

Emotion GaRage Vol. II:

A Workshop on Affective In-Vehicle Display Design

Chihab Nadri
Department of Industrial and Systems
Engineering, Virginia Tech,
Blacksburg, USA
cnadri@vt.edu

Ignacio Alvarez
Intel Labs, Portland, USA
ignacio.j.alvarez@intel.com

Jingyi Li
LMU Munich, Munich, Germany
jingyi.li@ifi.lmu.de

Michael Braun
BMW Group Research, Munich,
Germany
michael.bf.braun@bmw.de

Esther Bosch, Michael Oehl
German Aerospace Center (DLR),
Braunschweig, Germany,
Esther.Bosch@dlr.de
Michael.Oehl@dlr.de

Myounghoon Jeon
Department of Industrial and Systems
Engineering, Virginia Tech,
Blacksburg, USA
myounghoonjeon@vt.edu

ABSTRACT

Driver performance and behavior can be partially predicated based on one's emotional state. Through ascertaining the emotional state of passengers and employing various mitigation strategies, empathic cars can show potential in improving user experience and driving performance. Challenges remain in the implementation of such strategies, as individual differences play a large role in mediating the effect of affective intervention. Therefore, we propose a workshop that aims to bring together researchers and practitioners interested in affective interfaces and in-vehicle technologies as a forum for the development of targeted emotion intervention methods. During the workshop, we will focus on a common set of use cases and generate approaches that can suit different user groups. By the end of this short workshop, researchers will determine ideal intervention methods for prospective user groups. This will be achieved through the method of insight combination to generate and discuss ideas.

CCS CONCEPTS

• **Human-centered computing**; • **Human computer interaction (HCI)**; **HCI theory, concepts, and models**; **Interaction design**;

KEYWORDS

Empathic vehicles, emotions, user acceptance, interaction design, human-centered computing, affective computing

ACM Reference Format:

Chihab Nadri, Jingyi Li, Esther Bosch, Michael Oehl, Ignacio Alvarez, Michael Braun, and Myounghoon Jeon. 2020. Emotion GaRage Vol. II: A Workshop on Affective In-Vehicle Display Design. In *12th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

AutomotiveUI '20 Adjunct, September 21, 22, 2020, Virtual Event, DC, USA

© 2020 Copyright held by the owner/author(s).

ACM ISBN 978-1-4503-8066-9/20/09.

<https://doi.org/10.1145/3409251.3411736>

(AutomotiveUI '20 Adjunct), September 21, 22, 2020, Virtual Event, DC, USA. ACM, New York, NY, USA, 3 pages. <https://doi.org/10.1145/3409251.3411736>

1 INTRODUCTION

In recent years, research in the automotive sector has increasingly explored the relationship between driver affect and driving performance. Previous research uncovered anger's detrimental effects on attention, judgement, and decision making behavior [1–3]. The influence of anger on the driving experience also extends to automated vehicles [4], with research suggesting angry drivers perform worse takeovers. Researchers also found that driving anger was a significant predictor of risky driving behavior [5–6]. Moreover, other emotional states such as anxiety [7–8], boredom [9], and happiness [10] were also found to negatively impact driving performance.

As the effect of various emotional states has become clearer, in-car emotion detection and mitigation have emerged as significant areas of research. Different ways of affect detection exist, including physiological measures (skin conductance, heartbeat, respiration rate) [2–11], neuroimaging methods (fNIRS, EEG, fEMG) [12–13], and less invasive methods such as speech analysis and facial expression detection [14–15].

Likewise, many approaches exist for emotion mitigation. Intervention approaches explored in research include the use of music [13], speech [16], adaptive displays [17], and gamification principles [18] in reducing the effects of anger and boredom on driving performance. However, evidence suggests that the influence of these intervention methods differ between different population groups, in terms of age or mental faculties [2–19], requiring a targeted approach. For instance, disparities between age groups in terms of risk-taking behavior [6] and anxiety [20] may play a role in participant acceptance and response to in-vehicle displays [16–21]. In addition to age, differences in mental faculties (individuals with disabilities) [1] and cultural values [22] must be considered in the design of empathic vehicle interfaces. This is especially relevant as access to vehicles increases with advances in automation and greater global reach.

