

Driver Interactions with Adaptive Collision Avoidance Systems: Effects of Multiple Steering Interventions on Driver Performance and Trust

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This paper investigates the impact of different levels of automation control authority on drivers' performance, trust, and safety during critical situations. Previous research has indicated that drivers trust and accept automation so long as they possess final authority over the system; however, in some highly critical situations, it has been deemed necessary that authoritarian automation act independently. These paradoxes have resulted in the need for adaptive automation in which the system implements the automation level based on the situation, user capacity, and risk type. A driving experiment that included 40 participants was conducted to evaluate drivers' trust in, acceptance of, and interaction with multiple automated functions that are used with adaptive automation to avoid collisions during hazardous lane changes. The following four conditions were compared: no automation assistance; a haptic steering control system that provides varying degrees of force feedback to resist hazardous steering maneuvers; an automatic steering control system that decouples the driver's steering function (steer-by-wire) and autonomously controls the tire angle to drive the car away from the hazard; and an adaptive control system that can provide multiple (haptic and/or automatic) steering control functions based on the situation. While all systems were more effective in accident prevention compared to the unsupported driving condition, the adaptive system was more effective than the haptic system and less effective than the automatic system. Drivers' performance and trust significantly improved under the adaptive system, which was able to attenuate the negative effects resulting from the haptic and automatic systems.