SIP-adus Activities Report

—Human Factors—

Cross-Ministerial Strategic Innovation Promotion Program
Innovation of Automated Driving for Universal Services

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Tasks with high priority

Three tasks are included in the 3 year research project which started in FY2016. The tasks were selected as those with the highest priority through the SIP HMI Taskforce conducted in FY2015.

Task A

Task A investigates effects of system information (static and dynamic) on drivers' behavior in transition from Levels 2 and 3 to manual.

Task B

Task B investigates effects of driver state (readiness) with Levels 2 and 3 on his/her behavior in transition to manual.

Task C

Task C studies non-verbal communication between drivers and other road users, and investigates effective ways to functionalize the automated vehicle (Level3+) to be communicative.

Task A

❑ Aims

Task A investigates effects of system information (static and dynamic) on drivers' behavior in transition from Levels 2 and 3 to manual. Study of HMI to display dynamic state of the system is included. Year 1 focuses on the effects of static information of the system (knowledge).

❑ Method (Year 1)

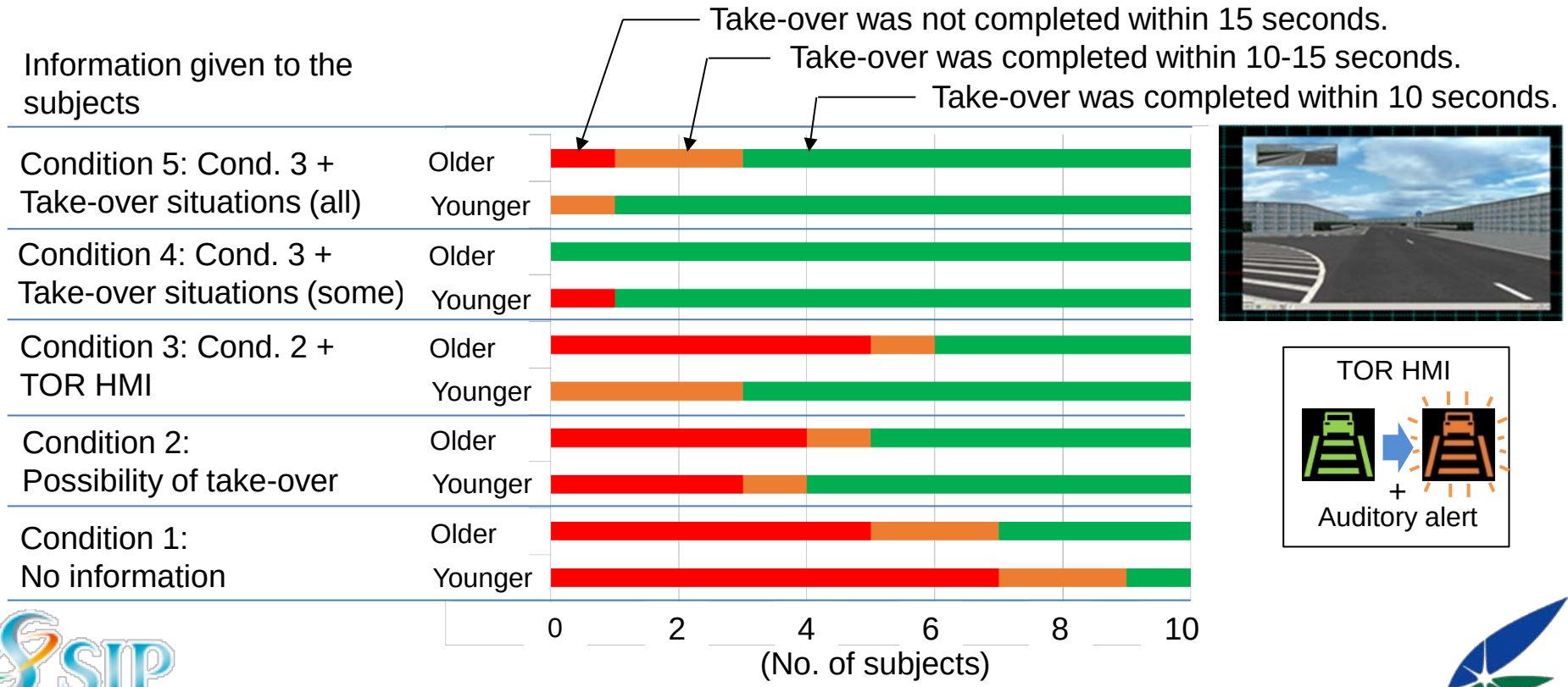
Subjects were given various controlled information about functions and limitations of Level 3 system before driving in the driving simulator. Subjects' behavior in transition was analyzed as a function of the given information.

