

Popular science summary of the PhD thesis

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Title of the PhD thesis	Modal Decomposition and Expansion for Virtual Sensing in Large Offshore Wind Turbines
PhD school/Department	DTU Construct

Science summary

* Please give a short popular summary in Danish or English (approximately half a page) suited for the publication of the title, main content, results and innovations of the PhD thesis also including prospective utilizations hereof. The summary should be written for the general public interested in science and technology:

The development of modern large-scale wind turbines has led to structures that are both large and flexible. This causes their natural frequencies to decrease, making the offshore wind turbines (OWTs) vulnerable to environmental and operational excitation, including wind and wave loads and forced excitation from rotor harmonics. This loading regime means that fatigue damage often governs the OWT's design life. Furthermore, current OWT designs largely rely on conservative assumptions to account for uncertainties in loading conditions and material resistance. This inherent conservatism suggests potential for extending the design lives, if wind farm operators can provide evidence of remaining structural capacity in their assets.

This required evidence can be obtained by monitoring strain histories. However, traditional structural health monitoring (SHM) approaches require installing sensors locally, often at locations that are not easily accessible. Therefore, virtual sensing---which estimates strain histories at any location in a structure based on a few easily accessible sensors and a digital model---has gained traction in SHM.

The present thesis addresses the issue of including the influence of a flexible rotor in the predominant deterministic virtual sensing approach: modal decomposition and expansion (MDE). To achieve this, a comprehensive database containing synthetic wind turbine response data for the IEA 15-MW Reference Wind Turbine has been established. Subsequently, a state-of-the-art multi-band MDE has been applied to identify potential areas of improvement. Finally, the influence of applying a flexible rotor model is investigated using two distinct modelling approaches. It is concluded that the introduction of a flexible rotor model significantly improves the MDE performance in the tower top region.