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Energy Exchange during Plunge/Surge Motions of a 2D Wing[1]
WESLEY KERSTENS, Illinois Institute of Technology, JEESOON CHOI, TIM COLONIUS, California Institute of Technology, DAVID WILLIAMS, Illinois Institute of Technology — The rate of energy transfer between an NACA-0006 wing and an unsteady flow is examined at pre-stall and post-stall conditions using numerical simulations and wind tunnel experiments. The plunge and surge motions simulate the fluctuating vertical (w_z) and longitudinal (w_x) velocity components of a wind gust. In a steady flow the wing loses energy to the flow through the drag power term, but in an unsteady flow the wing may gain energy from the fluctuating lift power and fluctuating drag power terms. The net energy transfer averaged over the period of oscillation depends on the phase angle between the plunge and surge motions. The largest increase of energy occurs when w_x and w_z are in-phase. When the fluctuations are large enough, then it is possible for the net energy gain to be positive. The numerical simulations conducted at Reynolds numbers near the critical value for vortex shedding show qualitative agreement with the experiments. The simulations highlight the role of vortex shedding in determining the optimal frequency and phase for energy extraction from the gust.

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