Adaptive Biomimetic Aircraft (ABA): Nature-Inspired Enhancement of the Aerodynamic Design of Aircrafts to Improve Sustainable Performance

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The aviation industry stands as one of the most threatening modes of modern mobility, producing 3.8% of the global CO2 emissions in 2023. CO2 emissions are expected to proliferate and surpass their previous levels by 2025. The goal of this project, Adaptive Biomimetic Aircraft (ABA), is to address the problem of rising CO2 emissions in this industry by offering novel solutions that effectively reduce the fuel consumption of traditional aircraft. This is achieved by enhancing the aerodynamic design of aircraft based on inspirations from nature, including shark hydrodynamics and owl flight mechanics. As such, the first feature of ABA involves microscopic riblet-like structures, similar to that of shark denticles, which are molded into the paint of an aircraft to reduce fluid friction. This research employed the use of SimScale CAE software to assess the efficiency of such structures when imprinted on different parts of an aircraft. The second feature of ABA involves the design of morphing wings characterized by adjustable, distinct degrees of curvature, mimicked after owl wing curvatures, that adapt to various laminar and turbulent conditions. This research assessed different wing models against varying airflow conditions using SimScale CAE to determine the optimal design criteria, that maintains a high lift-to-drag ratio, for efficient adaptability. The integration of these two features of the adaptive aircraft is presented in this research, along with its testing and evaluation. Preliminary results suggest promising outcomes, including optimized wing adaptability and smooth maneuverability, respectively minimizing aerodynamic drag and skin-friction, hence significantly reducing CO2 emissions.