

CLW 2015: The Fifth Workshop on Cognitive Load and In-Vehicle Human-Machine Interaction

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ABSTRACT

Interactions with in-vehicle electronic devices can interfere with the primary task of driving and increase crash risk. Interactions with in-vehicle interfaces draw upon visual, auditory, psychomotor, and cognitive resources. Researchers often investigate how these resources interfere with performance through the use of different measurement techniques, particularly doing so in applied settings such as automotive scenarios. The goal of this workshop is to share knowledge with the community regarding the theoretical underpinnings, collection, and filtering of physiological data, particularly focusing on heart rate, electrodermal activity (skin conductance, galvanic skin response, GSR, etc.) measures, and electroencephalography (EEG) as a measure of cognitive load within the scope of automotive research. The workshop will describe and demonstrate the physiology behind changes detected, approaches and issues in regards to collection, and successful methods of filtering data from heart rate and electrodermal measures. The focus of the workshop will be on ensuring participants acquire an understanding of the theoretical reasoning behind the measures shown in the workshop as well as practical knowledge of how to collect and filter data.

Categories and Subject Descriptors

H.5.2 Information interfaces and presentation: User Interfaces.
H.5.1 Multimedia information systems.

General Terms

Design, Experimentation, Human Factors, Measurement.

Keywords

Cognitive load, estimation, management, driving, physiological measures.

1. INTRODUCTION

In-vehicle human-machine interaction (HMI) can interfere with the primary task of driving. The concept of cognitive load can

help us understand the extent to which these interactions interfere with the driving task and how this interference can be mitigated. Research has progressed to the point at which some processes for collecting measurements for the estimation of cognitive load (but not analyzing them) has been standardized (i.e. [1]). However, as the popularity in measuring cognitive load increases within the in-vehicle HMI field, people are constantly exploring new options to gather this data. One increasingly popular way to measure cognitive load is the use of physiological measures. These physiological measures are being applied more often due to their objective nature, and the wider availability of the devices necessary for their collection. However, the successful use of these measures requires an understanding of the physiology behind the changes seen in the measures with a change in workload as well as knowledge regarding the best methods of data collection and filtering.

Following successful workshops at AUI for the past four years [2, 3, 4, 5] the purpose of this workshop, is to provide this theoretical knowledge behind the use of physiological measures and the practical experience of collection and filtering of this data. The workshop will focus in particular on the popular physiological measures of heart rate (HR), electrodermal activity (EDA) (also known as skin conductance, galvanic skin response, etc.) , and electroencephalography (EEG).

WORKSHOP GOALS

The workshop has three goals:

1. **Explain the theoretical underpinnings of the physiology behind common physiological measures of cognitive load.** The first goal of the workshop is to ensure participants understand the physiological reasons behind the use of HR, EDA, and EEG, and practical considerations of these changes within the automotive setting. A strong focus will be on ensuring participants understand the physiology behind the changes seen in HR, EDA, and EEG with differences in workload. The workshop will also then include discussion of practical aspects of using these measures in the automotive environment and how these can affect the outcome of the measure data.
2. **Demonstrate how measures of physiological workload are collected.** The attendees of the workshop will gain an understanding about how to actually collect physiological

measures of workload. The second goal of the workshop is to ensure participants receive a demonstration of how physiological measures are collected and some level of hands-on experience in the collection of HR, EDA, and EEG data. Again the focus here will be toward the practical considerations of using these measures within an automotive environment.

3. **Present techniques of how the data from these measures are reduced and analyzed:** The last goal for the workshop in an effort to allow attendees to walk away with applicable knowledge is ensure they understand how filter the data that they will collect. To some extent, this will involve summarizing existing practice codified in standards or discussed in previous studies within the space for the participants. However, the workshop will go beyond what is in those documents, discussing practical problems of filtering and cleaning the data, censoring, rules for determining and eliminating outliers, methods of quantifying lost data. The workshop will also discuss identifying potential confounding factors and situations that arise with the use of HR, EDA, and EEG that can bias interpretations of results as well as pointing attendees to software that can help produce results.

The workshop organizers will bring together a number of experts from government, industry, and/or academia to address the above topics.

2. WORKSHOP ORGANIZATION

2.1 Before the Workshop

2.1.1 Program Committee Recruitment

The program committee will be recruited from the extensive list of academic and industry contacts of the organizers, in the HCI, speech, ubiquitous computing, and human factors and ergonomics communities. We will primarily target our colleagues who were part of the PC in 2011, 2012, 2013, and 2014.

2.1.2 Publicity and Soliciting Papers

The workshop will be publicized using a dedicated website hosted by the University of New Hampshire [6] and the announcement of the workshop will distributed via the following channels:

- ACM CHI mailing list,
- Ubicomp mailing list,
- WikiCFP,
- HFES Surface Transportation Technical Group Newsletter,
- Driving Assessment conference email list,
- Contacts of program committee members in their fields.