In the previous iteration of the workshop [23], experts in the automotive field had discussed the importance of empathic vehicle displays and the detection technologies. While increases in automation were expected to relegate drivers to mere passengers,

empathic vehicle displays were posited to become relevant mediums for improving user experience and driving performance. Moreover, greater access to mobility for vulnerable population groups will also require vehicle interfaces to adapt to their unique needs. This raises the need to implement targeted intervention methods that account for individual characteristics. Specifically, cultural differences between different regions may play a large role in the acceptance of different emotion mitigation approaches. This is the motivation for this iteration of the workshop and hence, we will focus on developing and comparing ideas created through multiple short sessions conducted with experts from separate regions.

2 GOAL

This workshop will explore intervention methods in emotion mitigation for different user groups. To achieve this, experts from academia as well as industry will get together to ideate on various targeted approaches. Furthermore, a select number of use cases will be broached for a focused discussion. The workshop aims to bring together multidisciplinary researchers and practitioners interested in driving emotion recognition and mitigation. In particular, we hope to address experts from the field of Human-Machine Interface (HMI), Human-Computer Interaction (HCI), User Experience (UX), and Usability practitioners in the automotive sector who are interested in designing empathic cars. The workshop provides a forum for exchange and discussion on empathic user interfaces, including methods for emotion recognition and regulation, and ways in which these interfaces can adapt to various groups. Through this workshop participants will share experiences and ideas and discuss design and technology goals for the future. We will discuss prospective research directions and develop ideas on how to tackle them. Ultimately, novel intervention approaches for the implementation of affective vehicle interfaces will be developed. These methods will be relevant to future automotive vehicle design, making this workshop fit the scope of the conference.

3 TOPICS

The central aim of this workshop is to develop targeted intervention approaches for in-vehicle empathic user interfaces. To do so, it is necessary to determine salient user groups that would benefit in unique ways from empathic user interfaces. After reaching a consensus on target users, intervention approaches tailored to their needs will be envisioned. There will be time to discuss ideas brought forward by workshop participants and formulate directions for empathic interface design in vehicles.

4 OUTCOMES

Emotion recognition and mitigation have recently been the focus of research from major automotive industry players, academia, and governmental stakeholders. As experts who come from all three backgrounds, the workshop organizers seek to create and facilitate partnerships and discussion during the workshop. Therefore, experts from different backgrounds will work in parallel on similar research questions, and benefit from collaboration in this workshop. By highlighting challenges and opportunities in the field, this workshop will pave the road to identify a common understanding of emotion mitigation approaches and generate novel use cases for

empathic user interfaces in vehicles. Moreover, the workshop also aims to achieve the following objectives:

- Maintain and expand the community of experts in the field of affective in-vehicle interfaces.
- Facilitate the creation of partnership between stakeholders in academia, the automotive industry, and governmental organizations.
- Incorporate cultural and internationalization principles within the design of empathic vehicles.

A catalogue of these points and results of the insight combination activity will be collected over the course of the workshop. Based on a qualitative analysis of the workshop results, a report will be created and presented in the next Auto-UI conference. Additionally, we intend on guest-editing a journal special issue regarding affective in-vehicle interfaces based on the workshop outcome. By this, we expect to advance the state-of-the-art knowledge and understanding on the topic and sustain the topic for future AutoUI conferences.

5 SCHEDULE

We expect to conduct two separate one-hour workshop sessions with experts from different regions. Each workshop session will be divided into the following parts:

Introduction (10 min): After a short introduction with the summary of the last workshop by the workshop organizers, workshop participants will get to know each other by a short roundtable introduction (e.g., 30 seconds per participant).

