

Evaluation of Human Machine Interface for Vehicle-infrastructure Cooperative Driver Assistance

Fund: RoAD to the L4 (Theme 4)

Introduction

In the future, the social implementation of Level 4 automated driving is expected to begin with commercial vehicles, while Level 2 driver assistance systems are likely to expand to public roads for private vehicles. To facilitate Level 4 deployment, infrastructure-cooperative systems are being developed to transmit information such as traffic signals and detected objects from roadside sensors to vehicles. To extend the use of such systems to driver assistance, effective human-machine interfaces (HMIs) are being investigated through driving simulator experiments.

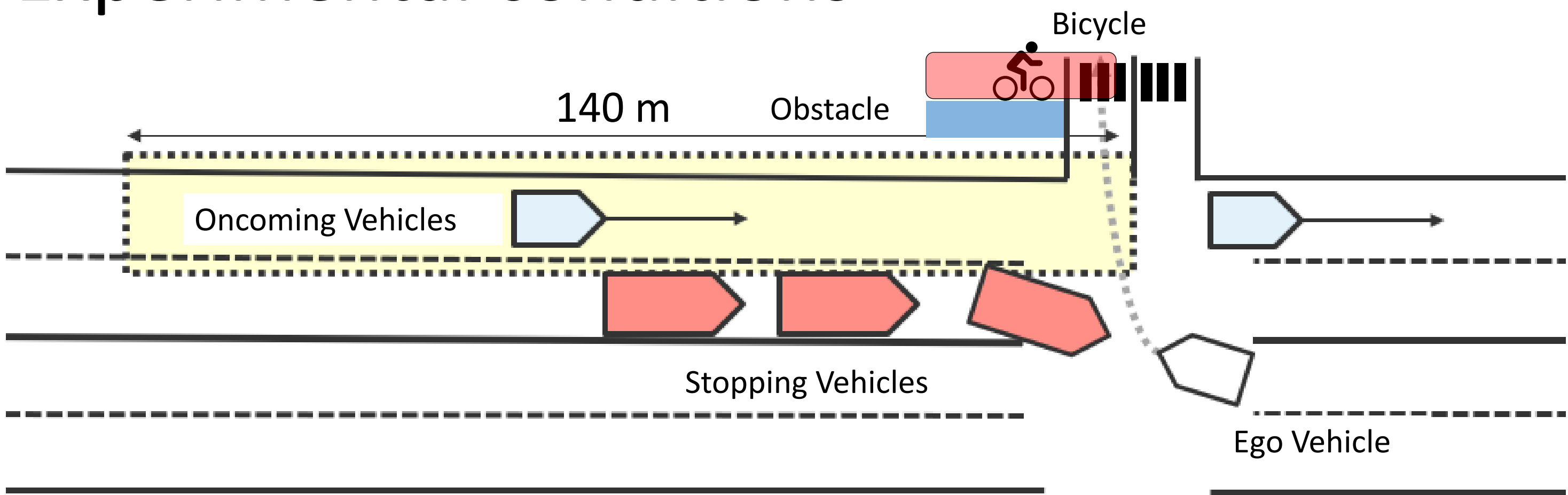
Proposed HMIs

In Level 4 automated driving, cooperative systems are expected to provide "free space" information indicating the absence of obstacles. However, such information may cause drivers—who remain responsible for safety—to become over-trust and less attentive. To assess this risk, four types of HMIs are presented to drivers making right turns, and their effects on driving behavior are evaluated.

- HMI 1: HMI that communicates the presence of oncoming traffic;
- HMI 2: HMI that communicates the absence of oncoming traffic;
- HMI 3: HMI that assists the driver's right turn decision;
- HMI 4: HMI that separately communicates the presence of oncoming traffic and pedestrians

	Coming car	No coming car	Conditions for triggering the messages
HMI 1		×	Oncoming car exists at a distance of 140m or less from the intersection
HMI 2	×		No oncoming car exist at a distance of 140m or less from the intersection
HMI 3			w or w/o oncoming car at a distance of 140m or less from the intersection
HMI 4		×	Oncoming car exists at a distance of 140m or less from the intersection
		×	Pedestrian/cyclist exists at a distance of 50m or less from the intersection
No HMI	×	×	×

