UTC Spotlight

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Improving Methods to Measure Attentiveness through Driver Monitoring

Researchers at the Virginia Tech Transportation Institute (VTTI) worked on a project sponsored by the Safety Through Disruption (Safe-D) National University Transportation Center (UTC) to improve algorithms that measure a driver's attention level in real time, leveraging pre-existing data collected during a private (proprietary) study for General Motors (GM).

Driver inattention poses a significant problem on today's roadways, increasing risk for all road users. In 2020, an estimated 3,142 lives were lost due to distracted driving.[1] This is most likely an underrepresentation of the number of lives lost, as distracted driving is only determined through self-reports and accounts from witnesses. Driver monitoring systems (DMS) have the potential to identify when a driver is distracted and refocus their attention back to the forward roadway. However, the potential safety impact of these systems depends on how accurately they can differentiate between distracted and attentive driving.

Dataset

Through a previous privately funded project, the research team had access to a naturalistic dataset housing DMS data along with full-time video and other vehicle parameters, such as brake, throttle, and steering wheel position. A dataset was developed based on video review of 10-second driving events. Researchers determined the driver's distraction level at the end of each event, with output summarized in Figure 1.

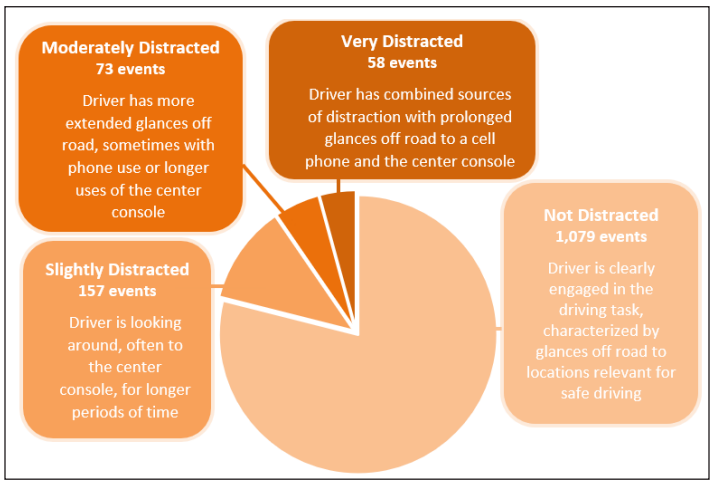

Figure 1. Driver distraction level determined from video review of 1,367 events.

The driver's glance locations were mapped for these same 10-second events to identify where drivers were looking based on each distraction level. Figure 2 shows an example of glance locations for an event during which the reviewer determined the driver was moderately distracted.

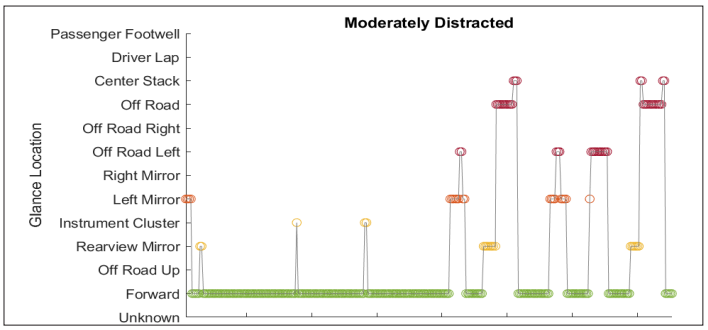

Figure 2. Driver glance locations during a 10-second clip in which the driver is determined to be moderately distracted.

Algorithm Development

The project focused on the continued development of a distraction algorithm that involved increasing and decreasing buffer values based on where the driver was looking. Once the buffers reached a certain value, the driver was determined to be either "attentive" or "inattentive." This algorithm was used to calculate the driver's attention level, which was then compared to the attention level manually determined through video reduction. Figure 3 shows the average mean-squared error (MSE) of the algorithm output per attention category, separated by the driver's speed during the event. The highest MSE occurred at low speeds in both the "not distracted" and "very distracted" events. This illustrates

1 National Highway Safety Administration (NHTSA), Overview of Motor Vehicle Crashes in 2020. USDOT https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813266

