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Instantaneous pressure field and aerodynamic loads across a harmonically pitching airfoil[1] JIBU JOSE, SUBHRA SHANKA KOLEY, CHRISTOPHER WILLIAMS, AYUSH SARASWAT, JIN WANG, JOSEPH KATZ, Johns Hopkins University — Experimental studies of complex unsteady aerodynamic loads on an airfoil undergoing dynamic stall were performed using a harmonically pitching airfoil. The experiments were performed at a Reynolds number of 45,000 in a refractive index matched water tunnel using a NACA 0015 airfoil with 50mm chordlength, oscillating harmonically between 5^o and 20^o at a reduced frequency of 0.411. Time resolved stereo PIV data were acquired at 1250 frames/s covering the flow on both sides of the foil simultaneously. Assuming a 2D flow, the pressure field around the airfoil was computed by direct integration of material acceleration calculated from the time-resolved velocity field, using an in-house developed, GPU based, parallel-line, omni-directional code. Surface integration of the pressure field was used for computing the lift and pitching moment on the airfoil. The formation and development of Leading Edge Vortex, and subsequent dynamic stall vortex, and the existence of a phase lag between the incidence angle and the development of suction side structures during upstroke and downstroke were evident from the data. Growth and migration of the pressure minima from the leading to the trailing edge induced pitch up and pitch down moments, respectively.

[1]AFOSR

Jibu Jose
Johns Hopkins University

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