The Effect of Road Environments on Driving Behaviour

Background

In this study, we develop an understanding of the effect of environmental factors on longitudinal speed and lateral offset chosen by a driver negotiating a variety of complex simulated road environments. Further, we introduce a novel approach to model a boundary of acceptable vehicle states including speed and lateral offset for human drivers. We propose a general mathematical representation of the model as well as the technique to derive situation-specific parameters for the model.

Method

Thirty-five participants, with a minimum of 2 years driving experience, and age range between 18 and 65 years (M=37.5, SD=12.8) completed this study at the University of Leeds Driving Simulator (UoLDS). The within-subject design of the experiment involved a combination of different environmental factors that can potentially affect driving demand, and hence risk-taking behavior, through longitudinal and lateral control of the vehicle.

Results

Measures of speed, lateral position and standard deviation of lateral position, as well as the 5% and 95% boundaries of speed and lateral position, were studied. As hypothesized, median and 95% of speed decreased significantly in the environments that imposed higher risks through the presence of oncoming traffic, sharp curves and road furniture with higher height profile. Moreover, 5% and 95% boundaries of lateral offset shifted away from the left edge of the road in the presence of road furniture with a higher height profile. Also as lane width decreased, the boundaries of lateral offset moved closer to the center of the lane.

The combination of observed speed-offset behavior is explained with a set of piecewise linear functions using a simple equation for minimum acceptable Time to Lane Crossing. The idea of the model is that drivers try to stay above the minimum Time to Lane Crossing by adjusting vehicle states when navigating different environments.

Conclusions

Boundaries of vehicle speed and lateral offset showed great sensitivity to the environmental changes. Imposed risks affect the boundaries of vehicle states through speed-lateral offset trade-off. The proposed model is a generic form that can be solved for other conditions that have not been introduced in the scope of this study.

Keywords

Driver Behavior, Satisficing Vehicle Control, Speed-Offset States, Driving Environment