"Technical Research and Development for Road Policy Quality Improvement" Study Summary

No.	Title	Principal Researcher
No.2022-5	Development of Traffic Safety Measures for Bicycles on Roadways based on Advanced Data Analysis	Osaka Metropolitan Univ. Assoc. Prof. N. YOSHIDA.

This study concentrates on traffic accidents between bicyclists and motorists on roadways., with a particular focus on accidents at large intersections. These locations are at high risk of serious accidents based on various analysis. This project aims to propose safety measures that will contribute to the reduction of serious accidents and to progressively improve sustainable safety measures that should be reflected in the design phase of road transport systems, through traffic conflict experiments using developed cooperative cycling simulators.

1. Background and Objective

This study focuses on traffic accidents between bicycles and automobiles on roadways, especially at large intersections, where serious accidents are more likely to occur. This project aims to propose safety measures that will contribute to the reduction of serious accidents and to progressively improve sustainable safety measures that should be reflected in the design phase of road transport systems, through traffic conflict experiments using developed cooperative cycling simulators.

2. Activities in Research Period

(1) Categorization of accidents on bicycle roadways by analyzing drive recorder data and traffic accident data. Furthermore, observational surveys at actual intersections and video analysis methods will be employed to typify dangerous driving or cycling patterns.

(2) Analysis of the relationship between the bicycle riding environment and user behavior using a mobile probe bicycle (MPB). The study will also attempt to directly observe the Time to Collision (TTC) of traffic conflicts, and clarify under what conditions dangerous complications occur, as well as the relationship between intersection conditions and behaviors. (3) Cooperative Behavior Experiment Using a Driving Simulator (DS)

A DS will be developed to evaluate the effects of different conditions on safety performance from both objective and subjective evaluations. In addition, using open, a 3D virtual space connecting DS and a cycling simulator (CS) will be developed to create a virtual experimental course with protected intersections and bicycle traffic signals.

(4) Traffic conflict experiments using a Cooperative Cycling Simulator (CCS) system.

Experiments will be conducted in a virtual space using CCS to safely reproduce dangerous conflicts such as collisions, etc. The results will be evaluated from the perspective of traffic safety measures and their impact on driving or cycling.

(5) Develop strategies to enhance bicycle safety on roadways based on experimental evidences and sustainable safety improvement measures.

By comparing and organizing the results of surveys, analyses, and experiments at large signalized intersections and single road/tunnel sections, we will propose measures to improve bicycle safety in terms of roadway structure, traffic conditions, and design elements.

3. Results

• The analysis of both Strategic Innovation Promotion Program (SIP) data and taxi-mounted drive recorder data identified the following types of accidents: encounters, left-turns, rearend collisions, and single vehicle off-road departures. Blind spot-related accidents at signalized intersections were found to be an issue when vehicles were turning left. We evaluated the risk of conflicts based on left-turning vehicles and bicycle traffic patterns.

- The study showed that it is possible to observe the TTC directly from the bicyclist's point of view using a MPB equipped with a Lidar sensor. It also showed how to calculate the time to collision at blind spots at the corners of intersections.
- In the CCS experiment, we tested different simulators and how driving behavior affects TTC. We also created a 3D virtual space based on real city data and tested it.
- A simulator was built to help cars and bicycles avoid traffic accidents. It was used to test how different situations, like corners at intersections, affect accidents.
- The results of the simulator experiments, along with accident analyses and observational surveys, were used to propose design elements for each road structure and traffic condition that would prevent dangerous traffic conflicts.

