

Introduce the Advanced Driving Simulator at Wichita State University

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Driving simulator

The Human Factors Division of the Psychology Department, Wichita State University has several driving simulators, including the OpenDS, the TORCS and the HyperDrive Driving Simulator. The advanced driving simulators can simulate almost any driving scenarios, events and conditions. Typical driving tasks include a car following task, a pedestrian crossing street task, a lane change task. All weather and road conditions can be simulated too, such as rural and freeway, windy, rainy and snowy road.

Driving simulator hardware



Figure 1. The HyperDrive advanced driving simulator setup. (Demo driver is wearing Google Glass while driving)



Figure 2. The TORCS driving simulator.



Figure 3. The OpenDS driving simulator.

Driving tasks

The advanced driving simulator at the Wichita State University can technically simulate any driving scenarios to evaluate driving performance. Here we describe some commonly used driving tasks, including the car following task, the lane change task, and the pedestrian crossing street tasks.

Car following task.

A car following task is one of the most commonly used driving task (He, Becic, Lee, & McCarley, 2011; He, Chaparro, Nguyen, Burge, Crandall, Chaparro, Ni, & Cao, 2013). Participants are instructed to follow a lead vehicle while maintaining a safe distance. The lead vehicle drives at a target velocity of 30 miles per hour, and brake at random time intervals, which follows a uniform distribution with the range of 30 to 60 seconds. During a brake event, the lead vehicle decelerates at the rate of 3m/s^2 for 5 seconds and then returns to the target velocity of 30 mph afterwards. If the participants drive too slowly with a headway distance greater than 100 m, the lead vehicle would gradually slow down at the deceleration rate of 0.5m/s^2 until the headway distance is smaller than 80 m. Participants are asked to observe all traffic

laws. During the driving scenario, headway distance, lane position, steering wheel position, and speed are recorded.

The simulated driving scenario consists of an 8000 m long two-lane highway (with straight and curved portions). Traffic includes the participant's vehicle and a lead vehicle.

Many important driving performance measures, such as braking force, braking response time, headway distance, headway time, time to collision can be collected using the car following task.

Lane change task.

Driving performance was assessed using a driving simulator consisting of a car seat, a Logitech Driving Force GT steering wheel and pedals. The simulator software used was the Daimler Chrysler AG Research and Technology Lane Change Test (LCT) driving simulator version 1.2 displayed on a 60" Sharp AQUOS 3D HD LCD television. This Lane Change Test (LCT) was developed to test driver distraction caused by in-vehicle tasks. The LCT task provides standardized driving performance measures, such as mean deviation of lane position, standard deviation of steering wheel position. The LCT task is accepted by the ISO standard and commonly used by automobile companies and driving researchers to evaluate in-vehicle devices.

Pedestrian crossing street task.

In the pedestrian crossing street task, drivers will drive in a straight urban road. Pedestrian standing by the street will sometimes cross the street. Drivers' braking response time and braking force in response to the pedestrian crossing street hazard will be measured to evaluate driving performance under different driver states or while they are interacting with in-vehicle devices.

Driving measures

An extensive array of measurements can be collected to evaluate driving performance, such as headway distance and headway time to the lead vehicle, braking response time, speed, lane position, steering wheel position, acceleration, brake force, response time to hazards etc.

Below are commonly used driving measures for longitudinal and lateral driving performance

- Vehicle Longitudinal Measures
 - a) Distance Gap
 - b) Time Gap
 - c) Distance Headway
 - d) Time Headway
 - e) Center of Gravity (CG) Distance Headway
 - f) Center of Gravity Time Headway
 - g) Braking response time
 - h) Braking force
 - i) Coherence of speed
 - j) Mean and standard deviation of speed

- Vehicle Lateral Measures
 - a) Standard deviation of lane position
 - b) Number of lane excursions/lane departure
 - c) Time to lane departure
 - d) Steering reversal rate
 - e) Steering holds frequency
 - f) Steering entropy
 - g) Steering response time