SiRoS: Simulation and Simulators to Study Road Safety

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***Abstract*—Driving simulators have gradually become a means of improving knowledge in the field of driving. The advantages linked to simulator studies are numerous: no real risk for users, reproducibility of situations, saving time and reducing experimental costs. Their flexibility also makes it possible to test situations that do not exist in reality or exist only rarely and randomly. Simulators also allow the evaluation of new driver assistance systems.**

The purpose of this special session is to explore the latest research conducted in the use of simulators in the field of road safety. From the construction of the simulator to the tests carried out, the different methods used as well as the results obtained will be presented.

Keywords-Motion Simulators design (Bicycle, Motorcycle, Vehicle), Vehicle dynamics validation, Accidents analysis, Road users behavior study, Impact of road characteristics on road safety, Drivers behavior study.

I. INTRODUCTION

Driving simulators provide a repeatable safe environment for a wide range of research and industrial applications. The virtual environment in the driving simulator may not be identical to real-world scenarios but should provide the necessary information for the driver to control the vehicle. Most of this information is provided by the visual. However, vestibular stimuli are also found decisive in the perception of distance and steering for the drivers [1][2].

Driving task requires perceptual, cognitive, and sensory systems, which provide information on the traffic and road infrastructure. Therefore, various cueing systems in the driving simulator have to ensure that the participant perceives the correct cues and feedback for driving. Visual cues provide the driver with the information required to detect the road, obstacles, road width and markings, that enables the driver to guide the vehicle during the simulation and generally agreed upon as the primary sensory feedback. However, the driving experience is dominated by the sensation of the motion, which, by providing the correct vestibular cue, can enhance driver immersion in the driving simulator. This feedback offers essential information for vehicle guidance, collision avoidance and road condition [1]. The vestibular cues in driving simulator were found to be crucial for accurate vehicle speed and distance perception in the driving simulator [2]. A study of the motion scaling for the slalom driving task using the human perception limitation of self-motion perception found that reduced or absence of the motion cues significantly degrades driving performance [3].

Motion is the feedback from the simulated vehicle in the virtual environment. The motion feedback can improve driver engagement in the virtual environment by providing motion stimuli on the vehicle states for the driver, while the driver may feel the absence of motion that cause even motion sickness, due to the impaired visual and motion cues for the human vestibular system.

Various types of motion platform can be used to reproduce the movement in driving simulation, but the reproduction of the real vehicle movement needs large movements, and therefore, Motion Cueing Algorithm is being used to control the movements within the platform operative limits. Motion Cueing Algorithm used in the simulator should be selected according to the motion platform architecture and the intensity of the required motion. For example, a classical Motion Cueing Algorithm is used in the 6 Degrees of Freedom (DOF) Renault driving simulator for motion with low frequency, but not including vibrations [4]. While an adaptive Motion Cueing Algorithm is implemented on a low-cost driving simulator with 2 DOF with longitudinal and seat rotation [5]. Other studies suggest using optimized Motion Cueing Algorithm [6] in order to investigate different Motion Cueing Algorithm for driving simulators.

Studying road-user behavior through simulations is then a promising tool to address challenges, such as: learning to drive, awareness of risks and road safety.

II. Submissions

The first paper entitled Subjective Validity of Bicycle Simulator is related to bicycle modeling and subjective validity taking into account the behavior of 10 participants in real experimentation. The authors explain that The bicycle simulator enables us to put cyclists in a riding situation and accurately measure their effective behavior, while controlling the variables at play and avoiding the risks associated with a real environment. Analyzing the different questionnaires, it is possible to verify the reliability and to subjectively validate the simulator. The presented results show low simulator sickness and relatively high workload, which could be explained by the effort done by the cyclists. In order to more validate the approach, the authors present future development on simulator including mathematical model improvements, development of the virtual environment and installment of new devices to simulate the interaction between the infrastructure and the bicycle. They also need to enlarge the study to additional experiment, including 36 subjects, in order to validate the new model physically and subjectively.

The second paper is entitled Driver Response to Gear Shifting System in Motion Cueing Driving Simulator. The aim is to investigate the motion cueing feedback in the driving simulator with different gear changing system. The authors present the developed vehicle model in detail together with the specifications of the 2DOF simulator and the Motion Cueing Algorithm. The authors show experimentation with 19 participants in the car following/braking scenario, overpassing and chicane maneuver. The subjective evaluation of the motion feedback on participants is carried out with the use of the simulator evaluation questionnaire and the simulator sickness questionnaire. The authors note that the simulator sickness scores showed no symptoms of sickness during the sessions, and the result of the session evaluation questionnaire showed that the motion cueing feedback was favorable by most of the participants and increased the immersion in the virtual environment.

Also, the investigation of the motion platform accelerations showed no significant difference in driver control input and output of the vehicle model with different gear shifting scenario. Only the maximum deceleration for the first braking phase found different by comparing three scenarios. But this effect did not continue over the whole simulation. From the results of this study, authors conclude that different gear change system did not significantly affect the driver's behavior and the perception of the motion cueing feedback.

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III. Conclusion

The SIROS special track includes papers related to simulation and simulators to study the rod safety. These works show important conclusion that prove the utility of the simulators in the field of road safety.

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