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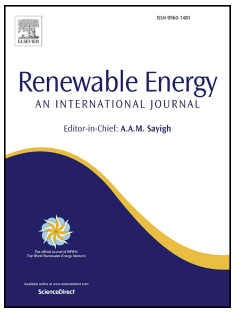

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Dynamic Aeroelastic Behavior of Wind Turbine Rotors in Rapid Pitch-Control Actions

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Abstract

Pitch control comprises a significant proportion of current wind turbine load-control approaches. Collective pitching is used in restricting the overall power generation at high winds, whereas individual pitching has the added advantage of mitigating cyclic loads that are detrimental in fatigue damage of the turbines. Currently, there are many studies on conventional pitching control that account for long-term variations in wind speeds and associated high loads, but a smaller number of studies in short-term pitch action.

The present study focuses on the use of rapid pitch control for handling short-term variations in wind conditions and load fluctuations within one cycle of rotation, with special attention to the prognosis of the aeroelastic response of the rotor. We use a numerical model capable of handling the complexities of the multi-physics dynamics of a wind turbine rotor. Based on a nonlinear adaptive ODE algorithm, it provides a natural way to integrate the various multi-physics aspects of wind turbine dynamics, including the control system and the coupled response of the aerodynamics and the structural deformations of the rotor. Results are presented for the case study of the NREL-5MW Reference Wind Turbine, and their significance for wind-turbine rotors in general is discussed.

Keywords:
Wind turbine, Rapid-action pitch-control, Innovative load-control

1. Introduction

Wind is a major source of renewable energy that is clean and sustainable, and holds a promising share for the future of power generation. Recent studies conducted by European Wind Energy Association (EWEA) envision state-of-the-art turbines capable of generating 20 MW with rotor diameters of 250 m [1]. The economies-of-scale factor indicates a trend towards increasing rotor sizes for reduced cost-of-energy in the wind power industry. This has led to various studies focusing on load mitigation control approaches [2, 3, 4]. Bianchi et al. [5] provides details on some of the most common load control methodologies. Some

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