Optimization of morphing flaps based on fluid structure interaction modeling

This article describes the design optimization of morphing trailing edge flaps for wind turbines with 'smart blades'. A high fidelity Fluid Structure Interaction (FSI) simulation framework is utilized, comprised of 2D Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD) models. A coupled aero-structural simulation of a 10% chordwise length morphing trailing edge flap for a 4 MW wind turbine rotor is carried out and response surfaces are produced with respect to the flap internal geometry design parameters for the design conditions. Surrogate model based optimization is applied in order to converge to a flap design, which maximizes aerodynamic lift control performance while minimizing drag penalty, subject to material strength and manufacturing constraints. The purely structural optimization of the flap response is compared to the coupled aerostructural optimization.

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