Wing Morphing Senior Design Team

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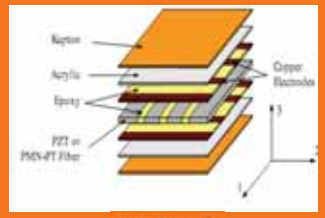
SMART MATERIALS

- Macro Fiber Composites (MFCs) were used due to their relatively high actuation and durability.
- The MFCs were arranged in a bimorph configuration to maximize deflection.



MFC Bimorph

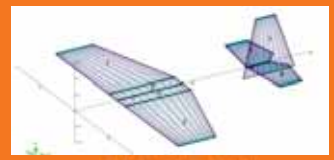
MISSION

Problem: Mechanical control systems on small unmanned aircraft are complex and lack resiliency.

Goal: Demonstrate the abilities of morphing materials technology by modifying an R/C aircraft through design and fabrication of control surfaces that use Smart Materials.

DESIGN

- Airfoils of varying thickness were generated using Matlab
- Aerodynamic characteristics of the morphing airfoils were determined using a panel method (XFOIL, Drela, MIT)
- Stability derivatives were found using a vortex lattice method (AVL, Drela and Youngren, MIT)



AVL Stability Model

CAD Model

MARKET RESEARCH

- Aircraft was selected to appeal to the majority of modelers
- R/C forums and magazines were scrutinized to determine most desirable aircraft characteristics (maneuverability, speed, fly anywhere)
- Electric propulsion system means no exhaust residue

Great Planes Edge 540

WIND TUNNEL TESTING

- The test was conducted in the Virginia Tech Stability Wind Tunnel on April 15, 2010.
- The goal of this test was to determine roll rates for the baseline aircraft (the Edge 540) and the morphing wing aircraft.
- Results show that the baseline configuration was able to achieve a 40% higher roll rate than the morphing configuration at full deflection. This is mostly due to the limited deflection of the MFCs.

Model Mounted in Wind Tunnel

FABRICATION

- A SolidWorks CAD model was developed
- Wing and stabilizer components were laser cut
- Lifting surface structure was fabricated from balsa wood, plywood, basswood, and fiberglass
- MFCs were bonded with epoxy to a steel substrate to form the control surfaces

ELECTRONICS

- MFCs operate between -500 to 1500 volts DC.
- RC receivers and servos operate on a PWM (Pulse Width Modulated) signal with an amplitude of 0.7 Volts.
- A printed circuit board (PCB) capable of converting PWM-DC was designed and constructed

PCB Board

Morphing Aircraft at Takeoff

FLIGHT TESTING

- A series of flight tests were conducted at VT Kentland Farms
- Baseline, partial morphing, and full morphing configurations were successfully flown

Morphing Rudder

Morphing Wing Fabrication