Research

Report Summary

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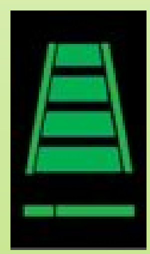
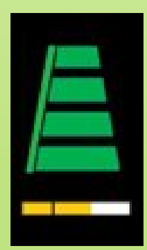
[11/19/2019]

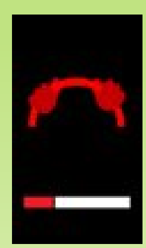
Using Human-Machine Interfaces to Convey Feedback in Automated Vehicles

The goal of this project was to understand the effectiveness of communicating automation capability to the driver of a conditionally automated vehicle. As vehicles become increasingly automated, drivers are tasked with the unfamiliar role of supervision while behind the wheel. However, an effective human-machine interface (HMI) can aid in the communication between the automation and the driver, allowing the driver to appropriately allocate attention where and when it is needed.

Research has found that providing (un)certainty information regarding the status of the automation can allow the driver to be more aware and better prepared to take over in the case of an automation failure (Parasuraman, 2010). The present work evaluated the impact of providing confidence information on subsequent takeover performance and overall trust and acceptance in using the technology.







Three different forms of feedback were compared: discrete, continuous visual, and continuous visual/auditory. Throughout the 40-minute drive, participants engaged the autodrive component of the vehicle, combining adaptive cruise control and lane centering technologies; additionally, while engaged in autodrive, participants were instructed to play trivia on a tablet to their right. All 60 participants experienced six automation failure events, imitating a failure of the lane centering system by gradually drifting onto the shoulder. The event, along with the specified HMI per condition, is detailed in Figure 1. The discrete condition served as the baseline, while the two continuous conditions received varying feedback regarding the automation's confidence.

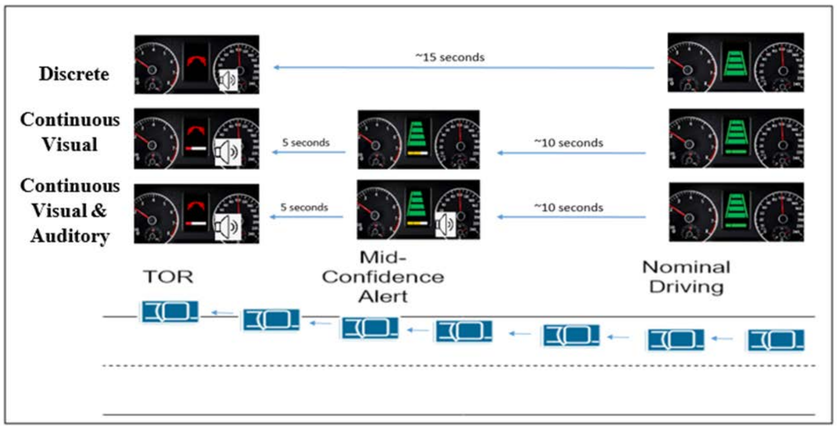


Figure 1. Automation failure event, from right to left, along with respective HMI display per condition

Results showed a clear advantage to the continuous groups, specifically for the visual/auditory condition. Look-up times, defined as the time between the takeover request (TOR) and the first glance forward, were significantly quicker for both continuous conditions than for the discrete condition (Figure 2a). Additionally, the location of the first glance following the TOR was coded using video data (Figure 2b). Looking down indicates the driver was looking at the trivia screen at the time of the TOR; looking up indicates the driver was looking somewhere other than at the trivia screen; takeover before TOR indicates the driver was aware of the automation failure and was able to take back manual control before receiving a TOR. Again, these results show a significant difference in preparing for an automation failure between conditions

a)

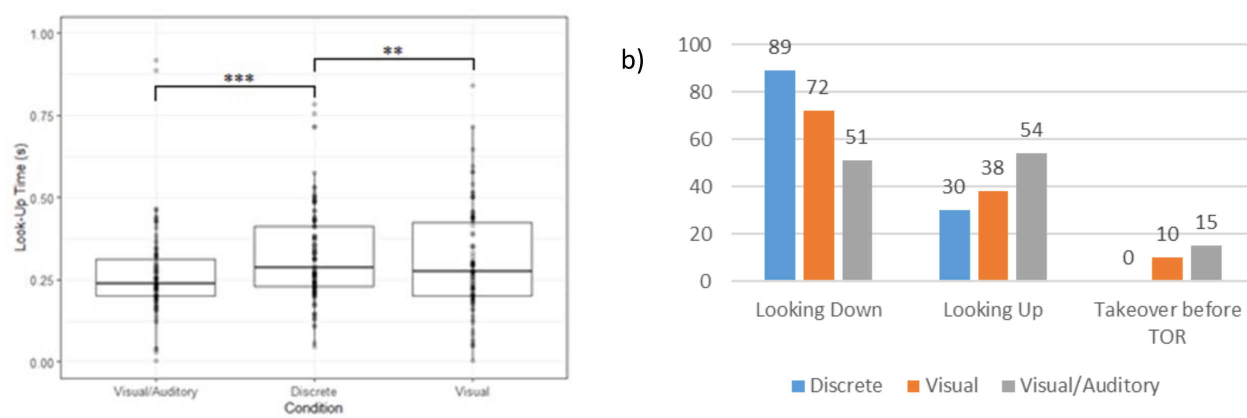


Figure 2. (a) Boxplot showing the significant difference in look-up times across conditions; (b) chart showing difference in initial eye position at the time of TOR

Reference

Parasuraman, R., & Manzey, D. H. (2010). Complacency and bias in human use of automation: an attentional integration. *Human Factors, 52*(3), 381–410. https://doi.org/10.1177/0018720810376055

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