Efficient automatic operation of a metro line: eco-driving design with optimized use of regenerative energy and rolling stock consideration

A. Fernández Cardador; A. Fernández Rodríguez; A.P. Cucala García; M. Blanco Castillo; S. Su

Abstract-

Metropolitan railways are major consumers of energy and are potential targets for the application of energy efficiency techniques. In this article, eco-driving, timetable design and regenerative braking are integrated to optimize operation while minimizing energy consumption. In addition, the rolling stock required to provide the service is considered, as it has an important impact on operational costs. First, the design of efficient automatic train operation (ATO) driving is carried out using multi-objective particle swarm optimization (MOPSO). Then, the timetable is optimized including a regenerated energy model and the number of trains required to satisfy the periodic service. For the timetable design, several algorithms are compared, proving that the grouped and linked mutation operator–non-dominated sorting genetic algorithm-III (GLMO-NSGA-III) is the best for the case study. The complete model is applied to the Madrid Underground line, achieving energy savings of 24.79% compared to the typical operator’s design criteria.

Index Terms- Energy-efficient train timetable; eco-driving; regenerative braking energy; automatic train operation (ATO); rolling stock

Citation:
Blanco-Castillo, M.; Cucala, A.P.; Fernández Rodríguez, A.; Fernández-Cardador, A.; Su, S. "Efficient automatic operation of a metro line: eco-driving design with optimized use of regenerative energy and rolling stock consideration", Engineering Optimization, , .