Railway track degradation modelling using dynamic multi-regression to predict failure patterns

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Railway Track Degradation Modelling Using Dynamic Multi-Regression Markov Model to Predict Failure Pattern and the Estimation of Remaining Useful Life

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Abstract

Due to constant use and exposure to environmental factors, railway systems frequently degrade. Pilot data from Network Rail and a review of the relevant literature indicate that railway tracks, switches and cross are critical assets for trains operation, as any related failure can induce significant impact on its operation as well as maintenance resources and budget. In order to prevent this kind of undesirable situation and events, being able to anticipate status changes before it becomes critical would bring significant benefits (Ciocoiu, L. et al. 2017; Luminita Ciocoiu et al. 2015).

Because track geometry flaws increase dynamic wheel/rail loads, replacement or other maintenance is usually undertaken when degradation accumulates over time, and eventually leading to failure, when the accumulated damage reaches beyond a failure threshold, which can be random or set by industry standards (Jardine, Lin, and Banjevic, 2006; Ye and Xie, 2015). However, the use of degradation signals that indicate the health of a system is a potential way for modelling the reliability of Safety-Critical Systems with a longer lifetime requirement.

This study focuses on stochastic dependence, in which the failure of some system components influences the failure or degradation of other system components. Despite this, it is difficult for conventional analytical models to incorporate multiple variables simultaneously.

The study classifies the published literature on railway track, switch and cross degradation and maintenance optimisation. It also identifies potential academic and professional research and practise gaps. The study is based on twelve years of actual historical field maintenance record data from Network Rail.

In this study, a Railway Track Degradation Modelling Using Dynamic Multi-Regression Markov Model to Predict Failure Pattern and the Estimation of Remaining Useful Life has been developed. The results of the model's learning algorithm will be useful to develop a control-limit policy for optimization of periodic inspection using performance data and improve the current maintenance interventions on tracks, cross and switches, and is expected to increase the network availability, by reducing corrective maintenance interventions.