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CONNECTED AUTOMATED VEHICLES AND ITS

An Economical Velocity Planning Algorithm for Intelligent Connected Electric Vehicles Based on Real-Time Traffic Information

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Abstract
The energy efficiency of intelligent networked connected electric vehicle (EV) is directly related to its velocity. Aiming at the influence of real-time traffic flow information on road speed interval, a two-layer speed planning method is proposed. The upper layer extracts the road speed interval according to the traffic flow information, and based on cellular automata and confidence interval theory, traffic information rules are introduced, and a road speed interval extraction method considering traffic density information is established. The lower layer is used to obtain energy-optimal cruising velocity profile. Taking the road speed interval as the variable boundary constraint, a dynamic programming algorithm that changes the state quantity boundary in real time is designed, which realizes the efficient acquisition of the energy-optimized velocity trajectory. To verify the effectiveness of proposed approach, the simulation model is formulated based on using collected real traffic information. The simulation results demonstrate that, compared with the conventional constant speed cruising strategy and dynamic programming (DP) strategy based on road speed interval, the strategy proposed in this study not only improves energy efficiency and reduces computing time significantly, but also can predict the traffic conditions ahead to avoid large fluctuations in velocity. Besides, the biggest significance of this study is the designed economic velocity planning algorithm based on real-time traffic density information improves the adaptability of intelligent networked connected EV control strategy to actual traffic conditions, and extends the optimization dimension of eco-driving.

Keywords Intelligent networked vehicle · Energy economy · Global optimal velocity profile · Cellular automata · Dynamic programming

1 Introduction

With the continuous growth of vehicle ownership around the world, it is urgent to solve the environmental pollution caused by vehicles (Fu & Fu, 2021; Yu et al., 2021). Therefore, countries around the world have formulated stringent energy-saving goals and regulations for automobiles, prompting automakers to improve the energy efficiency of cars by continuously innovating vehicle technology (Guo et al., 2019). Hybrid/electric vehicle (HEV/EV) technologies are the products of these goals and regulations (Liu et al., 2019; Wang et al., 2022). However, the energy-saving performance of vehicle is not only related to the type of vehicle (Silva et al. 2021; Sun et al., 2019), but also subject to the driving behavior of vehicle (Ardalan & Antonio, 2018). Economic driving technology is a method to improve energy efficiency by controlling vehicle speed. Because of its advantages such as low application cost, wide application range and good energy-saving effect, it has been widely concerned by automobile manufacturers, researchers and drivers in recent years (Barkenbus, 2010; Su et al., 2019). In addition, the booming intelligent transportation system (ITS) in recent years has also provided strong support for the development of eco-driving technology. ITS adopts advanced communication

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