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Lane changing assistance strategy based on an improved probabilistic model of dynamic occupancy grids

Key words: Occupancy grids; Probabilistic model; Lane changing assistance

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Motivation

1. Under extremely complex and dynamic driving conditions, adopting a reliable environment awareness model and a decision algorithm is crucial in effectively enabling safe and reliable lane changing of vehicles.

2. Lane changing assistance system based on a probabilistic model of dynamic occupancy grids can provide lane changing assistance to drivers taking into consideration the dynamics and safety.

Main idea

1. A set of vehicle lane changing driving assistance strategies is constructed through the driving area modeling algorithm based on the dynamic occupancy grid probabilistic model (DGPM) of an intelligent vehicle.

2. During the lane changing process, the information including lane line estimation, obstacle vehicles, and traffic laws should be comprehensively considered to obtain accurate lane changing results.

3. A four-layer probability map model is proposed based on the traditional occupancy grid model and dynamic occupancy grid data format.

Method

1. A road environment representation method based on a dynamic occupancy grid is proposed in this study. The model encapsulates the data such as vehicle speed, obstacles, lane lines, and traffic rules into a form of spatial drivability probability. This information is compiled into a hash table, and the grid map is mapped into a hash map by means of hash function.

2. The vehicle behavior decision cost equation is established based on a comprehensive consideration of the vehicle's drivability, safety, and power factors. A dynamic programming algorithm is used to calculate iteratively the behavior cost of each cell under different path selections, thereby guaranteeing the correctness and the enforceability of the strategy.

Major results

1. Architecture of DGPM

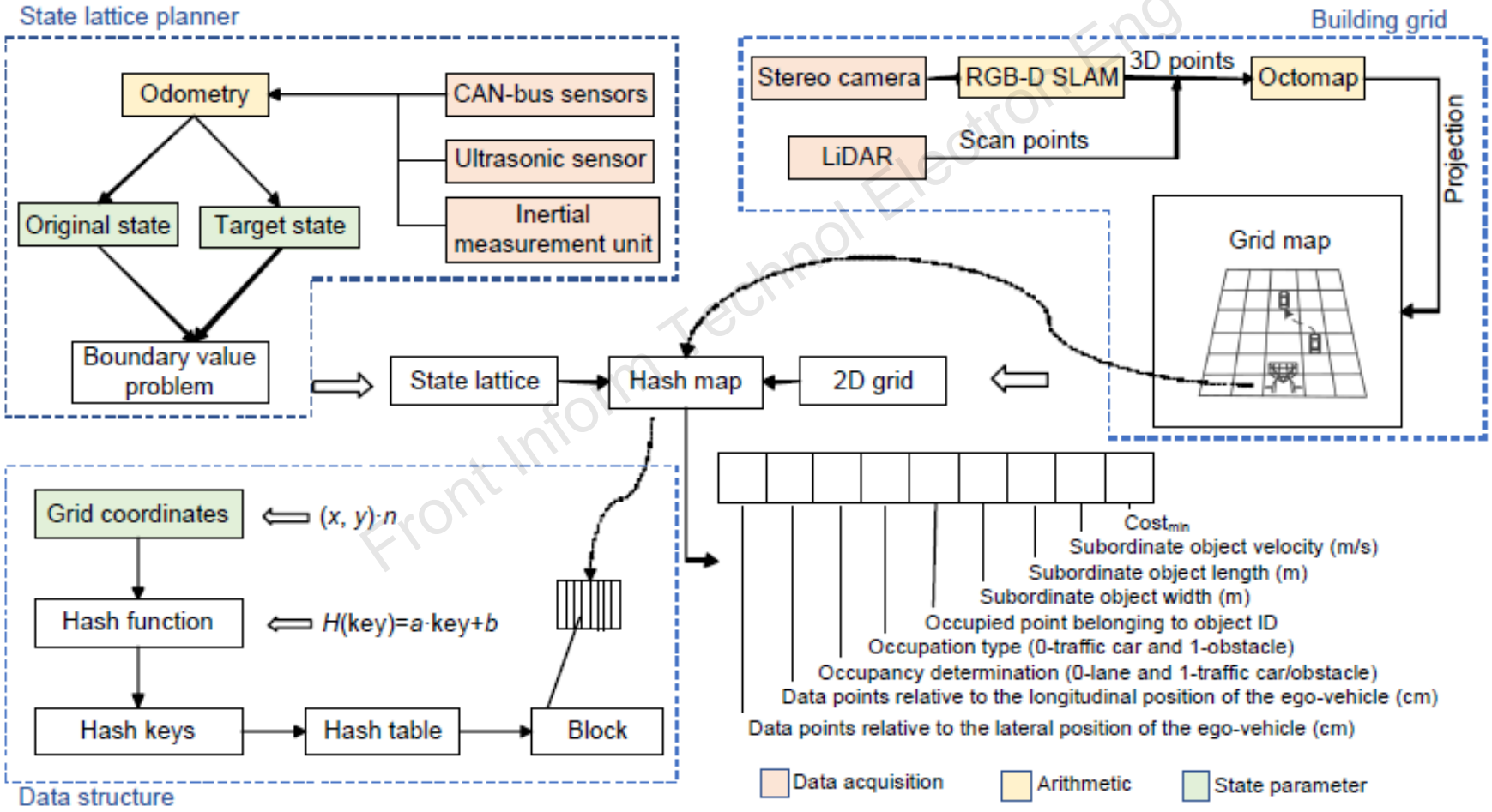

Fig. 1 Architecture of the dynamic occupancy grid probabilistic model (DGPM)

