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Using supervised machine learning to predict leading edge vortex growth, detachment, and wake trajectory[1] HOWON LEE, NICHOLAS SIMONE, YUNXING SU, KENNETH BREUER, Center for Fluid Mechanics, Brown University — The strength and trajectory of a leading edge vortex (LEV) formed by a hydrofoil (chord c) pitching and heaving in a water flume is studied. The LEV is identified using the Q-criterion calculated from the 2D velocity field obtained from PIV measurements. The relative angle of attack at mid-stroke, $\alpha_{T/4}$, proves to be an effective method of combining heave (h_0/c), pitch (θ_0), and frequency (fc/U_∞) into a single variable that predicts the maximum value of Q over a wide range of operating conditions. Once the LEV separates from the foil, it travels downstream and gradually weakens and diffuses and this behavior also seems to scale with $\alpha_{T/4}$. Supervised machine learning is used to create a regression algorithm that predicts the vortex strength and trajectory during growth and after separation. The size and shape of the LEV is parameterized by an ellipse with axes a and b, and orientation ϕ. The machine learning algorithm is trained using these vortex characteristics, along with the operating parameters $h_0/c, \theta_0, fc/U_\infty, \alpha_{T/4}, t/T$. During training, Gaussian process regression (GPR) models achieved excellent performance, with the lowest root-mean-square error.

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