Multi-Disciplinary Analysis in Morphing Airfoils

Anand Natarajan

***Abstract*—Fully morphing wings allow the active change of the wing surface contours/wing configuration in flight enabling the optimum wing design for various flight regimes. These wing shape deformations are obtained by using smart actuators, which requires that the wing structure be flexible enough to morph under applied actuator loads and at the same time be fully capable of holding the aerodynamic loads. The study of such wing surface deformation requires an aeroelastic analysis since there is an active structural deformation under an applied aerodynamic field. Herein, a 2-D wing section, that is, an airfoil is considered. Modeling a variable geometry airfoil is performed using B-spline expansions. B-spline representation is also favorable towards optimization and provides a methodology to design curves based on discrete polygon points. The energy required for deforming the airfoil contour needs to be minimized. One of the methodologies adopted to minimize this actuation energy is to use the aerodynamic load itself for wing deformation. Another approach is to treat the airfoil deformation as a Multi Disciplinary Optimization (MDO) problem wherein the actuation energy needs to be minimized subject to certain constraints. The structural analysis is performed using commercial finite element software. The aerodynamic model is initiated from viscous-inviscid interaction codes and later developed from commercial Computational Fluid Dynamics (CFD) codes. Various modeling levels are investigated to determine the design requirements on morphing airfoils for enhanced aircraft maneuverability.**

[Full Text Not Available]