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Electric Vehicle Information Systems (EVIS): Challenges and Chances of E-Mobility

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ABSTRACT

What would the interaction with an automotive user interface in an electric vehicle (EV) look like? In this workshop we will discuss how in-vehicle information systems (IVIS) and car interiors can be designed to meet challenges inherent in the development process of electric vehicles like e.g. range anxiety, energy recovery/recharging or automated driving. In accordance with the fundamental changes shown in today's EV concepts, we address the challenge of rethinking in-car interaction as well as interior design to overcome traditional implementation habits and see how EVs differ from contemporary cars. We want to open up the stage for new interaction techniques and flexible interior designs that embrace the future requirements of EVs.

Keywords

Electric Vehicles (EV), In-Vehicle Information Systems (IVIS), E-Mobility, Electric Vehicle Information Systems (EVIS), Workshop

1. INTRODUCTION

Much effort is put into the development of sustainable batteries for electric vehicles (EV), the conceptualization of electric motors and the development of a smart grid to provide a working infrastructure for an e-mobility future. Although the car as a design space has been identified in Human-Computer Interaction (HCI) [5], most researchers and professionals have mainly been focusing on state of art vehicles with combustion engines and do not address electric vehicles. Given the continuous progress in system development and infrastructure for EVs, one of the neglected issues appears to be that barriers of adoption in driving an EV persist. EVs differ in terms of how they are driven, how they sound or how they are refuelled. The mobility behaviour is further affected by the remaining vehicle range and the availability of charging stations.

We as researchers, designers and practitioners in this design space thus need to be sensitive to influencing factors such as acceptance, safety, distraction or anxiety that form barriers for driver adoption. Following a user-centred design process for an EV it is inevitable to consider user requirements and interaction concepts early and especially pay attention to the development of novel information systems. As information systems in electric vehicles (EVIS) are the connection between the user and the car, interfaces are the main channel to translate the characteristic of an EV. EVIS transport meanings and messages to both, the driver and the system itself and communicate the meaning and behaviour of certain functionalities that differ from what is already known about state of the art vehicles.

In a rising field of research and development like e-mobility, there is especially an opportunity to early transfer knowledge into the design process and to iteratively accompany the technology-centred development process. There are great possibilities and challenges for what interaction-driven approaches involving natural or multimodal user interfaces [2] can contribute towards reducing driver distraction [7], predicting driver behaviour [6] or assists in critical situations [8] to acquainting the future target group with new features and tools inside an EV. Additionally, there is also a chance to transfer already established energy-saving or energy-providing concepts [4] from other areas (e.g. households) into the automotive context.

One of the decisions made by original equipment manufacturers nowadays is to follow a conversion or purpose design approach. Conversion design is a possibility for manufactures to use what is already there and to fit what is new into a given structure. In the area of EVs this means that batteries, the electric motor and new in-vehicle information systems (IVIS) are integrated into a state of the art car with its existing electronics and systems designed for conventional powertrain. Purpose design on the other hand is aimed at creating and developing a whole new car in respect to the requirements of its electric parts. Regarding advantages and disadvantages of both approaches, it is intensively debated among designers and engineers in the automotive sector whether to design EV concepts in a traditional way or to risk an unconventional approach. Following a purpose design approach for EVIS would therefore mean to basically design their appearance and features according to a changing interior, to consider the EV properties in the interface design and create applications and interaction modalities to support the driver in handling the EV.

To overcome traditional implementation habits regarding modality placement, interface arrangement and design as known from state of the art conversion design approaches, it seems to be useful to take a closer look at the area of automotive purpose design approaches. We believe that this is a remarkable advantage for the development of novel information systems, but we also see that there will be a longer period of conversion design. The development cycles in the automotive sector are slow, as cars need to be designed and produced in a sustainable, cost-efficient way and also need to meet the market and legal requirements. It is therefore already predictable that there will be adapted car concepts in the future, which also require new information systems. In this workshop we will therefore address both, the target area of conversion design as well as purpose design.

We acknowledge that the spectrum of automotive user interface research is wide and broad, but referring to electric vehicles only little research has been conducted so far. Aso et al. [1] conducted early research concerning the process of designing an EV interface. They proposed a method that aimed at driving an electric car by using an electromyography (EMG) interface. The conducted study reports on the measurement of EMG signals from both hand palms and the neck using a simple electrode. The effective frequency band of the EMG signal was extracted and converted into binary signals to drive an electric car. As a result, they stated that the effective frequency band influences the operation feeling and riding comfort.

