University of Fribourg / Faculty of Science and Medicine / Department of Chemistry

# Adaptive and Multimodal Human-Vehicle Interaction Model for Supervision in Conditionally Automated Driving

**Marine Capallera**

The development of driving assistance aims to increase user safety, reduce accidents, traffic and the environmental impact of driving. Another challenge is to assist drivers in their driving and navigation tasks. Thus, vehicles become more and more autonomous in certain tasks related to driving. The framework of this thesis work is placed in the context of conditionally automated vehicles. That is to say that drivers are not required to monitor the behavior of their vehicle but that they must be able to take over control of it at the request of the latter. Thus, this automation modality tends to change the role of drivers. They will go from being the main actor in the driving to being the supervisor. However, if drivers are engaged in a non-driving related task when takeover is requested, it can be even more dangerous because they are no longer in the control loop. This is why it is important to keep the drivers aware of the situation during the autonomous driving phases in order to be able to perform an efficient and safe takeover if necessary.

The main objective of this thesis is to propose an adaptive multimodal system taking into account the whole interior environment of the car in the form of peripheral and subtle interactions in order to support the drivers in their supervision task and to increase/maintain their situational awareness.

For this purpose, a first analysis has been performed in order to highlight the factors limiting the proper functioning of autonomous systems and the information to be transmitted. A second analysis was performed in order to identify the parts of the vehicle used to transmit the peripheral information. This second analysis allowed to propose the association of interfaces using different modalities and parts of the vehicle which will be implemented in the adaptive system. These interfaces are ambient lights around the dashboard, vibrations in the driver's seat and contextual and visual information displayed on the driver's personal device used to perform a non-driving task. The proposed system is part of a larger architecture allowing to predict the driver's state and to adapt the interfaces to support the supervision of the drivers but also their intervention in case of takeover request. In order to test and validate the system, several scenarios and interaction prototypes have been realized and evaluated. Finally, the proposed system is governed by a rule-based model. The combination and characteristics of the interfaces depend on the state of the driver and the situation. The results encourage further studies to provide adaptive contextual information depending on the circumstances and state of the driver. It seems beneficial to maintain situational awareness, confidence and user experience of drivers by using a combination of interfaces to provide a complete multisensory and body experience.

Jury :
Prof. Dr. Rolf Ingold (thesis supervisor)
Prof. Dr. Elena Mugellini (thesis-co supervisor)
Prof. Dr. Omar Abou Khaled (co-examiner)
Prof. Dr. Nadine Couture (co-examiner)
Prof. Dr. Philippe Curdré-Mauroux (president of the jury)