Research Report Summary

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Assessing the Effectiveness of Connected Vehicle Technologies based on Driving Simulator Experiments

Connected vehicle technology is expected to reduce crashes and improve roadway safety. Due to the heterogeneity of pre-crash scenarios, connected vehicle technology has shown that it would have different effects on a driver's behavior, evasive strategies, and ultimate safety benefits. By identifying these different effects, development of a more proactive connected vehicle technology that adjusts the algorithm and parameter setting according to the pre-crash scenarios would be beneficial. By refining certain aspects, the effectiveness of the connected vehicle technology will improve overall.

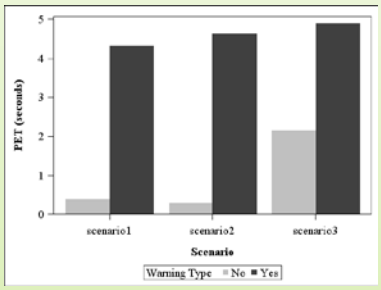
The goal of this project was to identify connected vehicle technology's disparity of effects in different pre-crash scenarios. The potential effect included driver behavior, evasive strategy, and ultimate safety benefit.

Two types of connected vehicle technologies, the forward collision warning (FCW) and the pedestrian-to-vehicle (P2V) warning, were tested in four rear-end pre-crash scenarios and three pedestrian pre-crash scenarios, respectively.

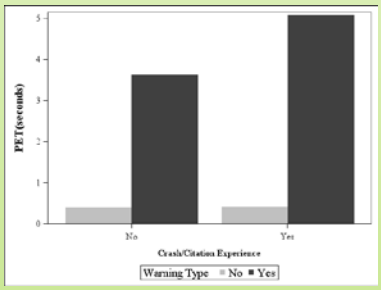
This study demonstrated the effectiveness of FCW and P2V warnings. The FCW reduced rear-end crashes by 56.6%-69.8%, and the P2V warning reduced pedestrian crashes by 89.2%-97.2%.

This study also demonstrated the disparity of FCW and P2V effects in different pre-crash scenarios. During FCW warning scenarios, results showed similar safety benefits in the rear-end pre-crash scenarios on the straight road. Safety benefits were not significant in right-turning scenarios since the scenario itself had

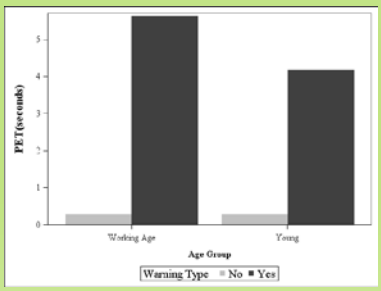
Example: P2V effect between pedestrian pre-crash scenarios



(a) PET between scenarios



(b) PET interacted with crash/citation experience in scenario 1



(c) PET interacted with age in scenario 3

conveyed enough evidence for a participant to prepare to stop. For P2V warning, the results showed obvious heterogeneities of safety benefits between scenarios. The warning was less effective in Scenario 3 when a vehicle was approaching a pedestrian hidden behind a parked car. The disparity of safety benefits between scenarios was due to the change of brake operation, brake profile, and evasive strategies triggered by the warning. For both FCW and P2V warnings, the technology was found to interact with different driver features between scenarios.

An adaptive design of the technology toward specific track scenarios is necessary to achieve the maximum safety benefits.

"FCW and P2V affect a driver differently and achieve different safety benefits between pre-crash scenarios."

Outcomes

This study identified the mechanism of the effect of FCW and P2V technologies on driver brake operation, brake profile, and evasive strategies, considering the heterogeneity of pre-crash scenarios. This study illustrated how the ultimate safety benefits were generated by the effect mechanism of FCW and P2V. The results demonstrated that a fixed-parameter-based warning algorithm may not be appropriate for the development of a high-efficiency connected vehicle technology. A more proactive design of warning algorithm, which can adjust the parameters based on the scenario, is expected to achieve maximum safety benefits.

Impacts

This study demonstrated the effectiveness of FCW and P2V. FCW reduced rear-end crashes by 56.6%-69.8%, and P2V reduced pedestrian crashes by 89.2%-97.2%.

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