Insight combination (30 min): To structure a compact online workshop, we will adopt the method of insight combination [21] to quickly generate initial solution ideas. We will present ten use cases of in-car emotion sets on yellow cards, e.g., "road rage". Blue cards contain ten methods of emotion detection and regulation, e.g., "speech analysis" or "the use of music". Before the workshop, we will compile two pages of all the yellow and the blue cards and distribute the pdf file to all attendees as insights material. During the workshop, we will divide into several small groups of four to five members, followed by a brainstorming session in online breakout rooms on Zoom. In multiple rounds each group member will pick two random sticky notes (one of each color). Then, everyone will record (on green cards) potential concepts combining the selected use cases and methods (yellow and blue cards).

Discussion (20 min): Each team will present concepts created in the insight combination activity. Concepts will be discussed before the workshop organizers conclude the session with closing remarks.

All results will be written into a summary analyzed to be submitted to the next conference as a Work-In-Progress report. We also intend on guest-editing a journal special issue regarding affective in-vehicle interfaces based on the workshop outcome. By this, we hope to sustain the topic for future AutoUI conferences.

6 ATTENDANCE

We estimate around 30 participants in total in our workshop (around four to five attendees per organizer). In each workshop session for a different region, we expect 15-17 attendees.

7 SUPPORT REQUESTS

No specific hardware or software is requested for this workshop. We plan to use Zoom if the conference does not provide/require any other platforms for the workshop. We also plan to use AWW, an online whiteboard tool for visual collaboration, during the insight combination session.

