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Separation and enhancement of gear and bearing signals for the diagnosis of wind turbine transmission systems
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Abstract
This paper is based on the analysis of a wind turbine vibration data provided by the National Renewable Energy Laboratory under a round robin scheme to diagnose faults in a transmission that had experienced a loss of lubricant for a period. Previously developed techniques were applied, but this is the first time that some were used in combination for a machine covering such a wide speed range and with such a low minimum speed. Another factor was that the gearbox design was far from 'hunting tooth', and this gave problems with the diagnosis. The paper describes how the techniques were adapted to solve these problems. The algorithms used for the diagnosis included the extraction of a pseudo-encoder signal from the vibration signals themselves, to allow order tracking and resampling in the rotation angle domain. This permitted successive resampling over several stages to give synchronous averages for each shaft in the planetary gearbox, allowing diagnostics of the gears on that shaft. Subtraction of all synchronously averaged signals leaves a residual signal containing bearing signals and allowing diagnosis of their faults. This is the first reported case of applying that technique over four separate stages. Bearing diagnosis was carried out using a semi-automated algorithm based on whitening the residual signal, filtering it to maximize the kurtosis and finally using the Hilbert transform approach to get the spectrum of the squared envelope. The analysis of the gears included using spectrum and cepstrum comparisons between healthy and faulty data. It is shown for the first time that cepstra from the same signal (from spectra in different frequency ranges) gives information about completely different gears at very different speeds. The analysis also involved obtaining synchronous averages for the individual planetary gears and for the sun gear by using software patented by the Australian Defence Science and Technology Organisation. The signal processing tools used for the analysis were shown to be capable of identifying both gear and bearing faults in the wind turbine gearbox, though one bearing fault was missed. Copyright © 2013 John Wiley & Sons, Ltd.

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