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HMI concept of ACSF - background knowledge from research

The development of automatically commanded steering functions (ACSF) presents different challenges for HMI design in vehicles. In comparison to manual steering or to some established low-functional driver assistant systems, the main focus lies on action by the human driver who is - with regard to the steering task - only sitting in the vehicle (not steering). As mentioned in many research papers (e.g. Bengler & Flemisch, 2011) as well as in Gasser et al. (2012), the driving task changes increasingly from a controlling and regulating procedure to a monitoring procedure. This requires an increase in human cognitive workload (Endsley & Kiris, 1995) and permanent attention (vigilance) because of potential transitory demands. Regarding this vigilance, the HMI design has to tackle the crucial challenge of maintaining human attention (see Parasuraman, Mouloua & Molloy, 1996; Muhrer & Vollrath, 2011; Vollrath, Schleicher & Gelau, 2011; Neubauer, Matthews, Langheim & Saxby, 2012).

Especially for automated steering systems, it is necessary to follow basic aspects of human sensation and perception in the automotive context, as well as to verify the transferability of well-known HMI design principles of driving assistant systems (ESoP, 2006; DIN EN ISO 9241-110). Specifically, aspects like compatibility, consistency, configuration in space, balance between mental underload and mental overload, comfort and a holistic view of the HMI have been proven to be effective (see Bruder & Didier, 2015). One of the most important issues is explicit information about the system mode to prevent mode-confusion (Bengler & Flemisch, 2011).

In general, the HMI must be able to get the driver safely back into the loop again and provide him with adequate situational awareness (Merat & Jamson, 2009; Vollrath & Krems, 2011) after he has merely monitored the driving procedure. Buld and Krüger (2003) as well as Muhrer and Vollrath (2011) report higher collision rates in a monitoring driving task compared to manual driving. Furthermore, people often do not detect system errors when driving just by monitoring (Niederée & Vollrath, 2009). At

last, drivers' reaction times (in this case speed reduction) are much longer in a monitoring driving task and differ in about five seconds to manual driving (Vollrath et al., 2011).

Current research indicates that warnings have a positive effect (Merat & Jamson, 2009; Dogan, Deborne, Delhomme, Kemeny & Jonville, 2014), because they reduce drivers' reaction times compared to situations without a warning (Fricke & De Flippis, 2008; Lee, McGehee, Brown & Reyes, 2002; Flemisch et al., 2011). By using a combination of visual and acoustic warnings instead of only visual Naujoks, Mai and Neukum (2014) achieved better driver reaction in transitory situations. Therefore it is important to create redundancies between all warning options (visual, acoustical and tactile) in line with Wickens' Multiple Resource Theory (Wickens, 2008). Comparing hands-on and hands-off driving in different automatic scenarios, first results (Gold, Lorenz, Damböck & Bengler, 2013) tend to indicate faster driver intervention with hands-on. It must be noted that all current results provide some indications for special driving and transitory situations in their respective testing scenario only: Many factors play an influencing and moderating role in finding a universal solution for HMI design for automated driving. Apart from the driver's condition the driving situation is another important factor, as Kleen and Vollrath (2012) have shown. Moreover, it is necessary to consider people's experience with established driver assistant systems (Weinberger, Winner & Bubb, 2001) when thinking about HMI design of automated steering systems, because learning of the system functions and its limits may take place (Strand, Nilsson, Karlsson & Nilsson, 2014).

In general – considering current research – there are merely some indications and tendencies for HMI design for ACSF with limitations of transferability and validity, involving driving simulation. Most questions and problems with regard to the HMI for automated driving tasks have still to be answered and solved in further research in national as well as in international projects.

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