Early Detection of Train Wheel Flats based on a Wavelet Approach

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Several methods have been employed in scientific research to detect train wheel flat in recent decades [1, 2]. However, reported literature on automatic early wheel flat detection has been limited so far. In most proposed wheel flat detection techniques, there is no indication of automatically distinguishing a defective wheel from a healthy one. Moreover, several sensors are employed in previous studies to detect wheel defects. In general, detecting wheel flat using several sensors in field studies is very expensive. Therefore, one of the novelties of this research is to propose a wavelet-based methodology for automatic detection of wheel flat, using only one sensor installed on the rail. A 3D numerical dynamic model of a vehicle-track coupling system is used to test and validate an indicator that automatically detects a defective wheel at an early stage. The shear and acceleration measurement points are defined to evaluate the sensitivity of the proposed methodology to the type of sensors (strain gauges and accelerometers) and the position where they are installed. The proposed methodology involves the following steps: (i) data acquisition from installed sensors; (ii) feature extraction from acquired responses; (iii) feature normalization to reduce environmental and operational variations; (iv) data fusion to merge features without losing wheel defect information and improve sensitivity; and (v) feature classification to label the extracted features into two categories: a healthy wheel or defective wheel. The proposed methodology is effective in detecting early wheel flats. In comparison with the previous ones [3], one of the main advantages of the proposed methodology is that it does not require the installation of several sensors on the rail, instead only one sensor is adequate to detect a defective wheel. Therefore, the proposed methodology has the advantage of minimizing the cost of the installation system and allowing a more automatic and straightforward implementation.

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