The Impact of Takeover Stress on Driver Responses and the Role of Information Provision: A Driving Simulator Study.

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Abstract

This study focuses on understanding the driver's experience and needs during takeovers from automated systems. We aim to assess how information deficiencies impact performance and if takeover pressures lead to more errors. Using methods like observations, surveys, and simulators, the data will shed light on drivers' cognitive responses and the significance of timely information. Insights will guide enhancements in human–machine interfaces, promoting clearer alerts and displays. Ultimately, we aim to boost safety and optimize the interaction between drivers and automated driving systems.

Introduction & Blackground

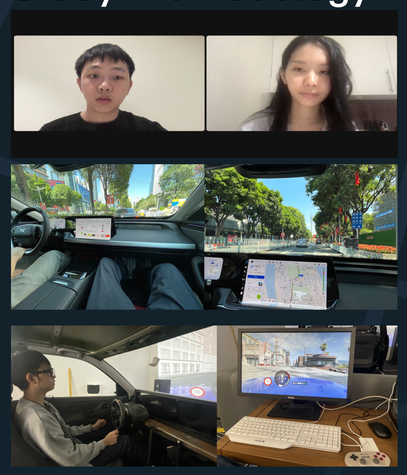
The handover process from automated driving systems to human drivers is vital, particularly during takeover requests. A central concern is how the vehicle provides information when signaling the driver to resume control. While automated driving technology has progressed, recent events highlight challenges in information clarity during these takeover moments. Although much research exists on human–machine interactions in automated vehicles, the specific study of information during takeover requests remains underexplored. Addressing this gap can improve both safety and trust in automated driving.

Design Concept

The information needed by the driver is to know in advance the driving dynamics of the self–driving vehicle and thus to react in advance to the takeover demand. And to provide as little unnecessary information as possible for excessive interference.

The main information in the interface is: route guidance / speed / level of concentration required / possible obstacles to be approached

Study Methodology



Literature review

Interviews

Field observation

Conceptual design

Comparative test

Testing & Evaluation

By comparing the driver's brainwave changes with eye–tracking tests during automated driving in six different working conditions, the results confirm the positive effects of the design in driving scenarios, improving attention and cognitive load distribution. Stable brainwave patterns under various road conditions proved the success of the message delivery. Overall, the design improved attention, cognitive load and driving experience, validating its effectiveness and potential for safer takeover.

BEFORT

AFTER

Research Results

Analyzing the research findings involved a comprehensive evaluation of data obtained through EEG brainwave and eye–tracking tests conducted during various driving scenarios. The brainwave patterns were analyzed to gauge attention focus and cognitive load distribution, while the eye–tracking data provided insights into visual attention patterns. This combined analysis allowed us to assess the impact of the information interaction design on driver responses and takeover processes across different road types.

Conclusions

Stress Impact on Driver Responses: High stress led to longer response times and lower quality, highlighting its negative effect on takeover performance, potentially causing delays and poor decisions.
Significance of Information: Clear, timely data provision in high–stress scenarios is crucial. Effective presentation reduces stress, improves responses, and boosts trust and takeover success.
Information Presentation Modes: Different delivery modes (visual, auditory, haptic) influenced response times and quality. Optimized methods cut response times and enhance takeovers.
Individual Differences: Drivers' diverse reactions underline the need for tailored strategies, considering cognitive and emotional variations.
Takeover Training Importance: Training aids drivers in takeover adaptation, stress reduction, and better performance.

Future Work

Advanced Interaction: Future studies could explore innovative ways of presenting information, such as augmented reality displays, to alleviate takeover stress and enhance driver responses.
Personalized Strategies: Tailoring information delivery based on individual traits could optimize takeover experiences.
Real–time Monitoring: Integrating stress assessment tools could enable systems to adjust information delivery according to driver stress levels.
Training Enhancement: More comprehensive driver training modules could better prepare drivers for takeover situations.
Ethical and Psychological Aspects: Research could investigate ethical decision–making by automated systems and the psychological impact of control handovers.
Long–term User Experience: Exploring extended user experiences and acceptance of automated systems could provide insights into their effectiveness and impact.