Information given to the subjects

- Condition 1: No information
- Condition 2: Possibility of take-over
- Condition 3: Cond. 2 + TOR HMI
- Condition 4: Cond. 3 + Take-over situations (some)
- Condition 5: Cond. 3 + Take-over situations (all)

❑ Results as of January 2017

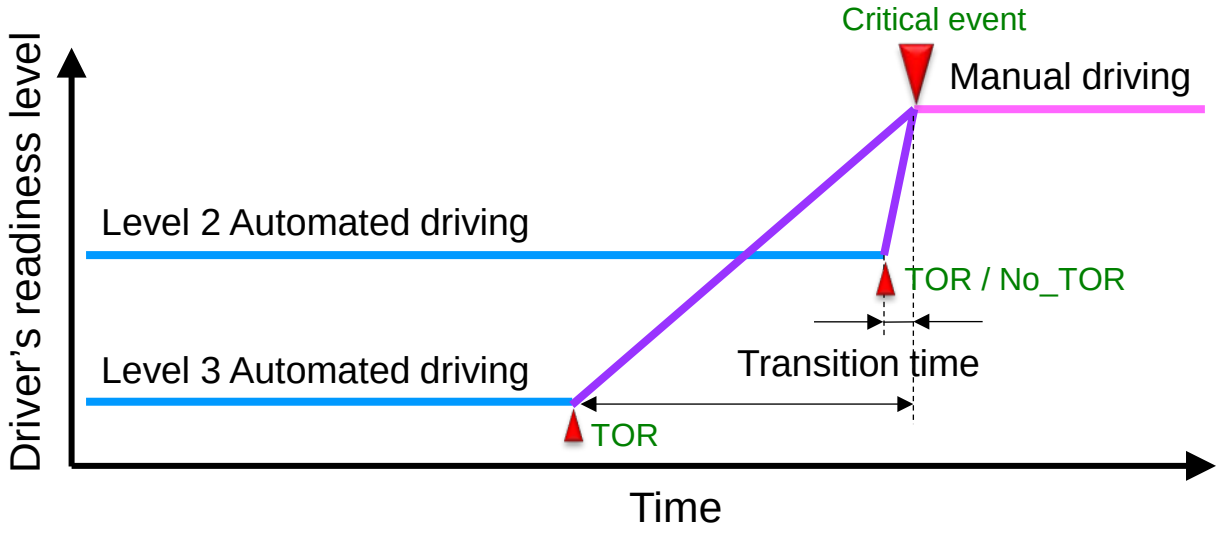
- Driver's knowledge of system functions influenced driver's take-over performance.
- Information about take-over situations was found to be important for successful take-over (Cond. 1-3 vs Cond. 4,5).
- However, too much information about take-over situations degraded subjects' behavior especially for older subjects (Cond. 5).



Task B

❑ Aims

Task B investigates effects of driver state (readiness) with Levels 2 and 3 on his/her behavior in transition to manual and extract metrics of readiness for the driver monitoring system in Year1. Transition time will be estimated as a function of readiness in Year 2 and 3. HMI to help the driver to stay with appropriate readiness will be also studied.



