Design and Analysis of Low-Cost Attritable Aircrafts using Dynamically-Data-Driven IGA Models

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In recent years, there has been a significant increase in the use of Unmanned Aerial Vehicles (UAVs) by the US military. UAVs are expected to fly a large number of long (48+ hours) missions, and operate without failure. Furthermore, in order to increase the durability of these vehicles and decrease weight, composite materials are currently experiencing a widespread adoption, both in the military and civilian aircraft design. As a result, in order to decrease costs associated with the operation, maintenance, and, in some cases, loss of these vehicles, it is desirable to have a Dynamically Data-Driven Application System (DDDAS) framework that can reliably predict the onset and progressions of structural damage in geometrically and materially complex aerospace composite structures operating in the environments typical of UAVs. In this work we pursue a dual objective: We first develop a Multiscale DDDAS framework for damage prediction in aerospace structures. As part of this development, we incorporate derivative-free optimization techniques for continuum damage mechanics (CDM) modeling parameter estimation using fatigue-damage experimental data (both static and dynamic). We then deploy our Multiscale DDDAS framework as part of the multi-fidelity decision-making support system for self-aware air vehicles.

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