

Psychological Field Effect Analysis and Car-Following Behavior Modeling Based on Driving Style

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Abstract

To analyze the car-following behavior accurately, this paper takes the drivers' psychological factors into the consideration based on the psychological field theory. The vehicle dynamics indexes are extracted through vehicle history trajectories and the driving styles are clustered by k-means methods. After that the perception coefficient, reaction coefficient, and driving style correction coefficient are obtained and integrated into the psychological field for characterizing the drivers' driving styles. The psychological car-following model which considers the driving styles is built based on the Full Velocity Difference (FVD) model. Finally, the model is validated under the MATLAB/Simulink environment and the result reveals that the psychological field car-following model achieves higher accuracy of characterizing car-following behavior compared with the FVD model and the interaction potential model.

Keywords Car-following model · Driving behavior · Driving style · Full velocity difference model · Psychological field theory

1 Introduction

The theory of psychological field was proposed in the 1990s (Lewin & Zhu, 1998) which is an artificial field formed by human psychology and the material world. It is used to characterize human intention, emotion, volition, and other psychological dynamic elements. The psychological motivations of drivers, pedestrians, and other traffic participants have a key impact on the traffic situation, based on which many studies are carried out in the transportation field.

A driving behavior model framework was established (Tao, 2012) based on the psychological field by analyzing the driver's perception characteristics, and the classic GM (General Motor) car-following model was improved. Many scholars utilized the theory of psychological field to

construct a safety field model (Mullakkal-Babu et al., 2017; Wang et al., 2015). Chen and You (2016) established the driver's psychological equipotential line by introducing the concept of time distance, and based on the theory of psychological field and physical field, the psychological model framework of the curve expressway was established. Finally the robustness of the car-following model was enhanced with the improvement of the headway. Liu (2016) studied the conflict scenarios in road traffic and combined with the urban road traffic conflict theory and the relevant theory of physical field, and studied the driver's driving behavior based on the theory of psychological field. Yu (2018) established the driver's psychological field in the traffic conflict environment by combining the theory of psychological field and psychological field in physics, and considered the effects of people, vehicles, and roads, providing a new research idea for traffic safety in the traffic conflict environment. Lu and Diao (2019) analyzed pedestrian crossing behavior by comprehensively considering traffic psychology and traffic behavior, and established a psychological field strength model for pedestrians crossing the street. Diao (2020) applied the theory of psychological field to the analysis of pedestrian crossing behavior. According to the psychological

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