A Human Machine Interface for the Ipswich Connected Vehicle Pilot

Ronald Schroeter[a], Andy Bond[b], Katharine Mosley[c], Michael Pascale[a]

[a]Centre for Accident Research & Road Safety - Qld (CARRS-Q), Queensland University of Technology,
[b]Queensland University of Technology, [c]Queensland Department of Transport and Main Roads

Abstract

The Queensland Department of Transport and Main Roads (TMR) with support from Queensland University of Technology (QUT) and iMOVE Cooperative Research Centre is undertaking a pilot of Cooperative Intelligent Transport System (C-ITS) technologies (the Ipswich Connected Vehicle Pilot). The pilot comprises a field operational test involving 500 public participants with C-ITS technologies retrofitted to their vehicles. A human-machine interface (HMI) will provide the driver with advisory information and warnings relating to eight C-ITS safety use-cases. This extended abstract describes the design of the HMI based on pilot needs and relevant human factors guidelines and standards.

Background

A core objective of TMR's Ipswich Connected Vehicle Pilot is to validate the safety benefits of C-ITS. C-ITS enables vehicles to 'talk' to other connected vehicles, roadside infrastructure and traffic management centre systems to share relevant, advisory safety-related warnings (use-cases) for drivers (e.g. hazard ahead). Those warnings are conveyed to the driver through a human-machine interface (HMI), a small screen mounted on the vehicle dashboard.

A Safe System

The key underlying principle in the design of HMI warnings is the safe operation of individuals' vehicles. The goal of these warnings is to alert the driver to potentially unsafe conditions well in advance, without distracting them from the driving task manually or visually.

To address manual distraction, no physical interaction with the HMI is required while the car is in motion. Functions that require input, such as participant selection (Figure 1), can only be completed between "ignition on" and the vehicle moving.

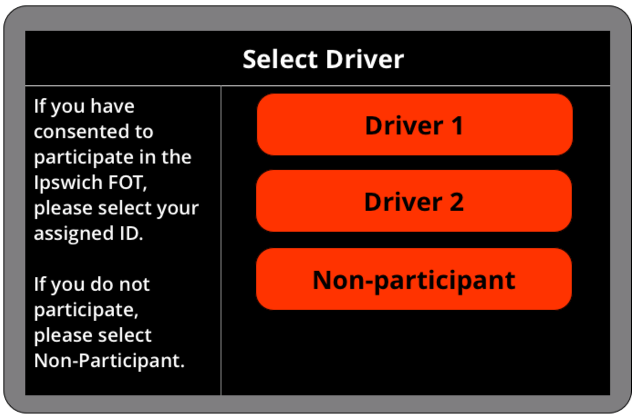

Figure 1. Example participant selection screen. Required for the safety analysis.

To minimise visual distraction and off-road glances, the screen is dash-mounted within 15 degrees of the forward field of view (J. L. Campbell et al., 2016, December), and follows simple, minimalist and consistent design principles for all use-case warnings, as described below.

Warning escalation framework

Warnings are only given if drivers are at a safety risk based on their current speed as they approach a hazardous situation. Risk is assessed using variables in the C-ITS data (e.g. current speed, distance to/ target speed at the hazard, safe braking deceleration).

Three urgency levels (low- 10 to 20 seconds, medium- three to 10 seconds, and high- less than three seconds) have been selected based on existing guidelines (ITC, 2011; SAE, 2002). Urgency is calculated using the driver's "Time to Action", or the time it will take to initiate safe deceleration to a target speed. This calculation follows a simple, deterministic, and consistent algorithm that also considers warning priority, based on criticality from a road-safety perspective (ISO, 2004).

Images and audio

The HMI warnings comprise of a combination of visual (dominant colours and large symbols for rapid processing (Ells & Dewar, 1979)) and audio (for high-level only (Campbell et al., 2007)) to strike a balance between nuisance-alerting and consistently/continuously providing information. Intuitive stimuli for the escalation framework (shape and colour, Figure 2) and use-cases (icons and labels, Figure 3) were generated based on a sample of representative participants' (n=50) responses to a brief survey.

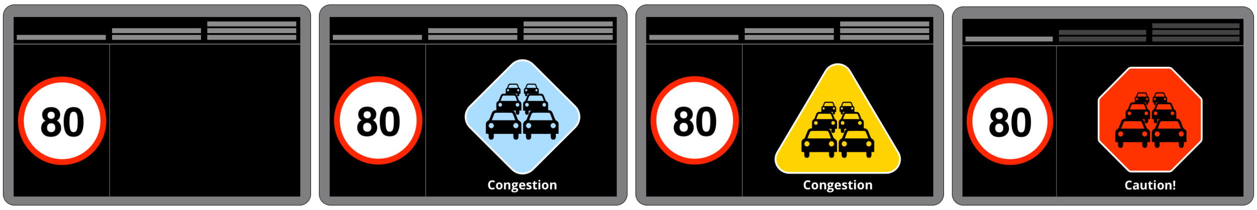

Figure 2. Example escalation of the "Congestion" warning. From left to right: no warning (blank), low-level warning (blue diamond), medium-level warning (yellow triangle) and high-level warning (red octagon).

Figure 3. Medium-level use-case icons and labels that were favoured by survey participants.

Conclusion

The ICVP HMI has been designed in accordance with best practice human factors and safety principles. Usability testing will be conducted to confirm the HMI, once developed, works as intended in real-world conditions.

References

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