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SAFETY EVALUATION FOR AUTOMATED VEHICLES IN INTERSECTION CROSSING

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ABSTRACT–Safety evaluation method for the intersection forward collision-avoidance assist (I-FCA) function is presented in this work. The I-FCA function can prevent traffic accidents in intersections by applying warning and brake when the radar and vision sensor can detect risk of collision. To specify safety evaluation, the actual vehicle tests are conducted. For ensuring repeatability and safety probability, a low-profile robot was used for the tests. Straight crossing path scenario at intersection is established by using NCAP and NHTSA studies. By using actual vehicle test data for the straight crossing path situation, the I-FCA operation boundary condition is suggested.

KEY WORDS : Intersection accidents, Autonomous emergency braking, Forward collision warning, Time to collision

1. INTRODUCTION

Recently, the level of autonomous driving technology has emerged as a significant competitive advantage for automobile manufacturers. Autonomous driving is commonly categorized into six levels ranging from zero to five according to the SAE J3016 standard (SAE International, 2014). The primary distinction lies in the control of the vehicle and the assignment of responsibility for accidents between the lower levels (Level 0, 1, and 2) and the higher levels (Level 3, 4, and 5). Currently, most autonomous vehicles available in the market employ level 2 technology, which enables simultaneous assistance to the driver in the adjustment of acceleration, braking, and steering functions. The autonomous driving system at level 2 is also referred to as the advanced driver assistance system (ADAS).

Typical ADAS encompass various functionalities aimed at enhancing vehicle safety and assisting drivers in diverse scenarios. The following functions are commonly found in ADAS: Forward collision-avoidance assistant (FCA) helps in warning or applying brakes if there is a risk of a forward collision. Rear cross-traffic collision warning function (RCCW) detects approaching vehicles from the left or right side during reverse driving and provides warnings or applies brakes if there is a risk of collision. Adaptive cruise control (ACC) assists in driving at a designated speed and adjusts the speed based on the distance from the vehicle in front. Forward collision warning (FCW) warns the driver when a collision risk is detected as a component of FCA. Autonomous emergency braking (AEB) detects imminent collision risks and automatically decelerates the vehicle by applying brakes as another component of FCA.

To ensure the safety standards of autonomous vehicles, the performance of ADAS systems requires evaluation. Different car manufacturers employ various sensor technologies and deceleration algorithms, leading to variations in ADAS performance based on their design strategies (Kim *et al.*, 2018). Evaluation methodologies for safety assist functions have been developed by the European New Car Assessment Program (Euro NCAP) to assess the effectiveness of ADAS technologies in promoting driving safety. Similarly, the Korean New Car Assessment Program (KNCAP) has presented evaluation results for ADAS functions available in the Korean market, with a specific focus on driving safety.

Numerous previous studies have been conducted to assess the active safety technology of ADAS in autonomous driving. For instance, Park *et al.* (2019) developed an unmanned target robot to evaluate the active safety capabilities of autonomous vehicles. Field tests were conducted, simulating cut-in situations and rear-end collisions. Additionally, they proposed an evaluation methodology for the AEB system, utilizing two test vehicles (Park *et al.*, 2022). In another study, Scanlon *et al.* (2017) analyzed cross-traffic collision data from accident databases in the United States to reconstruct scenarios. They specifically focused on modeling and simulating the Intersection Forward Collision-Avoidance Assistant (I-FCA) function for cross-traffic scenarios. The simulation results demonstrated that the I-FCA with AEB function had the potential to reduce straight-forward intersection collisions by 25 % to 59 % (Shin *et al.*, 2021).

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