EVIS 2014: 3rd Workshop on Electric Vehicle Information Systems

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Abstract
The effort to push the electric vehicle development worldwide is continuously rising. Production sites for electric vehicle components are built, billions are invested to create new battery electric vehicle concepts (BEV) and new players are entering the market. The information systems of electric vehicles (EVIS) need to cope with a variety of new features that are related to changes of vehicle components and driving behavior, but also with changes and new systems that are silently introduced into the vehicles. Sustainability, mobility concepts and smart mobility are just a few points out of many that can be attributed to the "silent" category. With this workshop, we continue to bring together researchers, designers and practitioners to explore the related field and generate a state of the art perspective on EVIS.

ACM Classification Keywords
H.5.2 User Interfaces: Evaluation/methodology

INTRODUCTION
"Range does not matter! Or, does it?" With this phrase we started the introduction of our last EVIS workshop. An article in the New York Times about a test ride with a Tesla Model S Sedan led to a controversial discussion about range. The tester was not able to reach his destination, despite Tesla's promoted maximum range of 300 miles [3]. One year later, the performance version of the Tesla Model S with an 85kWh battery has a theoretical range of above 400 miles, and on the company homepage it is now possible to adjust the key

impact factors that influence the range of the car [17]. These factors are driving type, highway speed, outside temperature, wheel size, climate control and state of the windows, as open windows increase the drag. This demonstrates two things: On the one hand that the range of the vehicle was remarkably increased in a short period of time. Secondly, the aforementioned test driver was representative for the broad majority of people who never used an electric vehicle before. Despite the fact that it is possible to reduce the range of an internal combustion engine vehicle significantly based on the driving style, the influencing factors on the range of BEVs are manifold and not yet in the scope of the target group of drivers. In the following, we present the condensed topics of interest that go beyond the everyday discussion about a BEVs range.

TOPICS of INTEREST

During the first two EVIS workshops [7,11] we discussed specific topics around electric vehicles with participants representing car manufacturers, automotive research and the US Department for Transportation. The result was a list of emerging areas, which will serve as a trigger for profound discussion during this follow-up EVIS workshop. In the following point out the state of the art in these areas.

Sustainability

BEVs are clean, emit no direct carbon dioxide and drive at low noise levels. This does not only contribute to a healthy environment, but is also a relief for other traffic participants and residents living close to busy streets. This fact is at least one of the reasons, why customers choose to buy BEVs [18]. Additionally, the reduction of emissions in traffic can potentially boost the support of renewable energy sources, needed to produce and run BEVs in order to achieve environmentally friendly mobility concepts [13]. Furthermore, driving an energy efficient, clean and quiet car has a symbolic and social significance [4].

Driving Behavior

Due to the underlying technology, BEVs offer a new kind of driving experience. The weight of the batteries integrated below the seats cause a low center of gravity. Together with a strong acceleration, this allows for an agile driving behavior [2]. Another example is the one-pedal driving [2] concept. Regenerative breaking, i.e. charging the batteries while slowing down, causes a relatively strong speed reduction. In normal traffic, this effect can help to drive the BEV only by pressing and releasing the acceleration pedal.

Sound

BEVs drive more quietly compared to cars driven by a combustion engine, especially at low speeds up to 30 km/h, but also while accelerating. This can be a blessing for other traffic participants or residents living close to busy roads. On the other hand, the missing audible feedback can pose a problem for pedestrians or cyclists who rely on sound to estimate distances to cars. The US Department for Transportation demands minimum sound requirements for BEVs [18]. Simultaneously, drivers might be confused about the state of the electric drive (on or off) without audible and haptic feedback [15], opening up for interesting sound design opportunities.

Range Prediction

Especially inexperienced BEV drivers suffer from range anxiety [16]. This is due to an underdeveloped network of charging stations, a strong influence of e.g. temperature on the state of the batteries and the rather limited range of the car caused by the underlying

technology. In our former workshops, Lundström et al. [9] suggested to analyze the drivers' coping strategies and implemented apps to allow for a precise range prediction. Baldauf et al. [1] developed an application supporting drivers to find and reserve charging stations by offering an intelligent routing service.

