HoliDes

HOLISTIC HUMAN FACTORS AND SYSTEM DESIGN
OF ADAPTIVE COOPERATIVE HUMAN-MACHINE SYSTEMS

OVERTAKING

ARTEMIS

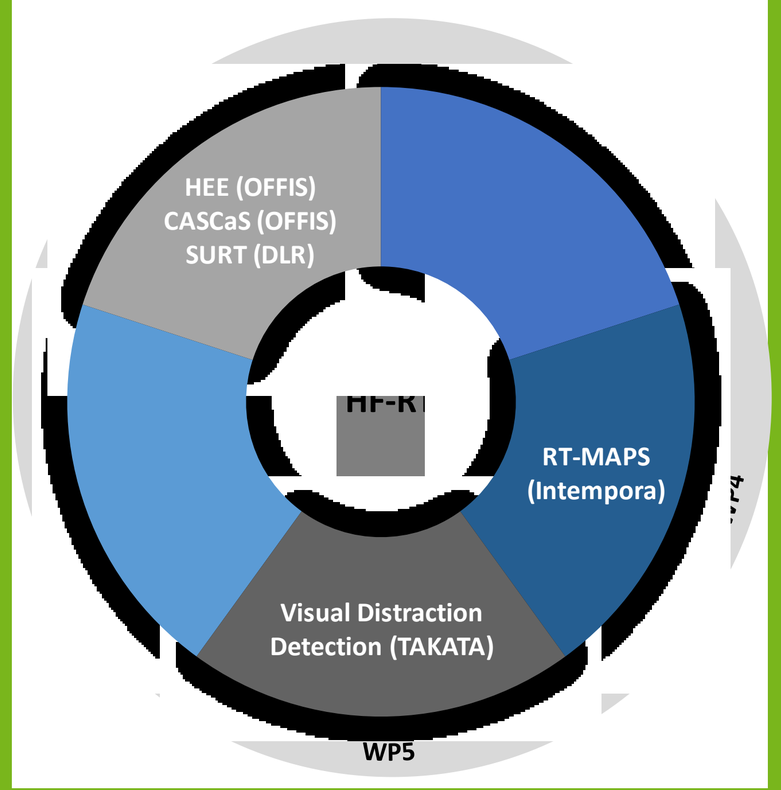
Domain

Motivation

The adaptivity of the HMI Adaptive-Cooperative-System (HMI-AdCoS) is based on situational demand and driver distraction. This selection reflects its relevance both for safety and for automation: while it is one of the most relevant accident causation factors in manual driving (Regan et al., 2013) engaging in non-driving related tasks is the major benefit when driving in automatic mode. In the latter case, detecting phases of non-driving related activities is crucial to adapt the start-time of warnings and information.

The TAKATA AdCoS consists of the situation classification, visual distraction detection and the HMI through which the adaptation is implemented. The HMI comprises the instrument cluster and a generic entertainment system on which a secondary task is presented.

Applied MTTs



Current State: Tailored HF-RTP

To model the adaptivity of the AdCoS, which is based on situation demand and distraction, both factors have to be assessed reliably and must be made available to a higher order instance that decides on the level of automation or support and warnings via the Human Machine Interface (HMI). To do so, several Methods, Tools and Techniques (MTTs) from the Human-Factors Reference Technology Platform (HF-RTP) were selected and adapted to the needs of the adaptive HMI AdCoS: RT-MAPS is used to model the entire system and to integrate the different data-sources. A secondary task (the SUrrogate Reference Task, SURT) is used to implement visual distraction and Visual Distraction Detection is used to assess the level of visual distraction based on gaze behaviour.

