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User experience of driver assistance systems

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Abstract

A positive user experience has become an important goal for interactive system design. The aim of this paper is to discuss the usefulness of the user experience concept for the domain of automotive UIs. An integrative approach to user experience of interactive systems will be presented. The application of the approach to the domain of automotive UIs is illustrated and discussed using a first example.

1 Introduction

The primary design goal for driver assistance and information systems is to increase or – in e.g. the case of entertainment systems – at least to maintain the level of safety. Design for usability is a sensible approach to achieve an increase or maintenance of the safety level when developing driver assistance systems (Landau 2002). Recommendations to utilize approaches to usability from other domains in the area of automotive UIs have already been made (e.g. Pataki et. al. 2005). Furthermore, formal approaches that use model-based simulations to evaluate the interaction between driver and interactive system have been proposed (e.g. Pettitt et. al. 2007).

In other areas of interactive system, design for usability has been broadened by design for a positive user experience. User experience design takes a user-oriented view on product quality and tries to consider all aspects of the interaction that are relevant from the user's perspective. Hassenzahl & Tractinsky (2006) discuss for example non-instrumental qualities and emotions as two important areas for user experience research that go beyond the traditional focus on instrumental aspects like usability.

Non-instrumental qualities can be described as quality aspects that address user needs that go beyond tasks, goals and their efficient achievement. Jordan (2000) argued for a hierarchical organization of user needs and claimed that along with the functionality and usability of the product, different aspects of pleasure are important to enhance the user's interaction with it. Further analyses studied selected non-instrumental quality aspects of interactive systems in detail, such as visual aesthetics (Lavie & Tractinsky 2004) and hedonic quality (Hassenzahl

2001). Also, the term emotional design (Norman 2004) has received significant attention. For example, Desmet & Hekkert (2004) presented an explicit model of emotions according to product perceptions.

2 An integrative approach to user experience

In Mahlke & Thüring (2007), we describe an integrative user experience research framework. A model defines instrumental and non-instrumental quality perceptions as well as emotional reactions as three central components of the user experience. Characteristics of the interaction impact these three components. Interaction characteristics primarily depend on system properties, but also user characteristics and context parameters play an important role. The actual consequences of the user's experience of an interaction, meaning the overall judgments of a product, usage behavior or choices between alternative systems are defined as outcomes of the user experience (Thüring & Mahlke 2007).

As non-instrumental quality perceptions and emotional user reactions are relatively new topics, there are no established methods for measurement available as for usability research. In Mahlke (2006) various approaches to the study of non-instrumental quality aspects were reviewed. Summarizing, in most approaches two distinct categories of non-instrumental qualities are differentiated. On the one hand, aesthetic aspects are discussed. These refer primarily to the visual aspects of a product, but can also refer to other sensual experiences like the haptic or auditory aspects of product use. The other category refers to a symbolic dimension of product appearance. Symbolic aspects refer to an interactive product's meaning in the communication with others. Based on this differentiation, we integrated questionnaire scales on visual aesthetics, haptic quality, auditory quality, and symbolic qualities and applied them in a study on non-instrumental qualities of mobile phones (Mahlke et. al. submitted). The results suggest that both aesthetic and symbolic qualities are important for users' overall judgment and that a detailed view on specific sub-dimensions of non-instrumental qualities can contribute to a better understanding of the user experience.

Regarding emotional user reactions we applied a multi-component approach from emotion psychology to the area of human-technology interaction (Mahlke et. al. 2006). We conducted a study to compare and integrate different approaches to emotion measurement. Based on the multi-component approach to emotions different aspects of emotions in an interactive context were investigated: subjective feelings, physiological activation, motor expressions, cognitive appraisals, and behavioral tendencies. We used questionnaire methods to assess subjective feelings and cognitive appraisals, measured heart rate and dermal activity as physiological reactions, applied electromyography (EMG) to learn more about facial expressions and analyzed performance data to get an insight into behavioral tendencies. The results suggest that a combination of methods that assess different components of emotional reactions provide a comprehensive basis for analyzing emotions as a component of the user experience.

3 A first application of the user experience approach to the automotive domain

But how can these ideas be applied to the design of driver assistance systems? In an evaluation of different night vision enhancement systems, we applied usability and user experience measures (Mahlke et. al. 2007; Pataki et al. 2005). Usability measures focused on the effectiveness and efficiency of the interaction. They addressed the question of how good the different systems support the detection and recognition of objects during nighttime driving. The number of recognized objects, time to detect an object and distance to the object at the time of object detection served as measures for effectiveness. Efficiency was related to subjective measures of workload and the amount of time attention was drawn towards the system based on eye tracking data. User experience measures captured the users' perspective on the quality of the systems. They focused on instrumental and non-instrumental quality perceptions as well as overall judgments and rankings of the systems as consequences of the user experience. Perceived usefulness and ease of use were measured as instrumental qualities (Davis 1989). Visual attractiveness (v.d.Heijden 2003) and hedonic quality (Hassenzahl 2001) were assessed to capture users' perception of non-instrumental qualities. The measurement of information about users' emotional state (e.g. satisfaction, frustration, joy) was not incorporated in this study.

The results demonstrated that usability and user experience measures resulted in different ranking orders of the systems. Instrumental quality perceptions by the users were not always correlated to the measured performance with the systems. Furthermore, non-instrumental qualities were able to outweighed deficits of some systems regarding performance measures and perceived instrumental qualities. Although interaction with some systems was more effective and efficient, the overall judgment of these system was worse in comparison to other systems that were rated better regarding visual aesthetics and hedonic quality. This example demonstrates that applying a user experience evaluation approach can also help to better understand the user-oriented view on system quality in the automotive domain.

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