

Experimental Study on Collision Avoidance Performance of the System during Rapid Approach of Another Vehicle while the Driver is Using Advanced Driver Assistance System (ADAS)

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KEY WORDS: safety, adaptive cruise control, driver support, Advanced Driver Assistance System (C1)

In this study, commercially available passenger vehicles equipped with an Advanced Driver Assistance System (ADAS) were used to measure vehicle behavior when a vehicle encountered an imminent risk of collision with another vehicle while the system was activated. Whether the Advanced Emergency Braking System (AEBS) was activated, along with other factors, was then evaluated.

The ADAS functions evaluated in the real-vehicle tests in this study were Adaptive Cruise Control (ACC), which enables constant-speed driving at approximately 30 km/h or higher and inter-vehicle distance control across the full speed range, and a Lane Keep Assist System (LKAS), which continuously provides steering assistance to keep the vehicle traveling near the center of the lane. In addition, two types of real-vehicle tests were conducted on the test track as examples of situations in which another vehicle rapidly approached the subject vehicle while the ADAS was in use:

- ① A test in which the lead vehicle suddenly decelerated while the subject vehicle was following it.
- ② A test in which another vehicle traveling in the adjacent lane cut in front of the subject vehicle.

For the lead vehicle in Test ① and the vehicle cutting in during Test ②, a self-driving platform (Freeboard Large, 4active) was used, and a 3D vehicle soft target compliant with ISO 19206-3:2018 was mounted on the platform.

Table 1 shows the experimental conditions for Test ①, while Table 2 shows the experimental conditions for Test ②. In Table 2, T_0 represents the Time To Collision (TTC) at the point when the cut-in maneuver is completed, assuming that the subject vehicle does not decelerate during the cut-in maneuver.

Two Japanese passenger cars (different manufacturers) were used as the subject vehicles. Both vehicles use a millimeter-wave radar and a monocular camera as their external environment perception sensors.

Fig.1 shows the relationship between the longitudinal relative distance at the time when the lead vehicle began to decelerate (horizontal axis) and the maximum deceleration of the subject vehicle (vertical axis). As shown in Fig.1(a), the maximum deceleration of Vehicle B was slightly greater than 7 m/s², suggesting that control transitioned from ACC to AEBS. As shown in Fig.1(b), the maximum deceleration values of approximately 7 m/s² or higher were observed in many cases for both Vehicle A and Vehicle B, suggesting that control transitioned from ACC to AEBS.

Fig.2 shows the relationship between the longitudinal relative distance at the time when the left front corner of the cut-in vehicle reached the lane boundary (horizontal axis) and the maximum deceleration of the subject vehicle during the deceleration period (vertical axis). As shown in Fig.2(a) and (b), the maximum deceleration of Vehicle A was approximately 3–4 m/s² in all cases except for one case in Fig.2(b), suggesting that the vehicle was controlled by ACC. As shown in Fig.2(a) and (b), the maximum deceleration of Vehicle B was approximately 5–6 m/s² in some cases, suggesting that control transitioned from ACC to AEBS.

Table 1 Lead vehicle hard braking experimental

Speed of LV [km/h]	ACC set speed of VUT [km/h]	ACC following distance setting of VUT (1/4 – 4/4)	Deceleration of LV [m/s ²]
60	80	2/4	approx. 4
60	80	2/4	approx. 6
60	80	1/4	approx. 6

Table 2 Cut-in experimental conditions

Speed of VUT [km/h]	Speed of CV [km/h]	T_0 [s] (Relative distance [m])	CV travel distance during cut-in [m]	CV lateral movement during cut-in [m]
80	60	1.5 (8.3)	83	3.6
80	60	0.8 (4.4)	83	3.6
80	60	0 (0)	83	3.6
80	40	1.5 (16.7)	55	3.6
80	40	0.8 (8.8)	55	3.6
80	40	0 (0)	55	3.6

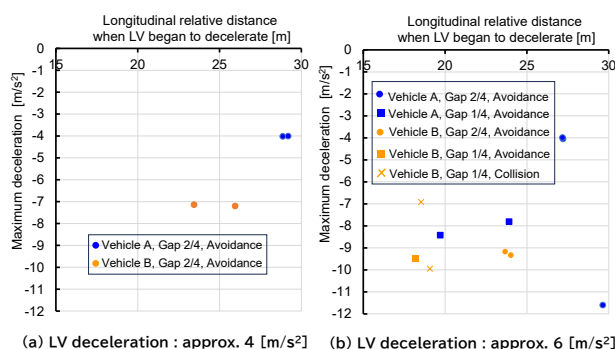


Fig.1 Maximum deceleration in Test ①

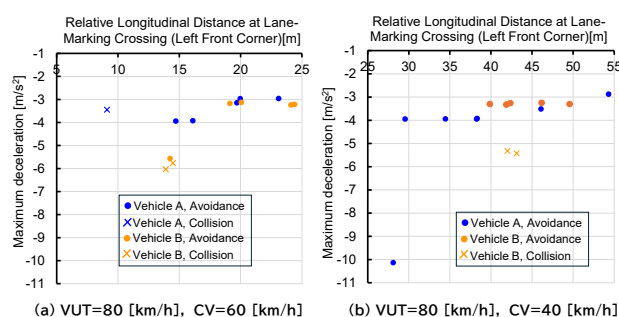


Fig.2 Maximum deceleration in Test ②