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Modeling the deformation behavior of wind turbine blades using artificial neural networks

Sergiu Zaporojan, Viorel Carbune, Radu Razvan Slavescu, Eugeniu Munteanu, Valeriu Dulgheru, Marin Guțu

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Abstract

In this paper, we propose a possible framework for modeling and predicting the deformation behavior of wind turbine blades. Blade reliability is vital in the operation and maintenance of a wind turbine. A possible way to intelligently monitor the condition of the blade is to acquire and process data on the current strains inside the blade structure. In this context, the first aim of the work was to numerically simulate the equivalent strains inside the composite material of a blade. A typical rotor of a 1.5 - 3.0 MW wind turbine was considered. The rotor was simulated under various boundary conditions such as wind speed and rotation speed. The purpose of the numerical simulation of the wind turbine blade was to determine and analyze the values of the equivalent strains depending on the wind speed in the range of 6 - 20 m/s. Then, we describe the proposed framework for modeling the deformation behavior. We assume that the deformations of interest obtained from the numerical simulations are used as training samples. Our approach incorporates simulated (synthetic) data into a statistical predictive model. These data further serve to create an artificial neural network model that would be able to predict the specific deformation values at nodes of interest as a function of, but not limited to, wind speed. Experimental results are presented and discussed.

Keywords: wind turbine blades deformation, rotors, artificial neural networks

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