4. Papers for Presentation

- 1) T. INAGAKI and N. YOSHIDA: Typification of near-miss incidents between bicycles and left-turn vehicles on roadway using drive recorder data, Traffic Sciences, Vol. 51, No. 2, pp.28-33, July 2021. (In Japanese)
- 2) N. YOSHIDA, K. SAWADA and A. TAKIZAWA: An Analysis on Bicycle and Left-Turn Vehicle Conflict with Trajectories Extracted from Faster Regions with Convolutional Neural Networks Method at Signalized Intersections, Japan Society of Traffic Engineers, Journal of Traffic Engineering, Vol. 8, Issue 2, pp. A_273-A_280, Feb. 2022. (In Japanese)
- 3) H. YAMANAKA, I. YAMADA, S. MATSUMOTO and N. YOSHIDA: Analysis on the Conflicts Between Bicycles and Left-Turning Vehicles at Signalized Intersections Using Coordinated Cycling and Driving Simulator, Japan Society of Traffic Engineers, Proceedings of the 42th Conference, pp. 709-714, Aug. 2022. (In Japanese)
- 4) N. YOSHIDA, H. YAMANAKA, S. MATSUMOTO, T. HIRAOKA, Y. KAWAI, A. KOJIMA, and T. INAGAKI: Development of Safety Measures of Bicycle Traffic by Observation with Deep-Learning, Drive Recorder Data, Probe Bicycle with LiDAR, and Connected Simulators, 10th Annual International Cycling Safety Conference, Nov. 2022.
- 5) R. KAMBAYASHI, S. MATSUMOTO, J. SAKURAI, H.YAMANAKA, N. YOSHIDA: Evaluation of Left-turning Vehicle-bicycle Conflict Risk with Elderly Drivers Using a Coupled Simulator, Japan Society of Traffic Engineers, Journal of Traffic Engineering, Vol. 9, Issue 2, pp. A_297-A_304, Feb. 2023. (In Japanese)
- 6) K. GOSHONA, N. YOSHIDA: Analysis of Selective Conflicts between Multiple Bicycles and Left-Turning Vehicle at Signalized Intersections by using Video Tracking Data, Japan Society of Traffic Engineers, Proceedings of the 43rd Conference, pp. 247-250, Aug. 2023. (In Japanese)
- 7) F. KOJIMA: Characteristic Analysis of Bicycle Accidents Focusing on Accidents on Road Sections, Japan Society of Traffic Engineers, Proceedings of the 43rd Conference, pp. 11-18, Aug. 2023. (In Japanese)
- K. GOSHONA, N. YOSHIDA: Analysis of Selective Conflicts between Multiple Bicycles and Left-Turning Vehicle at Signalized Intersections by using Video Tracking Data, 11th International Cycling Safety Conference, November 2023.
- 9) F. KOJIMA: Research on Characteristics of Serious Bicycle Accidents Using Traffic Accident Data, Japan, Japan Society of Civil Engineers, Proceedings of the 68th Conference, 6 pages, Nov. 2023. (In Japanese)
- 10) S. OKAZAWA, K. KOBAYASHI, J. SAKURAI, S. MATSUMOTO, N. YOSHIDA, H. YAMANAKA: Driving characteristics when passing a bicycle in a tunnel Japan Society of Civil Engineers, Proceedings of the 68th Conference, 9 pages, Nov. 2023. (In Japanese)
- 11) I. YAMADA, H. YAMANAKA, N. YOSHIDA, S. MATSUMOTO: Assessing the Safety of Left-Turning Vehicles and Straight-Running Bicycles Using Cycling and Driving Simulator-Effectiveness of Intersection Treatments-, Japan Society of Civil Engineers, Proceedings of the 68th Conference, 12 pages, Nov. 2023. (In Japanese)
- 12) Y. KAWAI, S. MATSUMOTO: Development of a Cooperative Driving Simulator Using a Game Engine, Japan Society of Civil Engineers, Proceedings of the 68th Conference, 5 pages, Nov. 2023. (In Japanese)
- 13) S. MATSUMOTO, N. TAGUCHI, A. WAKAMEDA, R, EBISAWA, N. YOSHIDA: Effect of signal head distance on bicycle stopping behavior by cycling simulator experiments, Japan Society of Traffic Engineers, Journal of Traffic Engineering, Vol. 10, Issue 1, pp. A_309-A_315, Feb. 2024. (In Japanese)

5. Future Prospects

The results of this research are expected to be reflected in related guidelines and guidance such as intersection design. It is also expected that the results will be used in the process of planning accident countermeasures, when using virtual space to explain what combination of safety measures can be selected to achieve the expected safety effects.

6. Contribution to Improving the Quality of Road Policy

The system is expected to contribute to improving the quality of road policies related to traffic safety measures by facilitating detailed preliminary studies before the actual introduction of the measures, thereby improving the presentation of more detailed countermeasure effects and the ability to explain them.

7. Website, etc.: None