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Drivers' Response to Scenarios when Driving Connected and Automated Vehicles Compared to Vehicles with and without Driver Assistance Technology

Project 1944
January 2022

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Driver errors are the leading cause of traffic crashes, contributing to about 94% of crashes. To reduce the number of crashes, automotive companies strive to enhance their vehicles to eliminate driver errors. They have designed various advanced features to assist with, or in some cases take over, certain driving maneuvers. These features include lane departure warning (LDW), blind spot warning (BSW), over speed warning (OSW), forward collision warning (FCW), lane keep assist (LKA), adaptive cruise control (ACC), and automated emergency braking (AEB). These features are part of vehicles with driver assistance technology and are vital for the successful deployment of connected and automated vehicles in the future.

In spite of the advancements, an increase in the number of total traffic crashes has been reported in recent years. The lack of clear understanding of these advanced features and their limitations, as well as drivers blindly trusting such features, are some issues. The impacts differ with the advanced features in the particular vehicle, driving scenario (rural, urban, or freeway), and driver characteristics. However, the drivers' response to scenarios when driving vehicles with advanced features has been meagerly explored. This study evaluates driver participants' response to scenarios when driving connected and automated vehicles compared to vehicles with and without driver assistance technology.

Study Methods

This study used the National Advanced Driving Simulator (NADS) miniSim™ to capture driver participant behavior (see figure 1). Researchers developed rural, urban, and freeway driving scenarios to test on the drivers (participants in the age groups of sixteen to sixty-five years) with varying weather and lighting conditions. The study captured other variables, including socio-economic and demographic characteristics, through a questionnaire. The study is categorized into four vital stages: 1) developing rural, urban, and freeway driving scenarios for evaluating using the driver simulator; 2) selecting participants such that the sample population represents the general population; 3) assigning vehicles with different advanced features, collecting data, processing, and computing measures like hard braking, hard cornering, lane departure, speeding, average headway, and brake pedal force; and 4) assessing changes in driver behavior when driving vehicles with and without advanced features.

Findings

Some of the key findings from this study are:

- LDW reduces lane departures in all driving scenarios (rural, urban, and freeway) while OSW reduces the average and maximum speeds, making driving less aggressive in only rural and urban scenarios. Similarly, BSW influences the brake pedal force and aggressive driving behavior.
- None of the warning features influence the participant following behavior as the average headway difference when driving a vehicle with and without driver assistance technology (warning systems) was not found to be statistically significant.
- The influence of warning features on the driver behavior varied with the driving scenario (rural, urban, or freeway).
- LKA and ACC improve braking, vehicle handling, and lane-following behaviors in all the three scenarios. Less aggressive speeding behavior is observed in the freeway scenario. However, more aggressive car-following behavior is observed when driving a vehicle with automated features.
- The variations in driving behavior among participants that drove a vehicle with LKA or ACC is lower.

Policy/Practice Recommendations

The findings from this study help to assess driver behavior when driving vehicles with and without advanced features. They can be inputted into microsimulation software to model the effect of vehicles with advanced features on the performance of transportation systems. The methodology can also be applied to develop additional driving scenarios, collect data from more participants, and evaluate the influence of other advanced features on safety and operational performance. This research contributes to technological advancements and bodies of knowledge that can help reduce driver-error caused crashes, ultimately saving millions of dollars and thousands of lives.

Figure 1. National Advanced Driving Simulator (NADS) miniSim™

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