REFERENCES

- [1] M. Jeon, 2015. "Towards affect-integrated driving behaviour research," *Theor. Issues Ergon. Sci.*, vol. 16, no. 6, pp. 553–585, 2015, doi: 10.1080/1463922X.2015.1067934.
- [2] G. Underwood, P. Chapman, S. Wright, and D. Crundall, 1999. "Anger while driving," *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 2, no. 1, pp. 55–68, 1999, doi: 10.1016/S1369-8478(99)00006-6.
- [3] M. Jeon, 2017. "Emotions and affect in human factors and human-computer interaction: Taxonomy, theories, approaches, and methods," in *Emotions and Affect in Human Factors and Human-Computer Interaction*, Elsevier, 2017, pp. 3–26.
- [4] H. Sanghavi, 2020. "Exploring the Influence of anger on takeover performance in semi-automated vehicles," Virginia Polytechnic Institute and State University, 2020.
- [5] E. R. Dahlen and R. P. White, 2006. "The Big Five factors, sensation seeking, and driving anger in the prediction of unsafe driving," *Pers. Individ. Dif.*, vol. 41, no. 5, pp. 903–915, 2006, doi: 10.1016/j.paid.2006.03.016.
- [6] D. C. Schwebel, J. Severson, K. K. Ball, and M. Rizzo, 2006. "Individual difference factors in risky driving: The roles of anger/hostility, conscientiousness, and sensation-seeking," *Accid. Anal. Prev.*, vol. 38, no. 4, pp. 801–810, 2006, doi: 10.1016/j.aap.2006.02.004.
- [7] A. Shahar, 2009. "Self-reported driving behaviors as a function of trait anxiety," *Accid. Anal. Prev.*, vol. 41, no. 2, pp. 241–245, 2009, doi: 10.1016/j.aap.2008.11.004.
- [8] J. E. Taylor, M. J. Connolly, R. Brookland, and A. Samaranayaka, 2018. "Understanding driving anxiety in older adults," *Maturitas*, vol. 118, no. September, pp. 51–55, 2018, doi: 10.1016/j.maturitas.2018.10.008.
- [9] E. R. Dahlen, R. C. Martin, K. Ragan, and M. M. Kuhlman, 2005. "Driving anger, sensation seeking, impulsiveness, and boredom proneness in the prediction of unsafe driving," *Accid. Anal. Prev.*, vol. 37, no. 2, pp. 341–348, 2005, doi: 10.1016/j.aap.2004.10.006.
- [10] M. Jeon, B. N. Walker, and J. Bin Yim, 2014. "Effects of specific emotions on subjective judgment, driving performance, and perceived workload," *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 24, pp. 197–209, 2014, doi: 10.1016/j.trf.2014.04.003.
- [11] S. Jansen, A. Westphal, M. Jeon, and A. Riener, 2013. "Detection of Drivers' Incidental and Integral Affect Using Physiological Measures," *Proc. 5th Int. Conf. Automot. User Interfaces Interact. Veh. Appl. (AutomotiveUI '13)*, no. June 2014, pp. 97–98, 2013, [Online]. Available: http://www.researchgate.net/publication/257985342_Detection_of_Drivers'_Incidental_and_Integral_Affect_Using_Physiological_Measures/file/3deec528080a401cd0.pdf.
- [12] K. Ngamsomphornpong and Y. Punsawad, 2019. "Development of Hybrid EEG-fEMG-based Stress Levels Classification and Biofeedback Training System," *ACM Int. Conf. Proceeding Ser.*, pp. 25–28, 2019, doi: 10.1145/3332340.3332349.
- [13] S. M. Fakhrosseini, S. Landry, Y. Y. Tan, S. Bhattarai, and M. Jeon, 2014. "If you're angry, turn the music on: Music can mitigate anger effects on driving performance," *AutomotiveUI 2014 - 6th Int. Conf. Automot. User Interfaces Interact. Veh. Appl. Coop. with ACM SIGCHI - Proc.*, no. September, 2014, doi: 10.1145/2667317.2667410.
- [14] C. Jones and I. M. Jonsson, 2008. "Using paralinguistic cues in speech to recognise emotions in older car drivers," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 4868 LNCS, pp. 229–240, 2008, doi: 10.1007/978-3-540-85099-1_20.
- [15] K. Ihme, C. Dömeland, M. Freese, and M. Jipp, 2018. "Frustration in the face of the driver: a simulator study on facial muscle activity during frustrated driving," *Interact. Stud.*, vol. 19, no. 3, pp. 487–498, 2018.
- [16] I.-M. Jonsson, M. Zajicek, H. Harris, and C. Nass, 2005. "Thank you, I did not see that: in-car speech based information systems for older adults," in *CHI'05 Extended Abstracts on Human Factors in Computing Systems*, 2005, pp. 1953–1956.
- [17] B. Donmez, L. N. Boyle, and J. D. Lee, 2006. "The impact of distraction mitigation strategies on driving performance," *Hum. Factors*, vol. 48, no. 4, pp. 785–804, 2006, doi: 10.1518/001872006779166415.
- [18] F. Steinberger, R. Schroeter, and C. N. Watling, 2017. "From road distraction to safe driving: Evaluating the effects of boredom and gamification on driving behaviour, physiological arousal, and subjective experience," *Comput. Human Behav.*, vol. 75, pp. 714–726, 2017, doi: 10.1016/j.chb.2017.06.019.
- [19] L. M. Lundqvist and L. Eriksson, 2019. "Age, cognitive load, and multimodal effects on driver response to directional warning," *Appl. Ergon.*, vol. 76, no. December 2018, pp. 147–154, 2019, doi: 10.1016/j.apergo.2019.01.002.
- [20] L. Kourkouta, C. Iliadis, and A. Monios, 2015. "Psychosocial issues in elderly," *Prog. Heal. Sci.*, vol. 5, no. 1, pp. 232–237, 2015.
- [21] H. J. Foy, P. Runham, and P. Chapman, 2016. "Prefrontal cortex activation and young driver behaviour: A fNIRS study," *PLoS One*, vol. 11, no. 5, pp. 1–18, 2016, doi: 10.1371/journal.pone.0156512.
- [22] J. Li, A. Butz, M. Braun, and F. Alt, 2019. "Designing emotion-aware in-car interactions for unlike markets," *Adjun. Proc. - 11th Int. ACM Conf. Automot. User Interfaces Interact. Veh. Appl. AutomotiveUI 2019*, pp. 352–357, 2019, doi: 10.1145/3349263.3351324.
- [23] E. Bosch *et al.*, 2018. "Emotional GaRage: A workshop on in-car emotion recognition and regulation," *Adjun. Proc. - 10th Int. ACM Conf. Automot. User Interfaces Interact. Veh. Appl. AutomotiveUI 2018*, pp. 44–49, 2018, doi: 10.1145/3239092.3239098.