Energy Management
In the case of a low state of charge and a greater distance to the next charging station, an intelligent energy management might be important. One approach is a special eco-mode [2] offered by car manufacturers to enable a more economic driving by limiting the car's performance and reducing the energy consumption of e.g. infotainment systems. On the other hand, Lundström et al. [9] suggested applications educating the driver about the energy consumptions of the BEV and the influence a change of the destinations has on the range of the car.

Mobility Concepts
BEVs will play an important role in future mobility concepts. Eventually, not every family will own one or more cars, whereas the significance of car sharing and public transport will rise. BEVs offer a clean and quiet technology, which is a major advantage especially in large cities. Schwab et al. [14] explored requirements for vehicles with the purpose of being shared between people in cities who may have different backgrounds and cultures. Specially designed interfaces paying attention to symbols, signals and colors are an approach to meet these issues.

Interior Design
Considering the interior of cars, BEVs offer new design opportunities. The electric drive enables the omission of several mechanical parts, leaving new room for designers and passengers. In the BMW i3 [2], the center console is missing, enabling a shared foot space for driver and co-driver, bringing both closer together. In their submission to a former EVIS workshop, Landau et al. [5] suggested the use of special materials representing the principles for which BEVs stand for, e.g. aluminum for 'clean' or artificial turf for 'sustainable'.

Needs of BEV Drivers
Due to the special characteristics of the new technology of their cars, BEV drivers have special needs differing from drivers of cars with combustion engines. Studies and evaluations with actual BEV drivers in their environments can help to understand these customer needs. Nilsson et al. [10] conducted such a field study focusing on the needs for information communication technology of drivers in order to ease BEV charging. Osswald et al. [12] and Schwab et al. [14] analyzed the population of Singapore before developing specific EVIS.

Interaction Techniques
New technology, new information interfaces and novel concepts for interior and exterior design for BEVs also raise the need for new interaction techniques. For instance, Loehmann [6] proposed the introduction of freehand gestures to control certain functions inside the car. This could allow for efficient driver-vehicle interaction and enable novel passenger-to-passenger experiences.

Multidisciplinary Development
Last but not least, we would like to discuss the involvement of different disciplines into the development of future EVIS. Interdisciplinary teams of designers, engineers, HMI experts, ethnologists, psychologists and software developers can enrich the design process and allow for interactive systems that

are conform to the needs of BEV drivers. Additionally, we bring together research, manufacturers and government officials to work on common visions for EVIS and electric mobility concepts.

Objectives and Expected Outcome

In the first EVIS workshop [11], we identified characteristic properties of BEVs, which have an influence on future interfaces and interactions (e.g. range and battery properties, safety of and trust in the new technology, user experience while interacting with EVIS, driving behavior of BEVs, etc.) In the second workshop [7], we extended the network of researchers, designers or practitioners. We invited participants to share their approaches to overcome the barriers that still keep the adoption of electric vehicles. With this third workshop, we want to broaden the scope regarding emerging topics that were discussed during the previous workshops and that are based on input from experts. These trends are e.g. smart mobility that deals with the vast amount of car/sensor data available nowadays. Further, the environmental impact of driving and the transparency for the driver needs to be analyzed. Especially in the context of electric vehicles different driving behavior methods are used to adapt the driving style to extend the range. But that a moderate driving style also reduces CO2 emissions is often not the primary mentioned effect. This interplay between a beneficial behavior and a secondary benefit might open up new ways of introducing gamification approaches in the context of electric vehicles.

The workshop will deal with but is not limited to the following questions:

- What are areas of interest that influence EVIS development besides the already identified needs to develop novel forms of interactions/UX?
- What are the key challenges for future EVIS development?
- How can the field of research on EVIS be defined?

Review Procedure and Publicizing

The submissions are going to be reviewed by at least two organizers and invited experts of the field of interest. A mix of industrial-related submissions and scientific contributions is favored, which will also be reflected within the expertise of the group of reviewers.

