University Partnership for Aeroelastic Control of Lightweight Flexible Structures

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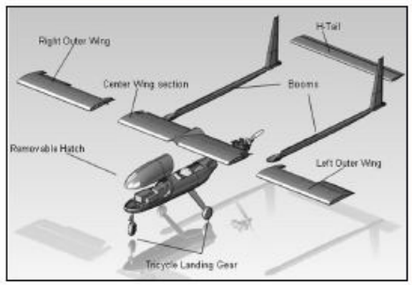
Motivation

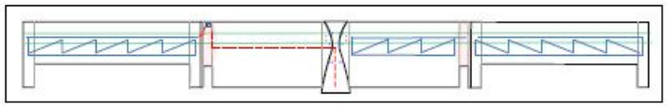
- Methods are investigated for monitoring and control of lightweight unmanned flying aerospace structures
- Utilize NASA Dryden's real-time fiber-optic strain sensing (FOSS) technology and deformation shape prediction capabilities to obtain structural deformation data
- Provide feedback to control system to mitigate aeroelastic effects on the airframe
- Development of methods to reduce the risk of in-flight breakups
- Results will be useful in the monitoring and control of a wide variety of current as well as future generations of aircraft and aerospace structures
- Application to the SPACE Center UAV (Odyssey)

Fiber-Optic Strain Sensing (FOSS) on CSULA UAV

- Instrument the SPACE UAV with FOSS technology
- Structural health monitoring during real-time flight
- Test-bed for real-time studies
  - Strain-based deformation shape estimation
  - Structural health monitoring, damage detection and condition assessment
  - Feedback to flight control system
  - Design of conforming trailing edge wing
  - Aero-elastic stability and flutter control



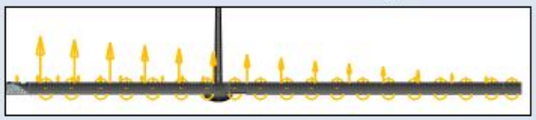
Odyssey UAV: component view

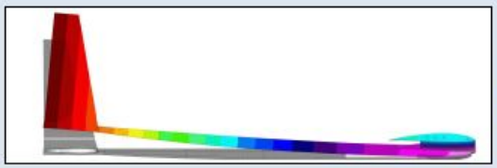


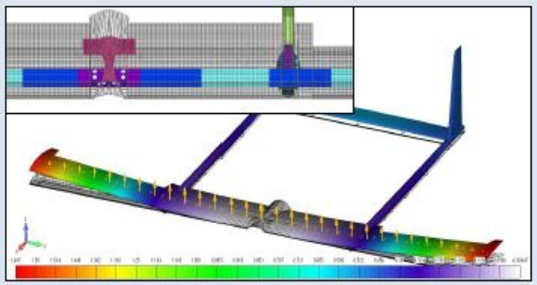
Odyssey UAV: Top wing fiber layout

Odyssey UAV Finite Element Model (FEM)

- Airframe modeled with Nastran/FEMAP
- Forces modeled after realistic flight loads



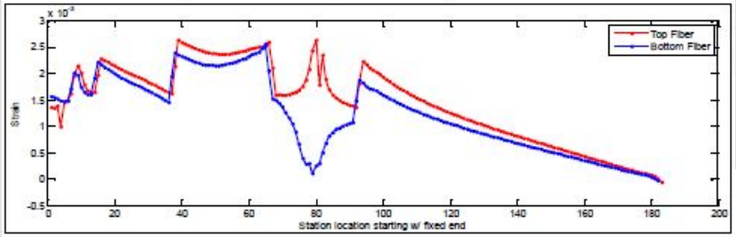


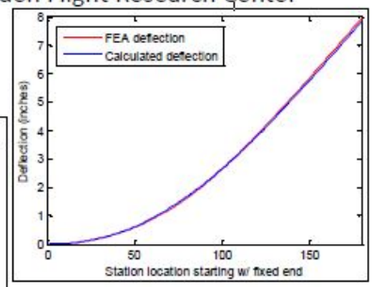


Above: FEM with component close-up view and wing deflection deformation and contour
Left: FEM Right wing force loading (top) and FEM with boom deflection deformation and contour (bottom)

Deformation Shape Estimation of CSULA UAV Wing

- Analytical and experimental studies on the Odyssey wings to evaluate the accuracy of the real-time deformation shape predictions and measure structural vibration of the UAV wings
- Strain-based displacement theories developed at NASA's Dryden Flight Research Center used to determine wing deflection
- Strain and deformation information extracted from FEM
- Results compared with expected displacement values

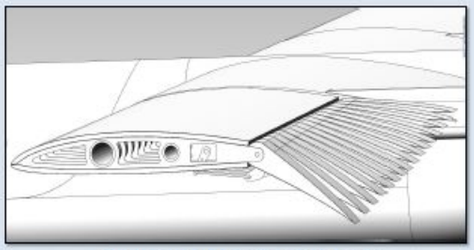




UAV Wing strain (left) and deflection calculations (above)

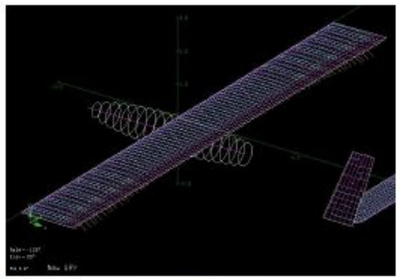
Conforming Trailing Edge (Micro-MUTT)

- Conforming trailing edge design using segmented aircraft control surfaces
- Suppression and control of structural resonance due to lift forces and vibration modes.
- Apply localized correcting forces to the structure
- Aerodynamic model created with the vortex lattice method for fluid dynamics.
- Investigate effectiveness of a segmented control surface design

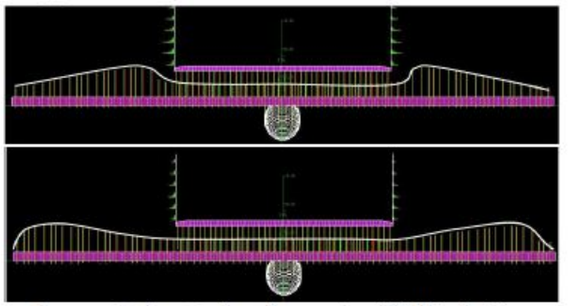


Segmented control surfaces

Loading Studies for Conforming Trailing Edge



SPACE Center UAV: AVL load distribution analysis for segmented control surfaces



Segmented control surfaces wing lift distributions: root bias (top) and tip bias (bottom)

Acknowledgements

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