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OPERATING SPEED PATTERN OPTIMIZATION OF RAILWAY VEHICLES WITH DIFFERENTIAL EVOLUTION ALGORITHM

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ABSTRACT–The railway transportation system has much advantage in eco-friendliness, punctuality and safety compared to any other transportation system. Most of the railway system administrators have to control and operate under limited resources such as trains and facilities. It is necessary to control traveling time and energy consumption for efficient operation in the railway systems, because the board rate of passenger is inconstant with time variance. It is common that the shorter traveling time causes the greater energy consumption. In this study, a new optimization method considering operation time or energy consumption is proposed by using differential evolution algorithm and some cases are reviewed. The total energy change due to operation time variation are investigated by using the proposed optimization method for tangent and gradient track conditions. Both cases, the total energy decreases exponentially. However, because of gradient the total energy are saturated after a certain time for gradient track.

KEY WORDS : Time optimization, Energy optimization, Differential evolution, RaPAS, Operation pattern, Cost function, Design variable, Constraint

1. INTRODUCTION

The high-speed train system over 300 km/h is widely spread in many countries these days and has attracted worldwide attention because of the rapid progress in railway technology, once stagnant. The railway transportation system has much advantage in eco-friendliness, punctuality and safety compared to any other transportation system. Most of major cities all over the world are facing problem like traffic jams and environmental problems according to economic growth and increasing populations. To handle with these problems, local governments are introducing the subway or the light rail transit (LRT) systems in the area where they are playing an important role in massive transportation system.

Most of the railway system administrators have to control and operate under limited resources such as trains and facilities, where the board rate of passenger is inconstant with time variance which rise the question about the necessity of the efficient method to control operation pattern of train scheduling.

The train operation interval must be tight to maximize the performance of a train for the rush hours when people commute to their place and home. Contrarily, trains can be operated with sufficient time intervals when the numbers of passengers are relatively decreased during the day time. Generally, a methodology is required to control traveling time and energy consumption for efficient operation as it is common that the shorter traveling time causes the greater energy consumption.

Many studies have been focused on efficient use of energy in subway and general railway systems, and those studies were conducted using various methodologies to minimize energy consumption (Mellitt *et al*., 1987; Lee and Hwang, 2006). Mellitt (Mellitt *et al*., 1987) proposed the coasting control method that is reducing energy consumption by determining the coasting point, which is the starting point to move the vehicles without motor powering. Wong (Wong and Ho, 2004) found the optimal coasting point by improving efficiency in the coasting control method using the various search algorithms and proposed a searching algorithm which is suitable for the coasting control method as comparatively analyzing the coasting points. Dorfman (Dorfman and Medanic, 2004) proved a design method that the travel schedule can be organized to improve energy consumption efficiency using the Greedy TAS technique. Otherwise, Ke (Ke and Chen, 2005) proposed new techniques that can design signal system interval, cycle and pattern among stations to reduce fuel consumption of trains. Apart from these studies, many studies have been introduced on a method of controlling traction, coasting and braking points to minimize fuel consumption at the given travel section, speed limit and

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