Dealing with plug-in hybrid electric vehicles, Gerding and colleagues [3] raised the question about how to coordinate EV charging in order to accommodate capacity constraints. They designed a novel online auction protocol, where vehicle owners use agents to bid for power and also indicate time windows in which a vehicle is available for charging. The mechanisms provide higher allocated efficiency and can sustain a substantially larger number of vehicles at the same per-owner fuel cost saving than a simple random scheme. Strömberg et al. [9] on the other hand focused already on a few of the issues regarding EV human-machine interaction. They evaluated two concepts for an EV instrument cluster to gain knowledge on which information is relevant to the driver and how information should be presented.

2. OBJECTIVES

It is the aim of this workshop to address the following goals:

- Identify properties of EVs that affect driving behaviour/needs for novel interface/interaction approaches.
- Transfer EV properties into design concepts that embrace areas like multimodality, natural user interfaces or interaction concepts.
- Consider a change in driving behaviour of the EV (e.g. acceleration, recuperation) as well as new concepts of e-mobility driving (e.g. mono driver cars, car sharing).
- Discuss user interface design issues for EV information systems.
- Address novel techniques of information representation that persuade, support or warn the driver related to EV-specific information and attributes.
- Discuss challenges associated with HCI and hardware/software development in the car.
- Identify key themes for developing a framework for user interfaces in EVs.
- Develop a network to discuss studies that aim for evaluation of e-mobility related issues.

3. AUDIENCE AND ORGANIZATION

We aim to address and gather both, academics and practitioners within the field of automotive research, design and engineering. The workshop is intended for: HCI researchers in general, who are interested specifically in the automotive context; experts from the field of human-computer interaction, computer science, social science and psychology, who are willing to identify challenges and goals for the specific characteristics of electric vehicles; automotive user interface designers and engineers from a scientific and from an industrial perspective; practitioners from OEMs, automotive industry suppliers and from other related field of industrial expertise, who want to explore the challenges of e-mobility.

The workshop's website provides information for participants as well as results and impressions from the workshop and can be reached via *evis.hciunit.org*. Further, the accepted position papers are made available on the website.

4. REFERENCES

[1] Aso, S., Sasaki, A., Hashimoto, H., and Ishii, C. Driving electric car by using emg interface. In IEEE Conference on Cybernetics and Intelligent Systems, 2006, pp. 1 –5.

[2] Siewiorek, D., Smailagic, A., and Hornyak, M. 2002. Multimodal Contextual Car-Driver Interface. In ICMI '02 (Washington, USA, 2002) IEEE Computer Society.

[3] Gerding, E. H., Robu, V., Stein, S., Parkes, D. C., Rogers, A., and Jennings, N. R. Online mechanism design for electric vehicle charging. In The 10th International Conference on Autonomous Agents and Multiagent Systems - Volume 2 AAMAS '11, (Richland, USA, 2011), pp. 811–818.

[4] Hiskens, I. A. What's smart about the smart grid? In DAC '10 (New York, USA, 2010), ACM, pp. 937–939.

[5] Kern, D. and Schmidt, A. (2009) Design space for driver-based automotive user interfaces, AUI'09, Essen, Germany.

[6] Krumm, J., Where will they turn: predicting turn proportions at intersections. *Personal Ubiquitous Computing,* 14, 7, 2010.

[7] Osswald, S., Meschtscherjakov, A., Wilfinger, D., and Tscheligi, M. Steering wheel-based interaction: Potential reductions in driver distraction. In AmI2011, Springer LNCS, 2011.

[8] Popiv, D., Rommerskirchen, C., Rakic, M., Duschl, M., and Bengler, K. (2010). Effects of assistance of anticipatory driving on driver's behaviour during deceleration situations. In: Human Centred Design of Intelligent Transport Systems (HUMANIST), Berlin, Germany, April 2010

[9] Strömberg, H., Andersson, P., Almgreen, S., Ericsson, J., Karlsson, M., and Nabo, A. Driver interfaces for electric vehicles. In *AUI'11* (Salzburg, Austria,