

Systematization of Traffic Disturbance Scenarios with Explicit Positional Relationships Among Traffic Participants on General Roads

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1. Introduction

Safety evaluation of automated driving (AD) systems requires the traffic disturbance scenarios an AD vehicle may encounter to be organized systematically. Scenarios are handled at three levels of abstraction: Functional, Logical and Concrete⁽¹⁾. In the safety evaluation framework published by the Japan Automobile Manufacturers Association (JAMA)⁽²⁾, traffic disturbances are systematized as a finite set of Functional scenarios defined by combinations of road geometry, ego-vehicle behavior, and the position and behavior of surrounding traffic participants. In a Functional scenario, however, the position of a surrounding participant is expressed by relative categories such as forward or lateral, and the lane or road area actually occupied is not identified. One Functional scenario therefore contains several distinct positional relationships at the level of road components. For expressways this gap has been addressed by Pre-Logical Scenarios (Pre-LS), an intermediate layer between Functional and Logical scenarios that makes the travel lanes of the ego vehicle and of the other vehicle explicit⁽³⁾. On general roads, sidewalks, road shoulders and crossing roads must also be handled, and the participants extend from vehicles to motorcycles, bicycles and pedestrians. This study extends Pre-LS to general roads and represents traffic disturbances with all of these participants by a common set of elements.

2. Elements of a Pre-LS

Two elements are added to the structure of the JAMA Functional scenarios so that the positional relationships it contains can be stated at the level of road components: the ego-vehicle position and the direction of the other traffic participant. A Pre-LS is thus represented by six elements, namely road geometry, ego-vehicle behavior, ego-vehicle position, and the behavior, position and direction of the other traffic participant (Fig. 1). Because a Functional scenario expresses the place of a participant by relative categories (location), whereas a Pre-LS identifies it at the level of lanes and road areas, the latter is called the position in this study.

Road geometry is either a non-intersection or an intersection, and it switches the definitions of position and direction. The ego-vehicle position is given by the traffic lane it occupies, from the first to the third lane, the minimum configuration that expresses conflicts between adjacent lanes on either side of the ego vehicle. The position of the other participant combines the lane offset from the ego vehicle with road areas such as the sidewalk and the road shoulder, and its direction expresses the heading within that area; twelve directions are defined in total. The participant type, that is vehicle, motorcycle, bicycle or pedestrian, is treated as an attribute that specifies the target of a Pre-LS rather than as a seventh element; differences between types are organized as whether each item of an element applies to that type, for example a lane change is not applied to a pedestrian.

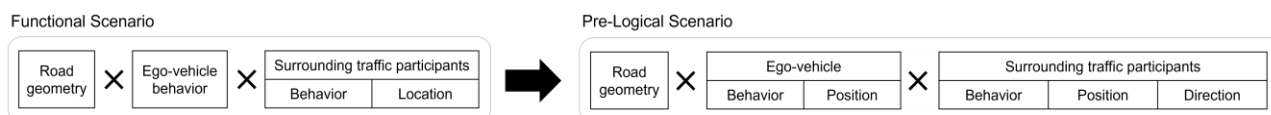


Fig. 1 Elements of Functional scenarios and Pre-LS

3. Expansion from a Functional scenario

Taking a cut-in at a non-intersection as an example, the ego-vehicle position, the position of the other vehicle and the direction of the lane change, none of which is specified in the Functional scenario, are made explicit. When the ego vehicle is in the first lane, only a lane change to the left from the adjacent lane ahead on the right is established, whereas in the second lane lane changes from the adjacent lanes on either side are both established. Over the whole Functional scenario, eight Pre-LS are obtained from the combinations of ego-vehicle position, position of the other vehicle, direction and lane-change direction. Expanding Functional scenarios in this way makes it possible to count the scenes to be considered at the level of lanes and road areas, for each road geometry and participant type.

4. Conclusion

This study extended Pre-LS to general roads and represented traffic disturbances with vehicles, motorcycles, bicycles and pedestrians by six common elements, introducing the ego-vehicle position and the direction of the other traffic participant. Exhaustive generation of Pre-LS, constraint checking against road structures, physical structures and traffic laws, and the tool implementing them are reported in a companion paper⁽⁴⁾. This work is based on the results of the SAKURA project (Ministry of Economy, Trade and Industry)⁽⁵⁾.

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