Research Report Summary

SAFER-SIM University Transportation Center, 69A3551747131

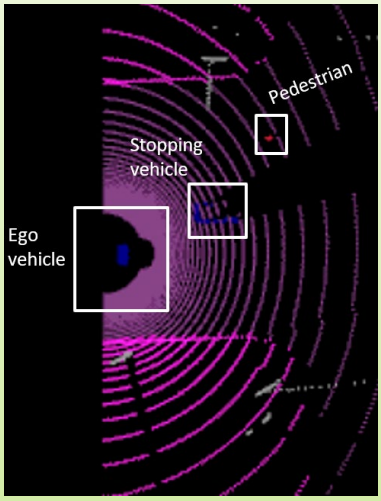
Yina Wu, https://orcid.org/0000-0001-6516-8144;
Mohamed Abdel-Aty, https://orcid.org/0000-0002-4838-1573;
Qing Cai, https://orcid.org/0000-0003-0822-2268 *11/16/2021*

Evaluating the Effects of Cooperative Perception on Avoiding Pedestrian Crashes for Connected and Automated Vehicles – Using Virtual Simulator to Evaluate the Automated Emergency Braking System for Avoiding Pedestrian Crash at Intersections under the Occluded Conditions

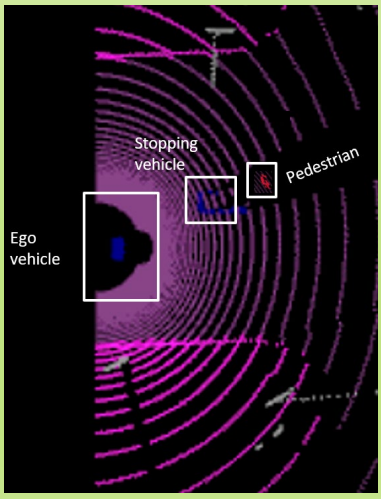
At an intersection, a crash between a pedestrian and a vehicle may occur under the occluded condition. The automated emergency braking (AEB) system could actively detect pedestrians and react to avoid potential conflicts. This study contribution is to evaluate the effectiveness of the AEB system under occlusion conditions.

An open-source approach was introduced by using the CARLA virtual simulator to evaluate the effectiveness of the AEB system under the occlusion conditions. The AEB control algorithm was developed in the virtual simulator. The evaluation was conducted by exploring the collision between a pedestrian crossing at the red light and a through vehicle, which is one of the most dangerous conditions at intersections. Three scenarios in which the pedestrian was occluded by a stopping vehicle on either the left-turn or right-turn lane were generated for the evaluation. By considering different motion statuses of the ego vehicle and pedestrian, and the AEB controls, a total of 10,368 cases were generated in the simulation platform.

Example: Illustrations of occluded and not-occluded conditions



(a) Illustration of a non-occluded condition



(b) Illustration of an occluded condition information

Different measures including the percentage of cases with collisions, impact speed of the collision, and collision locations were adopted to extensively evaluate the effectiveness of AEB under the occlusion condition. The results suggested that the AEB could still effectively avoid collisions between the ego vehicle and the crossing pedestrian. However, the effectiveness of the AEB would be reduced by the occlusion. The longer the pedestrian was occluded by the stopping vehicle, the more the effectiveness of AEB was reduced. The results also suggested that a larger TTC threshold to activate the AEB could improve the effectiveness. In addition, a logistic regression model was developed to explore the effect of other factors. The modeling results suggested that the pedestrian′s and ego vehicle′s speeds could have significant effects on the effectiveness of the AEB system. Furthermore, different effectiveness of AEB could be found in different occlusion scenarios.

Outcomes

This study focuses on the effects of AEB on avoiding pedestrian crashes at intersections under occluded conditions. It was found that the AEB system could fail to detect pedestrians crossing road, resulting in pedestrian crashes.

Impacts

The results of this study indicate that AEB could have limitations under occluded conditions. Based on the results, perception sensors could be better configured considering the potential failures of AEB to enhance pedestrian safety at intersections

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