DRISI

CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

Research Results

Developing Engineering Countermeasures for Wrong Way Driving

Identifying methods to communicate wrong way information to severely intoxicated drivers leading to the development of effective engineering countermeasures

Transportation Safety and Mobility

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Project Title:
Wrong Way Driver Mitigation

Task Number: 3705

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WHAT WAS THE NEED?

Only 0.14 percent of collisions on California state highways from 2012 to 2021 were caused by Wrong Way Driving (WWD), but WWD accounted for 2.2% of fatal collisions during the same period. Most wrong-way events on controlled-access highways are head-on collisions caused by drivers who are severely intoxicated. Research has consistently identified the cause of many wrong way driving collisions as drivers whose blood alcohol content is twice or more than the legal limit of 0.08 percent, often 0.20 and higher. Current countermeasures include installation of larger signs at driver sight level, flashing beacons, and retroreflective pavement markings. Research indicates these countermeasures are effective in producing self-corrective actions of wrong way driver movements when the driver is not intoxicated, but that they have had little to no effect on reducing wrong way collisions caused by severely intoxicated drivers. Current countermeasures require a certain level of cognitive ability to see the countermeasure, recognize what it means, and take appropriate action. The proposed research seeks to understand the cognitive abilities of severely intoxicated drivers as a first step in developing effective engineering countermeasures to prevent severely intoxicated drivers from entering highways in the wrong direction and causing fatal collisions.

WHAT WAS OUR GOAL?

The objective of this research was to understand the cognitive abilities of severely intoxicated drivers as a first step in identifying and developing effective engineering countermeasures to prevent severely intoxicated drivers from entering state highways in the wrong direction.

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WHAT DID WE DO?

Caltrans contracted with researchers in the Engineering and Psychology departments at Auburn University to design and conduct a study to investigate the effectiveness of novel wrong way countermeasures specifically designed for intoxicated wrong way drivers compared to the standard wrong way countermeasures prescribed by the Manual for Uniform Traffic Control Devices (MUTCD) and the California Manual for Uniform Traffic Control Devices (CAMUTCD). The novel counter measures included bidirectional pavement markings, flashing LED border Wrong Way signs, and directional rumble strips, which generate vibrations to provide haptic feedback alerts to intoxicated drivers who may not be able to recognize visual warnings. The standard countermeasures included Do Not Enter/ Wrong Way signs, type V arrows and two-way retro-reflective raised pavement markings. The researchers used human subjects in a driving simulator to test their responses to these various countermeasures.

In order to conduct this study, the Psychology Department researchers obtained approval to administer alcohol to human test subjects from Auburn University. The Engineering Department researchers designed and programmed virtual road networks into the driving simulator and developed simulation models for the proposed new WWD countermeasures and the MUTCD and CAMUTCD prescribed countermeasures. The Psychology department researchers operated the driving simulator and directed the test subjects through the testing process. Each subject virtually drove through the simulated road network while sober and intoxicated. The simulator courses were designed to require subjects to make turns to avoid passing through each countermeasure. The subjects wore an eye tracking device to monitor at which part of the simulator screens they were looking. The Engineering Department researchers recorded the driving behavior of the subjects and analyzed it to determine the effectiveness of the various countermeasures.

WHAT WAS THE OUTCOME?

According to the researchers' analysis, WRONG WAY signs with flashing LED borders performed the best in terms of deterring wrong way movements for both sober and intoxicated subjects, either by themselves or in combination with other countermeasures. Four intoxicated subjects and three sober subjects drove the wrong way when presented with the regular MUTCD required countermeasures, but only two intoxicated subjects and no sober subjects drove the wrong way when presented with the CAMUTCD required countermeasures.

WHAT IS THE BENEFIT?

The results of this research task could eventually keep California motorists safer from wrong way drivers by influencing highway design and maintenance staff and management to install flashing LED border Wrong Way signs on existing and planned exit ramps on state highways. The results also provide justification for adherence to the CAMUTCD standards when installing and maintaining Wrong Way countermeasures on state highways. The outcome of this study aligns with the Caltrans Strategic Goal of Safety and Health.

IMAGES

Image 1: Driving simulator at Auburn University

Image 2: Driving simulator after upgrades for Task 3705

Image 3: Subject's view of the Driving simulator screen

Image 4: Eye tracking system for Driving simulator

Image 5: WRONG WAY sign with flashing LED borders

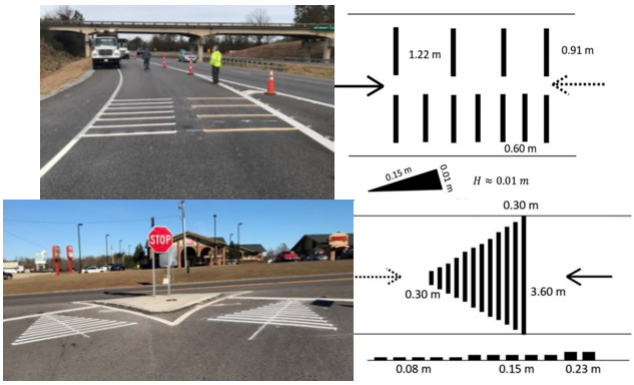

Image 6: Two bidirectional pavement marking alternatives

Image 7: Bidirectional pavement markings

Image 7: Exit ramp with enlarged DO NOT ENTER / WRONG WAY signs

Image 8: Type V arrows with two-way retro-reflective raised pavement markings