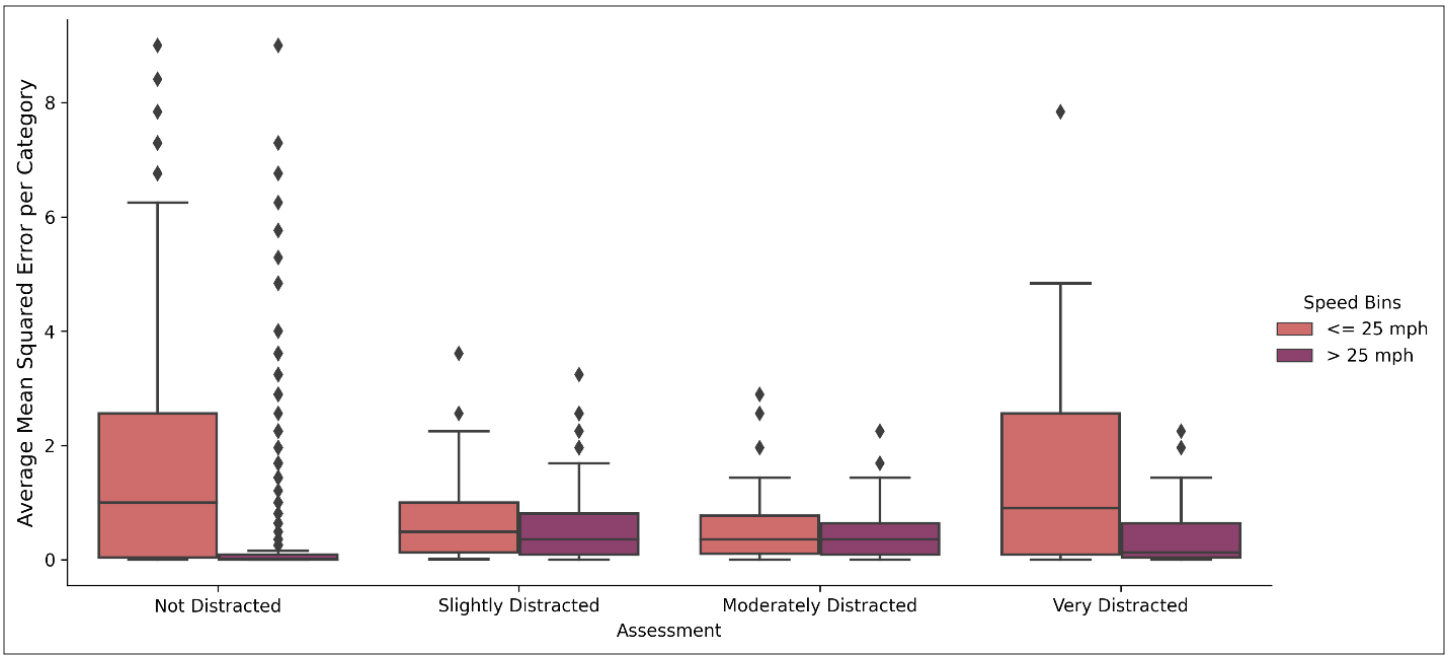

Figure 3. Initial algorithm error separated by ground truth attention level and the driver's speed.

that glance patterns at low speeds differed greatly from those at high speeds. At low speeds, drivers may be making a turning maneuver, navigating an intersection, or driving through a pedestrian-heavy area. Variations of the algorithm included other vehicle parameters such as speed, steering wheel input, brake pressure, and throttle pressure to provide additional environmental context.

Summary

- Tools available now make it possible to determine when a driver is inattentive to the driving task.
- Algorithms used to determine driver attention should be designed with an understanding of their limitations (and limitations of the data source).
- At a minimum, both glance location and vehicle speed should be used to assess driver attention.
- Driver monitoring is a crucial component in detecting and reducing distractions, but this does not mean that all the tools developed can immediately and correctly identify every instance of driver distraction

About This Project

This research was led by Luke Neurauter, Marty Miller, and Eileen Herbers. This project was supported and funded by the Safety Through Disruption (Safe-D) National UTC, with a consortium of universities led by the Virginia Tech Polytechnical and State University (https://safed.vtti.vt.edu/)