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A Flying Wing UCAV Design Optimization Using Global Variable Fidelity Modeling

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Abstract

This paper describes the multidisciplinary design optimization (MDO) process of a flying wing unmanned combat aerial vehicle (UCAV) using global variable fidelity modelling (GVFM) algorithm. A developed flying wing UCAV design framework combines aerodynamics, weight and balance, propulsion, performance, stability and control, and other disciplines. Analysis codes are based on low fidelity analysis and empirical equations. Design problem formulation focuses on features of a flying wing aircraft configuration that is known for its good aerodynamics, and poor stability and control (S&C). GVFM algorithm is implemented to increase prediction accuracy of analysis for important aerodynamic and S&C functions such as, lift-to-drag ratio, parasite drag coefficient, static margin etc. An automated high fidelity aerodynamic analysis (CFD) process is developed and integrated into GVFM model. Design optimization problems with low fidelity analysis and with implementation of GVFM model are successfully solved. The optimum solution obtained with low fidelity analysis shows 18.6% improvement of an objective function, while solution obtained with GVFM model about 15.9%. However CFD analysis of a low fidelity optimum solution indicates only 14.4% improvement, which means that low fidelity analysis underestimates the value of objective function by 4.2%. GVFM model converges to high fidelity value of a function by algorithm definition. The optimum UCAV configuration has longer operational range and improved stability and control characteristics comparing to the baseline.

Keywords: Unmanned Aerial Vehicle, Multidisciplinary Design Optimization, Variable Fidelity Optimization, Aircraft Conceptual Design, Computational Fluid Dynamics.