

Easy to Use Driving Behavior Analysis Using DriveLab

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Abstract. With the ever increasing computerization in vehicles it becomes essential to assess the impact these technologies have on drivers. DriveLab is an easy to use system for measuring and analyzing driver behavior. Introduced by Green Dino, Noldus Information Technology and SmartEye, it is designed to support researchers' need to quickly record and analyze a driver's behavior. It records common driver performance measures and various (cognitive) workload measures. Using real-time data exchange, data analysis can start immediately after a trial.

Drivelab is built on Green Dino's driving simulator, SmartEye's Smart Eye Pro and Noldus' The Observer XT.

Keywords: Driving Simulator, Driver Performance Measurement, Workload, Human Factors analysis, Systems Integration.

1 Introduction

The number of computer-based technologies in vehicles has increased exponentially over the last thirty years. One of the contributing factors are the high-speed ICT developments, such as miniaturization, in personalized computer technology; most people will carry at least one computational device with them during the day. For new generations of drivers cars are an extension of their plugged-in lives, with iPods and other gadgets (USA Today, 2009).

Parallel to that the automotive industry has significantly increased the number of features in vehicles. They increase comfort (climate control), fuel efficiency (eco drive) and safety (connected car). Despite the aim of a significant number of these systems to support drivers (Advanced Driver Assistance Systems, ADAS), they can also act as a source of distraction, that increases the complexity of driving. Combining this with the fact that distraction plays a role in most (near) accidents [1], it is crucial to ensure newly introduced systems do not add complexity nor increase distraction.

It is common to test the impact of systems on driver performance, distraction and cognitive workload, as a means to ensure new (ADAS) systems do not overload nor

distract drivers [2]. Preferably in a controlled environment, such as a driving simulator. Numerous proven driver observation methods, such as expert observation, lateral vehicle displacement and eye tracking), are available for driving simulator testing. Often these methods focus on different aspects of a driver's actions. So a multi-method research approach is important for researchers, to get the complete picture. However, in most studies only a small set of behavioral data is recorded, as a significant amount of knowledge is required to apply the individual data collection systems for the methods properly, so combining these techniques in one study is beyond the reach of most researchers. Another hurdle is linking the data from the different systems, which is time-consuming and frequently requiring advanced computer skills. This sometimes leads to controversial results. At the same time the pressure on researchers to produce is increasing.

2 DriveLab

With DriveLab, developed in the Advanced Driver Vehicle Interface in a Complex Environment (ADVICE) project [3], GreenDino, Noldus Information Technology and SmartEye introduce an easy to use, flexible and real-time multimodal driving behavior analysis tool. DriveLab is based on The Observer XT, Noldus' tool for behavioral analysis for over 20 years [4, 5, 6]. It integrates a multi-camera remote 3D eye tracker [7, 8] and a fixed-base medium fidelity driving simulator [9, 10]. Each system has its own strengths and has proven its value in numerous experiments [11 - 14]. The systems are synchronized using the Meinberg NTP client, to ensure accurate synchronization of all systems with a central computer clock [15].



Fig. 1. Driving simulator with eye tracking in action

2.1 Driving Simulator

The driving simulator consists of three screens providing a 140 degrees visual field, and a real-world steering column, seat gearbox and foot pedals. The simulator has a

pre-defined set of driving adaptable scenarios that covers all common driving tasks (such as car following, and city driving) in various driving conditions (e.g. day/night, fog). This allows the behavior of other traffic to be adjusted to create busy traffic. The simulator is not only used for generating the test environment it is also a source of driver performance data.

2.2 Noldus Communication Framework

The Noldus Communication Framework (NCF [16]) is an implementation of the Advanced Message Queuing Protocol (AMQP) [17]. It is a system that supports real-time scalable and flexible data exchange between the data acquisitions systems (SmartEye Pro and driving simulator) and the data recording systems (The Observer XT). NCF is an open communication framework, designed to easily extend the system with additional measurement systems such as acquisition of psycho-physiological signals or facial expressions

2.3 The Observer XT

The Observer XT is used for the collection and analysis of behavioral data. It allows integrated analysis and visualization of multimodal data, such as headway a video of the driving environment and gaze events (fig 2). Its data filtering features enables zooming in on specific situations (e.g. approaching a crossing) and driver characteristics (e.g. age and experience of drivers). The package is completed by a keen set of statistics.



Fig. 2. The Observer XT: integrated display of the driver's main front screen with gaze overlay, gaze events (red colored bars), driving tasks (multi-colored bars), and vehicle parameters (red/green/blue lines)

2.4 SmartEye Pro

The 3-camera eye tracker supports free camera placement for optimal unobtrusive tracking. It uses an open coordinate system, to be used by other systems. The eye

tracker has a big head box and a large tracking area, which allows for natural head motion.

3 Conclusion

Combined, these systems provide the most commonly used parameters for detecting distraction and inattention, measuring driver performance, such as speed variations and headway, and multiple cognitive workload measures (such as pupil dilation and steering reversal rate).

A unique feature is the matching of gaze point with other traffic, traffic lights and road signs (objects that move around, varying in size in the virtual environment). The fully automated matching results in Regions of Interest (ROIs) with varying size, location and existence, something which usually requires labor-intensive manual annotation. Additionally the distance at which these ROIs are seen is recorded.

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