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An integrated approach for wind turbine gearbox fatigue life prediction considering instantaneously varying load conditions

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1 **An integrated approach for wind turbine gearbox fatigue life prediction** 2 **considering instantaneously varying load conditions**

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6 **Abstract**

7 Wind power is a significant clean energy source. Operation & maintenance (O&M) costs account
8 for about 25% of the cost of wind power, and it is critical to improve the reliability of wind
9 power generators to reduce the overall cost and increase wind power competitiveness comparing
10 to other power sources. Wind turbines are subject to instantaneously varying load due to wind
11 turbulence, which challenges the prognostic study for predicting equipment future health
12 conditions and remaining useful lives. With existing prognostics methods, the average constant
13 load is typically used to approximate the varying external load. In this paper, an integrated
14 varying-load approach is proposed for predicting wind turbine gearbox remaining useful life by
15 specifically considering instantaneously varying external load, which is more realistic. Fatigue
16 crack damage is focused on. The method integrates gear physical models and available health
17 condition data, and the distribution of uncertain material parameter modeled in crack degradation
18 process is updated via Bayesian inference once new health condition data become available.
19 Examples are provided to demonstrate the effectiveness of the proposed varying-load approach.
20 A comparative study is conducted between the proposed approach and existing constant-load
21 approximation method, and the results show that the proposed varying-load approach can
22 provide more accurate prediction.

23 **Keywords:** *wind power, integrated prognostics, time-varying load, gear tooth crack propagation*
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