Telescopic Wing-Box for a Morphing Wing

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This paper describes the design and testing of a wing-box capable of producing wingspan changes for flight speed adaptation developed within the CHANGE project. One of the goals of CHANGE was to design and implement a morphing wing that could combine more than one morphing concept. The capabilities adopted for this wing are span change and leading edge (LE) and trailing edge (TE) camber changes. The last two can produce combinations of positive and negative chordwise camber changes and even spanwise twist. A modular design philosophy was adopted for this wing such that the individual systems producing span change, LE change or TE change can be separately developed and then integrated into the overall wing system. This approach facilitated the development of each required mechanism and made the integration of all components easier. The structure was designed for strength, stiffness and low weight using a structural finite element model. A prototype telescopic wing-box section of 0.6 m in span but with full scale cross-section was manufactured and fitted with the actuation system before full development of the wing system. This prototype was used to validate both the structural design through actual loading and the actuation system's proper functioning through hundreds of span extension/retraction cycles under load. Results from design and experimental tests demonstrated full functional capability of the telescopic wing-box system.

Nomenclature

C_L	=	lift coefficient
H	=	horizontal force
M	=	pitching moment
n	=	normal load factor
V	=	flight speed, vertical force

I. Introduction

MANY aircraft morphing concepts have been proposed since the early days of aviation. Most early concepts were developed and applied primarily for control purposes but soon it was realized that drastic changes in size and geometry could favor an expanded flight envelope allowing a single aircraft to perform different missions or fly in significantly different flight regimes in the same mission with improved performance. However, most concepts proposed for manned aircraft were heavy, difficult to actuate and produced only one shape change. With new composite materials and new types of actuators it is now possible to develop concepts which may see practical application in wider shape/size change situations at least in unmanned aircraft systems.

There has been a great effort by the scientific community and aerospace companies to develop morphing concepts to improve specific performance parameters or overall flight performance of aircraft. Most concepts are studied at a numerical level only, but there are already many that reached prototype development for performance validation or technology development. However, there are only a few systems that reached flight state and in most of those no performance data is available. Many span morphing concepts have been studied to different levels of development and maturity. A large number of those can be seen in Ref. 1. It seems that there will be a long way before one can see use of reliable and effective morphing technologies fitted to aircraft. Application of these technologies to unmanned aircraft seems to be more practical in the near future because some experimental vehicles are already flying[2].

This paper describes the design and testing of a wing-box capable of producing wingspan changes for flight

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