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Structural optimization of a variable camber leading edge

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To meet the demands of aerodynamic efficiency in various flight conditions, traditional aircraft achieve the goal by deflecting the high lifting systems such as leading edge and trailing edge. However, with a stiff skin and internal skeleton this kind of structural configuration maintains a fixed shape even though the reduction of necessary lift caused by the fuel weight decline during cruise, which will lead to a still high level of drag. Morphing leading edge and trailing edge can adjust their contour shape to adapt to different tasks(cruise, taking-off, landing, etc.) and conditions(Mach number, height, etc.) and accomplish the aim of aerodynamic shape real-time optimization. In addition, the gapless and smooth surface of wings can debase the acoustic noise induced by friction between the tips of structure and the air, which can effectively improve the comfort of civil aircraft. This paper illustrates a methodology for the structural optimization of a variable camber leading edge focusing on large-scale aircraft. Refer to a glass fibre reinforced composite skin, an optimal structure design method based on NAGA-Ⅱ is proposed to tackle the collaborative optimization issue involving diverse variables of the composite lay-ups, the position of joints and the size of actuator force. Results show that the method developed in this article can cope with the conflict between high bearing capacity and morphing accuracy and satisfy the need of engineering application.

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