Protocol for Eliciting Driver Frustration in an In-vehicle Environment

Ajjen Joshi, Youssef Emad, Taniya Mishra

Affectiva Inc., Boston, USA

OVERVIEW

- It is estimated that people spend an average of 17600 minutes per year in a car.
- A state of frustration can impair a driver's ability to make decisions that optimize safety of the driver as well as that of those around him or her.
- Equipping a car with the capability of detecting signs of driver frustration and responding with appropriate interventions can be an effective method to improve safety.

CONTRIBUTIONS

- We propose a **novel frustration data collection protocol**, which we implemented to elicit varying intensities of frustration in 105 participants.
- We provide an **analysis of face and speech data** that were captured during the protocol, illustrating observed trends in facial and vocal displays of frustration.
- We present **baseline machine learning methods** to assess the intended difficulty of the task and whether the user is multitasking or not using the facial and vocal signals.

DATA COLLECTION PROTOCOL

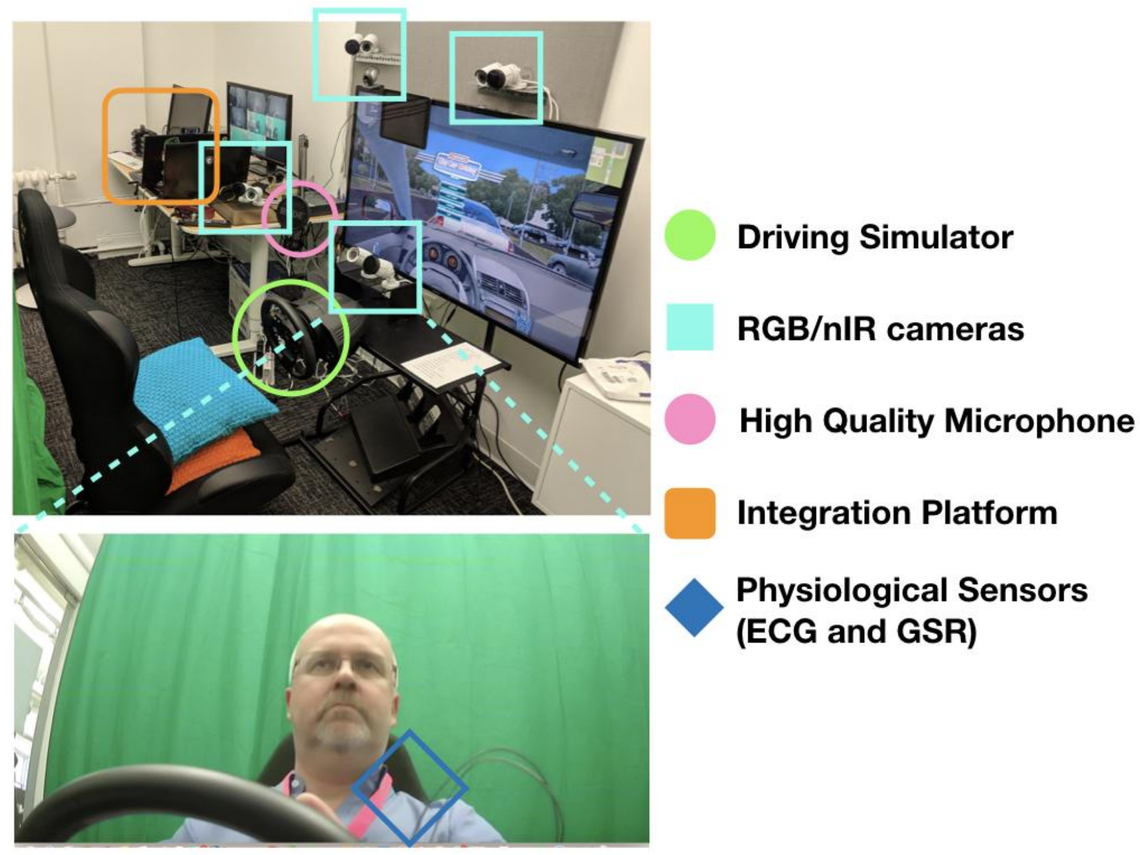
We collected audio, video and physiological recordings of the participants frustration while interacting with an in-car HMI under two conditions: 1) Performing a driving task *and* interacting with the HMI, and 2) Performing no other task while interacting with the HMI

Participants: 105 participants (55 female, 47 male, and 3 who did not specify gender) were recruited to participate in a "conversational agent interaction study" with no reference to frustration, so as to prevent any preconditioning that the experience may be frustrating.

