

Adaptive Envelope Protection Control for the below and above Rated Regions of Wind Turbines

Authors : Mustafa Sahin, Ilkay Yavrucuk

Abstract : This paper presents a wind turbine envelope protection control algorithm that protects Variable Speed Variable Pitch (VSVP) wind turbines from damage during operation throughout their below and above rated regions, i.e. from cut-in to cut-out wind speed. The proposed approach uses a neural network that can adapt to turbines and their operating points. An algorithm monitors instantaneous wind and turbine states, predicts a wind speed that would push the turbine to a pre-defined envelope limit and, when necessary, realizes an avoidance action. Simulations are realized using the MS Bladed Wind Turbine Simulation Model for the NREL 5 MW wind turbine equipped with baseline controllers. In all simulations, through the proposed algorithm, it is observed that the turbine operates safely within the allowable limit throughout the below and above rated regions. Two example cases, adaptations to turbine operating points for the below and above rated regions and protections are investigated in simulations to show the capability of the proposed envelope protection system (EPS) algorithm, which reduces excessive wind turbine loads and expectedly increases the turbine service life.

Keywords : adaptive envelope protection control, limit detection and avoidance, neural networks, ultimate load reduction, wind turbine power control

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