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Real time regulation of efficient driving of high speed trains based on a genetic algorithm and a fuzzy model of manual driving

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Abstract— Nowadays one of the main priorities for railways administrations and operators is the reduction of energy consumption, due to its impact on CO2 emissions and economic costs. This is especially important on high speed lines, in expansion in many countries, given that very high levels of consumption are involved. Energy saving strategies focused on traffic operation can be applied in the short term with low levels of investment, in particular ecodriving, timetable design and the on line regulation of trains. However approaches in the literature to minimize energy do not normally consider specific models for manual driving in high speed lines and the commercial punctuality constraints of this type of services, and do not take into account the uncertainty associated with manual driving.

The aim of this paper is the on line regulation of high speed trains recalculating the energy efficient manual driving to be executed by the driver when significant delays arise. The manual driving is modeled by means of fuzzy parameters: the speed regulation and the response time of the driver when a new driving command has to be applied. The punctuality requirement of the railway operator is represented as a necessity fuzzy measure of punctual arrival at stations.

The proposed method for the on line recalculation of efficient driving is a Genetic Algorithm with fuzzy parameters based on an accurate simulation of the train motion. This algorithm is applied on a real Spanish high speed line to assess the energy savings provided by the efficient regulation algorithm compared to the typical driving style that is applied when a train has to get back on schedule after a delay.

Index Terms— High speed railways; Ecodriving; Real time traffic operation; Fuzzy logic; Genetic algorithm; Simulation

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