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Developing Real-Time Solutions for Driver Drowsiness and Distraction Using a World-Leading Driver Behaviour Dataset

Michael G. Lenné [1*], Jonny Kuo [1], Michael Fitzharris [2], Tim Horberry [2], Christine Mulvihill [2], Kyle Blay [1], Darren Wood [3] & Anthony O'Connell [4]

[1] Seeing Machines Ltd, 80 Mildura St, Fyshwick ACT, Australia
[2] Monash University Accident Research Centre, Monash University, VIC, Australia
[3] Ron Finemore Transport Services Pty Ltd, Wodonga VIC, Australia
[4] Volvo Group Australia, Wacol QLD, Australia
[*] **mike.lenne@seeingmachines.com**

Abstract

Road safety and road transport sectors acknowledge the need to address heavy vehicle safety, both in terms of reducing the number of crashes and the flow-on impacts on productivity. Advances in technology now enable transport operators to strengthen their ability to measure and monitor in-cab driver performance in real-time as a way of complementing existing company safety policies and further ensuring they meet OHS requirements. This paper outlines a Commonwealth-funded program, the Advanced Safe Truck Concept project, led by Seeing Machines in collaboration with the Monash University Accident Research Centre, Ron Finemore Transport and Volvo Group Australia. This three-year program aimed to better understand the real-world risks faced by trucking operations and their drivers, and then through this high quality research to generate new technological solutions.

1 Introduction

Risks to road user safety associated with distraction and drowsiness continue to feature as key target areas in state, territory and national road safety strategies and action plans. For fleet operators these are challenging risks to manage on a daily basis. Real-time in-vehicle monitoring of driver state has been shown to be an important pillar within contemporary safety management systems in the workplace.

There are numerous approaches to driver monitoring that can include monitoring critical safety events (e.g., a lane departure), monitoring vehicle control inputs (e.g., steering, pedal use) as in some telematics systems and, in particular, camera-based approaches that assess measures related to head pose, gaze and eyelid behaviour - typically referred to as driver monitoring systems (DMS). The latter approach has been recognised in the European National Crash Assessment Program as the best method to address these issues.

The safety and well-being of heavy vehicle drivers is critical in supporting an efficient freight sector, which in turn sustains economic productivity. This program aimed to enhance Seeing Machines' driver monitoring technology to further enable the freight industry to monitor and improve driver safety and wellbeing, in ways not currently possible, resulting in significant economic gains.

2 Methodology

The three-year program utilised new data analysis methods to understand the behavioural risks in ways not previously possible. This was enabled by bringing together 'big data' analytics, simulation and computer vision expertise across Seeing Machines and Monash University and the operational and industry expertise of Ron Finemore Transport and Volvo Group Australia.

Extensive data were collected using car and truck driving simulators at Monash University (Phase 1 and 2, respectively, Figure 1). These represent one of the largest and in-depth drowsiness and distraction datasets available. The third phase was launched in April 2018, representing Australia's first naturalistic truck study, and the first worldwide to our knowledge to use driver monitoring technology. Ten trucks were instrumented with the sensing platform described later for up to 6 months, generating 12,000 hours of real-world data that is critical for technology development.

Figure 1. Data collection methods used in the Advanced Safe Truck Concept project

The data collection platform included Seeing Machines' automotive grade Driver Monitoring System, cabin-view webcam, time-of-flight camera, thermal imaging, electroencephalography, and pulse oximetry, with the addition of ADAS signals generated from Seeing Machines' aftermarket system in the Phase 3 study. The fourth phase involved a mixed-method approach to develop new Human Machine Interface concepts for driver distraction, drowsiness and workload and subsequent iterative design and evaluation of these concepts.

3 Key results

Findings to date support the efficacy of the prolonged wakefulness and driving task protocols, with preliminary analyses of the available data highlighting the novel insights achievable through further exploration of the data. Measurements of percentage eye closure (i.e. PERCLOS, an extensively validated ocular metric of drowsiness) highlight the efficacy of the prolonged wakefulness protocol, with PERCLOS levels differing significantly between Alert and Drowsy sessions (repeated measures t-test, $t=4.96$, $p<0.000$). An initial logistic regression analysis of the simulator data showed a significant main effect of drowsiness on the incidence of severe crashes, with the odds of crashing being 2.5 times higher when participants were fatigued. Participants' self-rated drowsiness (Karolinska Sleepiness Scale, or KSS) was associated with a 26% increase in the likelihood of a crash for every unit increase in KSS.

Comparing percentage of glances to the forward roadway, a significant effect of the visual distraction task was observed (Friedman Test, $F=7.24$, $p=0.001$), indicative of decreased scanning of the roadway and increased duration of distraction when engaging with a visual distraction task.

4 Implications and conclusions

The heavy vehicle industry is a core pillar of transportation systems worldwide and is critical to local economies. Keeping drivers and other road users safe not only reduces accidents and road trauma but also keeps freight moving.

This paper outlines a significant research effort to develop enhanced technology to measure and predict driver state in real-time, using Seeing Machines' driver monitoring technology as the core sensing. It represents a whole of industry approach to tackle driver drowsiness and distractions with involvement from an OEM, a truck operator, a driver monitoring technology provider and supported by strong university research partners.

While the scientific findings provide significant new insights to characterise drowsiness and distraction and links to safety events, the real value from the program is in how this information is used to generate enhanced algorithms that measure driver drowsiness and distraction in real-time. The program produced algorithmic improvements that are now incorporated into Seeing Machines product development programs. These will be discussed during the presentation.

5 Acknowledgements

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