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Towards an Immersive Driving Simulator to Study Factors Related to Cybersickness

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INTRODUCTION

What makes a good cybersickness testbed great? In this work, we discuss the characteristics of a realistic immersive virtual reality driving simulator developed to study cybersickness. The simulator's feasibility was evaluated by conducting a preliminary study. Results suggest that our platform is reliable and robust.

SYSTEM CHARACTERISTICS

Multisensory Feedback

- Proprioceptive Feedback
- Visual Realism
- Passive Haptic Feedback
- Translational Audio Feedback

Figure 1. (a) Real world setup (b) First person POV in IVE (c) Center Console Display Unit on car's dashboard used to present landmarks

High-fidelity Virtual Environment

- Life-sized environment (Figure 2)
- 120 block city radius
- Gender-matched arm-length scaled self-avatar
- Legible street, speed limit and stop signs (Figure 4a)
- Realistic dynamic car properties like acceleration, braking, torque, etc.
- Concentric arrangement for uniform optic flow (Figure 3)

Figure 2. Virtual Cityscape Environment spanning 120 blocks

Figure 3. City Layout features a concentric square pattern of buildings providing uniform optic flow

Data Collection

- Optic Flow Experienced
- Electrodermal Activity Level
- Heart Rate, BVP
- Head Sway
- Driving Statistics
- Periodic Comfort Rating

Figure 4. (a) Stop Sign at Intersection (b) City View (interior city)

PILOT STUDY

- Participants drove around the city in a virtual car using the steering wheel for a maximum of 30 minutes.
- They were tasked with finding the landmarks presented on the car screen (Figure 1c).
- The task was added to encourage participants to experience more optic flow and keep them engaged.
- Participants filled out the SSQ and provided qualitative feedback about their experience and the simulation.

Figure 5. Landmarks in the city. There are a total of 16 distinguishable landmarks. (a) Giant Red Ferris Wheel (b) Artistic Plane Sculpture (c) Horse Statue

PRELIMINARY ANALYSIS

- A paired samples t-test revealed significant differences in pretest ($M = 5.24$, $SD = 7.45$) and posttest ($M = 65.33$, $SD = 31.67$) SSQ total scores ($t(14) = 6.82$, $p < 0.001$), indicating that subjects got sick on experiencing our simulation.
- Participant comments described our simulation as lifelike, realistic, engaging and fun. See comments below.