Concurrent Aeroservoelastic Design and Optimization of Wind Turbines - DTU Orbit (12/08/2019)

Concurrent Aeroservoelastic Design and Optimization of Wind Turbines
This work develops and investigates methods to integrate controllers in the wind turbine design process and to perform wind turbine optimization. These techniques can exploit the synergy between wind turbine components and generate new design solutions. Two frameworks to perform wind turbine optimization design are presented. These tools handle workflows to model a wind turbine and to evaluate loads and performances under specific conditions. Three approaches to evaluate loads are proposed and integrated in the optimization codes. The first method is based on time domain simulations, the second exploits a linear model to evaluate fatigue damage loads in frequency domain, and the third allows avoiding resonant conditions that could lead to excessive fatigue damage. The first technique exploits nonlinear time domain aeroservoelastic simulations, here computed with HAWC2, and the other two approaches are based on a high-order aeroservoelastic linear model implemented in HAWCStab2. The limitations and advantages of each method are illustrated and discussed. Methods to systematically tune wind turbine controllers are improved and presented. This work focuses on basic controllers for wind turbine regulation under normal operation, therefore no controller for load reduction is considered. The approaches presented are based on a pole-placement technique and loads minimization. Two methods allow the tuning of the proportional integral gains of the pitch controller. A third approach, based on time domain simulations, allows the selection of any controller parameter. The methods to evaluate loads and the pole-placement technique are then employed to carry out wind turbine optimization design from an aeroservoelastic prospective. Several analysis of the NREL 5 MW Reference Wind Turbine and the DTU 10 MW Reference Wind Turbine are carried out to illustrate the validity and limitations of these approaches. In some of the test cases, the method reduces the blade mass and increases the annual energy production.

General information
Publication status: Published
Organisations: Department of Wind Energy, Wind turbine loads & control
Contributors: Tibaldi, C.
Number of pages: 204
Publication date: 2015

Publication information
Publisher: DTU Wind Energy
ISBN (Print): 978-87-93278-79-0
Original language: English
Electronic versions:
tbl_thesis.pdf
Source: PublicationPreSubmission
Source-ID: 123418584