Hybrid Morphing Trailing Edge Designed for Camber Change of the Control Surface

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In this study, the design and analyses of a novel morphing trailing edge control surface is presented. The developed control surface is intended to be utilized on an Unmanned Aerial Vehicle (UAV). The morphing features of the control surface was obtained by using different compliant materials, which are able to undergo large in-plane deformations. The design also includes the utilization of the composite materials together with conventional aluminum material hence the design is called a hybrid one. The actuation was applied by using various number of small servo actuators located inside the control surface at different locations. During the design, CATIA V5-6R2012 package program was utilized and the structural analyses were conducted with Finite Element Method by using ANSYS® Workbench™ v14.0 package program. First, the design and analyses were done for in-vacuo condition and the relevant aerodynamic loading was later considered. The required aerodynamic loads, which were representing the flight conditions of the UAV, were calculated by Computational Fluid Dynamics analyses. The aerodynamic mesh used was generated by Pointwise® V17.2 R2 package program. The SU2 (Stanford University Unstructured) V3.2.1 open source software was also used in the study as the flow solver. The UAV had a baseline wing with NACA6510 airfoil. The required camber and de-camber characteristics were tried to be achieved for various NACA airfoil targets. By conducting a non-linear Finite Element Analysis it was shown that the control surface can successfully undergo both camber and de-camber morphing, both in-vacuo condition and under aerodynamic loading.

I. Introduction

IT is generally believed that, in unmanned aerial vehicles, the wings having unconventional control surfaces are heavier as compared to the conventional wings due to the weight and the complexity of the actuation mechanisms involved. However the aerodynamic efficiencies attained at different phases of the flight usually pays off its dividents. In this study a hybrid tailing edge control surface is indigeneously designed and developed. Being hybrid is due to the fact that the control surface is made of a C section aluminum, composite rigid part filled with foam and a fully compliant material. The fully compliant material can have large in-plane strain and the displacement. The actuation acting on the composite rigid part then causes it to undergo a nearly rigid body rotation. The term rigid part is therefore used.

The study has been conducted within the scope of CHANGE (*Combined morpHing Assessment software usiNG flight Envelope data and mission based morphing prototype wing development*) Project financed under the 7th Framework Programme of the European Commission [1].

This paper first outlines the structural design in in-vauo condition and then the effects of aerodynamic loads have been presented. During the development phases of the study different number and location of the servo actuators, different compliant materials were considered [2-6].

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