2. DGPM algorithm framework

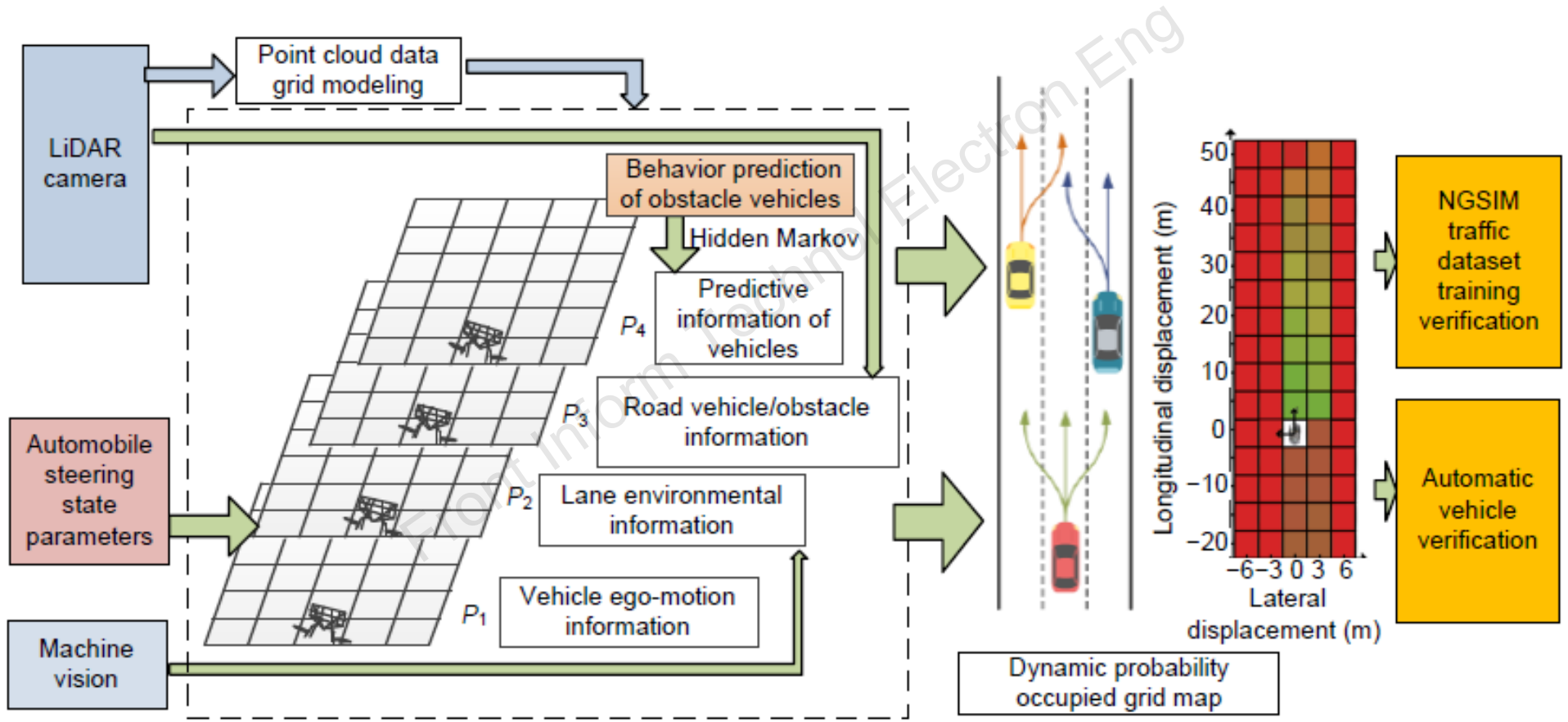

Fig. 2 DGPM algorithm framework

3. Test results of our model and related methods

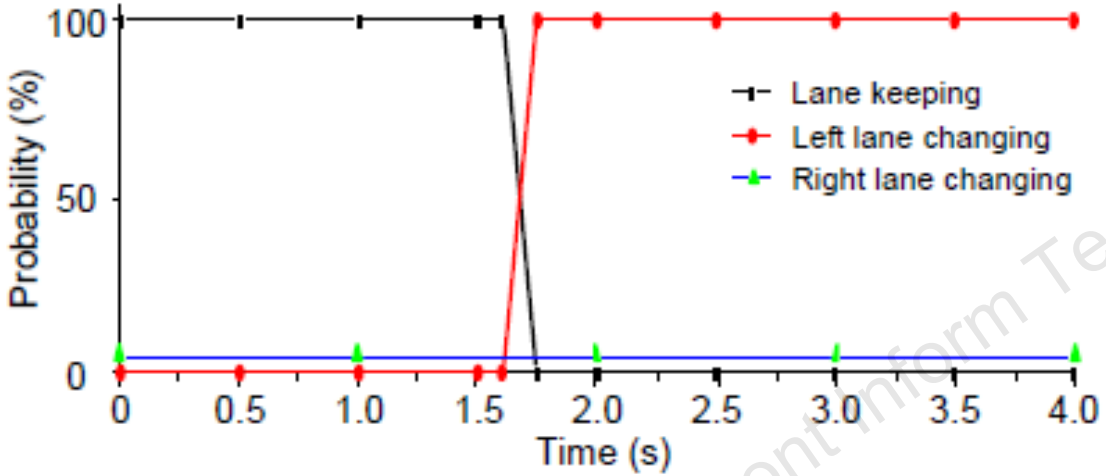

Fig. 6 Recognition probability of the right lane changing behavior

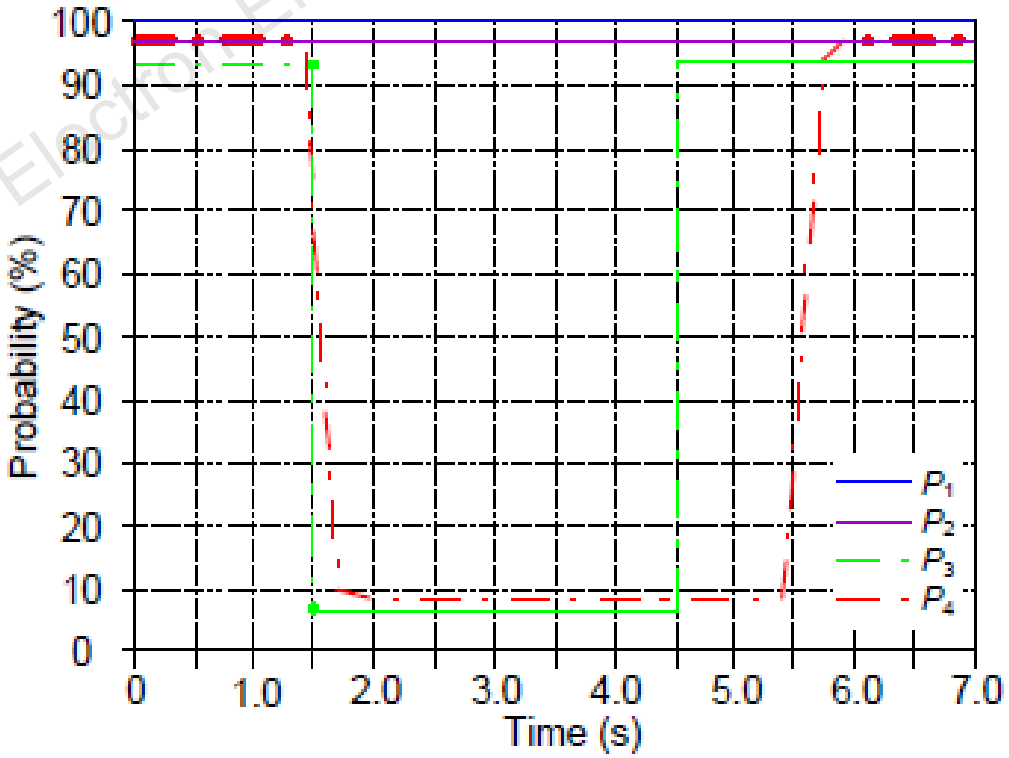

Fig. 15 Probability curves of DGPM

Conclusions

1. An improved DGPM is proposed. The model fully considers various influencing factors such as roads, vehicles, and traffic laws and regulations, and can accurately and effectively express the environmental information around intelligent vehicles.

2. The Markov model is introduced to predict and recognize the behaviors of road vehicles. The behavior of a traffic vehicle can be effectively predicted by observing the lateral deviation of the vehicle and its rate of lane changing, thereby enhancing the robustness of the lane changing assistance driving strategy.

3. A set of vehicle lane changing driving assistance strategies is constructed through the driving area modeling algorithm based on the DGPM of an intelligent vehicle.

Zhenhai GAO is a professor at Jilin University, Jilin, China. He is dean of School of Automotive Engineering and deputy director of the State Key Laboratory of Automotive Simulation and Control, Jilin University. He received his PhD degree from Jilin University in 2000. From 2001 to 2003, he was a postdoctoral researcher at Xi'an Jiaotong University, Xi'an, China. His main research interests include vehicle assisted driving and unmanned driving, driver manipulation behavior analysis, and human-computer interaction design under human vehicle co-driving.

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