

“Technical Research and Development for Road Policy Quality Improvement” Study Summary

No.	Title	Principal Researcher
No.2021-1	Research and Development of Automatic Determination of Turning Conditions at Intersections and Network Planning Model for Special Vehicles	Ritsumeikan Univ. Prof. Yasuhiro Shiomi

The research and development aim to establish an efficient transportation system by addressing various issues related to special vehicles. This involves structuring the administrative challenges of special vehicles and developing a database and visualization system for these vehicles. Additionally, the project includes the automatic extraction of intersection components from aerial photographs, the automation of turning conditions determination, the development of an automatic trajectory observation system, and the development of a route choice model, which will be integrated into a road network planning model.

1. Backgrounds and Objectives

Vehicles that exceed general size or weight limits or have unique shapes are classified as special vehicles and must obtain prior permission to use roads. However, the review process takes 28 days on average. The newly launched system that allows for immediate issuance of travel permits is not widely used due to the insufficient road network database, hindering the establishment of an efficient transportation system.

The objectives of this study are to address these issues by structuring social challenges, building a database to effectively utilize data, developing technology for the automatic determination of turning conditions at intersections, and building road planning method for special vehicles.

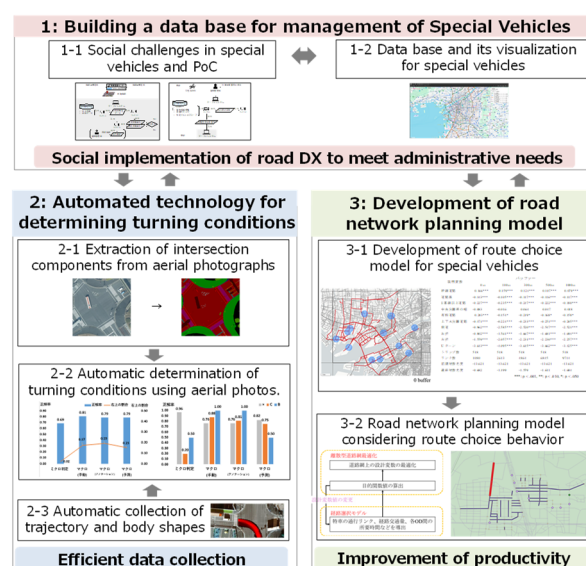


Figure 1 Outline of the research project

2. Activities in Research Period (Figure 1)

Theme 1 aims to clarify the overall position of this research by refining administrative issues related to special vehicles through interviews and surveys, and establishing use cases for the technologies developed in this study (1-1). Additionally, it involves developing a database and visualization system for special vehicle-related data (1-2). **Theme 2** focuses on automating the determination of turning conditions for special vehicles at intersections. This includes: Generating image data that identifies intersection components used as input for the model (2-1). Developing a system that determines turning conditions based on neural networks using training data and a path-finding algorithm for micro-level condition assessment (2-2). Developing an automated method for observing turning trajectories (2-3). **Theme 3** aims to develop road planning technology to enhance the efficiency of special vehicle operations. This involves: Constructing a route selection model for special vehicles (3-1). Developing a road network planning model that incorporates this route selection model (3-2).

3. Study Results

1-1: Research on Administrative Issues in the Special Vehicle Transport System

Based on interviews and questionnaire surveys, it was found that the reasons for the difficulties in registration of municipal road network to road information database include not only a lack of knowledge and manpower,

but also less motivations and lack of policies for registration.

1-2: Development and Operation of a Special Vehicle Database

A database related to special vehicles and its viewer were developed. Interviews with administrative officials confirmed that the developed tools are useful for their work.

2-1: Development of an Automated Segmentation Method for Intersection Components

A method was developed to identify intersection components such as roads, sidewalks, stop lines, and lane edge lines by applying semantic segmentation to aerial photographs. Additionally, a method to supplement occlusions such as pedestrian bridges with 3D point cloud data was developed.

2-2: Automatic Determination of Traffic Conditions Based on Segmented Images of Intersection Components

Models were developed to determine turning conditions by learning the combination of intersection parameters and turning conditions with Neural Network (macroscopic approach) and by exploring the feasible paths within intersections using Hybrid A* Path Planning (microscopic approach). Use cases for these models in determining turning conditions were proposed.

2-3: Automatic Collection of Special Vehicle Trajectories Based on Aerial Videos

A method was developed to detect special vehicles from UAV images and automatically extract their body shapes and travel trajectories.

3-1: Development of a Route Choice Model for Special Vehicles

Using commercial vehicle data and ETC data, route choice behavior for each vehicle type and OD characteristic was modeled using multinomial logit models, Path Size Logit Model, C-Logit Model, and recursive logit models.

3-2: Road Network Planning Model for Efficient Operation of Special Vehicles

A method was developed to identify links and nodes to be improved to allow special vehicle passage by incorporating the route choice model into a discrete road network optimization framework. Application to an actual road network suggested that improving links or nodes to ensure connectivity between major ODs or in suburban areas with low construction costs is desirable.

4. Papers for Presentation

- Tamotsu Shino and Yasuhiro Shiomi: An automatic judgement algorithm of turning conditions of over-size/over-weight vehicles at intersections, Proceedings of 20th ITS Symposium, 2022 (in Japanese). [Best poster award]
- Yufeng Gong, Junichi Susaki, Kakuya Matsushita, and Hitomu Kotani: Automatic extraction of crossroads position from mms data, Proceedings of Infrastructure Planning conference Vol. 66, 2022.
- Yue Ma, Jan-Dirk Schmöcker, Wenzhe Sun, Satoshi Nakao: Route Choice Analysis of Oversized Trucks in Osaka-Kobe Area Using Binomial Logit and Recursive Logit Models, Proceedings of the 27th HKSTS international conference, 2023.
- Yue Ma, J.-D. Schmöcker, Wenzhe Sun, Satoshi Nakao: Estimating Oversized Truck Route Choice Behavior Using GPS Trajectory Data and Recursive Logit Models, Proceedings of the 103rd TRB annual meeting, 2024.

5. Study Development and Future Issues

We will continue to elaborate the developed database and visualization system, the turning condition determination system, and the road network planning model that considers route choice behavior. The turning condition determination system will be expanded to account for the behavior of towing vehicles.

6. Contribution to Road Policy Quality Improvement

The systems developed in this study have been confirmed to have high demand through interviews with prefectural officials. We will continuously work towards the social implementation of these systems.

7. References, Websites, etc.

Web site of smart logistics sub-committee in Committee of Infrastructure Planning and Management:
<http://shiomi.rits-ese.jp/smart-logi/>