2.1.3 Paper Submission, Review and Selection

We will invite experts on physiological measures of cognitive load to present at the workshop and to have position papers for the proceedings of the workshop. We will work with the authors on any necessary edits and improvements.

Position papers will be submitted and reviewed using the EasyChair conference management system [7]. This will allow for online paper submission and simple management of reviewer assignments and feedback. Note that EasyChair is a free service hosted by the University of Manchester CS Department; therefore no funding will have to be secured for its operation.

2.1.4 Final Pre-Workshop Activities

The list of presenters and their topics will be posted on the workshop website in late August. The organizers will create a mailing list to distribute position papers to workshop participants prior to the workshop. Participants will also be encouraged to use the mailing list to initiate interactions before the workshop.

2.2 During the Workshop

2.2.1 Sessions

The workshop will start with an introduction by a leader in the automotive user interface research community to discuss the overall impact of measuring cognitive demand and how the use of physiological measures can help towards this goal. This introduction will be followed by three sessions:

Session 1: Discussion of the reasons behind the use of physiological measures – Invited presenters will discuss theoretical reasoning behind the use of popular physiological measures and practical considerations that can come along with the collection of this data. The presentations during this session will provide the audience with the theoretical understanding of why physiological differences are seen, so that in the following sessions they are able to understand the implications of the data being collected and filtered. The goal for the audience is to get basic affinity with physiological measures as well as a deeper understanding of practical issues in applying these measures within the automotive settings. These presentations will be aimed toward goal 1 of this workshop.

Session 2: Demonstrations of measure collection – Presenters will provide an opportunity during the second session to get either a hands on experience with the collection of certain physiological measures if the hardware is available or at the least a very in depth presentation on the process. Those attending the meeting will be invited to bring hardware and software or recordings of the use of these systems to demonstrate the physiological measures in question. This includes hardware and software for the measures (i.e. HR monitors, EDA and EEG detection equipment), as well as a driving simulator or driving video game to show how the data are collected in a real study. As with the whole workshop this will focus on issues that can appear during the process that are stumbling blocks for researchers within automotive research. This session is aimed at goal 2 of this workshop, in providing experience of actually using the physiological measures in a study.

Session 3: Discussion of techniques to measure reduction and analysis – The third session will focus on papers and invited speakers presenting on the topic of reduction and analysis of physiological measures. This process can be very long and tedious so it will not be as hands-on as other sessions but should still be informative to participants and give participants more applicable knowledge of the process of analysis in this space. This session will be particularly focused on “tricks-of-the-trade” within the automotive field and looking at different approaches and tools people use in the analysis of physiological data. This session aims to fulfill the 3rd goal of the workshop.

2.3 Feedback

As in 2011, 2012, 2013, and 2014, at the end of the workshop organizers will solicit feedback from participants in anonymous written form. Participants will be asked to evaluate the relevance and ultimate value of the workshop using responses on a Likert scale. Suggestions for improvements will also be solicited.

2.4 After the Workshop

2.4.1 Online Report

Based on the notes taken during the workshop, the organizers will create a journal article summarizing some of the practical issues that seem to be common and solutions to them. If not appropriate for a journal, then a proceedings paper will be written.

2.4.2 Workshop at AutomotiveUI 2016?

Assuming that participant feedback indicates that the workshop was successful, the organizers will contact participants for suggestions for a workshop to be held at AutomotiveUI 2016.

3. ACKNOWLEDGMENTS

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4. REFERENCES

- [1] ISO 17488, Road Vehicles - Transport information and control systems - Detection Response Task: (New Work Item for ISO TC 22 SC13 WG8). International Standards Organization, Geneva, Switzerland, 2013 draft
- [2] Kun, A. L., Heeman, P. A., Paek, T., Miller III, W. T., Green, P. A., Tashev, I., ... & Kern, D. (2011). Cognitive Load and In-Vehicle Human-Machine Interaction. *Adj. Proc. AutomotiveUI*.
- [3] Kun, A. L., Reimer, B., Froehlich, P., Heeman, P. A., Paek, T., Miller III, W. T., ... & Kern, D. (2012). CLW 2012: The Second Workshop on Cognitive Load and In-Vehicle Human-Machine Interaction. *Adj. Proc. AutomotiveUI*.
- [4] Kun, A. L., Reimer, B., Froehlich, P., Heeman, P. A., Miller III, W. T., Green, P. A., ... & Kern, D. (2013). CLW 2013: The Third Workshop on Cognitive Load and In-Vehicle Human-Machine Interaction. In *Proceedings of the 5th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*, ACM Press.
- [5] Kun, A. L., Miller III, W. T., Froehlich, P., Tashev, I., Green, P. A., Iqbal, S., ... & Heeman, P. A. (2014, September). CLW 2014: The Fourth Workshop on Cognitive Load and In-Vehicle Human-Machine Interaction. In *Proceedings of the 6th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (pp. 1-4). ACM.
- [6] CLW website: <http://www.auto-ui-cogload.unh.edu/> (accessed June 13, 2014)
- [7] EasyChair Conference Management System, <http://www.easychair.org/>