Research and Development of Human Machine Interface for Driver Initiated Take-over

Fund: New Energy and Industrial Technology Development Organization

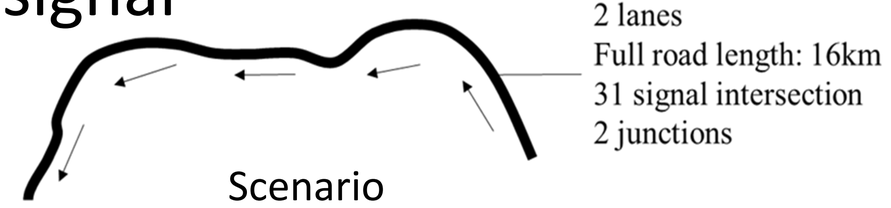
Introduction

The driver-led transition from automated driving to manual driving mainly occurs in level 2 automated driving. To expand the level 2 automated driving, which is currently limited to expressways, to general roads with many hazards, it is necessary to show that the drivers can respond appropriately based on an appropriate understanding of the system and achieve a quicker reaction. To enable the safe application of level 2 automated driving on general roads, especially near signalized intersections, human machine interfaces (HMIs) were proposed to improve drivers' attention levels and responses to risks. Driving simulator experiments were performed to investigate the influences of the proposed HMIs on driver behaviors.

HMIs for interacting with the change of traffic signal

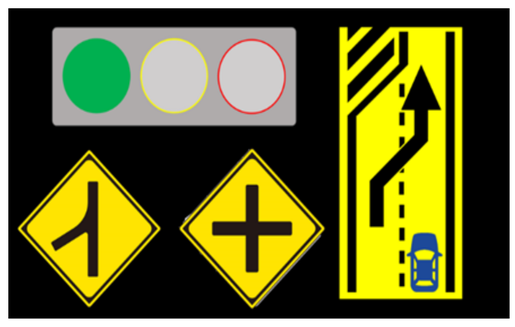
When traffic signal recognition is not included in the level 2 automated driving, drivers need to take over and stop the vehicle by themselves if the signal turns yellow when the vehicle is approaching a signalized intersection while following the preceding vehicle with Adaptive cruise control.

Two kinds of HMIs were proposed, of which static HMI is to notify the approach to intersections and confluences based on static map information and dynamic HMI is to present information of traffic signal and lane regulation based on dynamic information from the infrastructure. The presented traffic signal information is the predicted color of the oncoming signal when ego vehicle reaches the signalized intersection. Experimental results indicated that the use of dynamic HMI reduced sharp deceleration and improved the feeling of security during driving.

