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Thesis

Development of a Bayesian Decision Theory Framework to Enhance the Design of Rear-End Collision Warning Systems

Abstract

Collision warning systems, like any in-vehicle technology, must be useful to the driver and not interfere with normal driving. Warnings given to the driver must result in a minimum load on driver attention. Therefore, two critical requirements govern their success. First, the collision warning system must promote a timely and appropriate driver response. Second, annoyance associated with nuisance warnings must be minimized to promote driver acceptance.

Hence, research was conducted to contribute to the improvement of such systems. This involved developing a car-following model for off-line testing. Once validated, a rear-end collision warning algorithm was integrated along with a Bayesian statistical decision theory framework. This framework enables the combination of intelligent technology with human factors to address the limitations of the existing systems.

The developed car-following model assumes that drivers adjust their speed based on the current spacing and relative velocity to the lead vehicle. By using data from the System for Assessment of Vehicle Motion Environment (SAVME) database, desired and relative vehicle movements were obtained. This was conducted rather than using the assumptions about a driver's ability to ascertain the exact absolute speed and acceleration/deceleration rate of the lead vehicle.

The rear-end collision warning algorithm combines the principles of vehicle dynamics and driver response to ascertain a critical distance. While integrated into the car-following model, it uses the information pertaining to the current velocity and driver alertness from the following vehicle as input. In addition, to account for driver behaviour, a framework that utilizes the Bayesian statistical decision theory is incorporated. Prior conditions of driver reliability are combined with conditional probabilities of driver alertness to determine when and what type of warning should be given to the driver.

Overall, the results show a reduction in the number of warnings outputted while the driver is alert. This indicates a potential decrease in distractions for the driver, hence demonstrating the effectiveness of the Bayesian statistical decision theory framework. With further research and development, the proposed rear-end collision warning algorithm and framework can be embedded in driving simulators to examine the benefits with human operators. In addition, a prototype may be built and installed in an actual vehicle under controlled conditions in order to develop a commercial product.

Degree

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Completion

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Supervisors

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