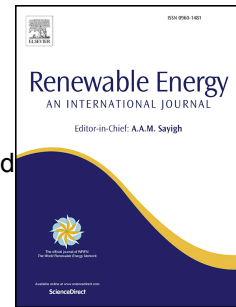


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An improved-accuracy method for fatigue load analysis of wind turbine gearbox based on SCADA

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Abstract

In spite of their increasing popularity, managing the use of wind turbines has been exceptionally challenging. Through computational prognostics, Sentient Science determined that current operating lifetime for a large number of turbines is only between five to thirteen years. Initial estimates indicate that savings of \$150,000 per turbine per gearbox replacement can be achieved using physics-based long-term prognostics, leading to a substantial return of investment for wind farm operators. However, long-term prognostics require a precise determination of the loads in all six degrees of freedom occurred on the drive-train. One of these loads—torque—can be directly estimated in situ from the historical data provided by the Supervisory Control and Data Acquisition (SCADA) system. In many cases, the historical data only provides 10-minute statistical values, and a common practice of reliability analysts is the calculation of torque using only 10-minute averages. Disregarding the load fluctuation within 10-minute intervals of recorded SCADA introduces a loss of accuracy in the resulting torque histogram that is indeed meaningful for an accurate life prognostic. This paper introduces a novel improved-accuracy method for calculation of torque histograms based on SCADA. Using 10-minute distributions of power output and rotor speed, this method is able to successfully reconstruct the distribution of instantaneous torque in between 10-minute intervals of recorded SCADA. The method predicts a high-torque region more dispersed than the current method used in the industry, which introduces substantially different results when used in life prognostics. Using this method in the life of a GE 1.5 SLE wind turbine, it is shown that the error in predicted L50 is reduced by 10.1%.

Keywords: Wind turbine; Gearbox failure; Load duration distribution; Torque; SCADA; Physics-based prognostic.

Nomenclature

Physical Parameters

τ	Torque (kNm)
P	Distribution of power (kW) over a 10-minute interval
μ_P	Mean power (kW) over a 10-minute interval
σ_P	Standard deviation of power (kW) over a 10-minute interval
ω	Distribution of rotor speed (RPM) over a 10-minute interval
μ_ω	Mean rotor speed (RPM) over a 10-minute interval
σ_ω	Standard deviation of rotor speed (RPM) over a 10-minute interval

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