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Analyze decision models and interactions among a pedestrian and drivers at an unsignalized intersection

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In recent years, automated driving technology has been researched and developed around the world. To develop safe automated driving systems, verification for these systems are important.

Automated driving systems are verified by computational simulation or implication in a real vehicle. Verification by vehicle can target situations that are close to those in the real world, but it is expensive and difficult to guarantee safety for traffic participants. On the other hand, simulation verification is less costly and safer. However, the presence of other traffic participants makes the behavior of traffic participants interactive, and the simulation must take this effect into account.

Therefore, to realize simulation verification of automated driving systems, this study focuses on human decisions and aims to build a simulation model that can reproduce the interactive behavior of traffic participants.

In this study, an unsignalized intersection is used as the assumed environment. The traffic participants assumed are a vehicle driving straight across the crosswalk (Car S), a vehicle turning right across the crosswalk (Car R), and a pedestrian crossing the crosswalk (Pedestrian). Car S travels on a one-lane priority road, while Car R makes a right turn from the one-way street onto the priority road.

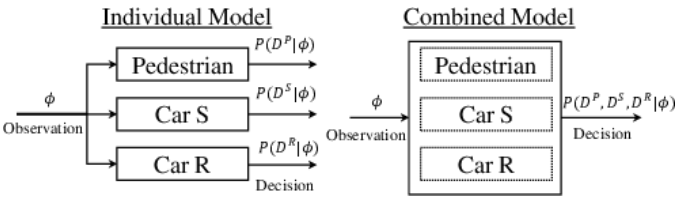

Fig. 1 Individual and combined mdoels

A multi-player simulator is used in verification experiments. This multi-player simulator consists of VR devices for pedestrians and two DSs, (for Car S and Car R). By using this multi-player simulator, all traffic participants in the virtual space can be moved, and interactions can be observed as in the real world. A total of eight pairs (A to H) participated in this experiment, with Pedestrians, Car S, and Car R in pairs of three.

The individual model and the combined model are presented, as shown in Fig. 1. These models are represented by a logistic regression model for the decision of Pedestrian, Car S, and Car R. The individual model consists of logistic regression models, and each traffic participant is represented parallelly. On the other hand, the combined model mixes the decisions of the three participants and represents them as a single model. Based on the comparison by simulation experiments, the individual model is adopted as the decision model. Behaviors of traffic participants are represented by average velocity and acceleration based on each decision.

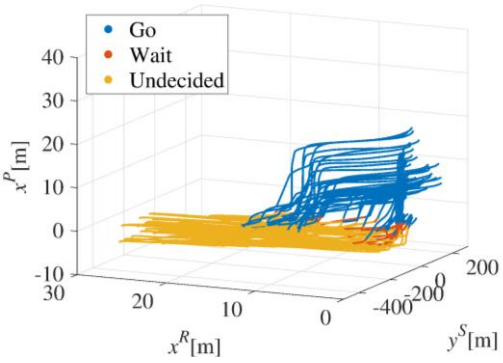

Fig. 2 Pedestrian's decisions of group H on observation data

The observed decisions of Group H pedestrians at each traffic participant location are shown in Fig. 2, and the simulation results are shown in Fig. 3. The colors in the graphs represent the pedestrian's decisions: blue for Go, red for Wait, and yellow for Undecided. Comparing the observed data with the simulation results, it can be seen that the pedestrian's decisions are similarly distributed, indicating that the simulation is able to represent the behavior and decisions of the traffic participants.

In conclusion, the simulation model based on decisions can reproduce the interactive behavior of traffic participants. Future work is needed to improve decision models and verify behavior model in another situation.

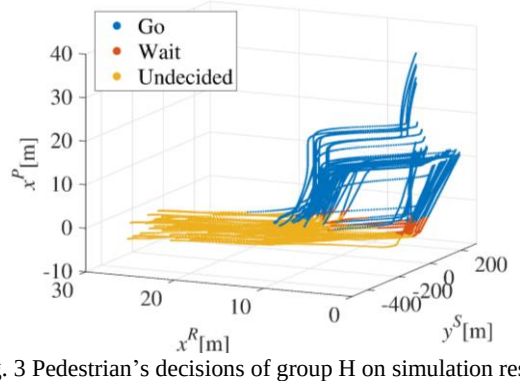

Fig. 3 Pedestrian's decisions of group H on simulation results