DEVELOPMENT OF A NEW SPAN-MORPHING WING CORE DESIGN

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Abstract - This paper introduces a new design for the core of a span-morphing wing that increases the span-wise length of the wing by fifty percent. The purpose of morphing the wingspan is to increase lift and fuel efficiency during extension, increase maneuverability during contraction, and add roll control capability through asymmetrical span morphing. The span morphing is continuous throughout the wing, which is comprised of multiple partitions. Three main components make up the structure of each partition: a zero Poisson's ratio honeycomb substructure, telescoping carbon fiber spars and pneumatic cylinders for actuation. The zero Poisson's ratio honeycomb structure is an assembly of solid PLA internal ribs and Nylon Alloy 910 flexible chevrons. This innovative multi-part honeycomb design allows the ribs and chevrons to be 3D printed separately from different materials to accommodate design iterations and future maintenance, and to offer different directional stiffness. Because of its transverse rigidity and span-wise compliance, the design maintains the airfoil shape and cross-sectional area during morphing. The telescoping carbon fiber tubes interconnect to provide structural support throughout the wing while undergoing morphing. The whole wing can be covered with a continuous flexible composite skin made of a silicone rubber matrix with embedded unidirectional chord-wise carbon fibers to allow for span-wise compliance while maintaining chord-wise stiffness. The wing model has been computationally analyzed, manufactured, assembled, and experimentally tested to validate the simulation results. The new design proved to be superior to previously published span morphing wing core designs in terms of complexity, manufacturability and functionality.

Keywords - Airfoil, 3D printing, carbon fiber tubes, telescoping spars, chevrons.