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Evaluation of workload during autonomous truck platooning from pupil diameter

Shoichiro Teranishi [1)] Hiroki Kawashima [1)] Genya Abe [1)] Mitsuru Nagatsuka [2)]

1) Japan Automobile Research Institute
2530 Karima, Tsukuba, Ibaraki, 305-0822, Japan
2) Japan Automobile Manufacturers Association
1-1-30 Shiba Daimon, Minato-ku, Tokyo, 105-0012, Japan

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In autonomous truck platooning, the driver is released from driving operations and constant monitoring of systems under certain driving conditions, so it is expected that drivers' workload will be reduced compared to manual driving. As a preliminary step toward unmanned following trucks, a demonstration project for autonomous truck platooning is underway in which all trucks are manned. It is not fully known whether following-truck driver's workload is reduced in autonomous truck platooning.

In this study, we conducted a comparative study of following-truck drivers' workloads under driving conditions and road segments using driving simulator. However, operations and events based on vehicle-to-vehicle communication were not assumed in this experiment because they are expected to change in accordance with future technological developments.

The experimental course consisted of a straight segment, curved segments, a merged segment, and a construction segment simulating request to intervene (RtI) scene. The driving conditions were manual driving (35 m between trucks), driving using adaptive cruise contorol(ACC) (35 m between trucks), SAE level 3 autonomous driving (35 m between trucks) and the autonomous driving (35 m between trucks)autonomous driving (70 m between trucks). In RtI scene under autonomous driving, participants were asked to regain manual control and changed lanes to avoid a collision with a construction vehicle. After each of the four driving conditions (first half), a 15 minute break was taken, and the four driving conditions were performed again (second half), for a total of eight times per perticipant. Participants' workloads were compared by pupil diameter after excluding data that were considered drowsiness.

Figure 1 shows change in mean normalized pupil diameter for each driving condition and road segment. The pupil diameter in the autonomous driving is smaller than that in the manual driving. Furthermore, the pupil diameter in the autonomous driving (70 m between trucks) is smaller than that in the autonomous driving (35 m between trucks).

Figure 2 shows the difference between mean normalized pupil diameter for each driving condition in the first and second halves of the experiment. Pupil diameter in the second half of the experiment was smaller than in the first half. Furthermore, the difference between the autonomous driving (70 m between trucks) and the autonomous driving (35 m between trucks) was smaller in the second half of the experiment than in the first half.

These results confirmed that following-truck driver in autonomous truck platooning have a lower workload compared to manual driving. Furthermore, it was confirmed that driver's workload in the large distance condition is lower than in the small distance condition. However, a comparison between the first and second halves of the experiment indicates that the difference in driver's workload due to distance between vehicles may decrease as the driver's proficiency level increases.

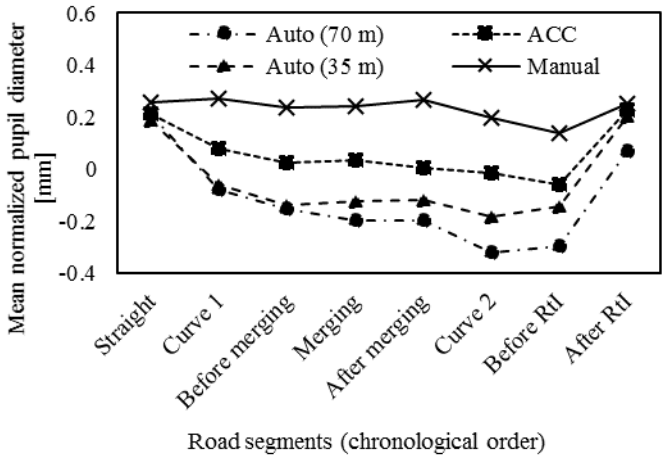

Fig.1 Mean normalized pupil diameter for each driving condition and road segment

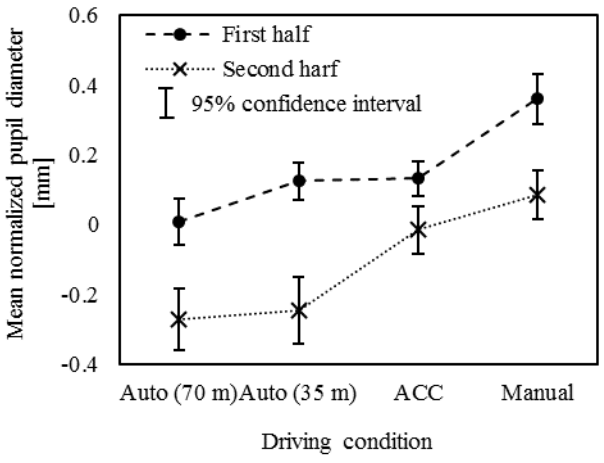

Fig.2 Mean normalized pupil diameter for each driving condition in the first and second harf