Towards the Measurement of the Perception of Ego-Motion in a Vehicle Simulator

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Abstract

It is well known that the control of a vehicle is the control of its motion. It is also known that the human operator senses that motion through several physiological receptor systems leading to the ultimate perception of the vehicle and operator's motion through the environment, in other words ego-motion. Furthermore, in order to ensure that operator behavior in a simulator, is consistent with operator behavior in the actual vehicle, the motion stimuli, whatever they are, must be adequate. It has long been stated that if a simulator has a "good" visual system that is sufficient to evoke the perception of ego motion. However, this has never been proved.

The perception of ego-motion produced solely by visual stimuli is referred to as vection. Vection has been evoked in psychophysical experiments in a laboratory for a very long time but little has been done in simulators. And what has been done has been subjective. This paper reports on research that aims to assess the occurrence of vection in flight or ground vehicle simulators by conducting experiments and employing quantitative metrics, in both the time and frequency domains, in a simulator, in addition to subjective assessments.

The paper begins with a discussion of the vection research literature, including examples of linear and circular vection, from ordinary locomotion scenarios and aviation. It also includes a discussion of opto-kinetic nystagmus as an involuntary response and therefore an objective metric.

The current experiments are to be conducted in a fixed base driving simulator. The instrumentation, used in the study, has been designed to measure body sway, head motion, eye movements and all vehicle dynamics variables as well as operator control activity. Of particular interest is the measurement of opto-kinetic nystagmus, which, based on the prior literature, is believed by the authors to be indicative of vection onset. The experimental design describes the scenarios, which are designed to provoke vection onset.

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BIO

Kirill Zaychik

Dr. Zaychik received his M.S. in Aerospace Engineering from Moscow Institute of Physics and Technology, Russia, in 2001. He received his PhD degree in Mechanical Engineering from the State University of New York at Binghamton in 2009. After working as a postdoctoral research scientist at the same university for one year, Dr. Zaychik joined Bombardier Aerospace in Montreal, Canada. His experience in industry concentrated in the field of Fly-by-Wire Control Systems design & development. In 2012, Dr. Zaychik joined the faculty at his berth department of Mechanical Engineering at SUNY Binghamton. His research interests include but not limited to: investigation of human perceptual system, Man-Machine system interaction and human-in-the-loop modeling, application of machine learning techniques in parameter estimation, flight and ground vehicle simulation, transfer of training in healthcare, transport delay compensation. In addition, application of numerical methods in modeling and simulation, design of micro/macro mechanical systems, dynamic system characterization and development of the control laws for small scale mechanical systems are of significant interest. Dr. Zaychik has authored 19 referred technical papers and reports, including technical reports for government agencies like NASA and US Air Force.