Output-only modal analysis of linear time-periodic systems with application to wind turbine simulation data - DTU Orbit (18/01/2019)

Output-only modal analysis of linear time-periodic systems with application to wind turbine simulation data

Many important systems, such as wind turbines, helicopters and turbomachinery, must be modeled with linear time-periodic equations of motion to correctly predict resonance phenomena. Time periodic effects in wind turbines might arise due to blade-to-blade manufacturing variations, stratification in the velocity of the wind with height and changes in the aerodynamics of the blades as they pass the tower. These effects may cause parametric resonance or other unexpected phenomena, so it is important to properly characterize them so that these machines can be designed to achieve high reliability, safety, and to produce economical power. This work presents a system identification methodology that can be used to identify models for linear, periodically time-varying systems when the input forces are unmeasured, broadband and random. The methodology is demonstrated for the well-known Mathieu oscillator and then used to interrogate simulated measurements from a rotating wind turbine. The measurements were simulated for a 5 MW turbine modeled in the HAWC2 simulation code, which includes both structural dynamic and aerodynamic effects. This simulated system identification provides insights into the test and measurement requirements and the potential pitfalls, and simulated experiments such as this may be useful to obtain a set of time-periodic equations of motion from a numerical model, since a closed form model is not readily available by other means due to the way in which the aeroelastic effects are treated in the simulation code.

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