

Development and Implementation of a Novel Intelligent Speed Adaptation System based on Sight Distance Analysis

Summary

Road safety can be improved by designing the road infrastructure along with the vehicle, a concept or process known as Simultaneous Vehicle Infrastructure Design (SVID). This study aimed to develop and implement an innovative in-vehicle driver assistance system taking into account the prevailing road environment.

To begin with, driver behaviour and performance were ascertained when negotiating road curves with sight limitations. In a driving simulator study, road safety conditions were examined by comparing stopping distance (SD) with the available sight distance (ASD). It was noted that a number of drivers adopted risk compensation strategies that resulted in lower SDs compared to ASDs, thus operating in safe driving conditions. Some drivers reduce the speed to lower SDs, some increase the lateral distance from the sight obstruction to obtain higher ASDs, some adopted both strategies, and others did nothing. However, a significant number of drivers even though used the risk compensation strategies, but they were not able to correctly judge the vehicle speed and they negotiate the road curves at excessive speed and travel in unsafe sight conditions ($SD > ASD$). In another study, it was confirmed that providing safety barriers (i.e., guardrails) along the inner side of the road curves influences the drivers' behaviour. With the increase in the guardrail height, drivers tend to increase the lateral distance. As a higher guardrail influences the driver's line of sight, which resulted in the lower ASDs.

In light of the inconsistency of drivers' performance and assisting them to adapt safe operating speed along curves with limited sight distance, we developed an in-vehicle driver assistance system, called V-ISA (Intelligent Speed Adaptation for Visibility). The functionality of the V-ISA is based on the real-time road environment and operates as a dynamic speed control system. The V-ISA is proposed in three different variants: (i) V-ISA information, (ii) V-ISA warning, and (iii) V-ISA intervening. Further on, the V-ISA algorithm (model) was implemented, tested, and validated in the simulated environment.

Subsequently, the present study provides the effectiveness and influence of the V-ISA variants on driver behaviour and performance at the driving simulator. Experiments were conducted with the use of V-ISA variants under different geometrical and traffic conditions. Results indicated that the V-ISA have a significant influence on the drivers' longitudinal behaviour (speed) and was effective in risk reduction associated with speeding. For most of the cases, the feedback modalities implemented for the V-ISA variants had no significant effect on the drivers' transversal behaviour. The system acceptance, usability and mental workload were also measured on a subjective scale. The investigation suggested that V-ISA can have a positive impact on road safety with a higher acceptance rate and system usability.