The organizers will commit to publicize their workshop. The call for participation for this workshop will be distributed via related mailing lists as well as specialized ones (e.g. CHI announcement list, AUI list, TUM and LMU list) and will be distributed at several HCI- and E-Mobility related research groups and companies. The website of the workshop (http://evis.medien.ifi.lmu.de/) will provide information about the workshop preparations, the CfP and links to related material, so that people interested can become familiar with the scope of the subject and the goals of the workshop. Accepted position papers and other pre-workshop materials will be made available on the website in time before the workshop. A short article presenting impressions, pictures and first results will be published on the website shortly after the workshop. To retain the outcome of the workshop in a meaningful way, an overall whitepaper presenting the research challenges of EVIS is envisaged to be published on the website as well. To frame the field of research towards EVIS we envisage further a special issue in a journal like IEEE Computer.

Organizers

Having consolidated experiences in hosting workshops, tutorials and conferences, the organizers will facilitate the discussion before, during and after the workshop.

Sebastian Osswald is a research associate and PhD candidate at the Institute of Automotive Technology at the Technische Universität München (TUM), Germany. He is focusing on improving driver-car interaction in BEVs by the means of a prototyping HMI tool chain, based on a mobile operating system. Sebastian investigates driver and passengers' experiences as well as automotive hardware boundaries to derive requirements for different levels of granularity in the prototyping process for automotive information systems. His work aims to narrow the gap between conceptual design and prototyping.

Sebastian Loehmann is a member of the HCI Group at the University of Munich (LMU), Germany as a PhD candidate and research associate. He was part of the interdisciplinary CAR@TUM User Experience cooperation of BMW AG, Technische Universität München (TUM) and the University of Munich (LMU), focusing on emotional aspects of e-mobility. Sebastian builds and formalizes experience prototypes for automotive applications and explores gestural interfaces in the car.

Ronald Schroeter completed his PhD at the Urban Informatics Research Lab in 2011. His research investigated forms of in-place digital augmentation, which refer to the ability to enhance the experiences of citizens in physical spaces through digital technologies that are directly accessible within that space. In particular, he developed mobile phone and public screen applications for public civic engagement of local citizens, in particular young citizens. He received the 2012 National iAwards Merit in Research & Development.

Anders Lundström is a research associate and PhD candidate at the Royal Institute of Technology in Stockholm, Sweden. He is also affiliated with the Mobile Life Center in Stockholm, Sweden. In his research Anders focuses on sense-making and interaction with abstract and intangible data and entities such as energy. He has worked on the design of visual representations for drivers of electric cars in order to aid drivers in understanding the underlying complexities and correlations between battery level, driving range, driving style and climate control. An overarching aim of this strand of work has been to challenge prevailing norms in the instrumentation of electric work by exploring this surprisingly unexplored design space within research.

Andreas Butz is professor for Computer Science and head of the HCI Group in the CS department at the University of Munich (LMU), Germany. His main research focus is on novel interaction techniques and concepts beyond the desktop. He currently advises five PhD students in the field of automotive interaction and particularly enjoys collaborations beyond the borders of his discipline. Andreas won the 2007 Alcatel Lucent research award for "technical communication". He is regularly involved in major conferences of the field (CHI, TEI, IUI, ISMAR, MobileHCI) as a co-organizer or senior PC member.

Markus Lienkamp is professor for Automotive Technology at the Technische Universität München (TUM), Germany and researches the area of electromobility with the objective of developing new vehicle concepts. He is Director of Research at TUM's Science Center for Electromobility and the CREATE project in Singapore. Before is professorship at TUM, Markus was the head of the "Electronics and Vehicle" research department in Volkswagen AG's Group Research division. One of his main priorities there was

developing vehicle concepts for electromobility. He is further a board member of the VDI Society for Automotive and Traffic Systems Technology.