Experimental conditions



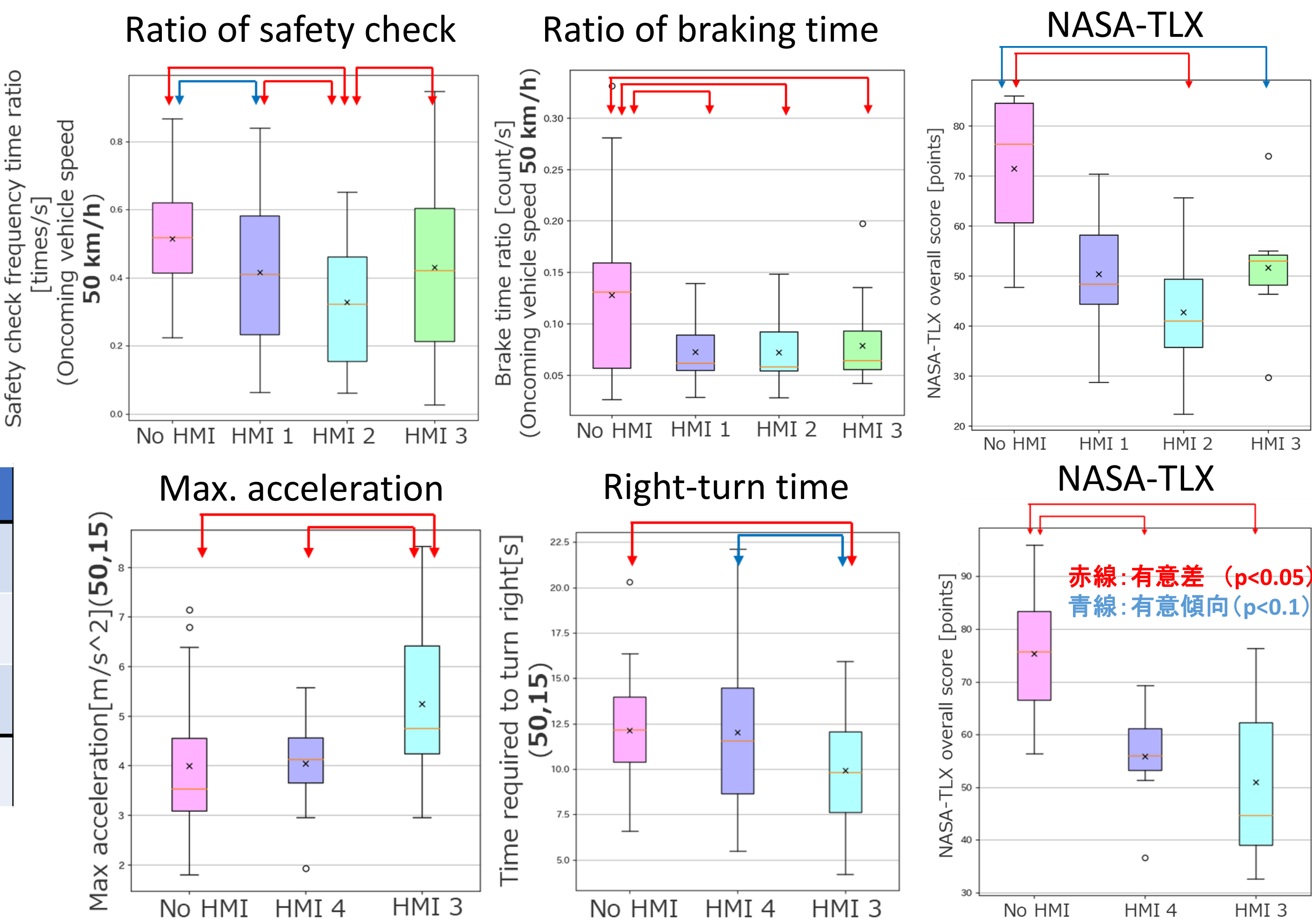
A right-turn scenario at a signalized two-lane road intersection was created by placing large left-turning vehicles to block drivers' view of oncoming traffic. Roadside units were assumed to detect vehicles within 140 m and pedestrians or cyclists within 50 m. Vehicle speeds were 50, 60, and 75 km/h; cyclist speeds were 15 and 25 km/h.

Experimental results



Number of collisions

	No HMI	HMI 1	HMI 2	HMI 3
Coming car 50 km/h	2	0	0	0
Coming car 60 km/h	0	0	1	0
Coming car 75 km/h	4	0	3	0
Total	6	0	4	0



Conclusion

- In the case of HMI2, which provides free space information, driving workload is reduced, but there is a risk of contact with oncoming vehicles.
- HMI3, which communicates right-turn decisions to the driver, reduces driving workload compared to no notification, both when only oncoming vehicles are present and when both oncoming vehicles and bicycles are present. However, compared to HMI1, which informs the driver of the presence of obstacles, HMI3 tends to induce sudden acceleration.

Publications

Jun SAWADA, Masaaki ONUKI, Kimihiko NAKANO, " Evaluation of Human Machine Interface for Vehicle – infrastructure Cooperative Driver Assistance “, Proc. of Translog2024, No.24-45 (2024), JSME.