Research

Report Summary

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The Impact of Connected Vehicle Market Penetration and Connectivity Levels on Traffic Safety in Connected Vehicles Transition Period

The recent advent of Connected Vehicles (CV) technologies could bring unprecedented opportunities to improve road safety, especially under reduced-visibility conditions. Reduced-visibility conditions increase the probability of rear-end crash occurrences and their severity [1-3]. Moreover, slow traffic may be formed due to bottlenecks on freeways. This phenomenon may lead to higher rear-end crash risk when vehicles approach slow traffic, since drivers might not notice the lead vehicle's speed reduction in time to respond.

For the abovementioned reasons, this research investigates the CV crash warning systems that have the potential to improve vehicle safety by assisting drivers to be aware of imminent situations ahead and then take timely

NADS MiniSim driving simulator with HUD interface

The National Advanced Driving Simulator (NADS MiniSim) was used for the driving simulator experiment.

crash avoidance action(s). This study provides a driving simulator study to evaluate the effectiveness of a head-up display (HUD) warning system and an audio warning system on drivers' crash avoidance performance when the lead vehicle makes an emergency stop under fog conditions. Drivers' throttle release time, brake transition time, perception response time, brake reaction time, minimum modified time-to-collision, and maximum brake pedal pressure are analyzed. According to the results, the crash warning system could help decrease drivers' reaction time and reduce the probability of rear-end crashes under a CV environment. In addition, the effects of fog level and drivers' characteristics, including gender and age, are also investigated in this study. The findings of this study could help car manufacturers design rear-end crash warning systems that enhance the effectiveness of the system's application under fog conditions.

Furthermore, this study also aims to develop an integrated variable speed limit (VSL) and CV control strategy to reduce rear-end crash risk at freeway bottlenecks under fog conditions. Based on the car-following model, the VSL control algorithm is developed considering the different relationships between gap and visibility distance. Then, a feedback control framework is developed to combine the VSL and CV control. The proposed VSL strategy is tested for a freeway section with a bottleneck through VISSIM, and an Intelligent Driver Model (IDM) is employed to build the CV environment. Finally, two measurements, time to collision at braking and total travel time, are employed to evaluate the effectiveness of the proposed control strategy. The results demonstrate that the VSL control played an important role in reducing rear-end crash risk. The CV control could also enhance traffic safety by increasing the traffic homogeneity. Moreover, the combination of VSL and CV control (VSL & CV) could further enhance traffic safety and diminish the increase of travel time due to VSL.

References

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