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”DATA1#3 - Wind turbine drivetrain fault detection using physics-informed multivariate deep learning”

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Vibration analysis is a prevalent technique in the predictive maintenance of wind turbines. It is an effective method for early fault detection and enables the creation of cost-effective maintenance strategies. Commonly used vibration analysis methods in the literature rely on signal processing techniques such as time and frequency domain approaches. However, the signal processing techniques require manual interpretation by domain experts. It is important to note that different indicators exhibit sensitivity to specific faults. Manual analysis of indicators can be avoided by fusing them to derive high-level wind turbine health status. It enables the learning of complex non-linear relationships among the indicators. This research focuses on a multivariate deep learning model, i.e., autoencoder, which fuses different signal processing indicators to provide a single high-level health status. The proposed model is a normal behaviour model that learns the indicator's normal behaviour and labels faults if it observes deviation from the normal behaviour. The proposed fusion method of indicators is robust compared to individual indicator models as it learns complex non-linear relationships among indicators. The proposed method is tested for fleet-level fault detection both with and without fine-tuning for a specific wind turbine. Furthermore, it decreases the time required for wind farm health prognosis analysis and computation. Various autoencoder architectures have been compared, including simple feedforward neural networks, convolutional neural networks, and recurrent neural networks. The proposed method is demonstrated using real-life, high-frequency condition monitoring data from offshore wind turbines over several years, including wind turbines observed faults. The method's effectiveness and performance were demonstrated through analysis of planetary stage, generator, and high-speed stage failure cases.

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