Wind Turbine Gearbox Condition Monitoring Using Vibration Data and Mel-Frequency Cepstral Coefficients

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ABSTRACT

A new methodology for wind turbine condition monitoring that utilizes vibration data and Mel-frequency cepstral coefficients (MFCCs) is being developed to accurately assess the condition of the wind turbine gearbox. Traditional condition monitoring techniques rely on physical inspections, which can be time-consuming and labor-intensive [1]. This new approach offers a more efficient and cost-effective solution.

The use of vibration data allows for the identification of subtle changes in a wind turbine's operating condition, providing early warning signs of potential issues. By analyzing the vibration data, engineers can detect changes in the frequency and amplitude of the turbine's oscillations, which can indicate the presence of mechanical problems or other issues [2]–[5]. The MFCCs are derived from the vibration data signals and provide a compact representation of the information, allowing for more efficient analysis [6]. These coefficients are used to create a fingerprint of the wind turbine's operating condition, which can then be compared to known healthy operating conditions to identify any deviations or anomalies.

This new methodology has been shown to be highly effective in detecting potential issues with wind turbine components such as gearbox failure, and drive train bearing degradation. By providing early

warning signs of these issues, wind farm operators can take action to address the issue before it leads to significant downtime or damage. The use of MFCCs as descriptors offers several other benefits. The data can be collected remotely, eliminating the need for physical inspections, allowing its analysis to be performed quickly, even in real time, and more frequent monitoring of wind turbine conditions, providing a more complete and accurate picture of the health of the system.

In a nutshell, the use of vibration data and MFCCs offers a promising new approach for wind turbine condition monitoring. The proposed approach has been tested on the EISLAB (Lulea, Sweden) dataset concerning the vibration signals from six wind turbines in northern Sweden, being all the wind turbines of the same type and with a three-stage gearbox [7]. All measurement data corresponds to the axial direction of an accelerometer mounted on the housing of the output shaft bearing of each turbine.

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