Research Report Summary

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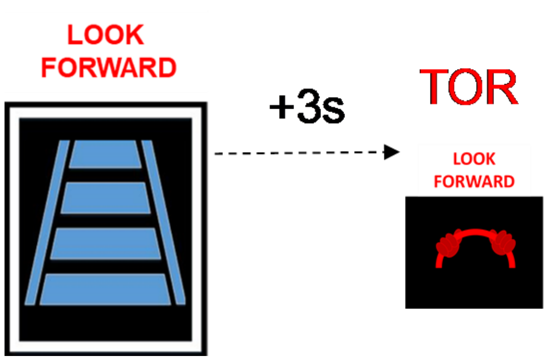
Using Driver State in Automated Vehicles

The goal of this project was to understand how driver state monitoring could be used in a Level 3 partially automated vehicle. As vehicle automation assumes more and more of the dynamic driving task, drivers may have the opportunity to disengage from manual driving for longer periods of time. However, because drivers are still expected to be the fallback during automation failures or transfer of control requests, they must remain aware of the driving task and ready to take back control. That is, they must have high situational awareness, despite not actively controlling the vehicle.

Driver monitoring technology can be used to identify the driver's state and provide input to interfaces to modify driver behavior. Here, we used a



State contingent takeover request

Driver monitoring system and attentional maintenance alerts

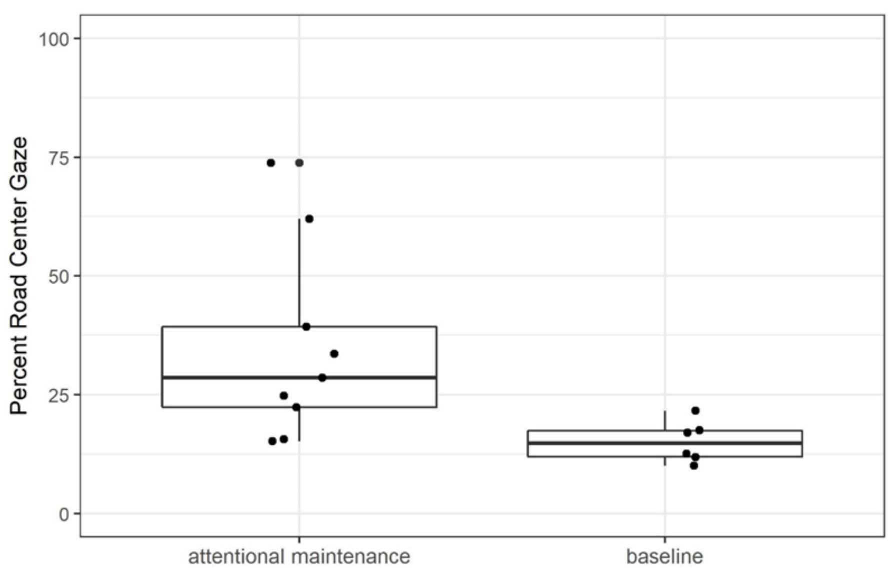
production driver monitoring system from Aisin in two ways.

> *"Providing attentional feedback, based on driver monitoring, can keep drivers in the loop and more aware of the driving environment during automated driving."*

We compared two methods of using driver monitoring data in the context of automation. One approach, ***attentional maintenance alerts*****,** provided warnings to drivers when they had been looking away from the road for 30 seconds. The other method, ***state-contingent takeover requests,*** provided an earlier look forward message during takeover when drivers were distracted.

We compared these driver monitoring conditions against those of a baseline group, who received no attentional maintenance reminders and takeover alerts that did not vary based on driver state. We evaluated situation awareness with the SAGAT method (Endsley, 1988) by blanking the simulation and asking about the location of surrounding traffic. Drivers also encountered four takeover events where the automation requested the driver retake control during a sudden dropout and before a work zone.

Compared to the baseline condition, the attentional maintenance alerts improved situation awareness and driver response to unexpected automation dropouts. Drivers in the attentional maintenance group had higher accuracy on the SAGAT freeze probe and higher percent road center gaze, indicating enhanced situation awareness relative to the baseline group. Importantly, drivers in the attentional maintenance group also had faster steering response times and lower maximum lane deviation compared to the baseline group, indicating a performance benefit of keeping drivers in the loop during periods of automated driving.



State-contingent takeover requests, on the other hand, showed mixed effectiveness during the takeover situations compared to the baseline group. Drivers in the state-contingent group returned their hands to the steering wheel slightly faster than baseline drivers.

Overall, these results indicate that driver monitoring, particularly in the form of attentional maintenance that continuously provides feedback on driver state, can keep drivers engaged in the driving task during periods of automated driving and help drivers respond faster during takeover situations.

Reference

Endsley, M. R. (2000). Direct measurement of situation awareness: Validity and use of SAGAT. In M. R. Endsley & D. J. Garland (Eds.), *Situation awareness analysis and measurement.* Mahwah, NJ: Lawrence Erlbaum Associates.

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