Driving simulator applications in research and clinical practice

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Abstract

This special issue reports on papers presented at a simulation user group meeting held in association with the University of Florida, Gainesville. This is the sixth in a series of special issues that have reported on driving simulator applications presented at simulation users conferences [1 - 5]. The meeting attracted 32 attendees from 5 different countries. This special issue includes 8 papers covering a wide range of research topics. The papers in this volume address in-vehicle systems, simulator sickness, simulator validation, driver behaviour and investigation of rider behaviour with a novel motorcycle simulator.

1. Introduction

This is the sixth special issue devoted to driving simulation research and application concerning driver behavior and transportation system safety. The first special issue in 2004 resulted from papers given at a conference in San Diego, California, USA [1]. The theme of the first conference was “New Directions in Driving Simulation Research.”

Four more symposia have been held and reported on in the last four years:

“Multidisciplinary new approaches to old problems: an overview of driving simulation research” held in Stuttgart, Germany in September 2005 [2];

“New approaches to simulation and the older operator” held at the Massachusetts Institute of Technology in October of 2006 [3];


the sixth conference “Training the Older Driver” was held at Universite Laval in Quebec City in 2008 [5].

This current special issue contains papers presented at two of the most recent simulation user conferences. The meeting in 2009 was co-hosted in Belgium by the Faculty of Kinesiology and Rehabilitation Sciences at the Katholieke Universiteit Leuven, and the Transportation Research Institute of Universiteit Hasselt.

The 2010 meeting was organized in conjunction with the University of Florida, Gainesville and took place in St. Petersburg, Florida during October 2010. For this meeting, the diversity of the research was remarkable and speaks out for the increasing role of simulation in studying driver behaviour and vehicle and roadway design issues.
Two keynote presentations addressed general simulator applications: Loren Staplin of TransAnalytics spoke on “Safe Driving Tactics: What Role for Low Cost Simulation?” and Orit Shechtman of the University of Florida at Gainesville spoke on “A method for validating driving simulators: comparing driving errors with on road assessment.” Technical sessions were held on Traumatic Brain Injury, Driver/Vehicle Interaction, Traffic and Roadway Interaction, Simulator Sickness, Measurement, Assessment and Training, a panel discussion on Experimental Procedures and Methodology, and a poster session on a wide variety of simulator and desktop assessment applications.

2. Contributions

“Simulator methodologies for investigating fatigue and stress in the automated vehicle”

This paper examines and illustrates the utility of using a driving simulator to investigate relationships between vehicle automation and driver fatigue. It offers several key criteria that simulator methods should meet in order to establish functional fidelity, so that simulators offer valid measures of subjective fatigue states as well as objective performance changes. Guidelines are offered for traffic researchers in evaluating the effectiveness of simulator methods as well as the influence of automation use on fatigue and stress.

“Investigating design issues for the use of touchpad technology within vehicles”

This paper provides an overview of two studies investigating the human factors design issues for touchpad technology within vehicles. The first study considered control location preferences for left handed versus right handed people. The second study considered what tasks are most appropriate for use of touchpad technology.

“Simulated lane departure warning system reduces the width of lane that drivers use”

This pilot study addressed the use of rumble strips as a lane departure warning system. Encounters with the rumble strip were simulated with auditory feedback. Results showed that the rumble strip warning reduced the number of edge line crossings, the number of drivers who crossed the edge line, and reduced lane deviations. Survey results also showed that this approach is socially valid.

“Simulator sickness among returning combat veterans with mild traumatic brain injury and/or post-traumatic stress disorder”

In this retrospective simulator study, the occurrence of simulator sickness was analyzed for combat veterans compared to healthy controls. Susceptibility to simulator sickness occurred in combat veterans at two time periods and increased as driving exposure progressed. Overall, these findings suggest that combat veterans may have pre-existing conditions that make them more susceptible to simulator sickness; and that they are affected more severely compared to healthy controls. Simulator sickness is an important side effect incurred in simulator research, and this study illustrates possible additional considerations associated with head injury.

“Validation of driving simulators”

This paper provides a literature review of driving simulator validation studies, addresses the possible reasons for the controversy in the literature, suggests using health measurement terminology for simulator validity and offers ways to match the types of measurement validity terms with examples of existing diving simulator validation studies.
“Investigating motorcycle rider behaviour: developing an integrated experiment approach”

This paper presents one of the first in-depth motorcycle simulation studies to compare groups of road users who have fundamentally different skills, attitudes and behaviours. A study was designed to compare Novice, Experienced and Advanced trained riders across a range of motorcycle activities. The approach adopted allowed for comprehensive data collection and analysis with minimal disruption to participants or biases creeping into the data.

“Driver behavior and advanced driver assistance systems: an exploratory driving simulator study”

This paper explores potential driver behavior changes due to the interactions with advanced vehicle technologies emerging on the market. These technologies were designed mainly to improve roadway safety and provide comfort to drivers. Performance without the systems was compared to that obtained while the systems were in use. Results showed changes in driving behavior due to the systems and specific driver’s characteristics that are more likely to be affected by these technologies.

“Using electrooculography for glance analysis during simulated driving”

This paper considers the feasibility of using electrooculography (EOG) to monitor eye movements during simulated driving. Electrooculography may be a feasible and affordable way to measure eye movement during simulated driving, but is understudied. Results confirmed that participants spent more time glancing away from the road to the right when visual instructions were given in the lower right hand corner of the screen. Though electrooculography does not provide the same amount or quality of data as head-mounted eye trackers and multiple camera systems, it does yield sufficient data to address questions such as the ones posed in this study.

3. Summary

Simulators continue to provide a safe and perceptive means for studying, assessing and training drivers to positively affect their safe behaviors. The technological basis for driving simulation continues to improve and will allow improvement in capability and performance for the foreseeable future.

New and innovative driving simulator applications continue as evidenced by the papers in this volume. The capability of simulation to produce realistic virtual worlds is expanding, and the cost of achieving these conditions is falling, and therefore the application of driving simulation is becoming more appealing to a wide range of researchers in various disciplines and is encouraging new innovative assessment and training applications.

The papers herein give testament to these assertions, and we see this trend continuing in the near future.

References
