Summary of SIP-adus Project (FY2016)

Name of the project	Human Factors and HMI Research for Automated Driving
Responsible Organization	SIP-adus Human Factors and HMI Research Consortium

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Background and Objectives of the Project

One of the social expectations towards the automated vehicle technology is dramatic reduction of road crashes. It is known that over 90% of crashes are due to human errors. The technology is expected to eliminate the human errors by driving the car by a computer. The industry is targeting to commercialize the partially/conditionally automated vehicles in coming several years as strategic steps towards the fully automated vehicles. The driver partially or conditionally performs driving tasks as well as new tasks in the partial/conditional automation. Such a role of the driver potentially generates risk of new safety problems, system induced problems.

The objective of this project is to minimize the system induced problems with the partial/conditional automation, based on understanding of human factors underlying the problems. The project focuses on understanding of human limitations in use of the systems and development of HMIs that support the driver to perform the new tasks and the new role successfully. It also includes development of system functions that minimize conflicts with surrounding road users in mixed traffic.

Project Summary

This project includes three tasks identified as those with high priority as common foundation for safe automated vehicle technology.

❑ Task A: effects of diver’s understandings of the system on his/her behavior in transition.

【Planned goals in FY2016】

The goal is to understand effects of driver’s knowledge about the system functions and its limitations on his/her behavior in transition from automated (levels 2 and 3) to manual. It also identifies requirements for the knowledge information given to the drivers prior to actual driving to be effective for driver’s successful take-over. (Driving simulator experiments)

【Outcomes in FY2016】

- Divers need pre-driving information about the system functions for successful take-over in response to TOR. The pre-driving information must include “possibility of necessary take-over”, “how the HMI displays TOR”, “concrete examples of take-over situations”. The information must be simple because excessive information gives negative effects to older drivers.
- When explaining take-over, expression “the system stops working” is inappropriate. The information needs to be explained from driver’s perspective such as “you must take over driving”.
- Experiencing take-over situations (by simulation or test drive etc.) improves chance of successful take-over afterwards.
- For the situation where the vehicle approaches hazards without TOR due to functional limitations (level 2) and the driver is expected to overtake the driving task, the pre-driving information “you must be monitoring the environment” is insufficient. The information must include the expression “There are critical situations where TOR does not go off”. Also the information must include undetectable objects as concretely as possible (e.g. pylons) .

❑ Task B: effects of driver state on his/her behavior in transition

【Planned goals in FY2016】

The goal is to extract metrics of driver state that influences driver’s behavior in transition from automated (levels 2 and 3) to manual. Fundamental specifications for a driver monitoring system is determined. (Driving simulator experiments)

【Outcomes in FY2016】

- Driver state when driving with the system influences his/her behavior in transition from automated to manual after TOR. The behavioral changes in transition varies depending on the type of driver state.
    - Cognitively loaded →The sluggish cognitive process degrades driver’s performance to avoid collision with an obstacle.
    - Physically (visually and manually) loaded →Insufficient situation awareness causes abrupt steering that leads to increase in unstable steering operation and increase in time to stabilize the vehicle laterally. →This will increase the risk when accurate steering operation is necessary after TOR (e.g. TOR in a curve).
    - Low arousal level →The time to initiate steering operation after TOR is delayed.
- Physiological metrics of driver state that degrades driver performance in transition have been extracted. Metrics measurable in a vehicle in real time are amplitude/frequency of the saccadic movements of the eyes, frequency of blinking, percent time of looking away from the front, and percent eye closure.
- Fundamental specifications for a driver monitoring system have been determined and the system has been prototyped.

❑ Task C：Non-verbal communication between the automated vehicle and surrounding road users

【Planned goals in FY2016】

The goal is to model the methods and procedures of non-verbal communication between drivers and between driver and pedestrians based on observed communication behaviors. The model will be used for functionalizing Level 3+ systems to be communicative. Preliminary investigation (questionnaire survey) of cross-cultural differences in communication is included. (Fixed point/in-vehicle observation and closed field experiments)

【Outcomes in FY2016】

- Drivers mainly use vehicle behaviors (e.g. deceleration and stopping vehicle) as communication signals to surrounding drivers. External HMI displaying intention of the system is expected to be effective in some conditions where the perceived meaning of the vehicle behavior is unclear as communication signals.
- Pedestrians mainly read intention of the driver/vehicle to yield from vehicle behavior. External HMI of the Level 3+ systems is expected to be effective to send the message to yield earlier than using vehicle behavior.
- Fundamental communication procedures using vehicle behaviors and other signals (e.g. hazard lights) have been modelled quantitatively for typical scenarios.
- Perceived meanings of communication signals differ depending on attribute of pedestrian (i.e. child/older person, licensed/unlicensed etc.) and traffic culture in some conditions. It must be considered in designing vehicle behavior and external HMI as communication signals.

Future plan

For all the tasks A, B and C;

- The results obtained from the driving simulator experiments will be tested in test tracks and FOT.
- Various HMIs will be prototyped and evaluated in driving simulators and test tracks.
- The obtained results will be used for various policies, guidelines and standards.