講演番号	069

文献番号	20226069

Identification of Environmental Factors in Intersections Leading to Traffic Accidents for Safety Assessment of Automated Driving Systems

Hiroshi Yoshitake [1)] **Motoki Shino** [1)]

1) The University of Tokyo
5-1-5 Kashiwanoha, Kashiwa, Chiba, 277-8563, Japan (E-mail: hyoshitake@edu.k.u-tokyo.ac.jp)

KEY WORDS: **Human engineering, Automated driving,** Safety Assessment, Environmental Factors, Intersection [C2]

Automated driving systems (ADS) are expected to reduce the number of traffic accidents. However, a thorough safety assessment is necessary to commercialize a vehicle equipped with an ADS and bring it to the market. Scenario-based assessments are being considered as a means of achieving such safety assessments. In this assessment, methods to identify critical scenarios are essential. Furthermore, it is particular for the safety assessment of ADSs in urban environments because of the wide variety of road environments, traffic rules, and traffic participants involved. Therefore, this paper proposes a method to identify critical scenarios that lead to traffic accidents in urban environments by analyzing driving databases. The feature of this method is that the environmental factors that lead to traffic accidents are extracted by analyzing driver error in human driving and understanding the factors that influence the driver error.

The framework of the scenario identification method proposed in this paper is shown in Fig. 1. This method utilizes two driving databases (The near-miss incident database collected by TUAT and the naturalistic driving database collected by JARI) in each step (Step 1 & Step 2). In Step 1, driver errors that led to near-miss incidents are analyzed using DREAM, a method to analyze accident factors. Then, the environmental factors that affect driver error are further analyzed. Finally, environmental factors that lead to traffic accidents are extracted by aggregating the driver errors and environmental factors that influence the driver errors in each incident data. In Step 2, each naturalistic driving data are checked to determine whether it contains the environmental factors extracted in Step 1. Then, the characteristics of the ego vehicle behavior and surrounding traffic environment are analyzed among the data containing the factors. Finally, critical scenarios are identified by taking a combination of the features of the ego vehicle behaviors and surrounding traffic environments.

We applied the proposed method to a scenario where an ego vehicle encountered an oncoming vehicle when making a right turn at a signalized intersection and investigated the environmental factors that lead to traffic accidents. Figure 2 shows the results of DREAM in Step 1. "Phenotypes" are critical events and "Genotypes" are contributing factors to the near-miss incidents. Among the Genotypes, K1 and F2 accounted for approximately one-third of the entire sample. As for K1, an oncoming right-turn vehicle was the most frequent object that obstructed the view of the ego vehicle. In terms of F2, change in traffic lights made the ego vehicle's driver expect the oncoming vehicles to stop; however, they did not. From this analysis, "dynamic occlusion by oncoming right-turn vehicles" and "change in traffic lights" were extracted as environmental factors that lead to traffic accidents in this scenario.

The extracted factors' component ratios were compared among near-miss incidents and naturalistic driving to examine the proposed method's validity. The component ratios for each factor were higher in near-miss incidents, indicating that the extracted factors induce driver errors and that extracted factors were valid as environmental factors leading to traffic accidents. Therefore, it was confirmed that the proposed method in this paper could identify environmental factors leading to traffic accidents.

Among the environmental factors extracted in this paper, dynamic occlusion has been pointed out to be an essential factor in critical scenarios by existing studies. Thus, the proposed method is also considered reasonable from this point of view. Furthermore, while existing studies implicitly state the importance of considering dynamic occlusion based on conventional knowledge, the method proposed in this paper can explicitly state the importance of it based on driving data. Therefore, the proposed method can contribute to the explicit identification of various critical scenarios.

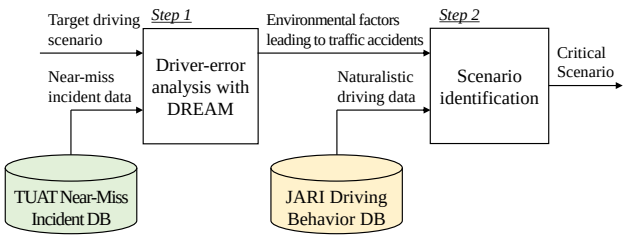

Fig. 1 Framework of proposed method.

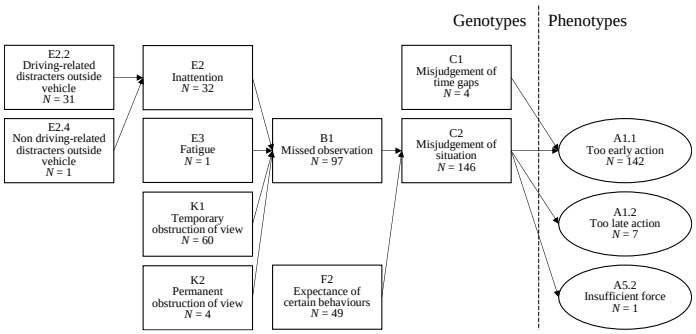

Fig. 2 Relationship between phenotypes and genotypes among near-miss incidents against oncoming vehicles when making a right turn at a signalized intersection (N = 150).