

Cultural Adaptive Human Machine Interaction in Driver Information and -Assistance Systems

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Abstract

Adapting to the cultural differences in Human Machine Interaction (HMI) needs first to find out the cultural differences in HMI. Reduction of mental workload of the driver in dangerous traffic situation requires adaptive systems. Furthermore, the functional and informational complexity of driver information and -assistance systems today can not longer be handled only by the driver alone without employing adaptability. Cultural adaptive systems automatically adapt the HMI to the needs of user groups, exposing a certain HMI behavior that depends on the cultural background. Careful design using methods of intercultural usability engineering can help to overcome the problems arising by adaptability.

1 Cultural Differences in User Interfaces

Culture influences the interaction of the user with a computer system or a machine because of the movement of the user in a cultural surrounding (Röse 2002). To be able to design user interfaces for the global market that can adapt to the cultural needs of the user automatically, the first step is to find out the differences in the cultural needs of the users and hence the cultural differences in HMI on all levels of HMI localization (surface, functionality, and interaction) (Röse et. al 2001). Areas like presentation of information and language or dialog design as well as interaction design are concerned (Vöhringer et al. 2006). One promising method to accomplish this task is to observe and analyze the interaction behavior of users, from different cultures, with the system by an appropriate automated analysis tool to determine different interaction patterns according to the cultural background of the users (Heimgärtner 2005). A study using this tool revealed different interaction patterns according to the cultural background of the users regarding e.g. design (ample vs. simple), information density (high vs. low), menu structure (high breath vs. high depth), personalization (high vs. low), language (symbols vs. characters) and interaction devices (Heimgärtner 2007). From this,

cross-cultural usability metrics can be derived, which can be used for the design of cultural adaptive HMI.

2 Cultural Adaptive Driver Information and -Assistance Systems

The mental workload of the driver has to be as low as possible for the sake of preventing accidents in traffic. But today, driver information and -assistance systems are very complex both in functionality and in usage and therefore tend to need much mental power of the driver. Hence, when the driver is in danger to be mentally overloaded the characteristics of the interaction between the system and the driver must be adapted automatically to reduce mental workload and to prevent mental *overload* (Piechulla et. al. 2003). Therefore, it is necessary to make driver information and -assistance systems adaptive: in dangerous traffic situations the driver does not have enough time to change settings for HMI manually (e.g. blocking a phone call when turning left in right hand traffic). There are some target user groups of drivers which have their own characteristics of using driver information or -assistance systems in vehicles depending on their preferences (e.g. driving beginners vs. experienced drivers, old vs. young people, female vs. male users) that are imprinted by their primary culture (Honold 2000). The meaning of the conception of „culture“ as ethnical determined must be extended to „individual culture“ of the driver (e.g. driving, communicating, using the user interface etc.). If a driver information or -assistance system knows the culturally imprinted preferences of the user, it can adapt its behavior to the expectations of the user to reduce mental workload, to prevent mental distress and to increase driving security as well as joy of use and comfort.

3 Discussion: Scope and Problems of Cultural Adaptability

Cultural adaptability does not only concern the look and feel of the user interface, but also the interaction devices as well as the number and the kind of system functions (Röse et al. 2001) that can be changed dynamically according to driver preferences, driver situation and driving situation (Heimgärtner & Holzinger 2005). Many questions arise: How many dynamic changes are optimal for and will be accepted by the user? When does a „hidden“ adaptation occur? How can this be prevented? How much does the user trust the adaptive system? Adaptability may not surprise the user but must be in accordance with the mental model of the user (Kobsa 1990). Additionally there are culture dependent questions which have to be answered. E.g.: What cultural aspects must be adapted? Which of them can be adapted automatically?

4 Conclusion

Cultural adaptability in driver information and assistance systems is necessary: the functional and informational complexity of infotainment systems today can not longer be handled only by the driver alone without employing adaptability. There are many different groups of drivers, which exhibit their own „culture“ whether regarding groups at international level (e.g. countries) or within the national level (e.g. social, ethnic, or driver groups). Enhanced algorithms are needed to enable the system to automatically and correctly adapt itself to the cultural imprinted needs of the user to bring the mental model of the system in accordance with the driver's mental model. The reduction of the mental workload by recognizing and knowing the cultural expectances of the user by the system supports system usability and driving security.

5 Outlook

The near-term objective is to enhance the tool for „cross-cultural human computer interaction analysis“ by applying enhanced techniques using statistical and data mining methods and semantic processing to extract cultural variables and its values as well as guidelines for cross-cultural HMI design in a more automatic way. The mid-term objective is to analyze and evaluate the test data in more detail to generate several algorithms for adaptability based on neural networks as well as structured equal models to prove basic theoretical cultural interaction models. The best discriminating algorithms for adaptability will be transformed and implemented into driver information systems to be evaluated qualitatively using intercultural usability tests with users of different culture and under mental stress. These studies must also reveal the acceptance of cultural adaptability by the user as well as the degree of the reduction of the driver's mental workload using cultural adaptability.

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