

# Development of a Real-Time Intersection Risk Prediction Method Utilizing Two-Dimensional Occupancy Grid Maps

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Intersection accidents remain a serious safety issue in urban traffic. Vehicle-mounted sensors alone cannot always detect potential hazards several seconds in advance because of occlusions and limited sensing range. Therefore, infrastructure-assisted approaches using roadside sensors are attracting attention as a complement to Advanced Driver Assistance Systems (ADAS). However, conventional prediction methods struggle to represent interactions among multiple road users and to find potential future conflicts across the entire intersection.

This study proposes a real-time, data-driven risk prediction method for signalized intersection utilizing a two-dimensional occupancy grid map. The current traffic scene is represented as a grid map, and similar past scenes are retrieved from a historical database. An extended grid ID is introduced to distinguish different road-user types within a unified spatial framework. Signal phase and speed are also considered to avoid inappropriate matching between stationary and moving road-user groups. The future states of the retrieved scenes are aggregated into occupancy probability distributions. Risk candidates are then extracted from locations where the predicted distributions of multiple road users converge, and their probabilities are estimated without using an explicit behavior model. We set the prediction horizon to 15 seconds.

The proposed method was applied to real traffic data collected at a signalized intersection in Toyota City. The results identified realistic candidate conflicts, including a near-miss between a straight-through vehicle and a right-turning vehicle. Evaluation using the hit rate showed that performance improved with larger historical databases and decreased with longer prediction horizons, reflecting the characteristics of similarity-based retrieval prediction.

These results suggest the feasibility of real-time risk prediction for multiple road users using observed traffic and signal data. Future work includes improving robustness to data quality, validating risk candidates with near-miss events, and extending the method for integration into a traffic digital twin platform.

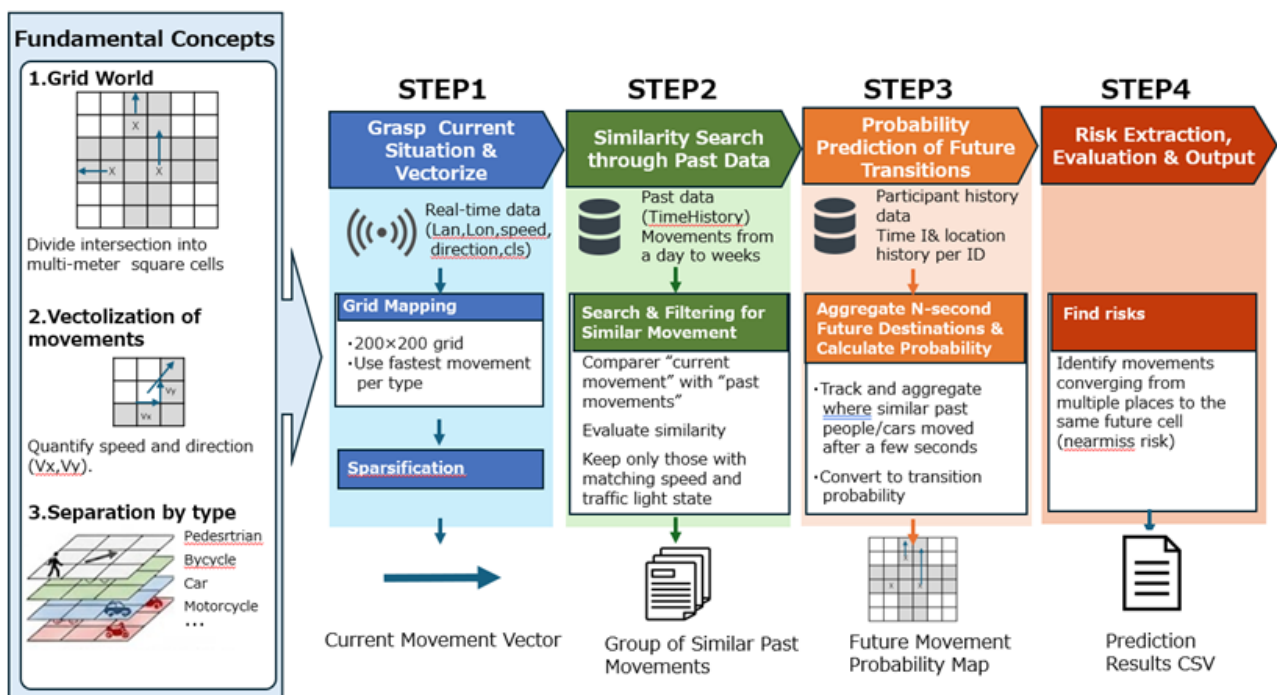


Fig.1 Overview of the proposed method (four-step processing flow)