2nd Workshop on User Interfaces for Public Transport Vehicles: Interacting with Automation

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AutomotiveUI '19 Adjunct, September 21–25, 2019, Utrecht, Netherlands

ACM ISBN 978-1-4503-6920-6/19/09.
https://doi.org/10.1145/3349263.3350766

Abstract
Automation is increasingly gaining traction not only for individual but public transportation, especially in the last-mile sector. With no human driver at the helm, there is a need for adequate interaction replacements for passenger- and roadside information – not only as the bus is already in transit but before and during boarding as well. This workshop is intended to address these needs by exploring this design space in a hands-on setting. The expected outcome of the workshop is a set of interaction scenarios, design concepts and future challenges. These should serve as a basis for ongoing research and development for the field.

Author Keywords
User experience; autonomous buses; public transport apps; passenger services; mobility-as-a-service

CCS Concepts
● Human-centered computing ● Social and professional topics~User characteristics

Introduction
Our transportation system is currently facing a significant transition. Besides changing attitudes towards a higher willingness to share and use multimodal transport options [6], the increasing

Workshop Plan

1. IGNITION (20 min, including questions)
The workshop starts with a short introduction by the organisers and an invited talk, to set the scene for attacking the future challenges of (semi-) autonomos public transport vehicles. The speaker will not come from the core of the Automotive UI but be a representative of the user-centered public transport research domain.

digitalization and automation is a strong driver for this change. The Automotive UI 2018 workshop "User Interfaces for Public Transport Vehicles" provided a first forum for the discussion and reflection of digital interfaces for public transport vehicles [14]. This initial workshop looked at the general potential of interactive passenger services, as well as the support of vehicle automation and new mobility types.

This workshop edition seeks to get a step further in this consultation within the Automotive UI community, taking advantage of inputs from researchers and practitioners from automotive UI design, public transport management and human factors. This time, we will strengthen the focus on automation in shared and public transport within and outside the vehicle.

The increased connectivity and autonomy of automated vehicles is a strong enabler for on-demand solutions and similar modern forms of mobility service provision. It is both possible and likely that the current standard of fixed schedules and stops will no longer be the norm once automated transportation becomes more and more widespread in everyday public transportation [9]. These novel challenges span not only the time the vehicles (and passengers) spend on the road but also pre-boarding events and the boarding process. Due to the rapid pace of development and still relative novelty of on-road automation technology, research and development efforts often ignore this broader interaction umbrella. In detail, the workshop will address and discuss the following research areas:

Awareness and Intent Communication

In a fully automated setting, a driver is no longer available as the (human) point of reference we are used to in today's predominantly manual to semiautomated public transportation means. This constitutes a considerable change in how we interact with and experience the public transportation systems of the near and far future. No longer will it be possible to, e.g., quickly ask an oral question whether or not a bus in question also stops at station x, or wave at the driver in order to get him/her to wait a just a few seconds longer, or simply buy a ticket from a human individual after boarding.

Passengers' trust is an important prerequisite for the intention to use automated shuttles, as has been found by cross-national studies on the technology acceptance of automated shuttles [7,8]. Further critical acceptance factors for automated buses are effectiveness and usefulness, and previous research has shown limitations here [1]. Recent research has recommended awareness and intent cues for road users to make them aware of automated vehicles future actions [6]. However, as of now few insights are available which information to present to customers of a public transportation vehicle to alleviate the above described gaps in communication through the absence of a human driver.

The following challenges arise with regard to awareness and intent communication for public automated buses:

- Intent and awareness communication for passengers to maintain and increase trust
- Interaction with other vehicles (e.g., indicating priority when pulling over from bus stop)
- Support of safety and security in unmanned public vehicles
- Assistance systems for drivers and operators

Workshop Plan (ctd.)

2. CREATIVE THINKING (120 min, including a break)
The session is allocated for working on promising approaches for a particular challenge. Based on a list of challenges prepared by the workshop organizers and own ideas of workshop participants, participants discuss about challenges and add additional ones. Depending on the final number of participants, the workshop will be divided into smaller teams that each work on a challenge.

The expected output from the group work is a set of interaction scenarios, design concepts and future challenges. The format of the proposed solutions is open to the participants and could for instance be sticky notes, flipchart notes, but also they could comprise design ideas summarized in slides or presented as a sketch.

Capacity Management and Service Provision

Capacity and flexibility of public transportation both in urban and rural regions could be considerably increased with driverless buses operating at the "last mile" [10,11,12]. The form factor of such "people-movers" is mostly smaller than current buses, to cater for faster entry and exit times, short rides, and on-demand flexibility. State-of-the-art vehicles reach a level of conditional autonomy (SAE Level 3 [2]), and they do not feature a driver seat and traditional controls such as the steering wheel and pedals any more. However, these systems still have to be considered experimental, with a large unexplored design space with regard to overall shape, interior design, and available interactive technology (displays, audio announcements, etc.).

