HMI for the anticipation of upcoming curvature in automated lateral control

Abstract:
Driving Automation Systems conduct the driving task to a partial or even full extent. HMI concepts that support the understanding and predictability of the system's behaviour may be beneficial for the safe and efficient use of such systems. We investigated HMI concepts indicating the predicted curvature of the road section in two consecutive studies. The research questions were: How do drivers perceive curvy roads? What do drivers expect from a visual HMI concept indicating the upcoming curvature during driving with automated lateral control? Using a Wizard-of-Oz set-up, two on-road studies were conducted on rural roads and highways in Germany. In the first study, N=24 drivers evaluated the curvature of the experienced road sections on a visual-numeric rating scale. The results showed a strong correlation between lateral acceleration in the curve and the curve ratings. A possible explanation might be that drivers take into account not only the visual perception of the curve geometry but also the perceived lateral acceleration. A second study was conducted with the same Wizard-of-Oz vehicle setting. Another N=24 drivers evaluated different HMI concepts for automated vehicles that depict upcoming curvature. We used two
experimental methods: First, the drivers influenced the curve images in the HMI display themselves using a mechanical slider. Second, the drivers experienced a dynamic display indicating upcoming curvature based on two different parameterizations. The display either used the radius of the curve ("geometry" concept), or it indicated curvature based on the lateral acceleration in the vertex of the curve ("acceleration" concept). Each condition was experienced twice with different driving speeds. The participants evaluated the appropriateness of each display for presenting the upcoming curvature. The results showed that drivers preferred the geometric concept and used the manual slider according to the geometric appearance of the curvature, independent of diving speed. We discuss the results in both studies based on the characteristics of the curves. Overall, the results of the study allow for conclusions on a human factors based parameterisation of a visual feedback system for automated lateral control.