Studying Driver Behavior in Self Driving Cars Using a Driving Simulator
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There are several concerns with highly automated or semi-automated driving, mainly surrounding the driver or the human operator, such as issues related to transition of control from automated mode to manual mode, overreliance on automated systems and the resulting consequences of automated driving system errors. Traffic safety has been a primary component of the promotion of automated driving. Public-media articles often cite the fact that 90% of crashes are due to "driver error," implying that removing the driver from the loop will eliminate these crashes. However until higher levels of automated vehicles become the norm, humans will stay remain an important part of the driving loop. To better understand the role of the human in the driving automation loop, this research aims to empirically study test drivers during the transition from automated to manual driving modes in a driving simulator capable of simulating a level three automated vehicle. Sixteen participants will be recruited for the purposes of this research and their driving behaviors and responses will be recorded and measured using driving simulation and eye tracking methods. Driver responses will be analyzed for comparisons across various transition timings and alert and warning modes.

Is the driver still relevant in self-driving cars?-Using driving simulation to examine driver behaviors in automated vehicles

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Introduction

- According to NHTSA, self driving cars (L3-see Fig 1) are expected to launch in the market as early as 2020. This poses an interesting question concerning how drivers will adapt to this change (Trimble, Bishop, Morgan & Blanco, 2014).

Level 0	The human driver is in complete control of all functions of the car
Level 1	One function is automated
Level 2	More than one function is automated at the same time, but the driver remains attentive
Level 3	Driving functions are sufficiently automated - the driver can safely engage in other activities
Level 4	The car is self-driving - no human driver required

Figure 1

- Public-media articles often cite the fact that 90% of crashes are due to "driver error" (Hamilton, 2010).

- There are several concerns with highly automated or semiautomated driving, mainly surrounding the driver such as:

  1. Issues related to transition of control from automated mode to manual mode

  2. Overreliance on automated systems

  3. The resulting consequences of automated driving system errors.

Research Questions

1. How do drivers respond to transfer of control from automated to manual mode at level three of automation?

2. How do drivers respond to transfer of control from automated to manual mode at level three when engaging in another task?

Objectives

- The study will be to examine driver responses and behavior during simulated transfer of control from an automated vehicle to the driver.

- The automated vehicle simulator will be used as an experimental platform to present various categories of scenarios of control handoff in a controlled and replicable laboratory environment.

- Driver behavior and responses will be recorded using the simulator data logging systems, as well as via other integrated systems such as an eye tracker and audio/video recording.

Approach

Driving Simulation:
- Driving simulation provides a virtual reality environment with a high level of ecological validity. Driving behaviors and performance can be measured in a safe, controlled, replicable, and economical manner using driving simulator.

Participants

- 16 Participants distributed equally between males and females (25-45 years).

- Participants are required to have Michigan driver license.

Equipment

UMTRI Driving Simulator:

- The University of Michigan Transportation Institute driving simulator consists of a highly automated stationary vehicle simulator located in a dedicated lab space.

- The simulator is capable of showing road lanes, signs and collecting a variety of driver performance metrics (speed, steering wheel angle...)(see Fig 2-4).

- A virtual reality world is displayed which includes urban, rural, suburban, and freeway environments and a wide variety of buildings, trees, and other objects. In addition to weather models (Fog, rain, snow) and traffic.

Figure 2

- In order to track eye movement, an eye-tracking system is installed to provide head-pose, eye-blink, and gaze data.

Figure 3

Method

- Each participant will be required to complete a practice drive followed with two other drives, one involves a secondary task and the other doesn't.

- Participants driving behaviors and responses will be recorded and measured using driving simulation and eye tracking methods.

- Driver responses will be analyzed for comparisons across various transition timings and alert and warning modes.

Figure 4

References

- Trimble, T. E., Bishop, R., Morgan, J. F., & Blanco, M. (2014, July). Human factors evaluation of level 2 and level 3 automated driving concepts. Washington, DC: National Highway Traffic Safety Administration.

- Hamilton, J. (2010, February 12). Most auto accidents caused by drivers, not defects. (NPR) Retrieved from http://www.npr.org