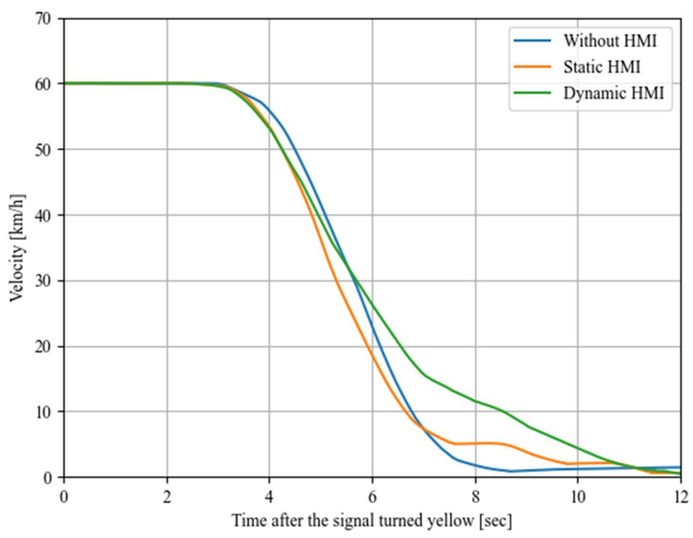


Scenario

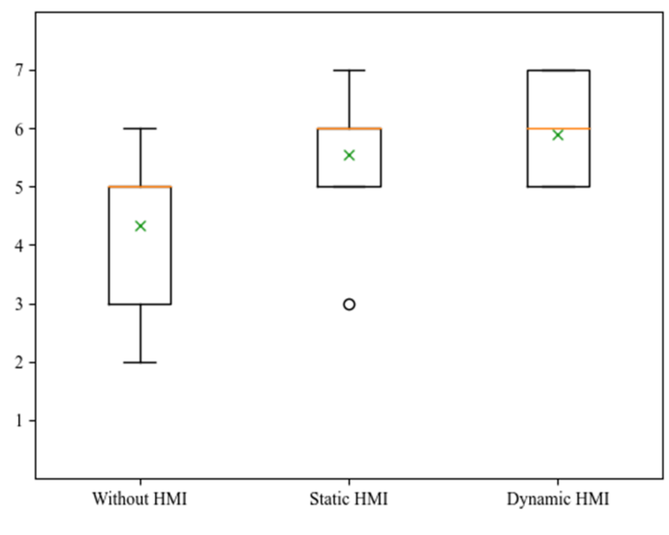
Static HMI



Dynamic HMI



Changes of velocity

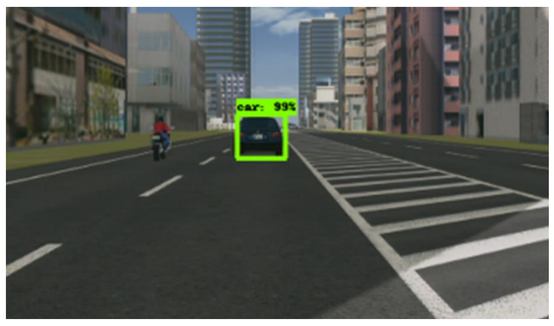


Feeling of security

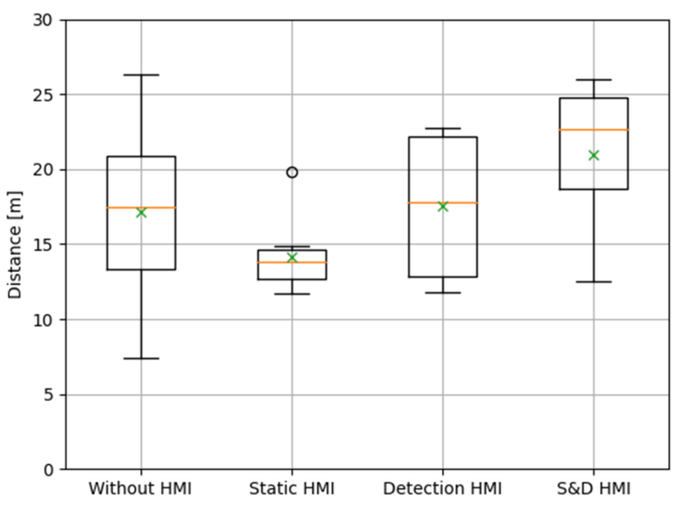
HMIs to avoid vehicle-to-vehicle accidents at intersections

The purpose of this experiment is to investigate the requirements of HMI to prevent vehicle-to-vehicle accidents near signalized intersections by appropriate driver-led takeovers while applying level 2 automated driving. Two kinds of HMIs were applied, of which one is the static HMI used in the experiment 1, and the other is detection HMI which presents real time results of image recognition by the level 2 automated driving system.

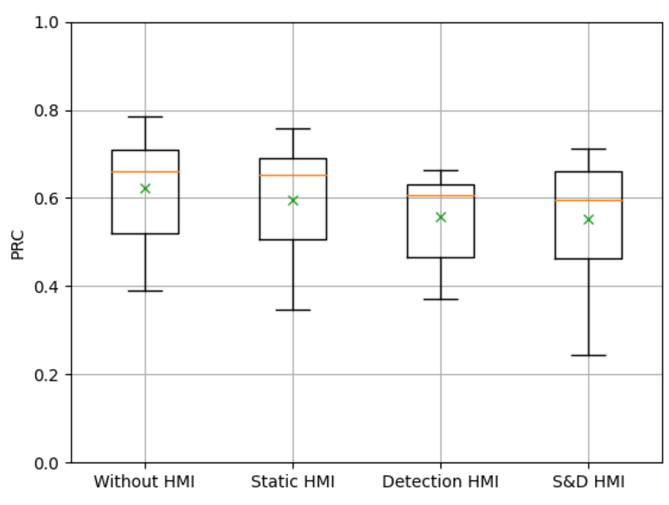
During the experiment, the ego vehicle follows the preceding vehicle in the second lane at 60 km/h. A motorcycle in the first lane suddenly interrupts in front of the ego vehicle near the signalized intersection, and a collision will occur if the drivers do not take over. It was shown that the presence of the detection HMI significantly increases the inter-vehicle distance during driving intervention. Meanwhile, the inter-vehicle distance under the combined condition of static and detection HMI was the longest. On the other hand, the use of detection HMI might reduce the gaze to the road center areas.



Detection HMI



Distance between vehicles while intervention



Percent road center

Publications

Saito K., Yang B., Wang Z., Nakano K., Kitazaki S., 2021, Requirements of HMI to support proper driver takeover during partially automated driving on general road, TRANSLOG, JSME

Saito K., Yang B., Wang Z., Nakano K., Kitazaki S., 2021, Requirements of HMI to support proper driver takeover during partially automated driving at a signalized intersection, ITS symposium, ITS Japan