Ensuring sufficient seating in these relatively small vehicles with high turnover times, due to the distances traveled, will be a nontrivial challenge. In addition, maintaining flexibility when buying a ticket (online, at the station or on the vehicle) will be difficult to combine with measures to ensure that only those with a valid ticket or valid claim to obtain one on the vehicle can board (or disembark when necessary), considering that there is no human conductor who would normally have this function. Thus, a number of issues will need to be discussed in order to eventually realize flexible capacity management and service provision in automated public transport; these are:

- Interaction techniques and application scenarios for on-demand routing
- Designing the "passenger turnover experience", i.e., the intuitive (dis-) embarkment without guidance by the driver
- New personalized routing services considering preferences such as eco-friendliness
- Concepts for creating private space within a small-sized public transport system
- Concepts for creating emotional attachment to a public transport system despite missing ownership

Supportive Infrastructure and Integrative Services

The emergence of automated public transport vehicles will lead to major changes in physical public traffic infrastructure and supportive digital services. Prior relevant research, for example, investigated the design of bus stops enriched by interactive technology to improve the passengers' experiences and engagement with traditional public transport [11,13]. Other research addressed mobile support for so-called micro-navigation, which provides personalized and contextual travel information including details on the physical public transport infrastructure (for tourists or people with impairments) [4]. Multi-modal navigation and routing in general (cf. [2]) have become a de-facto standard feature in modern mobile transport apps.

So far, the impact of upcoming automated public transport vehicles on such trends and developments is unclear. Exemplary relevant topics regarding the change of public traffic infrastructures and services and their passenger-oriented design and evaluation include:

- Information and interactive services regarding automated public transport at stops and stations
- Design and adaptation of stops for automated public transport

Workshop Plan (ctd.)

3. PRESENTATION OF APPROACHES (30 min)
The participants gather in the plenum and discuss their solution approaches to the workshop audience

4. CONSOLIDATION
(70 min, incl. a break)
The workshop participants consolidate both the challenges and the related ideas and solutions. The focus will be on the consideration of ongoing and future research projects and their challenges. In this light the developed approaches and solutions will be appraised. Plans for a dedicated programmatic publications will be drawn, which could materialize in form of a special journal issue and magazine article.

- New overall passenger information concepts and models for automated public transport
- Services for integrating automated public transport vehicles with existing multi-modal offers
- Multi-modal navigation and routing concepts considering automated public transport

Workshop Goals & Structure

The overall objective of this workshop is to discuss the various requirements, opportunities, challenges and impact of novel concepts for interaction with and within (semi-)autonomous public transport vehicles. In accordance with this overall goal, this workshop will address the following goals:

- Reflect on challenges of user interfaces for autonomous public transport vehicles and discuss ways to address them
- Enable an exchange of ideas and networking to produce promising ways to foster user interaction for public transport vehicles
- Provide a systematic overview of the hitherto cluttered field of public transport vehicle user interfaces

The proposed workshop will be a half-day event and will cover the following agenda points: 1) Ignition Talk, 2) Creative Thinking, 3) Presentation of Approaches, and 4) Consolidation. Details about these phases are described in the side boxes on pages 2 to 4.

Expected Outcomes and Impact

Overall, this workshop series shall provide a continued forum for the discussion of issues related to user experience and interaction in public transportation. This year's edition is expected to bring about detailed insights related to the interaction with (semi-) autonomous public transport vehicles, especially with regard to the three defined lines.

The workshop brings together representatives of multiple stakeholder groups as well as individuals involved in research regarding public transport automation. The conference focus on user interaction and human factors is especially beneficial to the human needs driven nature of the workshop focus areas outlined above. We also see a good chance to attract human factors and transportation experts to the conference for the first time, as this workshop opens up a new entry point for human factors experts active in the wider transportation community.

The workshop duration of half a day is in line with the expected outcome and should provide ample time for rich discussion, focused group work, and concise presentation of outcomes in a streamlined structure. To increase the impact of the outcomes, we will promote post-workshop activities, such as planning a joint publication on one or several of the workshop topics.

Given the currently ongoing research activities and the related opportunities for researchers to come up with innovative solutions, this workshop will serve for knowledge and experience sharing. It is of high importance to establish a joint forum, in order to foster collaboration and to minimize inefficient parallel work. We expect to collate the jointly agreed requirements on (semi-)automated public transportation vehicles in an overview paper. Visibility of the workshop will also be provided through cross-dissemination through the project websites of the organizers and their partners.

About the Organizers

PETER FRÖHLICH is a Senior Scientist at the Austrian Institute of Technology (AIT), Center for Technology Experience, dealing with user experience of ubiquitous computing applications. Currently, he explores novel communication methods between autonomous busses, passengers and other road users, together with public transport operators.

