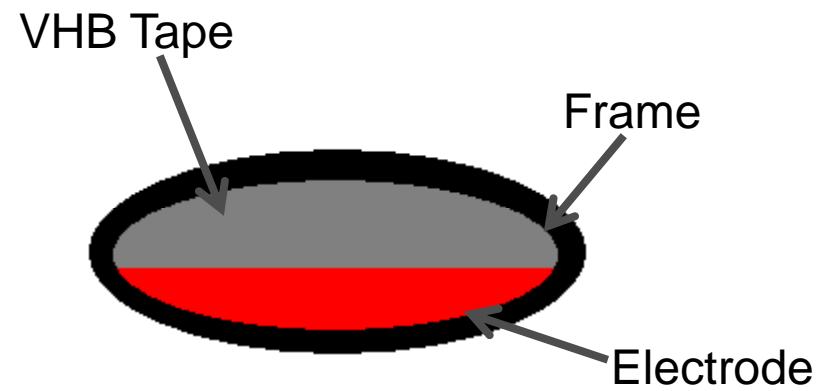


Figure 11: Electrode Placement

Electrode Configuration: Roll

Vary Electrode Thickness

- 1.32 in
- 2.64 in
- 3.96 in

Focus:

- Viability

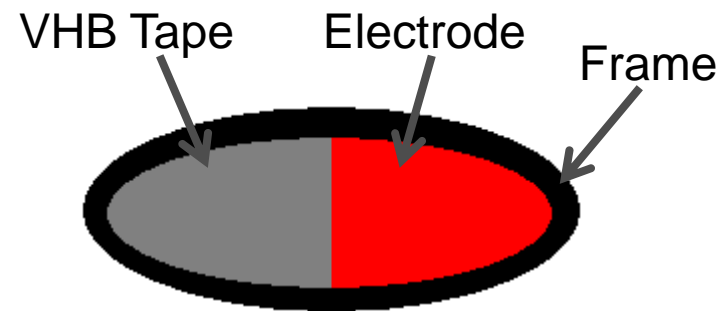


Figure 12: Electrode Placement

Testing: Force Measurement

REEF testing facilities

- Low speed wind Tunnel
- Sting Balance

Test Parameters:

- Wind Tunnel Velocity
- Angle of Attack
- Applied Voltage

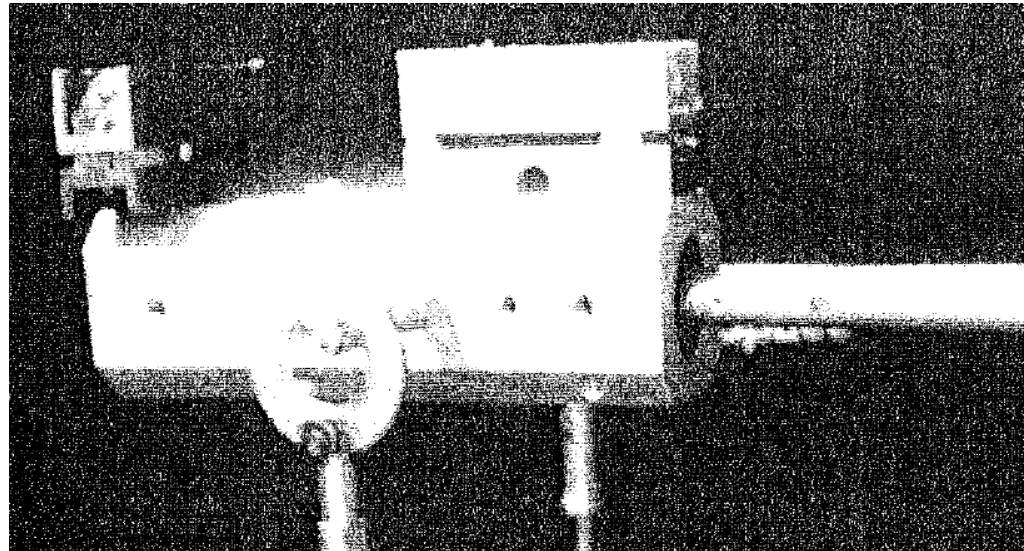


Figure 13: Sting Balance

Testing: Flow Visualization

FCAAP testing facilities

- Low speed wind Tunnel
- Smoke Wire

Test Parameters:

