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Exploration of Data Selection Methods for Building Recommended Speed Driver Model Driven By Past Near-Miss Experiences

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The near-miss events involving vulnerable road users can lead to serious accidents. Based on previous studies, current advanced driver assistance system functions reach their limits in helping avoiding or mitigating crashes in some driving scenarios, such as when other road users (i.e., pedestrians and cyclists) suddenly dart out from occlusions or blind spots. When expert drivers with more driving experience are facing uncertainty, they naturally seek to reduce the uncertainty by attempting to fit their current driving context into a pre-existing category based on knowledge-based decision making. Our study goal is to develop ADAS to attain a hazard-anticipatory driving to reduce the vehicle velocity depending on driving contexts.

The near-miss incident database has been managed by the Smart Mobility Research Center (SMRC) of Tokyo University of Agriculture and Technology since 2004. The near-miss incident data are useful not only for analyzing identifying the occurrence mechanism of near-misses, but also for designing context-aware and proactive safety systems. In the previous research, we have proposed a context-sensitive driver model to determine the recommended speed in intersection scenarios, as shown in Fig. 1.

By using the near-miss database, the 869 events were extracted as our target scenario in which a cyclist attempted a road-crossing from a blind spot at an intersection. One of the key aspects in developing the context-aware driver model was to categorize the extracted near-miss data into two levels based on safety margin quantification. The events identified as larger safety margin were associated with the driver's appropriate adjustment of the vehicle velocity to the given road environment context.

The annotations that expressed environment variables had been attached to the recorded data. The 13 parameters excluding the lateral distance, Y_{gap}, were qualitative properties. With the exception of the lateral distance, Y_{gap}, the data used in this study were transformed into dummy variables (symbol 1 or 0). Thus, a total of thirty-seven categories (such as residential area, one way road) were used.

The purpose of the multiple regression analysis was to investigate the impact of explanatory variables (environment variables) on the objective variable (vehicle approach speed). The goal of the analysis using the multiple regression was to find the best fit parameters. Based on training with a low-risk event dataset, we constructed a context-aware driver model to produce the recommended vehicle speed depending on the given road environment context. To evaluate the generalization performance of the constructed model, 10-fold cross-validation or leave-one-out cross-validation (LOOCV) was conducted. To measure the performance, the coefficient of determination, R^2, was used for evaluating the goodness-of-fit, and the mean absolute error (MAE) was used for evaluating the degree of error between the observed value and predicted outcome.

The context-aware driver model was feasible to be used to adjust the approaching speed at blind intersections in accordance with the road environment factors. In this paper, data selection methods for building a recommended speed driver model driven by near-miss experiences were discussed. Further investigations on the definition of near miss events, selection of explanatory variables, machine learning methods, and drivers' acceptance, trust, and behavioral changes towards machine decisions will be done in future studies.

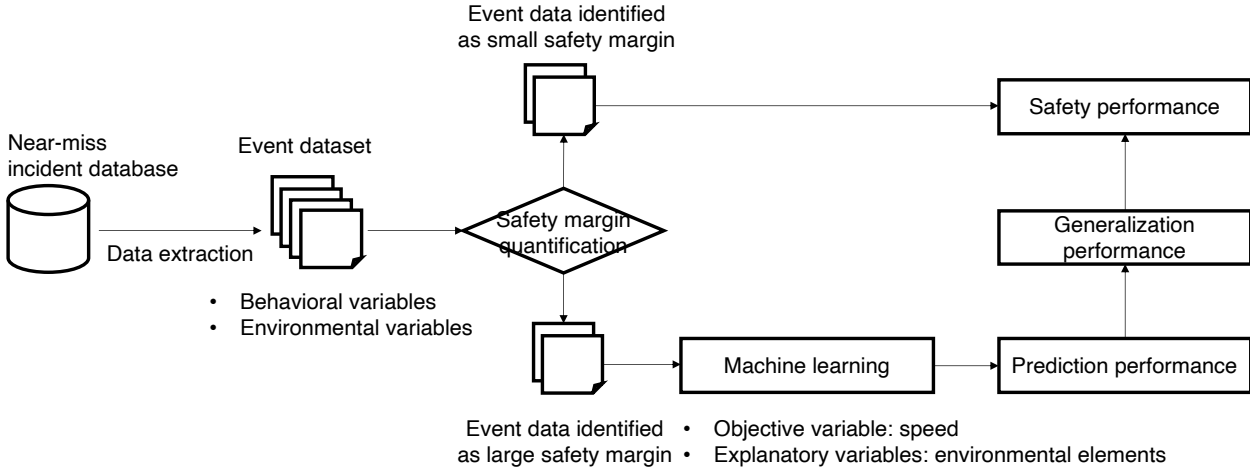

Fig. 1 Procedure for constructing a driver model to calculate the recommended speed.