Workshop on Practical Experiences in Measuring and Modeling Drivers and Driver-Vehicle Interactions

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ABSTRACT
The search term "driver-vehicle interaction study" results in 2,690 Google Scholar hits of research papers published in the past 5 years (2010-2015). This huge number clearly points out the problem that researchers (particularly, new to this field) are exposed to, namely that many decisions regarding the setting, (e.g., lab/field, low-/high-fidelity simulator, within/between subjects, sample size, biased subject, learning effect, sensor technology, mobile hardware, synchronization issues, briefing, etc.) have to be established early in the design phase without the reference of principled guidelines and best practices to support them in identifying the optimal solution to answer their research question of interest. This workshop invites a) people active in the field to share their experiences in executing studies to measure driver behavior or vehicle conditions (driver-vehicle interactions), and b) young researchers to draft research questions, present their problems, and discuss possible solutions with the other participants.

Author Keywords
Sensing and modeling, Lab/field studies, Driver behavior, Good/bad experimental settings, Best practices.

ACM Classification Keywords
Human-centered computing → Human computer interaction (HCI) → HCI design and evaluation methods → User studies; Human-centered computing → Human computer interaction (HCI) → HCI design and evaluation methods → Field studies.

INTRODUCTION AND MOTIVATION
In the recent years, rapid advances in sensor technology have pushed the boundaries of personal transportation with a clear trend towards achieving fully intelligent transportation systems. Numerous efforts have been made to instrument vehicles with complimentary sensor arrays that utilize cameras, LIDAR, infrared and ultrasonic sensors to make sense of short and long-range environment context along the road. Some of these vehicles have already made it to the roads [4] and further trials keep industry excited [5]. A more limited approach has looked at instrumenting the interior of the cockpit with similar sensor arrays [6, 2]. Whether it is due to the big brother concern of the commercial application or to the lack of real-time value for in-vehicle information (IVI) systems, user modeling remains in an early stage. Our aim in this workshop is to present and review the available sensor technology, understand the limitations and present state-of-the-art methods, measures and modeling to achieve a complete understanding of user behavior in the vehicle. This exercise aims at having an expert review discussion from sensor data that can be utilized in non-autonomous vehicles for Advanced Driver Assistance Systems (ADAS), for enhancing adaptive in-vehicle user interfaces and for learning user preferences in a system where personalization is so important for both brand value and user comfort.

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WORKSHOP OBJECTIVES

The **goal of this workshop** is to bring together both young and experienced researchers active in the field of automotive UI research and **discuss settings, experiences, best practices, etc., for conducting lab or field experiments**. **Submissions** span the range from **small-scale studies to large-scale deployments, from the lab to the field, with small or large number of participants.** We are interested in **understanding the variety of sensors, protocols, techniques, and contexts used in different automotive UI studies to model real-time user state and behavior.**

Overall, **the workshop is about**

- **Discussing topics related to measuring and modeling** of driver, driving or explicit interactions based on Natural User Interactions (NUIs),
- **Networking and exchanging ideas** and learning from each other (different areas of application, projects, etc.),
- **Demonstrating best practices** and discussing optimal settings for driver-vehicle interaction research.

Successful submissions will have the potential to raise discussion, provide insights for other attendees, or illustrate problems and provide potential solutions.

Topics of interest

Potential topics to be discussed at the workshop include, but are not limited to:

1) Measuring and Modeling of Driver [3], Ch. 13

- Sensors in driving simulators vs. sensors in commercial vehicles (used in on-road studies)
- Cameras and multi-camera arrays
- Depth/Infrared/Acoustic sensors
- "Brought-in sensors" such as smartphones
- Contextual databases/sensors (contact lists, addresses, etc.)
- Neuroergonomic sensors (e.g., EEG, fNIRS, ECG, EMG, fEMG, SCR, etc.)
- Driver emotion models
- Driver intent models
- Shared situational awareness
- "Driver as sensor"

Ultimately, we are interested in sensor input that can be used to evaluate and/or model the in-vehicle user experience.

