

Appendix B Description of Driving Simulator

In January 2005 a high-fidelity driving simulator was completed for use by researchers at the National Older Driver Research and Training Center (NODRTC), University of Florida. This system, a virtual reality simulator, was used for this study of the influence of enhanced roadway intersection designs on the performance of older and younger drivers. The simulator is housed at the University of Florida “Smart House” in Gainesville, Florida. It is an adaptation of the STISIM Drive developed and marketed by Systems Technology, Inc. of Hawthorn, CA¹ Following is a brief description of the major components of this simulator.

The Visual Display: This simulator provides a large forward visual field-of-view (fov) of 180 degrees and displays virtual objects behind the car as well. As can be seen in Figure 1 below, the entire scene is computer-generated.



Figure 1. A “driver’s view” of the forward and rear scenes

The wide fov is accomplished by connecting three flat screens with scenes provided by three high intensity projectors (Sanyo, with 2000 ANSI Lumens) onto joined flat screens. Although a continuous curvilinear surface would provide a somewhat improved representation of the forward visual scene, the cost of achieving such a continuous surface screen was prohibitive. After a few minutes of practice by a subject the process of “perceptual filling” prevails and the subject indicates no notice of partitioning of the three separate segments. The wide fov allows drivers to make changes in direction at intersections in a very natural way.

Although the current configuration is limited in variations in brightness and contrast of the driving scene, overall contrast can be altered to simulate a wide range of weather conditions including situations where visibility is reduced such as when driving in heavy rain or in fog. This capability is however not being currently deployed in initial (NODRTC) studies.

The Vehicle Configuration: In the 1997 Dodge Neon car, the “driver” operates normal accelerator, brake, and signaling and steering controls with the corresponding visual scene responding accordingly. Apparent longitudinal and lateral movement allows the driver to speed up or slow down, come to a halt, steer laterally including making lane changes or change direction at intersections. All changes are controlled by software that interface a junction box under the hood of the vehicle. See Figure 2).



Figure 2. Junction box that distributes computerized signals to steering wheel, accelerator, brake and retrieves turn-signal indications.

The simulator was built on a computerized platform developed by the Systems Technology Inc. (STI).. The specific configuration is the STISIM Drive Model 500W

produced by STI. The vehicle and tire model runs on a dedicated processor linked to the simulation via a network. It operates at fast update rates necessary to provide high-fidelity simulation of the vehicle dynamic responses as well as provides proper steering force/feel feedback. Road-feel is also captured via a low-frequency audio woofer and amplifier that provides engine, transmission and road noise at varying intensities and frequencies.

Auditory Display and Apparent Motion: The STISIM DRIVE software simulates sounds related to vehicle performance and external factors. These sounds include engine sounds mentioned above, tire screech associated with to heavy braking or high cornering loads, horn, and the turn indicators. External sounds include a crash sound, siren sound, and tire noise that can discriminate between on and off-road surfaces. We also have the capability of substituting standard sounds provided with the simulator's customized sound files and playing recorded messages at specific locations in the driving scenario.

Workstation: A control area situated to the rear of the vehicle overlooks the driver, vehicle and viewing screens. See figure 3 below). At this workstation the three visual screens are duplicated and a fourth control monitor allows the experimenter to set parameters for each trial and to monitor data being collected.

Two-way communication is maintained via speakers and microphones in the vehicle and at the workstation.



Figure 3. The Workstation overlooks the driver, vehicle and projected scenes.

Measurement and Performance Recording: The recording software permits the acquisition of up to 40 vehicle, driver and simulation parameters. The specific data

recorded depends upon the driving scenario being used and the assessment goals. For our present purposes the parameters shown in Table 1 are recorded:

Table 1. Basic Parameters and Measures Recording in EAS
Elapsed time from beginning of run (sec)
Total distance traveled from beginning of the run (feet)
Longitudinal velocity (feet/second)
Longitudinal acceleration (feet/second ²)
Lateral acceleration (feet/second ²)
Lateral lane position with respect to the roadway dividing line, positive to the right (feet)
Lateral control during turn (Difference between vehicle and roadway curvature (0.1 ft)
Yaw rate (radians/second)
Vehicle heading angle (degrees).
Steering wheel angle input (degrees)
Brake Actuation
Left signal
Right signal
Current traffic signal light position
Roadway traffic data.
Vehicle collisions includes: other vehicles, off-road and pedestrians

In addition to these parameters, statistical data such as mean and standard deviation of parameters such as lane deviation, speed, steering angle can be included. An Open Module can also be used to develop additional performance measures such as physiological indices of GSR, EMG, or EEG, although none of these measures were obtain in the present study. See Appendix D, Data Recording and Analysis for more detail on the measures obtained in the study.

Development of Specialized Roadway Configurations: For the current work on intersection negotiation, non-standard presentation modules had to be developed. Using STI's proprietary Simulation Definition Language (SDL) as a starting point, the NODRTC's technical support staff developed scenarios that included a variety of intersection types and roadway control configurations incorporating realistic traffic signals, signs and markings appropriate to specific highway environments. Using standard traffic engineering design drawing and photographs of real world intersections, computerized imagery has been developed that is extremely realistic. Through a process known as "texturing" standard roadways have been recast to display roadway medians, left-turn offsets, extended receiving areas at intersections and other configurations.

General Utility of the NODRTC Driving Simulator: This simulator is primarily a designed for research where experimental control and safety of participants is paramount. Initial experience with this system indicates that a wide variety of research can be conducted with this system. For example for subjects with some cognitive dysfunction, it should be possible to evaluate a variety of training strategies and devices that may extend the period during which some older persons with such disabilities can safely drive and maintain a high quality lifestyle.

References

1. See <http://www.systemstech.com/content/view/14/29/> for details on the basic configuration of this system.