Dissertation

Driver Recognition and Reaction to Unintended Acceleration

意図しない加速時のドライバの認知と応答

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論 文 要 旨
Abstract of Dissertation

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Recently, research on automation system development is attracting a lot of attention ranging from researchers to automotive industry manufacturers to leading technology brands. In 2008, the US National Highway Traffic Safety Administration's (NHTSA) National Motor Vehicle Crash Causation Survey reported that 98 percent of road accidents were caused by human error. Researchers estimate that automation technology will reduce human errors that can lead to road accidents. However, some accidents were related to self-driving automated vehicles. These accidents indicate that the system is far from perfect and that drivers still need to take control in dangerous situations. Drivers can sometimes rely too much on automation systems. Most drivers involved in an accident have admitted that they were not paying attention and not ready to take control at the time of the crash. Sometimes, the driver could take control but did not have enough time to make the safest decision. This situation shows that recognition time is crucial. Shorter recognition time means that the driver has plenty of time to think and react safely. In recent years, researchers have begun studying recognition and reaction times, but they were using highly simplified conditions. In cases of real accidents, the conditions are complex. Therefore, research on recognition and reaction times in complex and actual situations are critical.

Unintended accelerations can occur in vehicles unexpectedly and uncontrollably. Most studies related to unintended acceleration have focused on potential malfunctions in electronics that control the vehicle's powertrain, software defects, accelerator pedal entrapment, sticking, and missed application. Few studies have focused on human factors such as driver recognition and reaction times. Unintended accelerations occur without warning. For years, the NHTSA has received

many incident reports related to unintended acceleration. Incident investigations by car manufacturers often find no fault. In many accidents related to unintended acceleration, drivers claim they were unable to regain control of the vehicle by braking. Some cases have resulted in severe injuries and deaths.

In this study, the primary purpose was to analyze the driver's ability to recognize unintended acceleration in the automated vehicle. To achieve this goal, the author divided the study into two phases. In phase one, the conditions were simple and the road used was a 5km straight road. In phase two, the conditions were complicated and imitated a real driving scenario. The roads used were straight, intersections, and left and right curved roads.

Recognition time and recognized velocity are two of the most important factors that can prevent crashes. Recognition time refers to the time it takes for the driver to recognize the unintended acceleration. Recognized velocity refers to the velocity at which the driver detected the unintended acceleration. The statistical tools used for analysis were the F-test, t-test, and ANOVA method.

The result show that drivers reacted differently depending on the situation, type of road, acceleration or deceleration, engine sound, and type of traffic conditions; for examples with and without a leading vehicle and type of pre-crash situation. Drivers react faster during deceleration-unintended acceleration than acceleration-unintended acceleration because neurons in the middle temporal lobe are more sensitive to deceleration visual stimuli. Drivers also realize unintended acceleration earlier and can take control without delay. Engine sound is one of the important indicators of unintended acceleration. Drivers recognize unintended acceleration earliest at the pre-crash scenario with a pedestrian because the pedestrian and the relative velocity of pedestrian from driver was the lowest, and the pedestrian was visible from a distance. Leading vehicles also affect the driver's ability to recognize velocity changes.

The implication of these results is that in developing an automated vehicle system related to driver recognition or reactions to unintended acceleration, researchers should consider curve direction as an important factor. These findings provide insights that can be useful in developing automated vehicles and silent vehicles. Recognition time and velocity are important factors that can help prevent a crash and improve road safety. Early detection gives drivers more time to make decisions in response to the road hazard. By developing advanced fail-safe systems, smart sensor technology, and pedestrian tracking, autonomous driving systems can be considered safe for future universal deployment in cars. These will also give car manufacturers insight into driver reaction to automation failure during unintended acceleration. Simultaneously with the

development o automated vehicle technology, car manufacturers and engineers should develop multiple fail-safe systems. If the technology malfunctions, the system should be able to detect the malfunction in the vehicle, other surrounding vehicles, and use pedestrian tracking to avoid accidents.