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An eco-driving algorithm for interoperable automatic train operation

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Abstract-

The new Automatic Train Operation (ATO) system over the standard European Rail Traffic Management System (ERTMS) will specify the requirements that an automatic train driving system must fulfil in order to be interoperable. The driving is defined by target times located along the journey that are received from the trackside system. Then, the on-board equipment drives the train with the objective of meeting all of the target times. The use of eco-driving methods to calculate the train driving is necessary, as one of the main goals of modern train driving systems is to increase the energy efficiency. This paper presents a simulation-based optimisation algorithm to solve the eco-driving problem constrained by multiple target times. This problem aims to minimize the energy consumption subject to a commercial running time, as the classical eco-driving problem, and also to meet intermediate target times during the journey between stations to enable automatic traffic regulation, especially at junctions. The algorithm proposed combines a Differential Evolution procedure to generate possible solutions with a detailed train simulation model to evaluate them. The use of this algorithm makes possible to find accurate speed profiles that meet the requirements of multiple time objectives. The proposed Differential Evolution algorithm is capable of finding the feasible speed profile with the minimum energy consumption, obtaining a 7.7% of energy variation in the case of a journey with one intermediate target time and 3.1% in the case of two intermediate targets.

Index Terms- ATO over ERTMS; differential evolution; eco-driving; energy efficiency; railway operation; train simulation

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