Real-Time Estimation of Damping in Wind Turbines

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ABSTRACT

Operational Modal Analysis (OMA) is being more and more used as a non-invasive method to asses structural health of civil structures and in particular Wind Turbines (WT), to detect possible failures and to predict the remaining life-time. WT, being rotating structures, pose serious limitations to the use of conventional OMA techniques since the basic assumption of excitation by AWGN does not hold. Unbalances in the rotor and the blade-shadow effect contaminate the acceleration signals with harmonics, hampering a correct determination of modal parameters of the structure.

Another limitation is that OMA algorithms are costly in terms of memory and computational resources, and cannot be implemented on site. Thus, data must be massively transferred, from a huge number of WT, and processed off-line.

In order to circumvent these limitations, we propose a combination of strategies which allow a real-time calculation of the modal parameters of wind turbines (modal frequency and damping), minimizing the effects of harmonics.

The procedure builds firstly on the idea we presented in [1] to identify, and later remove, the interfering harmonics from the raw acceleration signal. The same idea is now alternatively implemented by a linear Kalman Filter (KF) to extract not only the harmonics but also the very modes. Each isolated mode represents a degree of freedom whose signature (a damped sinusoid) is extracted by a Random Decrement Technique (RDT), avoiding the calculation of correlation functions. Then damping and modal frequency are then straightforwardly obtained. All these methods are amenable to be implemented in real time.

In this paper we will explain the method and its validation with synthetic data and real measurements.

[1] M. Zivanovic, A. Plaza, X. Iriarte, and A. Carlosena, “Instantaneous amplitude and phase signal modeling for harmonic removal in wind turbines,” *Mech Syst Signal Process*, vol. 189, no. December 2022, p. 110095, 2023, doi: 10.1016/j.ymssp.2023.110095.