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AN INTENTION-AWARE AND ONLINE DRIVING STYLE ESTIMATION BASED PERSONALIZED AUTONOMOUS DRIVING STRATEGY

Bohua Sun[1)], Weiwen Deng[1, 2)*], Jian Wu[1)], Yaxin Li[1)] and Jinsong Wang[3)]

[1)]State Key Laboratory of Automotive Simulation and Control, Jilin University, Changchun 130022, China
[2)]Beijing Advanced Innovation Center for Big Data and Brain Computing, Beihang University, Beijing 100191, China
[3)]Electrical & Control System Research Lab, GM R&D Center, 30565 William Durant Blvd., Warren, MI 48092-2031, USA

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ABSTRACT–Autonomous vehicles are aiming at improving driving safety and comfort. They need to perform socially accepted behaviors in complex urban scenarios including human-driven vehicles with uncertain intentions. What's more, understanding human drivers' driving styles that make the systems more human-like or personalized is the key to improve the system performance, in particular, the acceptance and adaption of autonomous vehicles to human passengers. In this study, a personalized intention-aware autonomous driving strategy is proposed. An online driving style identification is proposed based on double-level Multi-dimension Gaussian Hidden Markov Process (MGHMP) with arbitration mechanism and evaluated in field test. A Mixed Observable Markov Decision Process (MOMDP) is built to model the general personalized intention-aware framework. A human-like policy generation mechanism is used to generate the possible candidates to overcome the difficulty in solving MOMDP. The index of surrounding vehicles' intention of the upper-level MGHMP is updated during each prediction time step. The weighting factors of the reward function are configured with the identification result of lower-level MGHMP. The personalized intention-aware autonomous driving strategy is evaluated on a Real-Time Intelligent Simulation Platform. Results show that the proposed strategy can achieve the online identification accuracy above 95 % and for personalized autonomous driving in scenarios mixed with human-driven vehicles with uncertain intentions.

KEY WORDS : Autonomous Vehicle, Driving style, Online Identification, Intention-aware, MOMDP

1. INTRODUCTION

Autonomous driving technology has developed rapidly in the past few years. Reliable lane change and lane keeping navigation have been achieved based on current path planning strategies, and path tracking controls. Their features can enable vehicles to navigate through feasible planned trajectories based on a MIMO controller considering the nonlinearity of the vehicle model and the fast computational time for multi-actuators intervention (Hamid *et al*., 2018). Capturing individual characteristics and humanlike based decision-making to improve vehicle safety and passenger acceptance will be future research trends (Gkartzonikas and Gkritza, 2019). As the key element in personalized driving behavior pattern, understanding human drivers' driving styles that make the systems more human-like or personalized is the key to improve system performance. This fact has motivated numerous research and development efforts on driving style identification and classification (Martinelli *et al*., 2018). Typical features of driving styles are extracted based on huge driving data and model or machine learning based identification algorithms for driving styles are established in a variety of ways, which consist of vehicle states, human factors and their statistical characteristics (Guyonvarch *et al*., 2018; Martinez *et al*., 2018). What's more, context awareness subsystem consisting maneuver classification and vehicle type is added to evaluate driving style (Bejani and Ghatee, 2018). The essence for driving style is the personalized decision-making process, which has great advantages in perceiving and dealing with complex, dynamic and interactive environments (Li *et al*., 2018a). The data-driven humanlike algorithms based on the artificial intelligence generalize to unpredictable situations and reasons in a timely manner about the interactions with many traffic participants and need to reach human-level reliability in decision-making (Noh, 2019; Schwarting *et al*., 2018).

Various researches on classification and identification for driving styles are conducted to make autonomous vehicles work in a human-like way. Classifier with unlabeled driving data and identification process of driving style are developed basing on objective physical models and machine learning algorithms (Wang *et al.*, 2017b) or subjective questionnaire (Bellem *et al.*, 2018) respectively. However, it is doubtful whether the classification and identification results are the truth-value of the specific

**Corresponding author*. e-mail: wdeng@buaa.edu.cn