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Reducing Turbine Mechanical Loads Using Flow Model-Based Wind Farm Controller

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Abstract

Cumulative O&M costs of offshore wind farms are comparable with wind turbine CAPEX of such wind farm. In wind farms, wake effects can result in up to 80% higher fatigue loads at downstream turbines compared to other wind turbines when compared to optimal wind farm control approaches. Future work shall enhance the controller with more advanced turbine fatigue models in order to further improve the controller’s performance.

Motivation

Objectives

Control approach
- Optimal turbine operation setpoint is derived using model predictive control (MPC).
- Controller uses linear, dynamic, two-line wind farm operation model.
- Offshore wind farm model is based on engineering models.

Comparison of linear flow model with SimWindFarm

Wind farm controller based on engineering models.

Flow model-based optimal wind farm controller

Methods

Simulated wind farm consists of:
- Turbulent flow with 15-spacing
- REL, SPM, turbine model's wind
- Loads and fatigue loads

Simulated wind conditions are:
- Wind direction along turbine row
- Wind speed + 15 km/h
- Turbulence intensity = 8%

Results

Conclusions

This work presents a case study of a newly developed, optimal wind farm controller. The objective of the control is to follow a power reference while reducing the loads at wake turbines in the wind farm. Simulation tests of the controller show a reduction of fatigue loading at downstream turbines when compared to other optimal wind farm control approaches. Future work shall enhance the controller with more advanced turbine fatigue models in order to further improve the controller’s performance.

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