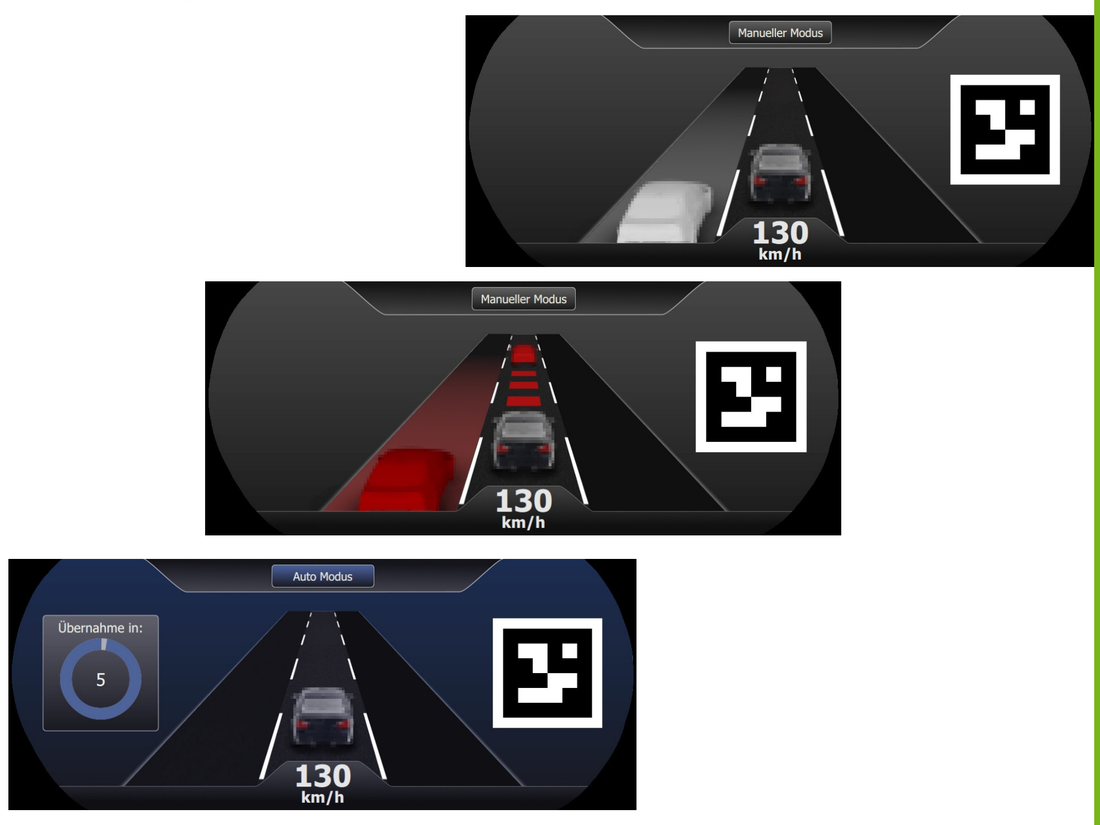


Figure 1: different views of the instrument cluster.

Additional MTTs were selected and applied in preliminary versions to ease the pre-evaluation of future HMI designs. Such is the case with the Human Efficiency Evaluator (HEE) that makes use of CASCaS (Cognitive Architecture for Safety Critical Task Simulation) and CASCaS itself. Visual distraction is induced via the SUrrogate Reference Task (SURT).

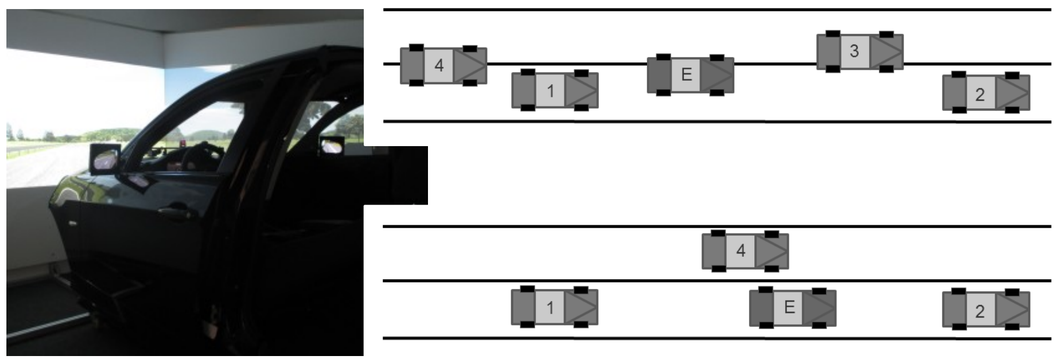


Figure 2: simulator setting and experimental scenarios.

Depending on the experimental condition, adaptivity is implemented to deactivate the source of distraction or to activate automated driving. The entire AdCoS is integrated into the TAKATA driving simulator and is evaluated in predefined overtaking scenarios.

Results

During HoliDes, two versions of the adaptive HMI AdCoS were tested in separate evaluation studies.

For both AdCoS generations the results were positive regarding the AdCoS and its functionality. However, for the first generation AdCoS no positive behavioural effects of the adaptivity were found. A post-hoc analysis of gaze data revealed the reason: drivers stopped engaging in the SURT before the AdCoS could show its positive effects.

Based on this experience several changes were implemented in the second generation AdCoS. First of all, the SURT was presented continuously to increase visual distraction. Further, the Visual Distraction Detection developed by TAKATA was implemented. In addition, physiological data was assessed with TAKATA's Vital Sign Steering Wheel (VSStW) and an additional standard device. Finally, the experiment itself was adjusted, amongst others to include cognitive distraction conditions.

The data of the second experiment confirmed the general functionality of the AdCoS and the Visual Distraction Detection. Although the behavioural effects were not statistically significant a positive tendency for adaptation was found. Moreover a significant positive effect of workload was found for the adaptive condition.

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