Current Insights in Human Factors of Automated Driving and Future Outlook Towards Tele-Operated Remote Driving Services

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Abstract. Across the automotive industry, manufacturers have recently released various Partial Automation systems (SAE Level 2) which allow simultaneous/combined execution of both lateral and longitudinal vehicle control at the same time, yet still require active human supervision/engagement. Current reactive trends will be reviewed across major automotive players regarding differences in terminology, HMI input/outputs, and escalation intervals. Scholarly research is also reviewed pertaining to proactive strategies for driver engagement. Additionally, human factors research and findings will be presented regarding recommendations for situation awareness, human machine interfaces, TOR, as well as shared control concepts. The tutorial will conclude with discussion and brainstorming around outlook toward tele-operated remote driving services (Tele-Driving); what they have to offer beyond assisted/automated driving, autonomous vehicles, and ride-hailing/car-sharing paradigms; as well as the design/conduct of human factors research regarding Tele-Driving.

Keywords: Human Factors · Automated Driving · Autonomous Vehicles · Self-driving Cars · Situation Awareness · Take Over Request · Human Machine Interface · Tele-Operated Driving

1 Introduction

Across the automotive industry, manufacturers have recently released various Partial Automation systems (SAE Level 2) which allow simultaneous/combined execution of both lateral and longitudinal vehicle control at the same time. However, at such a level of automated driving, drivers still retain responsibility and are at high risk for losing engagement with the driving, for example “monitoring of driving environment” and “performing all remaining aspects of the dynamic driving task”.

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First, the tutorial will begin by revealing current trends already observable out on the roads of today. Present on-the-market reactive driver engagement strategies (for SAE Level 2) will be reviewed across major automotive players (Volvo, GM/Cadillac, Tesla, Audi, BMW, Infiniti, Mercedes-Benz). The review will cover differences in terminology, HMI input/outputs, and escalation intervals (including specific examples of initial/first stage warnings). Individual summary sheets with further details and examples per each of the reviewed manufacturers will be provided. Secondly, the tutorial will continue with an overview from scholarly research to underscore developments and avenues to address the problem of driver engagement in various preventative manners. Proactive strategies for engagement will be broadly surveyed across various human factors literature concerning different operator domains, and six different key theme/categories will be used to organize and summarize their insights. Additionally, (and applicable to higher levels of automation coming down the road), human factors research and findings will be presented regarding recommendations for situation awareness, and human machine interfaces regarding transitions of control (e.g., TOR) back towards a human driver, as well as shared control concepts.

Comparatively, in the last portion of the session, the tutorial will conclude with discussion and brainstorming around outlook toward another new alternative advanced transportation concept: tele-operated remote driving services (Tele-Driving). Regarded as a golden benchmark for safe and efficient transport operations, the aviation domain has evolved over many decades (e.g., beyond the single dimension of levels between human-automation control). For example, in terms of remote operation, Unmanned and Remotely Piloted Aerial Vehicles have been widely expanding operations since the early 2000s, and it is currently estimated that more than a million have been sold (a commercial enterprise now in excess of military application origins).

Through identification of key underlying emergent triggers/trends, the potential of such a concept area for enhanced research, development, and application in the automotive domain will be considered relative to that of already recognizable large scale game-changers and money-makers. Compared to assisted/automated driving, paid professional operators could be expected to be safer drivers than those from the common public who would rather be doing something else and furthermore, little to no costly and sophisticated on board vehicle sensors (e.g., RADAR, LIDAR) would be required. Compared to autonomous driving, human judgment currently remains more flexible than machine logic, humans retain ethics/responsibility without direct programming, and no advanced driving decision algorithms (e.g., SLAM) would be required. Compared to ride-hailing/car-sharing, using the consumer's own vehicle could increase comfort (privacy) and convenience (carry-on/storage), while reducing cost (extra trips and wait times due to dispatching a vehicle), and risks (improved circadian phases of a global operator network, healthier professional operators from a safer/cleaner controlled environment). After the introduction of potential benefits of Tele-Driving, envisioned use cases and solution feasibility will be covered in detail including technology maturation trends and preliminary studies from both the perspective of the tele-driver as well as the tele-passenger.

2 About the Speakers

All speakers were Marie Curie Research Fellows in the Human Factors of Automated Driving project (www.hf-auto.eu) with a mission to train Early Stage Researchers and to generate knowledge on human factors of automated driving towards safer road transportation.

Christopher D. D. Cabrall, pursues the PhD degree from the Delft University of Technology, Department of Cognitive Robotics - Intelligent Vehicles Group. Previously, through SJSURF he was a contract employee at NASA in their Human Systems Integration Division for 5+ years. He has also served as a civil servant in the Human Factors Department at the U.S. DOT Volpe National Transportation Systems Center for several years. He is an author on 30+ human factors scientific publications.

Alexander Eriksson, is a Researcher in the Driver and Vehicle section of VTI. Formerly, he completed his PhD in the Transportation Research Group at the University of Southampton. Alexander's primary research focus is on human-automation interaction. His work draws on lessons learnt in aviation, which is then combined with experiments in driving simulators and on the road.

Zhenji Lu, is a member of the Intelligent Vehicles Group of the Cognitive Robotics Department and pursues the PhD at the Delft University of Technology. He studies human behavior in authority transitions between manual and highly automated driving (i.e., Transitions of Control), situation awareness and unexpected situations, such as system failures.

Bastiaan Petermeijer, is a Post-Doctoral Researcher on the Symbiotic Driving Project at the Haptics Lab of Delft University of Technology. He completed his PhD at the Technical University Munich, Department of Ergonomics, where he developed a vibrotactile seat to support the driver during the take-over process. His Master's thesis research from Delft University of Technology resulted in a publication that won the 2014 Human Factors Prize in Human-Automation Interaction/Autonomy.

3 Tutorial Submission Decision

Dear Christopher Cabrall, We are pleased to inform you that your half-day tutorial submission has been accepted for presentation at the 1st International Conference on Intelligent Human Systems Integration: Integrating People and Intelligent Systems (IHSI 2018) to be held at the JW Marriott Marquis, Dubai, United Arab Emirates, January 7-9, 2018. From many tutorial proposals submitted this year, we were able to accept only three! The acceptance decision for your tutorial submission is based on the quality of the tutorial and outstanding tutorial presenter background and knowledge in the subject field, the acceptance is based on reviews conducted by the tutorials chairs.

Tutorial ID#: 150 [T-2]. *Date/Time*: (8:00 – 12:00) Monday, January 8, 2018.

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