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Incorporating swirl effects into the coefficient of momentum for separation control[1] KUNIHIKO TAIRA, PHILLIP MUNDAY, Florida State University — Addition of swirl in flow control has been known to enhance suppression of separation over airfoils at high angles of attack. Utilizing large eddy simulations, the present open-loop control study examines the influence of wall-normal and angular momentum injections in mitigating separation over a NACA0012 airfoil at $\alpha = 9^\circ$ and $Re = 23,000$. We introduce these swirling jets near the separation point with wall-normal momentum and swirl independently prescribed through velocity boundary conditions. The changes to the flow from control are examined and the corresponding lift enhancement and drag reduction are assessed as a function of the two velocity components. Since the standard coefficient of momentum does not consider swirling effects, we extend its definition to incorporate both the wall-normal momentum and swirl to quantify the overall flow control effectiveness. We are able to observe a trend in lift force enhancement over this single modified coefficient of momentum (that is dependent on the non-dimensional jet velocity ratio and swirl number). Moreover, we are able to identify a critical value for the modified momentum coefficient and categorize controlled flows into separated, transitional, and attached flows.

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