ABSTRACT

Aeroservoelastic Design Optimization of Aircraft with Morphing Wings

This research investigates how a technology known as "morphing wing" can reduce aircraft fuel burn and the impact of aircraft operations on the environment. Inspired by birds, morphing-wing aircraft can change the wing shape during flight to adapt to the ever-changing flight conditions, allowing aircraft to save fuel through two different mechanisms. One is the reduction of aerodynamic drag during flight. The second is the reduction of structural weight by actively reducing peak loads that only appear during certain flight conditions such as maneuver and gust turbulence. Actively reducing these loads during flight allows aircraft to be designed with lighter wings that can constantly adapt to operate at its optimal performance, ultimately translating into further fuel savings. Due to the complex interactions that occur to these morphing and more flexible wing structures involving the disciplines of aerodynamics/structures/dynamics/controls (also known as aeroservoelasticity), careful multidisciplinary considerations to evaluate the net energy savings and operational safety of this technology must be taken. Moreover, morphing wings add extra weight and complexity to aircraft, making it difficult to estimate its net benefit. The main scientific objective of this research is to help determine the net performance gain from morphing-wing technology. This is achieved by developing a multidisciplinary computational framework capable of analyzing and optimizing aircraft equipped with morphing wings to investigate the potential of this technology to reduce fuel burn.