講演番号	111

文献番号	20226111

Development of Simulation-Based Method for Estimation of Collision Avoidance Benefit of Automatic Emergency Braking and Lane Departure Warning in Traffic Collisions

Nana Takeuchi [1)] Hironori Chaya [1)] Yasutomo Okumura [1)] Tomoyuki Miyoshi [1)] Takao Matsuda [1)] Yuichi Kitagawa [1)]

1) TOYOTA MOTOR CORPORATION
1, Toyota-cho, Toyota, Aichi, 471-8572, Japan (E-mail: nana_takeuchi@mail.toyota.co.jp)

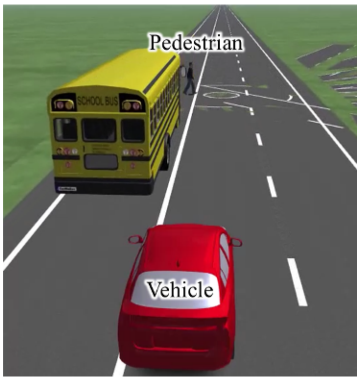
KEY WORDS: **safety, active safety, driving simulation**, Accident Avoidance [C1]

Recently, the spread of Advanced Driver-Assistance System (ADAS), such as Automatic Emergency Braking (AEB) and Lane Departure Warning (LDW), is expected to contribute towards collision avoidance and injury mitigation. The performance of ADAS is usually evaluated under the prescribed conditions assuming common scenarios, while actual traffic collisions occur in various situations. This makes it difficult to quantitatively estimate the real-world effectiveness of ADAS. It takes several years after the launch of a new ADAS function to collect enough data to estimate the effectiveness in the field. In this study, a simulation-based method was developed to estimate the effect of collision avoidance by AEB and LDW, considering the variation of traffic collisions.

A vehicle simulation model was generated to duplicate the AEB and LDW functions. Simulations were conducted assuming the top nine near miss cases, such as pedestrian crossings and head-on collisions, that are commonly observed in Japan (Fig. 1). The parameters such as vehicle speed, vehicle trajectory, and position were stochastically varied based on the actual statistical data. Seventeen thousand (17,000) combinations of behavioral characteristics were simulated for each near miss case. The assumed vehicle model was a sedan type, and the driving environment was assumed to be during daytime, under sunny weather, and a dry road surface. The simulation model assumed that AEB always decelerated the vehicle at the maximum performance, and that the free running time from detection to braking was not considered. To estimate the effect of AEB, another series of simulations were conducted assuming a human driver that did not activate AEB. To help replicate individual differences in brake operation, the free running time, brake jerk, and maximum deceleration was varied, based on volunteer test results data. LDW alerts the driver when the vehicle approaches the lane boundary. It was assumed that the driver steers to return to the center of the lane. The parameters of steering maneuvers such as reaction time, steering angular velocity, and maximum steering angle were also varied based on volunteer test results.

A pair of simulations were conducted with and without AEB and LDW under same traffic conditions for 153,000 cases. The reduction rate in collisions was defined as the percentage of collisions avoided with AEB and LDW out of the number of collisions that occurred when the systems were not activated. The overall collision avoidance effect was calculated by multiplying the reduction rate in each collisions case by the percentage in the field.

When AEB or LDW were not activated, collisions occurred in 117,031 cases out of 153,000. When AEB and LDW were activated, collisions occurred in 44,125 cases out of 153,000. The reduction rates in collisions was 62.3% and collision avoidance effect was 30.6% (Table 1).



(a) Pedestrian Crossing

(b) Head-On Collision

Fig.1 Simulation Example

Table 1 Collision Avoidance Effect

Collision Scenario		Percentage of Collisions in the Field	Reduction Rates in Collisions	Collision Avoidance Effect
AEB	Pedestrian Crossing	6.2 %	83.9 %	29.0 %
	Bicycle Crossing	24.5 %	85.3 %	
	Motorcycle Crossing		23.6 %	
	Pedestrian in Right-Turn	12.7 %	74.9 %	
	Bicycle in Right-Turn		99.8 %	
	Pedestrian in Left-Turn		57.2 %	
	Bicycle in Left-Turn		99.4 %	
LDW	Single-Vehicle Collision	2.7 %	21.2 %	1.1 %
	Head-on Collision with Vehicle	3.5 %	14.1 %	
Total			62.3 %	30.1 %