***Rehabilitation Driving Simulator***: Requirements Document (v 1.0)

Project: Rehabilitation Driving Simulator

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**1. Introduction**

This document contains the system requirements for Rehabilitation Driving Simulator. These requirements have been derived from several discussions with Dr. Brendan Smith, Ph.D and members of his staff.

**1.1 System Overview**

The Rehabilitation Driving Simulator project is to develop a driving simulator to help rehabilitate drivers who have been physically challenged in some way and are re-learning to drive a car. An existing driving simulator will be modified. This simulator currently provides a seat and controls, but the seat moves around, providing haptic feedback which is [in many cases] too stressful for the rehabilitating driver. Instead, the simulator will be “quasi-haptic”, being modified to simulate the physical forces of driving by inflating/deflating pneumatic bladders within the seat to give the driver the feeling of turning, bumps, acceleration, and braking. Precise computer control is required to link to the controls and the simulated roadway to provide a life-like experience.

**1.2 How to Use This Document**

This section explains the structure of this document Section **2** gives a full description of the project itself. Section **3** discusses the requirements that the software will meet from a user and technical standpoint.

The following language will be used to specify requirements.

**1.2.1 “Shall”**

This expresses a mandatory requirement which must be satisfied by the product.

**1.2.2. “Should”**

This expresses a non-mandatory provision, which may or may not be satisfied during the course of this project.

**1.2.3. “Will”**

This declares a design goal, outlining a narrative by which other requirements accomplish a purpose.

**1.3 Scope of the Product**

We intend the product to be used in assisting the recovery of victims of brain injury and in research to that effect. It should help compromised users regain ability to perform complex motor coordination tasks, including relearning how to drive, and the haptic feedback should assist even unimpaired users in driving performance relative to a system without feedback.

We do not, however, expect the product to have applications for other forms of physical and psychological injury. We expect it to be of relatively minimal use for unimpaired persons, as there is no obvious recovery outcome.

**1.4 Overview of the Requirements Document**

The most important requirements are:

1. a software interface for the researchers/therapists to manage session conditions and user settings
2. a training mode to allow subjects to practice with the quasi-haptic feedback and researchers to collect data
3. a test mode to evaluate and collect data on subjects’ progress

**2. General Description**

This section will give the reader an overview of the project, including why it was conceived, what it will do when complete, and the types of people we expect will use it. We also list constraints that were faced during development and assumptions we made about how we would proceed.

**2.1 Product Perspective**

We have chosen to develop this product because there is a large need for a system that can provide useful driving experience for people who might otherwise cause danger on the road. This project will be developed by Dr. Brendan Smith, Ph.D and members of his staff. The final product should result in making driving rehabilitation experience more easily accessible.

**2.2 Product Functions**

Our product will allow for a variety of driving environments which will test for multiple different skill sets. Users should be able to test specific skill sets, and have their performance recorded in a “subject profile.” Users should be able to perform multiple different training scenarios, as well as be tested on certain skill sets that might or might not improve throughout those training scenarios.

**2.3 User Characteristics**

Our finished product is intended to be used in 2 specific contexts:

**2.3.1 Medical Facilities**

The primary purpose of our product is for specialized rehabilitation professionals to aid in the recovery of stroke victims. As these medical professionals’ core expertise is in the medical field rather than computer technology, the goal is to build an interface that will minimize any such obstacles that may arise so that they would not need to acquire any special skills.

**2.3.2 Research**

A secondary goal of the project is to conduct research on optimal ways in which rehabilitation regimes can be refined. These research professionals likely will not require any additional expertise beyond any existing experience they have with Windows machines.

**2.4 General Constraints**

Our project requires the use of customized SimGear driving simulator hardware running on the Windows 10 operating system. All software must therefore remain compatible with both the Windows development and runtime environments and the SimCommander and SimTools motion control software which connects the hardware and the front-end software.

**2.5 Assumptions and Dependencies**

As discussed in **2.4**, our project depends upon the particular technical infrastructure of the SimGear simulator hardware and the Windows 10 operating system, and it use requires an administrator qualified to oversee human social and behavioral research and/or rehabilitation.

