Computation of Impulsively Generated Jet for Aeronautic Stall Control

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Flow control techniques can be applied to a lifting body to control the stall phenomenon which decreases the aerodynamic performance of aircraft. Various actuation techniques have been investigated to control stall events, including mechanical (e.g., slat, flap, etc.) and fluidic (e.g., blowing, suction, etc.) actuators. Among various flow control methods, impulsive actuation with a high-velocity jet [Matalanis2016,2017] is of interest in this study. Such impulsive flow manipulation has been tested experimentally to improve the aerodynamic performance of lifting bodies including wings [1, 2, 3], and a fuselage [4]. In the current study, a high-speed impulsive jet is numerically applied to the VR-12 airfoil, and a detailed mechanism of the impulsive jet actuation for stall suppression is investigated numerically. A rotorcraft-relevant flow is computed, i.e., Re=2,600,000 and Mach=0.3, with the validated computational methodology [5]. The actuator boundary condition is constructed to generate the jet flow to the computational domain, and it shows comparable jet parameters measured in the previous wind tunnel test. A single jet flow can control the critical events in the dynamic stall of the pitching airfoil, i.e., moment and lift stall, but not both at the same time. Multiple jet actuation is applied with a fixed actuation frequency for an additional control benefit. It is observed that the moment and lift stalls can be controlled effectively by concentrating the jets around the critical region in the airfoil pitch period.

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