World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:9, No:10, 2015

Sensor Network Structural Integration for Shape Reconstruction of Morphing Trailing Edge

Authors : M. Ciminello, I. Dimino, S. Ameduri, A. Concilio

Abstract : Improving aircraft's efficiency is one of the key elements of Aeronautics. Modern aircraft possess many advanced functions, such as good transportation capability, high Mach number, high flight altitude, and increasing rate of climb. However, no aircraft has a possibility to reach all of this optimized performance in a single airframe configuration. The aircraft aerodynamic efficiency varies considerably depending on the specific mission and on environmental conditions within which the aircraft must operate. Structures that morph their shape in response to their surroundings may at first seem like the stuff of science fiction, but take a look at nature and lots of examples of plants and animals that adapt to their environment would arise. In order to ensure both the controllable and the static robustness of such complex structural systems, a monitoring network is aimed at verifying the effectiveness of the given control commands together with the elastic response. In order to achieve this kind of information, the use of FBG sensors network is, in this project, proposed. The sensor network is able to measure morphing structures shape which may show large, global displacements due to non-standard architectures and materials adopted. Chord -wise variations may allow setting and chasing the best layout as a function of the particular and transforming reference state, always targeting best aerodynamic performance. The reason why an optical sensor solution has been selected is that while keeping a few of the contraindication of the classical systems (like cabling, continuous deployment, and so on), fibre optic sensors may lead to a dramatic reduction of the wires mass and weight thanks to an extreme multiplexing capability. Furthermore, the use of the 'light' as 'information carrier', permits dealing with nimbler, non-shielded wires, and avoids any kind of interference with the on-board instrumentation. The FBG-based transducers, herein presented, aim at monitoring the actual shape of adaptive trailing edge. Compared to conventional systems, these transducers allow more fail-safe measurements, by taking advantage of a supporting structure, hosting FBG, whose properties may be tailored depending on the architectural requirements and structural constraints, acting as strain modulator. The direct strain may, in fact, be difficult because of the large deformations occurring in morphing elements. A modulation transducer is then necessary to keep the measured strain inside the allowed range. In this application, chord-wise transducer device is a cantilevered beam sliding trough the spars and copying the camber line of the ATE ribs. FBG sensors array position are dimensioned and integrated along the path. A theoretical model describing the system behavior is implemented. To validate the design, experiments are then carried out with the purpose of estimating the functions between rib rotation and measured strain.

Keywords : fiber optic sensor, morphing structures, strain sensor, shape reconstruction
Conference Title : ICAST 2015 : International Conference on Adaptive Structures and Technologies
Conference Location : Bali, Indonesia
Conference Dates : October 11-12, 2015