

Learning to drive with Advanced Driver Assistance Systems. Empirical studies of an online tutor and a personalised warning display on the effects of learnability and the acquisition of skill

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Beside all the technical challenges concerning sensor quality and control algorithms one of the main issues related to the introduction of advanced driver assistance systems (ADAS) constitutes the human-machine interaction. This covers not only the physical interface between the driver and the system but also the understanding and cognitive model the driver needs to operate the system. The explorative analysis of a long-term field study of the use of ACC, was aimed at identifying characteristics of the learning process and their potential implications for conceptualising novel displays to increase, particularly in the early phases, usability and safety of the system through the adaptation of information to the drivers. The analysis of the learning aspects derived from drivers' interaction with the system enabled the identification of learning aims for the usage of an ACC system and an objective classification of observable behaviours from which different levels of skill can be interpreted. It was concluded that by responding to the difficulties met by users in the actual situation and by adapting the information to the drivers' experience, drivers' learning progress could be accelerated through better comprehensibility and predictability of the system. To this aim, two innovative help-systems were conceived, implemented and evaluated in terms of drivers driving behaviour and interactions with the ACC system, in the BMW fixed-base driving simulator. A learn-adaptive, multi-modal, on-line tutor system that covered interactions with the system at every level of the driving task (Reichart, 2001) for which learning must be effectuated, was tested with 11 participants. A personalised learning model of the driver was used to relate the drivers' prior usage of the system and his situational experience, to give the driver additional advice and explanation in order to shorten the learning period. A main effect was found between the experimental groups' understanding of the system and in participants' ability to predict when to reclaim control of the system, as measured by the reduction in unnecessary interventions and reduced number of panic reactions. The use of cognitive apprenticeship methods (Cognition and Technology Group at Vanderbilt, 1993) on an online adaptation of feedback showed a positive influence on the learning process, increasing the speed of the learning process towards the acquisition of skill. The second experiment's objective was to develop an interface that most effectively helped drivers learn to predict the need to reclaim control and the appropriate sensitivity of response in take-over situations. Drivers interactions with a didactic, two-step warning display, based on a time algorithm that was personalised to drivers maximum preferred deceleration level, was tested with 24 participants. Display effects were observed in time-to-collision, reaction times, the number of false alarms (unnecessary driver interventions) and misses (collision or near collisions). Significant differences were also found in distance error, adequate deceleration rates, panic braking and reaction times on the peripheral detection task. These results were also largely supported by the subjective measures. The proposed concepts have shown methods of reducing the ADAS learning phase and accelerating drivers behaviour to a skill level. The theoretical and empirical work described in this thesis plays an important role in deriving recommendations for systems that reduce the amount of learning demand on the driver and eliminates learnability issues that can lead to safety-critical traffic situations.