The simulator itself is composed of an off-the-shelf performance car seat mounted on a platform with actuators, an array of 3 HD monitors, an XBox-branded steering column with game buttons (including paddle shifters) and minimal adjustment, and an array of hydraulic pedals. s

**3. Specific Requirements**

This section of the document lists specific requirements for Rehabilitation Driving Simulator. Requirements are divided into the following sections:

1. User requirements. These are requirements written from the point of view of end users, usually expressed in narrative form.
2. Subsystem divisions.
3. Experiment scheduler. These are detailed specifications describing the functions the system interface must be capable of doing.
4. Training scenarios. These are detailed requirements relating to the software’s training mode.
5. Test scenarios. These are detailed requirements relating to the software’s evaluation system.
6. Data acquisition. These are detailed specifications describing the software’s capacity to interact with files and other applications.

**3.1 User Requirements**

Users to need to know the instructions and allow consent to be using the driving simulator. Users need to know the safety precautions and protocols that researchers will share and inform them with. Users must know that jolting might occur with the simulator. The purpose of the simulator is to mimic what one should feel while on the road. The actions and jolting the users make will also reflect on the way the user is driving.

**3.2 Subsystem Divisions**

The Rehabilitation Driving Simulator will have four main subsystems. The first will be called the Experiment Scheduler, which is responsible for the organization and execution experiments. The second, Training Scenarios, will be long-duration practice sessions that simulate real world driving. Third, Test Scenarios, will evaluate their skills in post-training scenarios. Last, Data Acquisition for evaluation and monitoring systems.

**3.3 Experiment Scheduler**

3.3.1 The experiment scheduler shall be implemented as a web app or software (TBD).

3.3.1 The scheduler interface shall allow a researcher to set up experiment conditions, start/stop an experiment, send triggers, and adjust haptic feedback factors.

This custom build application will present the researchers with a user’s profile, current experiment, upcoming experiments, start/stop toggle, and obstacle triggers.

**3.4 Training Scenarios**

3.4.1 The training sessions shall be initiated from the experiment scheduler.

Training sessions should run autonomously once started.

The training scenarios will simulate real world driving and give participants practice.

Training scenarios will take place in the simulator; no custom or extra interfaces will be built.

3.4.2 The software shall collect quantitative data from these sessions.

3.4.2.1 Data collected shall include cars hit

3.4.2.2 Data collected shall include obstacles hit.

3.4.2.3 Data collected shall include lines crossed.

3.4.3 The collected data shall be used to generate a report about the session.

**3.5 Test Scenarios**

3.5.1 Test scenarios shall include looping courses or challenges to test a user’s ability.

Test sessions will be less variable than the training sessions.

3.5.2 During test scenarios, the software shall collect more detailed data. For example: stopping distance, following distance, reaction time, lane position, and g-force.

Test scenarios will take place in the simulator, no custom or extra interfaces will be built.

**3.6 Data Acquisition**

3.6.1 Data from each session shall be saved, exported, and remain associated with the user.

Data will be exported as “TBD.”

3.6.2 The software shall communicate with and monitor the hardware actuators via SimCommander and SimTools.

The project should incorporate an additional monitor so the researcher can see real-time hardware data.

**4. Glossary**

**Subject Profile**: Individual profile which will be assigned to all of our participants, in which, all of said subject’s pretinant data is recorded.

**Actuator**: A component of a machine that is responsible for moving and controlling a mechanism or system

**Haptics:** Relating to the sense of touch, specifically relating to the perception and manipulation of objects using the senses of touch or proprioception (the sensation of the body’s position).

**5. References and Further Reading**

SimGear - https://www.simgear.com/

SimCommander - https://www.simxperience.com/en-us/products/software/simcommander4.aspx

SimTools - https://www.xsimulator.net/simtools-motion-simulator-software/

Project Cars 2 - https://www.projectcarsgame.com/explore/?lang=en-us

American Truck Simulator - https://americantrucksimulator.com/

City Car Driving - http://citycardriving.com/