Comparative Analysis of Dynamic Stall Models for Wind Turbines

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Background:

The climate crisis is one of the most critical problems that humanity has been grappling with for the past decades. The transition to renewable energy is fundamental in the fight against climate change. This is why wind energy development is so crucial in today's world. One of the problems wind energy researchers have encountered is dynamic stall. Dynamic stall occurs when the angle of attack on a wind turbine blade changes rapidly, posing a significant challenge in the pursuit of efficient and reliable wind energy generation. As turbines grow in size and complexity, understanding and mitigating dynamic stall becomes a major challenge for the wind turbine industry. The accurate modelling of this phenomenon is crucial for optimizing turbine performance, ensuring safety, and maximizing energy output.

Currently, many software tools are available to simulate turbine performance under various conditions. One such tool is openFAST - an open-source wind turbine simulation tool developed by the National Renewable Energy Laboratory (NREL). This software already contains some Unsteady Aerodynamics models. However, the use of these models has yet to be validated experimentally.

Objectives:

The main objective of this study is to refine and validate the openFAST dynamic stall model for the 15 MW IEA Wind offshore reference wind turbine, which utilizes the FFA-W3-211 tip airfoil. This will be achieved by obtaining the static data required to calculate the model parameters through experimental wind tunnel experiment. A comprehensive comparative analysis will be conducted between the results obtained from openFAST simulations and those derived from the optimized dynamic stall models. This work aims to improve the accuracy and reliability of wind turbine performance prediction, which will ultimately contribute to the decrease of LCOE and extended lifetime of the equipment.