2) Measuring and Modeling of Driving

- Best-known methods for modeling different driving behavior in on-road and simulator studies
- Feasibility of the lane change task
- Detection response and peripheral detection task (PDT) [1]
- Best-known methods in qualitative & quantitative data gathering
- Examples of good/bad experimental settings
- Settings to use for tests in mixed automated settings
- How to test interaction with autonomous cars in the exterior (pedestrians ↔ autonomous vehicles)
- Simulator studies settings (platform, connected sensors/actuators, data extraction and processing, synchronization issues)
- Study design (lab, on-road; comparison lab ↔ field, Wizard of Oz, Safety of test subjects, etc.)

3) Measuring and Modeling for Explicit Interactions

- Sensors for NUIs (e.g., Leap motion, Kinect, Myo, Emotiv, Neurosky, etc.)
- Testing from OEMs and HW providers point-of-view
- Main issues and constraints of the in-vehicle environment
- How to recognize deliberate commands from random in-car activities
- Discussion on standards (for gestures, tactile feedback, etc.)

SUMMARY OF CONTRIBUTIONS

The position papers submitted to the workshop on "Practical Experiences in Measuring and Modeling Drivers and Driver-Vehicle Interactions" have undergone a rigorous peer-review process where the manuscripts were reviewed by at least two reviewers each. Nine position papers were selected for publication in the workshop proceedings and presentation/discussion at the workshop, held on September 1st, 2015 in the frame of the 7th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (AutoUI'15).

The contribution of Ignacio Alvarez and Laura Rumbel ("How my car got to know me: reflection on in-vehicle user modelling") is one of several papers from industry. The authors discuss efforts made in order to (better) model human behavior – a very important topic for automotive UI research these days. For example, many studies - in particular on large scale - (i.e., validating safety issues of self-driving cars, etc. etc.) are replaced by simulation for different reasons, and simulation models have to tackle with individual human behavior, unpredictability, etc. The paper picks up on that issue, presents some background about user modeling, and discusses approaches that support modeling of drivers in a car based on standard sensors.

Nikolas Martelaro present in his paper "CRUISE: Measuring and Smoothing Driver Behavior Through Haptic Feedback" results from the CRUISE system, a driver behavior modification tool based on pedal input (acceleration, break), GPS, and CAN data. The system provides real-time haptic feedback via vibration patches attached to the pedals so that drivers can correct

immediately inefficient driver behaviors (harsh breaking, steep accelerations, etc.). Results from a field test on the University campus seem to provide evidence of behavior modification as users consistently learned to maintain behaviors below the set thresholds during the road event.

Andreas Löcken describes in the workshop paper ”Experiences with User Studies when Investigating Light Displays” his experiences of the research on in-vehicle ambient light displays. The paper outlines the core elements of human-centered design: requirements, design, and experiments. Given that the paper has a specific design application domain, it is expected to facilitate lively discussions with workshop participants who are interested in automotive HMI studies and the use of (ambient) light in user studies.

The paper “Report on the In-vehicle Auditory Interactions Workshop: Taxonomy, Challenges, and Approaches” by Myounghoon Jeon, Pavlo Bazilinskyy, Jan Hammerschmidt, Thomas Hermann, Steven Landry, and Katieanna Wolf is an excellent framework on auditory interactions. The paper focuses on four areas of investigation (auditory displays for 1) BEV vehicles and automated driving, 2) fuel efficiency, 3) infotainment, 4) collision warning) and many suggestions and starting points in each of the four areas are put on the table for further discussions at the workshop.

Katharina Oeltze and Mandy Dotzauer, the authors of the paper “Towards a best practice for multi-driver simulator studies” discuss best practices that they have implemented in the field of multi-simulator studies. In such a setting, several subjects can drive in the same virtual environment and influence each other (i.e., studying driver-driver interaction). This type of user studies is not very common today, but can be expected to be used more and more in the future.

In the paper “Nudge: Haptic Pre-Cueing to Communicate Automotive Intent”, the authors Nikhil Gowda, Srinath Sibi, Sonia Baltodano, Nikolas Martelaro, Rohan Maheshwari, Dave Miller and Wendy Ju evaluate three haptic cuing prototypes in two different simulated car designs. In summary, participants were found to favor haptic cues presented via the “Pneumatic floorboard” and the “Pneumatic shoulderpads”, while effective also, appeared to induce anger in participants.

