Proceedings of the Canadian Society for Mechanical Engineering International Congress 2021
CSME Congress 2021
June 27-30, 2021, Charlottetown, PE, Canada

Bistable Composites: Design Platform for Hyper-Elliptic Cambered Span (HECS) Morphing Wing

Sam Nakhla[1*],Ahmed Elruby[1]
[1]Department of Mechanical Engineering,
Memorial University of Newfoundland,
St. John's, Canada
*satnakhla@mun.ca

ABSTRACT

Unsymmetric bistable composite laminates provide an appealing platform for morphing applications. In particular early start of the field of biomimetics documented many designs inspired observing birds and flying insects. Current advances in this field reflect better understanding of biologically inspired morphing wings to be mimicking the function of birds' or insects' wings instead of identical imitation. This work provides examples on the design of morphing wing of uninhabited aerial vehicle (UAV) utilizing bistable composites. Conventional winglet and Hyper-Elliptic Cambered Span (HECS) configurations are elected to demonstrate design flexibility. HECS configuration, biologically inspired, and conventional winglet configuration are selected for their ability to offer aerodynamic advantages in terms of drag minimization. Combination of Bistable and symmetric laminates are arranged spatially in different proportions within wing planform to arrive at several design alternatives. The cured shapes and stability characteristics of these design variations are predicted using a generalized finite element nonlinear procedure. Geometries of developed morphing HECS and winglet configurations are assessed against NASA wind tunnel models. This assessment confirmed the ability to optimize the morphing wing geometry hence achieving the sought aerodynamic benefits. Moreover, the use of bistable laminates for morphing wing design offers innovative alternative to the use of heavier mechanisms linkage systems as documented earlier in literature. Furthermore, bistable composites provide a cost-effective platform where actuators are required to trigger shape change without any requirements on maintaining morphed shape(s) stability.

Word count: 231