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Adjoint-Baed Optimal Control on the Pitch Angle of a Single-Bladed Vertical-Axis Wind Turbine[1] HSIEH-CHEN TSAI, National Taiwan University, TIM COLONIUS, California Institute of Technology — Optimal control on the pitch angle of a NACA0018 single-bladed vertical-axis wind turbine (VAWT) is numerically investigated at a low Reynolds number of 1500. With fixed tip-speed ratio, the input power is minimized and mean tangential force is maximized over a specific time horizon. The immersed boundary method is used to simulate the two-dimensional, incompressible flow around a horizontal cross section of the VAWT. The problem is formulated as a PDE constrained optimization problem and an iterative solution is obtained using adjoint-based conjugate gradient methods. By the end of the longest control horizon examined, two controls end up with time-invariant pitch angles of about the same magnitude but with the opposite signs. The results show that both cases lead to a reduction in the input power but not necessarily an enhancement in the mean tangential force. These reductions in input power are due to the removal of a power-damaging phenomenon that occurs when a vortex pair is captured by the blade in the upwind-half region of a cycle. This project was supported by Caltech FLOWE center/Gordon and Betty Moore Foundation.

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