Paper Title: Requirement Determination for an Environment Detection System for Conduct-by-Wire

Authors: Sebastian Geyer*, Stephan Hakuli**, Andrea McDougall Irizarry***, Hermann Winner*, Benjamin Franz****, Michaela Kauer****

* Institute of Automotive Engineering, Technische Universität Darmstadt, Germany
** The results contributed to this paper were achieved when serving as research assistant at the Institute of Automotive Engineering at Technische Universität Darmstadt. Stephan Hakuli is now with the IPG Automotive GmbH, Karlsruhe, Germany
*** University of Puerto Rico at Mayagüez, United States of America
**** Institute of Ergonomics, Technische Universität Darmstadt, Germany

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Research and/or Engineering Questions/Objective

Conduct-by-Wire (CbW) is a research project, which breaks away from today’s vehicle guidance by shifting the vehicle control task from a stabilization level to a conducting level. Instead of continuous stabilization on a designated trajectory – using the conventional control elements for manual steering, braking and accelerating – a Conduct-by-Wire vehicle is controlled by means of maneuver commands. This research project at Technische Universität Darmstadt aims to provide a technical feasibility assessment of this concept focusing on the driver-vehicle interaction, the identification of the functionality the automation has to provide, and on the requirement determination for the environment detection system.

Methodology

This paper introduces a systematic top-down approach that allows identifying the requirements for an environment detection system for a CbW vehicle. Starting with the development of a catalog of driving scenarios, derived from guidelines for road design and traffic laws, potential driving scenarios for highways, country roads, and urban scenarios a CbW vehicle has to cope with are identified. This step is followed by a detailed analysis of the information needs occurring for the combinations of driving scenarios, CbW automation levels, and possible driving maneuvers. Hence, these information needs allow deriving the requirements an environment detection system has to fulfill in order to realize fully maneuver-based vehicle guidance and to guarantee safe maneuver execution. The requirements are finally validated using the vehicle simulation tool IPG CarMaker.

Results

The paper introduces a catalog of driving scenarios that builds the basis of this method. The information needs for different classes of driving scenarios are systematically analyzed for different CbW automation levels and maneuvers. The requirements for an environment detection system, derived from the identified information needs, are further specified for static information (e.g. priority regulation at an intersection) and dynamic information (e.g. the detection of moving obstacles). Furthermore, the performance parameters, e.g. the detection range of the sensors, are determined. Moreover, this paper shows the simulation results using IPG CarMaker, where real driving scenarios are implemented and their maneuver-based completion with the determined sensor configuration is tested. This paper closes with an analysis of today’s environment detection systems and an assessment of their suitability for CbW based on the previous results.

Limitations of this study

This paper presents the results of a theoretical approach that aims to identify the requirements for an environment detection system for Conduct-by-Wire. Effects such as typical failures of different sensor concepts are to be focused in a future study and thus are not part of this paper. Although this method is able to reveal technical challenges in realizing the Conduct-by-Wire concept an experimental validation with a prototype vehicle seems to be the indispensable next step.

What does the paper offer that is new in the field including in comparison to other work by the authors?

The method presented in this paper allows for the first time the requirement determination for an environment detection system for maneuver-based vehicle guidance based on the Conduct-by-Wire principle. In previous studies of the authors this fundamental aspect has not been considered. Thus, the presented results build the basis of the technical feasibility assessment of Conduct-by-Wire.
Conclusion
The proposed approach allows a top-down analysis of the requirements for an environment detection system for a Conduct-by-Wire vehicle. The results presented in this paper will have a fundamental influence on the development of the system architecture and the safety concept of a future prototype vehicle. Knowledge gained may also be valuable not only for the realization of Conduct-by-Wire but also for the development of future advanced driver assistance systems.

References