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Modeling and optimizing energy-efficient manual driving on high-speed lines

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Abstract-

This paper presents a simulation-based model for manual driving strategies that will minimise energy consumption for high speed trains. Specific characteristics of both high speed lines (HSL) and manual driving strategies are considered in order to obtain achievable designs that can be tested on commercial services. The proposed design model calculates a list of efficient high-level commands to be systematically executed by the driver on an HSL along the trip. The design is based on a detailed simulation model of the train’s motion (taking into account track and train characteristics and operational constraints), combined with genetic algorithm to select the best driving. Continuous control solution by mathematical optimisation is avoided as it is not an appropriate reference for manual driving in HSL. The validation of the simulation model is focused on running resistance, tractive/braking efficiencies and consumption of auxiliary equipment, and shows differences between real measurements and simulated results which are lower than 2% both in run time and energy consumption. Finally, a real case is presented in which the proposed model was used to design efficient driving strategies that were subsequently implemented on commercial services along the Spanish HSL Madrid-Barcelona in both directions, measuring average energy savings of 23% and 18% respectively when the efficient driving strategies were compared with measured standard manual driving. The future scope will be the application of this model to on-line recalculation of driving commands.

Index Terms- electric railway, energy saving operation, ecodriving, simulation, genetic algorithms

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