Validation of a driving simulator for research in human factors of vehicle automation

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Abstract

This study evaluated the behavioural validity of the Monash University Accident Research Centre driving simulator for research in human factors of automated driving. The study involved both on-road and simulator driving. Twenty participants gave ratings of their willingness to resume control of an automated vehicle and perception of safety for a variety of situations along the drives. Each situation was individually categorised and ratings were processed. Statistical analysis of the ratings confirmed the behavioural validity of the simulator, in terms of the similarity of the on-road and simulator data.

Background

Driving automation is on the brink of becoming the mainstream from a technological point of view but there are many unanswered questions from human factors perspective that are preventing legalisation of automated driving. These questions are difficult to answer without proper testing facilities such as naturalistic field operational tests on automated vehicles which are not readily available. The natural approach to this problem is utilisation of driving simulators.

Objective

The aim of this study was to evaluate the behavioural validity of a driving simulator for research in human factors of automated driving.

Method

As automated vehicles were not available, several technical obstacles needed to be overcome in preparation for this study. Simulator and on-road drives were compared, while all other conditions were kept as similar as possible. The simulator drives were conducted in a Monash University Accident Research Centre (MUARC) simulator that incorporated two seats mounted on individual motion bases providing motion and vibration cues. The main caveat of the adopted approach was that in both driving environments participants were seated in a passenger seat while the researcher was controlling the vehicle and therefore playing the role of an automated driving system.

20 fully-licenced participants were presented with automated driving in both an instrumented car and the simulator. The two experimental drives were conducted on similar road types and consisted of the relatively similar events. Each drive comprised both freeway and urban sections.

At various points in the drives, participants were asked to indicate the level of their willingness to resume manual control of the vehicle as well as their perception of safety rating for the current situation. Each drive contained between 20 – 25 such situations. Willingness to resume control was rated with four available categories (Very willing, Willing, Unwilling, Very Unwilling) while the perception of safety was rated using a slash line on a linear scale, from 1 to 100. At the end of each drive, participants were asked to give their ratings for willingness to engage automated driving and the perception of safety over the whole drive. Participants' responses were recorded and later analysed. Before the start of the experimental session, each participant completed a questionnaire containing demographics, driving habits and attitudes towards automation data. Each drive was video recorded.

Using video recordings, each situation (decision point) was coded in order to facilitate data analysis. Several parameters were used to categorise decision points such as specific events, situation complexity, traffic density, road type and speed limit.

Results

Statistical analysis consisted of series of tests using generalised estimating equations. Results show that for the large majority of events, there was no statistical difference (p-value > 0.05) in ratings when comparing two driving environments.

The only events that produced significant statistical differences in ratings were merging onto the freeway and to a lesser extent unrestricted driving on an urban road.

Conclusions

The results confirmed the behavioural validity of the MUARC driving simulator. These will be used for the design of future simulator experiments investigating willingness to resume control or engage automated driving and associated perception of safety.