ALEXANDER MIRNIG is a Research Fellow at the Center for Human-Computer Interaction at the University of Salzburg, Austria. He earned a Master's degree in Analytic Philosophy. His current research focuses on human factors in automated public transportation, control transitions in semi-automated vehicles, and Machine Ethics.

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Acknowledgments

The authors gratefully acknowledge the funding granted from the Austrian Ministry for Transport, Innovation and Technology (bmvit) and the Austrian Research and Promotion Agency (FFG) under the grant numbers 860822 (auto.Bus – Seestadt) and 865110 (Digibus Austria) within the Programme "Mobility of the Future" which made this work possible.

References

1. V. Distler, C. Lallemand, and T. Bellet. 2018. Acceptability and Acceptance of Autonomous Mobility on Demand: The Impact of an Immersive Experience. *In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (CHI '18). ACM, New York, NY, USA, Paper 612, 10 pages.
2. Claas Digmayer, Sara Vogelsang, and Eva-Maria Jakobs. 2015. Designing Mobility Apps to Support Intermodal Travel Chains. In *Proceedings of the 33rd Annual International Conference on the Design of Communication* (SIGDOC '15). ACM, NewYork, NY, USA, https://doi.org/ 10.1145/2775441.2775460
3. International SAE. 2016. Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems. Standard J3016. (2016).
4. Stefan Foell, Gerd Kortuem, Reza Rawassizadeh, Marcus Handte, Umer Iqbal, and Pedro Marrón. 2014. Micro-navigation for urban bus passengers: using the internet of things to improve the public transport experience. In *Proceedings of the First International Conference on IoT in Urban Space* (URB-IOT '14). DOI=http://dx.doi.org /10.4108/icst.urb-iot.2014.257373
5. Madigan, R., Louw, T., Dziennus, M., Graindorge, T., Ortega, E., Graindorge, M., & Merat, N. (2016). Acceptance of Automated Road Transport Systems (ARTS): an adaptation of the UTAUT model.
6. Mahadevan, K. Somanath, S. and Sharlin, E. 2018. Communicating Awareness and Intent in Autonomous Vehi-cle-Pedestrian Interaction. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (CHI '18). ACM, New York, NY, USA, DOI: https://doi.org/10.1145/3173574.3174003

7. Nordhoff, Sina & de Winter, Joost & Payre, William & Arem, B & Happee, Riender. (2018). What Impressions Do Users Have After a Ride in an Automated Shuttle? An Interview Study. *Transportation Research Part F: Traffic Psychology and Behaviour*, 63, 252-269.
8. S. Nordhoff, J. de Winter, M. Kyriakidis, B. van Arem, and R. Happee, "Acceptance of Driverless Vehicles: Results from a Large Cross-National Questionnaire Study," *Journal of Advanced Transportation*, vol. 2018, Article ID 5382192, 22 pages, 2018.
9. Pavone, M. (2016). Autonomous Mobility-on-Demand Systems for Future Urban Mobility. In M. Maurer, J. C. Gerdes, B. Lenz, & H. Winner (Eds.), Autonomous Driving (pp. 387–404). Berlin, Heidelberg: Springer Berlin Heidelberg.
10. C. Rohr, L. Ecola, J. Zmud, F. Dunkerley, J. Black, E. Baker. 2016. Travel in Britain in 2035: Future scenarios and their implications for technology innovation. In Innovate UK from www.rand.org /pubs/research_reports/RR1377.htm
11. Sumit Arora. 2014. Designing a Smart Bus Stop for Metropolitans and Tier-1 Cities of India. In *Proceedings of the India HCI 2014 Conference on Human Computer Interaction* (IndiaHCI '14). ACM, New York, NY, USA, DOI: https://doi.org/10.1145/2676702.2676722
12. John Urry. 2016. What is the future. Polity Press, Cambridge, UK, Malden, MA
13. Catia Prandi, Valentina Nisi, and Nuno Nunes. 2017. Bus Stops as Interactive Touchpoints: Improving Engagement and Use of Public Transport. In *Proceedings of the 12th Biannual Conference on Italian SIGCHI Chapter* (CHItaly '17). ACM, New York, NY, USA, Article 20, 6 pages. DOI: https://doi.org/10.1145/3125571.3125593
14. Peter Fröhlich, Alexandra Millonig, Anna-Katharina Frison, Sandra Trösterer, and Matthias Baldauf. 2018. User Interfaces for Public Transport Vehicles: Future Opportunities and Challenges. In *Adjunct Proceedings of the 10th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (AutomotiveUI '18). ACM, New York, NY, USA, 50-55. DOI: https://doi.org/10.1145/3239092.3239101; https://www.auto-ui.org/18/program/day1/