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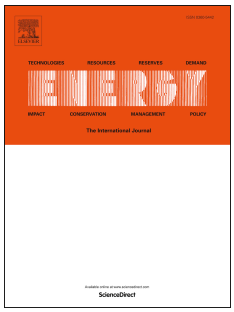

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Real-time Global Driving Cycle Construction and the Application to Economy Driving Pro System in Plug-in Hybrid Electric Vehicles

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Abstract: This paper proposes a global driving cycle construction method based on the real-time traffic information, which can realize online optimal energy management for plug-in hybrid electric vehicles (PHEVs). The construction method is mainly divided into three parts: the construction of velocity segments database; the construction of real-time traffic information tensor model database, and the construction of real-time global driving cycle. For the acquisition of the real-time traffic information, a two-step completion method is adopted to obtain the complete and accuracy traffic information; for the driving cycle construction, the velocity segment database, the road section velocity and the Markov transfer matrix with Monte Carlo are used to generate velocity segments which constitute the global driving cycle. With the updated real-time traffic information, the global driving cycle is reconstructed which further reflect the real-time road condition. The efficient dynamic programming (DP) algorithm is applied to realize online energy management in PHEVs. Its simulation shows that the fuel efficiency improves by at least 19.83% compared with charge depleting and charge sustain (CDCS) control strategy. Finally, the economy driving pro system (EDPS) is presented in this paper, and it contributes 5.79% fuel efficiency compared with non-EDPS.
Keywords: global driving cycle; traffic information; tensor completion; dynamic programming; EDPS; PHEV

I. INTRODUCTION

The global driving cycle, which is described as a velocity profile varying with time, is mainly utilized to describe vehicle driving characteristic and quantitatively detect tail gas pollution [1]. Moreover, in the new energy vehicles research area, global driving cycle can be adopted as an input for the calculation of optimal control sets (the optimal distribution of fuel and electricity) [2,3]. The optimal control sets can reach the results of energy-saving and emission-reduction, which is in line with the present resource saving tendency. At present, many countries and automobile manufacturers are making plans to replace traditional fuel vehicles with new energy vehicles. In the current energy consumption basis, it is essential to further reduce the new energy vehicles consumption level. Based on the current research foundation, it is a good way to further reduce the consumption level by acquiring the global driving cycle before the vehicle departs, which could be applied to the energy management system. Therefore, it is necessary to explore the online global driving cycle construction methods.

Existing methods of global driving cycle construction are generally divided into four types: short range method, wavelet analysis method, markov method and clustering method [4]. Wan Xia used a short-range method to construct driving cycle for passenger vehicles in Shenzhen [5]. Ping Jiang adopted wavelet analysis to construct city road driving cycle, and the results illustrated wavelet analysis could reflect the driving cycle on urban road in China more preciously [6]. Jiankun Peng proposed a Markov method to construct city driving cycle for plug-in hybrid electric bus, and the correlation coefficient of the constructed driving cycle could reach 97% compared with the original driving cycle [7]. Qin Shi applied a combine cluster method to analysis driving cycle, which improved the accuracy of driving cycle compared with K-means clustering method [8]. All these global driving cycle construction methods do not consider the influence from the real-time traffic information. Accordingly, there is an issue that the driving cycles may not well reflect the actual driving conditions. Therefore, it is essential to explore a global driving cycle construction method which considers the real-time traffic information.

For PHEVs global optimal energy management, the dynamic programming (DP) algorithm is usually applied in offline global optimal energy management or online predictive optimal energy management within the model predictive model (MPC) predict horizon [9,10]. Shuo Zhang used typical driving cycle classified into different driving pattern to realize PHEVs engine-generator and battery optimal energy allocation [11]. Zeyu Chen proposed a