- Wind Tunnel Velocity
- Angle of Attack
- Applied Voltage

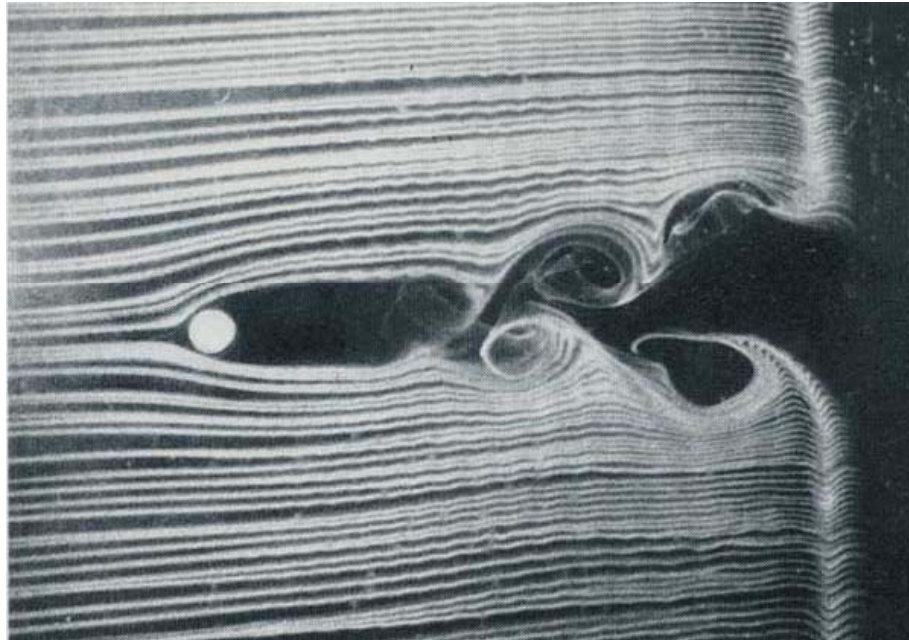


Figure 14

Wind Tunnel Test



Cost Analysis

| Part | Material | Vendor | QTY. | Part Cost | Total cost |
|--------------------|-----------------------------|---------------------|------|-----------|------------|
| Frame Connector | Aluminum | eMachineShop.com | 1 | \$30.00 | \$30.00 |
| Elliptical Frame | Aluminum | eMachineShop.com | 1 | \$60.00 | \$60.00 |
| Sting Connector | Sting Connector | McMaster-Carr | 1 | \$7.20 | \$7.20 |
| Actuating Material | 3M-VHB | McMaster-Carr | 2 | \$28.32 | \$56.64 |
| Electrode | Carbon Grease | Circuit Specialists | 1 | \$12.40 | \$12.40 |
| Electrical Wiring | Small Gauge Electrical Wire | Hardware World | 1 | \$6.78 | \$6.78 |
| Cutting | X-Acto Knife with Blades | Amazon | 1 | \$8.84 | \$8.84 |
| Transportation | Gasoline | Gas Station | 40 | \$2.79 | \$111.60 |
| | Total Cost | | | | \$293.46 |



Future Plans

Fall

- Schedule time at Eglin's REEF facilities
- Order Parts
- Smoke Wire Scheduling

Spring

- Prototyping
- Testing



References

Hays Michael, Jeff Morton, Ben Dickinson, and William Oates. "Aerodynamic Control of Micro Air Vehicle Wings."

Figure 1: http://www.skilluminati.com/research/entry/there_is_only_one_war_and_it_is_a_class_war/

Figure 15: http://www.sugawara-labs.co.jp/bigimages/smoke_b.jpg



Acknowledgements

Dr. Ben Dickinson

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