Optimization and Experimental Development of a Morphing Flaperon for Small UAVs Using Fused Deposition Modeling

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Abstract

Airfoil morphing replaces conventional discrete control surfaces with continuous camber change over a partial or full chord length. This article presents the development of a morphing flaperon, spanning from initial conceptual design and optimization to the experimental demonstrator phase and preparation for flight testing on a small unmanned aerial vehicle (UAV). In the preliminary design stage, a morphing technique utilizing a standard wing structure, a rigid flaperon trailing edge, and a connecting compliant upper skin was selected. Kinematic design options and optimization via genetic algorithms were investigated. Subsequent development focused on a kinematic demonstrator produced using Fused Deposition Modeling (FDM), including the selection of an actuation mechanism and suitable polymers. This demonstrator, consisting of a short wing section with an integrated actuator, successfully verified the morphing kinematics and actuator capacity. Current research aims to integrate this technology into a flight-ready UAV wing. This stage involves wind tunnel testing to evaluate behavior under aerodynamic loads, as previous tests only accounted for loads induced by skin stiffness. Furthermore, structural modifications are being designed to incorporate the morphing section into the full wing assembly. Finally, a series of flight tests has been proposed to verify the viability of the concept in a safe and controlled manner.