

A New Driving Simulator for Sleep Research

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Introduction

Driving safety is sensitive to conditions and diseases that affect sleep, and individuals with obstructive sleep apnea syndrome have a high risk of at-fault accidents. Most driving simulators used for research are unrealistic, stationary, prohibitively expensive, or not specifically designed to study sleep disorders. The purpose of this study was to test the feasibility of a new low-cost, portable, realistic driving simulator intended for use in sleep disorders research.

Objectives

- Free, open-source software, based on Ogre3D graphics engine
- Portable, inexpensive hardware
- Realistic
- Specifically aimed at studying daytime cognition and performance of individuals with sleep disorders
- Track lane position, speed, steering wheel position, braking, acceleration, collisions, and reaction times
- Configurable via XML files

Rural Scenario

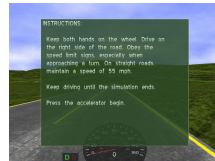
- 2 30 minute sessions
- Low stimulation, monotonous environment intended to induce sleepiness
- Long, straight two-lane roads with few turns

City Scenario

- 2 30 minute session
- High stimulation environment intended to induce high cognitive load
- 10x10 block grid layout with storefronts, high-rises, and parks
- Short two-lane roads and many turns
- Directional signs indicate path through city
- Reaction time challenge: Balls appear from a screen quadrant and fly directly at the subject at random intervals. Subject must press the brake pedal to avoid balls.

Rural Scenarios

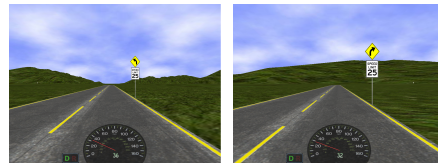
① Voice Assisted Practice Session



② Long, straight roads

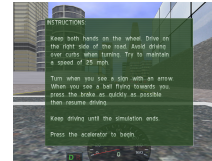


③ Occasional turns



City Scenarios

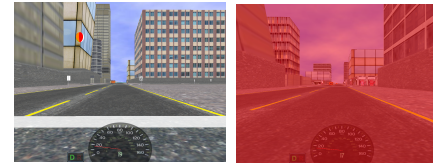
① Voice Assisted Practice Session



② Short roads and many turns



③ Reaction time challenges



Feasibility Study

A feasibility study among healthy individuals is ongoing. Prior to simulations, subjective sleep quality and sleepiness questionnaires are administered. After each simulation, a realism and difficulty questionnaire, a sleepiness questionnaire, and a simulation sickness questionnaire are administered.

Questionnaires

Questionnaire	Measurement
Epworth Sleepiness Scale	Recent daytime sleepiness
Stanford Sleepiness Scale	Instantaneous daytime sleepiness
Pittsburgh Sleep Quality Index	Sleep quality during the previous month
Functional Outcomes of Sleep Questionnaire	Impact of disorders of excessive sleepiness on everyday activities
Driving History Questionnaire	Driving History
Realism and Difficulty Questionnaire	Difficulty and realism of various aspects of the simulation
Simulator Sickness Questionnaire	Index of overall simulator sickness severity and locus of simulator sickness
NASA Task Load Index	Task workload and contributors to workload

Schedule

Hour	Task
0	Informed Consent ESS, SSS, PSQI, FOSQ, Driving History
1	Simulation 1 SSS, Realism and Difficulty, SSQ, NASA-TLX
2	Simulation 2 SSS, Realism and Difficulty, SSQ, NASA-TLX
3	Simulation 3 SSS, Realism and Difficulty, SSQ, NASA-TLX
4	Simulation 4 SSS, Realism and Difficulty, SSQ, NASA-TLX

Acknowledgements

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Simulator



- Processor: AMD Opteron 270 Dual Core, 2.01 GHz
- Memory: 2.75 GB RAM
- Graphics Card: NVIDIA GeForce 7900 GTX
- Operating System: Windows XP
- Graphics Engine: Ogre3D v1.6.5 [Shoggoth]
- Driving Controls: Fanatec Porsche 911 Turbo S Wheel "Clubsport edition"
- Driving Seat: Gamepod GT2