Multimodal modeling of driving behavior in the presence of distraction

Arianna Giguere, Cecilia Alm, Gabriel Diaz, Reynold Bailey

Introduction

Human behavior is highly multimodal and complex. In our research track we collect, study, and model considering a range of human sensing modalities.

Driving involves complex human behaviors:

- Driving requires visual, auditory, and other sensory input [1]
- Driving studies have mostly focused on visual strategies for steering control [2]
- Conversation during driving can increase cognitive load [3]
- Driving is more challenging with distraction
- We collect a multimodal dataset with levels of distraction using controlled tasks and task-based dialogue for analysis and inference

This project takes advantage of human sensing technologies to record multimodal driving behavior with a virtual reality simulator. The experimental setup centers on **gaze**, **facial expressions**, and **galvanic skin response**, together with **steering behavior**, **distraction level**, and **spoken dialogue utterances**.

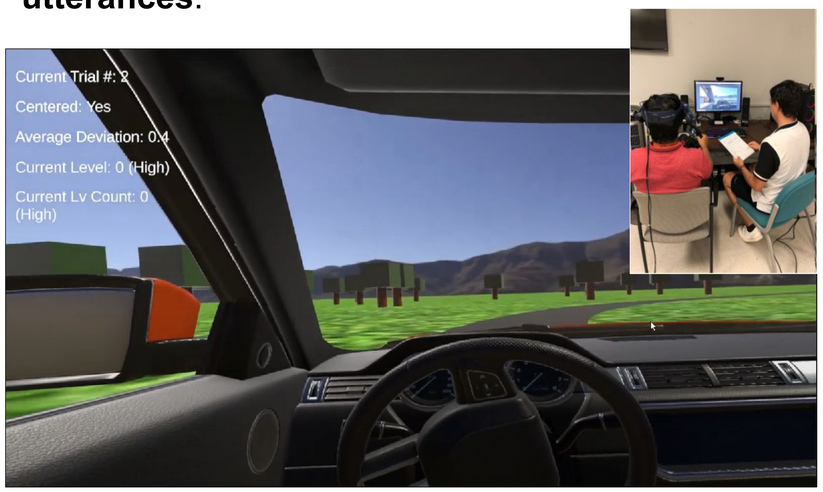

Fig. 1: View in the driving simulator developed in Unity at the PerForM Lab in Imaging Science at RIT.

Research Questions

RQ1: Does our model predict a statistically significant correlation between distraction level and driver reliance on optic flow to navigate?

RQ2: To what degree can our model predict changes in steering behavior in the presence of distraction from task-based dialogue?

RQ3: Which modalities are most predictive of distracted steering behavior based on a computational ablation experiment?

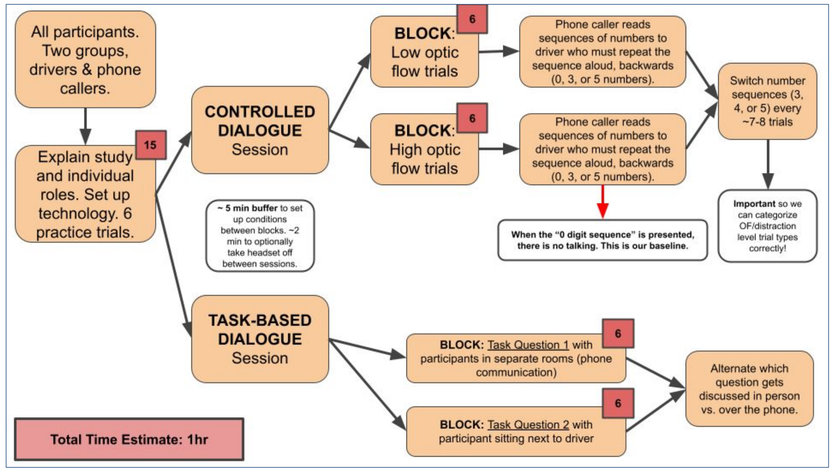

Fig. 2: Overview of data collection experiment with driving simulator.

Methods

- We use a custom-built driving simulation software with the ability to control all settings
- Participants include one driver and one person interacting with the driver
- **Controlled dialogue**: Driver must listen to, remember, and recall aloud sequences of numbers backwards, read to them by the other participant during driving
- **Task-based dialogue**: Driver and other participant discuss questions to arrive at consensus while driving

Project Contributions

- A novel multimodal dataset for research
- Methodology for studying, analyzing, and modeling multimodal driving behaviors
- Identifying research questions that can be addressed using the collected dataset
- AI model that can be used to answer these questions and encourage continued research

Challenges with multimodal data

- Potential loss of data (missing frames)
- Data sampling at varying rates by modality
- Strategies to effectively fuse modalities
- Integrating data from two (or more) individuals

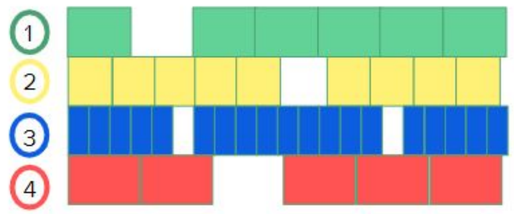

Fig. 3. Illustration of multimodal data challenges.

References

[1] J. Engström, E. Johansson, J. Östlund. 2005. Effects of visual and cognitive load in real and simulated motorway driving. Transportation Research Part F: Traffic Psychology and Behaviour, 8(2), 97-120.

[2] U. A. Abdurrahman, Y. Shih-Ching, Y. Wong, W. Liang. 2021. Effects of neuro-cognitive load on learning transfer using a virtual reality-based driving system. Big Data and Cognitive Computing, 5(4), ar54.

[3] D. L. Strayer, J. Turrill, J. M. Cooper, J. R. Coleman, N. Medeiros-Ward, F. Biondi. 2015. Assessing cognitive distraction in the automobile. Human. Factors, 57(8), 1300-24.

Acknowledgement

This material is based upon work supported by the National Science Foundation under Award No. DGE-2125362. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.