Methodology: Each participant performed two sessions: 1- A "multitasking" session, where the participant performed 6 voice interaction tasks while free driving on an urban route using a driving simulator; 2 - A "unitasking"session, where the participant did not need to drive while performing the same voice interaction tasks. After each session, the participants reported their frustration for each task on a scale of 1 (not frustrated) to 4 (highly frustrated). Each session consists of the following 6 interaction tasks:

Tasks:

- Add and remove items off of a shopping list
- Ask the HMI to tell a joke
- Ask the HMI to set timers
- Ask the HMI to play various radio stations
- Ask the HMI to play various media
- Compose and send text messages to another person

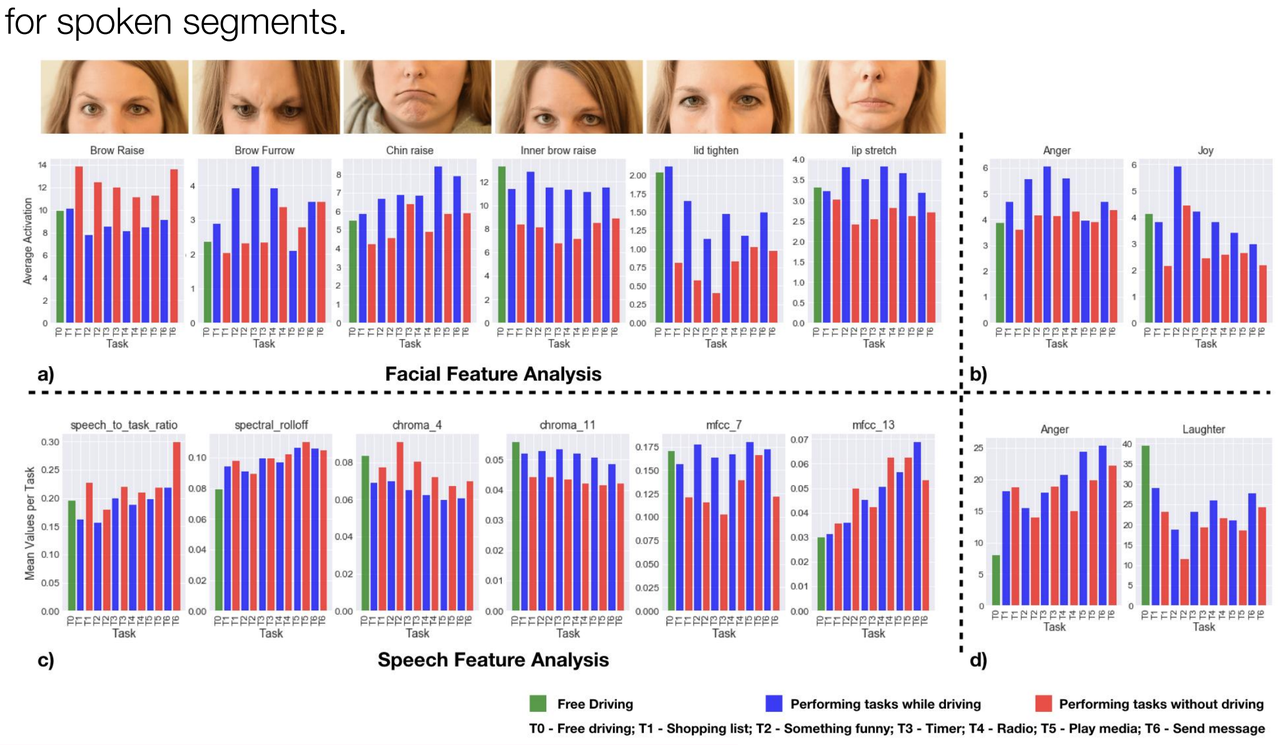


Instrumentation and Sensors

EXPLORATORY DATA ANALYSIS

We analyzed the average activations of facial action units and emotions using Affectiva's SDK, along with acoustic features, such as energy features, spectral features, mel-frequency cepstral features and chroma features for spoken segments.

- Participants displayed more brow furrows, chin raises, inner brow raises, lid tightens and lip stretches for tasks completed while driving compared to tasks where they focused solely on interacting with the HMI. **Figure (a).**
- Anger classifiers are activated more for tasks completed in conjunction with driving compared to tasks where the participants focus solely on interacting with the in-car HMI. **Figures (b and d).**
- A subset of acoustic features that showed high variance across the tasks is shown in **Figure (c).** For matched tasks participants spoke less when they were driving.
- Participants smiled, laughed or showed facial expressions of joy when frustrated. **Figures (b and d).**



BASELINE MODELS

- We plot the counts of the various intensities of frustration as reported by the participants for every task. As can be observed, the distribution of self-reported intensities is fairly uniform, with each intensity of frustration being reported more than 150 times. **Figure (a).**
- We trained and evaluated baseline random forest models on a) statistics of facial expressions and emotions, b) acoustic features. Speech features were found to be more predictive of both difficulty level (Mean accuracy of 0.76 for speech, 0.59 for vision) and multitasking (Mean accuracy of 0.78 for speech, 0.58 for vision). **Figure (b).**