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Perspective

Synthetic Jets Control the Flow Separation Between the Airfoils

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DESCRIPTION

Analyses of the effects of a synthetic jet typically, the pitch of the rotor's retreating blade is greater than that of its advancing blade, particularly when the helicopter is flying at a high forward speed and is in a large maneuvering flight status. When the angle of attack is high, the leading-edge vortex over the airfoil can cause flow separation, which can result in loss of lift, divergence of drag, and pitching moment, as well as further degradation of the rotor's aerodynamic performance and blade vibration. As a result, one of the primary concerns in helicopter aerodynamics is the delay and even suppression of airfoil flow separation and stall. Synthetic jets can transfer momentum to the surrounded flow and enhance the mixing of the boundary layer without net mass injection across the flow boundary, making it more suitable for airfoil flow control than injected jets. Active Flow Control (AFC) for airfoil flow separation and stall has been rapidly developed as an emerging method.

Utilizing the PIV method, measured the three-dimensional flow structures of a synthetic jet with a finite span. The results of the experiments showed that the highest velocity did not necessarily mean the highest momentum, and that the increased momentum might be better for flow control than the synthetic jet's highest velocity. As a result, the flow control's effectiveness may be altered as a result of the jet orifice's geometry effects on the flow field structures.

The studies of synthetic jet flow structures in still and cross flow revealed that when a synthetic jet interacts with an external cross flow, it can displace the local streamlines and cause an apparent or virtual change in the surface's shape. As a result, the synthetic jet has the potential to be used in flow control applications, specifically to control the performance of aerodynamic surfaces by fluidically changing their apparent aerodynamic shape. Against this backdrop, active flow control (AFC), which is used to prevent airfoil stall, has received a lot of attention and grown quickly. One of the most promising AFC methods for controlling an airfoil's stall characteristics is the novel periodic excitation method with a synthetic jet.

There are a variety of conclusions regarding the control effects of incline angles of synthetic jet on delaying the stall of an airfoil, despite the fact that some mechanisms of control effects of synthetic jet on airfoil stall have been revealed and recognized at this stage. Several studies suggested that an airfoil's aerodynamic performance could be significantly improved in a nearly tangent jet state with a jet angle of less than 30 degrees demonstrated that the best angle for a synthetic jet's NACA23012 airfoil in a large Angle Of Attack (AoA) is approximately 45 degrees.

A number of wind-tunnel tests for parametric verifications of NACA0021 airfoil stall characteristics, including the measurement of velocity profile in the boundary layer, were carried out in this paper in order to investigate the control effects of the incline angle of the synthetic jet and other parameters in the mechanism. The jet angle, location, and momentum coefficient of the jet are all thoroughly considered in the studies.

A variety of free stream conditions and electrical excitation voltages were used to conduct in-depth investigations into the inconsistent influences that the jet angle had on actual tests.

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