Quantifying and Rating Distractibility of In-Vehicle Infotainment Systems: An End-User Toolkit

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SUMMARY

Given the increasing availability of technology within the vehicle, the potential for distraction from an infotainment system and resultant collisions is high. Currently the in-vehicle-infotainment-system (IVIS) is not considered within a vehicle's safety rating, and currently no recognised standards to quantify the level of distraction of an IVIS. This paper summarises the testing of multiple vehicles for their distractibility which informs the development of an evaluation framework to determine the level of distraction of an IVIS.

KEYWORDS

Driver distraction, infotainment system, vehicle safety

Introduction

Driver distraction is a significant challenge for road safety, resulting in a high number of crashes and fatalities (Young et al., 2007), and secondary tasks have been identified as the most common distraction activities by road users (McEvoy et al., 2006). Research has demonstrated that drivers spend between 30%-40% of their driving time engaged in secondary tasks (Metz et al., 2014). While still an issue worldwide, within Australia, road trauma remains a major public-health issue, with approximately 100 deaths occurring each month and a comparable number of people hospitalised each day as a result of road-crash injuries (Australian Institute of Health and Welfare, 2023; Bureau of Infrastructure and Transport Research Economics, 2023). Every year road trauma costs the national economy almost $27 billion and brings tragedy into the lives of thousands of Australians (Steinhauser et al., 2022). With similar statistics around the world, road safety is a crisis that demands real solutions.

Commensurate with the increase in driver distraction crashes and fatalities, is the development of increasingly sophisticated in-car entertainment system (infotainment systems), where the driver can engage in a range of entertainment and operational tasks. The increasing sophistication of infotainment systems means that the driver has access to a range of information, with increasingly complex components, requiring a range of complex multi-modal interactions. While a vast amount of useful information is now – literally - at the driver's fingertips, the increasing amount of information available, coupled with a need to place more information into increasingly smaller devices, has resulted in a driver that is vulnerable to a high degree of in-car distraction. Such visual distraction can lead to task-neglect, impaired hazard detection and frequent, and long off-road glances, dramatically increasing the driver's risk of a crash.

As drivers, we have limited attentional resources. Most of our attention is devoted to monitoring the driving environment and operating the vehicle. When a driver engages in a secondary task, the attention required to engage in that task, draws attention away from driving the vehicle, resulting in a deterioration in driving performance (Choudhary & Velaga, 2017; Strayer et al., 2011). The distraction associated with interacting with an infotainment system, is therefore a combination of eyes-off-road visual distraction, an increase in cognitive load as interacting with the infotainment system stretches limited cognitive resources, and manual distraction from physically interacting with the system.

The ingenuity of car designers and consumer demand means infotainment distraction will continue to be ubiquitous in new cars. However, the technologies within these cares vary considerably in their potential distractibility. While systems may offer similar functions, the design and implementation can differ greatly vehicles. While the aesthetic choices of vehicle design may be considered secondary to performance, these same design choices may result in greater demands on drivers attention; making them more likely to divert attention away from safe driving. This variability has been demonstrated in a series of research within the USA. This work has resulted in distraction safety ratings for more than 40 vehicle models and highlights the wide range of distraction potential across systems (e.g., Strayer et al., 2017; Strayer, et al., 2015). However, there are major design differences between left-hand and right-hand drive vehicles that will impact distractibility. Therefore, the aim of the current project is to develop an updated distraction rating system for infotainment systems in vehicles, within an Australian context. The outcome is to provide guiding metrics for vehicle manufacturers to produce safer vehicles, and to allow consumers to make safer purchases.

Project Methodology

Data collection occurred at a road testing centre in Victoria, Australia over 12 days. During testing, participants performed a series of IVIS tasks during an on-track drive (Phase 1) and while stationary and simultaneously completing simulated driving tasks (Phase 2). We tested 20 participants across 13 vehicles; with each participant tested in multiple vehicles across a 2-day period.

While the detailed on-track and stationary tests yield rich data for researchers and independent vehicle-safety assessment bodies such as ANCAP, the resulting distraction metrics are not easily interpretable by consumers. There is a need for a simple assessment method that produces clear, intuitive outputs so that new-car buyers can meaningfully compare the distraction potential of different IVIS systems. Consumers require straightforward information that communicates relative safety without the need for technical expertise or familiarity with experimental measures.

We then proceeded to develop an easy-to-use metric that could translate the complexity of the earlier phases into a practical, accessible assessment tool for end users. To achieve this, we conducted exploratory modelling on the on-track and stationary testing to determine whether a readily obtained measure could reliably predict IVIS distractibility. This represents a novel contribution to the driver-distraction literature, offering a simplified and scalable method that has not previously been available to Australian consumers or industry.

Results

Phase 1 testing generated an extensive dataset from ‘real-world’, validated, on-road testing and presents an accurate assessment of driver distraction, using psychometrics over many participants tested in many vehicles. This dataset has been modelled using advanced statistical modelling techniques to provide end-users with a reliable tool to quantify the distractibility of an IVIS. Drivers have been shown to make more glances off-road and higher cognitive workload while completing the tasks; as well as allowing us to directly compare different vehicle configurations.

Phase 2 testing allowed us to validate non-driving tasks to simulate distraction in the real driving experience. We have found a strong correlation between the two techniques provides support for the methodology as a valid measure of distraction. This demonstrates that a cost-effective non-driving task can be used as a proxy for assessing driver distraction when using IVIS.

Following this, we used operator event sequence diagrams to assess individual components of different IVISs to determine their relative contribution to the overall distractibility rating of an IVIS. This allowed derivation of operator load measure of driver distractibility for each IVIS and task, across touchscreen, centre stack and voice recognition. It was consistently observed that lower operator loads relied on voice recognition systems, thus greater availability of these systems may help to decrease distraction and thereby improve road safety.

Key Takeaways

While the results of the on-road and stationary testing have developed higher fidelity measures of distraction, we intended to develop an end-user tool that would be suitable for wider uptake. Drawing heavily on the Phase 1 and Phase 2 data, we have established a cross-model prediction of distraction based on the number of interactions with the IVIS and the system's inherent level of distractibility. Our mixed-effects model analyses showed that each IVIS interaction produces a predictable, monotonic increase in visual demand and cognitive workload, providing a statistically defined cost that applies across vehicles, tasks, and participants. The intention is to then develop a framework that parallels common categorial structures used in vehicle safety assessments, that is anchored in the modelled relationship.

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