References

1. Baldauf, M., Bessler, S. & Fröhlich, P. Prototyping a Mobile Routing Assistant for Optimizing Energy Scheduling and Charging of Electric Vehicles. In *Adj. Proc. AutoUI 2102*, 106-110.
2. BMW i Concept. http://www.bmw.com/com/en/insights/corporation/bmwi/concept.html. Last accessed June 12, 2014.
3. Broder, J. The New York Times: Stalled Out on Tesla's Electric Highway. Last accessed 13.06.2014 http://www.nytimes.com/2013/02/10/automobiles/stalled-on-the-ev-highway.html
4. Heffner, R. R., Kurani, K. S. & Turrentine, T. S. Symbolism in California's early market for hybrid electric vehicles. *Transportation Research Part D: Transport and Environment, 12*(6), 2007, 396-413.
5. Landau, M., Koerber, M. Loehmann, S. Towards a Multisensory Representation of Electromobility Characteristics. In *Adj. Proc. AutoUI 2013*, 17-20.
6. Loehmann, S. Sneaking Interaction Techniques into Electric Vehicles. In *Adj. Proc. AutoUI 2012*, 111-112.
7. Loehmann, S., Osswald, S., Gleyzes, D.,Bengler, K., Tscheligi, M. & Butz, A. EVIS 2013 - 2nd Workshop on Electric Vehicle Information Systems. In *Adj. Proc. AutoUI 2013*, 7-9.
8. Lundström, A. & Bogdan, C. COPE1 – Incorporating Coping Strategies into the Electric Vehicle Information System. In *Adj. Proc. AutoUI 2012*, 113-115.
9. Lundström, A. & Bogdan, C. Designing & Understanding the Impacts of Electric Vehicle Apps. In *Adj. Proc. AutoUI 2013*, 10-12.
10. Nielsson, M. & Habibovic, A. Identifying BEV drivers' needs for information communication technology to ease the BEV charging process. In *Adj. Proc. AutoUI 2013*, 13-16.
11. Osswald, S., Loehmann, S., Gleyzes, D., Butz, A., Bengler, K., and Tscheligi, M. Electric vehicle information systems: The challenges of e-mobility. In *Adj. Proc. AutoUI 2012*, 103-105.
12. Osswald, S., Zehe, D., Mundhenk, P., Sheth, P., Schaller, M., Schickram, S. & Gleyzes, D. HMI development for a purpose-built electric taxi in Singapore. In *Proc. MobileHCI 2013*, ACM, 434-439.
13. Reuter, B., Schönsteiner, K., Wagner, M., Gleyzes, D., Massier, T., Hamacher, T., & Lienkamp, M. Life cycle greenhouse gas analysis for automotive applications–A case study for taxis in Singapore. 2013, 11-13.
14. Schwab, A., Osswald, S. & Loehmann, S. HMI Design for shared-use electric vehicles in Singapore. In *Adj. Proc. AutoUI 2012*, 116-117.
15. Strömberg, H., Andersson, P., Almgreen, S., Ericsson, J., Karlsson, M., and Nabo, A. Driver interfaces for electric vehicles. In *Proc. AutoUI 2011*, ACM, 177-184.
16. Tate, E. D., Harpster, M. O. & Savagian, P. J. The electrification of the automobile: from conventional hybrid, to plug-in hybrids, to extended-range electric vehicles. *SAE int. journal of passenger cars-electronic and electrical systems, 1*(1), 2009, 156-166.
17. Tesla motors. Go Electric. http://www.teslamotors.com/goelectric#range. Last accessed June 13, 2014.
18. Turrentine, T., Garas, D., Lentz, A. & Woodjack, J. The UC davis MINI E consumer study. Institute of Transportation Studies, UC Davis Institute of Transportation Studies Research Report 5, 2011.
19. United States Department of Transportation. Minimum Sound Requirements for Hybrid and Electric Vehicles. http://www.nhtsa.gov/staticfiles/rulemaking/pdf/Quiet_ Cars_Draft_EA.pdf. Last Accessed June 12, 2014.