The paper “Multi-Dimensions Motivational Factors in Autonomous Driving” by Nidzamuddin Md Yusof and Juffrizal Karjanto describes an experimental plan for designing takeover scenarios based on the varying motivational factors of drivers. Such motivational factors include being in “hurry”, “pressure” and “thrill”. The objective is to explore the target best feeling between the occupant demands and the systems performance as well as evaluate the different scenarios derived during the takeover of a vehicle.

Lewis Chuang and Heinrich Bülthoff’s paper “Towards a Better Understanding of Gaze Behavior in the Automobile” gives a concise introduction into gaze tracking, attention, and EEG and relates them to show how they can be used together to infer user behavior. This is a topic of high interest for the automotive UI research and the focus of the actual workshop.

Finally, Andreas Riener and Jürgen Noldi discuss in the paper “Cognitive load estimation in the car: Practical experience from lab and on-road tests” findings on estimations of driver mental workload derived from seat pose under simulator and real drive scenarios. The hypothesis to be tested was that movement dynamics of a driver in the car seat dependent on the effective level of cognitive load. Most interesting for the workshop are the correlations and differences between the two settings, as it is critical to the validity of simulation testing.

SUMMARY

The papers submitted to this modeling and sensing workshop range from theoretical insights for appropriate inference from sensor data to evidence-based evaluations of novel implementations to best practices in simulated- and field-testing.

In conclusion, we greatly appreciate all the authors, participants, and reviewers contributing to making this a fruitful workshop.

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Andreas Riener is Senior Research and Teaching Assistant at the University of Linz’s Institute of Pervasive Computing. His research interests are the recognition of vital bodily functions using embedded sensors, multimodal sensor-actuator systems, embedded intelligence, context-sensitive data processing, and human factors in driver-vehicle interfaces.

Ignacio Alvarez is Research Scientist at Intel Labs, USA. He obtained his PhD in Computer Science at University of the Basque Country, Spain. His background is in Human Computer Interaction. His research interest is on future intelligent transportation systems and the practical application of cognitive sciences to affective computing and ADAS.

Myounghoon “Philart” Jeon is Assistant Professor of Cognitive Science and Computer Science at Michigan Tech. He directs the Cyber-Human Systems Center at Tech. His research focuses on driver emotion modeling.

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Wendy Ju is Executive Director for Interaction Design Research at Stanford's Center for Design Research, and an Associate Professor in the Graduate Design Program at the California College of the Arts in San Francisco. Her research is primarily focused on the design of interactive devices, particularly human-robot interaction and autonomous car interfaces.

Bastian Pfleging is Researcher at the Institute for Visualization and Interactive Systems at the University of Stuttgart, Germany. His research interests are multimodal and natural user interfaces, especially in the automotive context. He received his Diploma in Computer Science from TU Dortmund, Germany.

Mario Chiesa is Head of the Creativity and Design Innovation Research Unit at Istituto Superiore Mario Boella in Turin, Italy. His research interests include NUIs, data visualization and social innovation in several domains, like automotive, cultural heritage, and energy.

REFERENCES

1. M.H. Martens, W. van Winsum (2000). Measuring distraction: The Peripheral Detection Task. TNO Human Factors, Soesterberg, The Netherlands.
2. J.-M, Lequellec, F. Lerasle, (2000). Car cockpit 3D reconstruction by a structured light sensor, in Proceedings IEEE Intelligent Vehicles Symposium, PP. 87-92.
3. J. Lazar, J.H. Feng, H. Hochheiser (2010). Research Methods in Human-Computer Interaction, Wiley.
4. Google (2015). The latest chapter for self-driving cars, from http://googleblog.blogspot.com/2014/04/the-latest-chapter-for-self-driving-car.html (2015-05-25).
5. B. Snavely (2015). Delphi to drive autonomous car coast-to-coast, from http://www.freep.com/story/money/business/2015/03/13/delphi-autonomous-test-drive-/70198196 (2015-05-25).
6. S. Boverie, Giralt, J. Lequellec, and A. Hirl (1998). Intelligent System for Video Monitoring of Vehicle Cockpit, SAE Technical Paper, 980613, 1998, DOI:10.4271/980613