❑ Method (Year 1)

Subjects drove Level 2 and 3 systems with cognitive and physical additional tasks in the driving simulator. The scenario included several events with low criticality. Subjects' physiological metrics were measured to extract those correlated with degraded performance in the events.

Driver state

- Cognitively loaded by N-back tasks
- Physically (visually & manually) loaded by SuRTs※
- Low arousal

Controlled

※SuRT: Surrogate Reference Task (see ISO/TS14198)

Physiological metrics

- EEG (ERP)
- Visual behavior
- Saccadic movements
- Pupil diameter
- Blinking behavior
- Perclos
- Heart rate
- Blood pressure

etc.

Performance at the event

- Longitudinal and lateral control of the vehicle
- Minimum distance and minimum TTC to the hazard
- Time spent to regain control

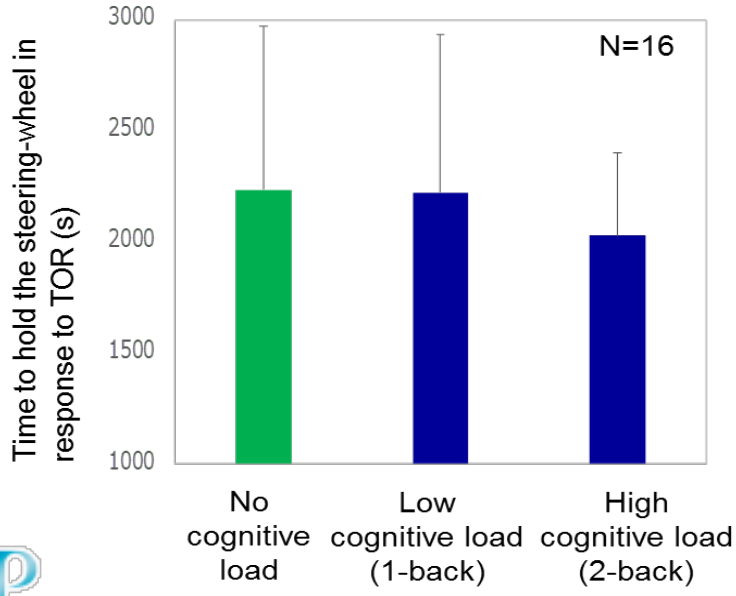
etc.

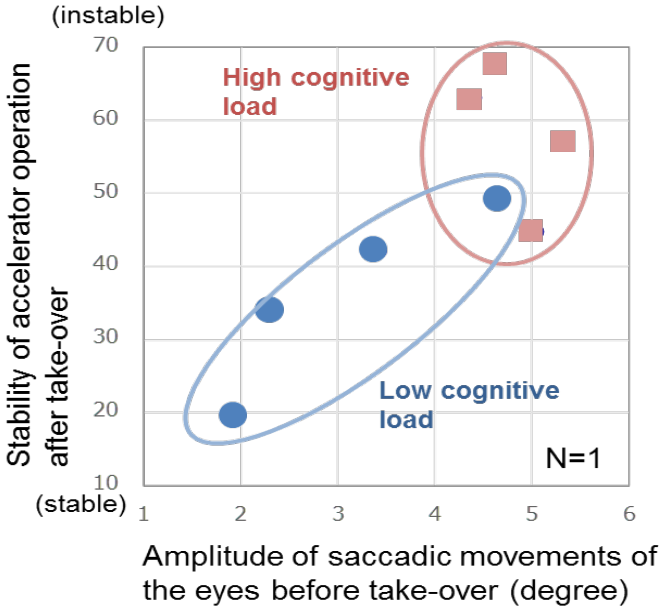
Correlation

System terminates
→ Leading vehicle changes lane
→ Stationary vehicle appears

❑ Results as of January 2017

- Low arousal state of the driver while driving with the automated system delayed the time for the driver to hold the steering wheel in response to TOR and also degraded driving performance after holding the steering wheel. Perclos was found to be a good measure of the arousal state.
- Physically loaded and cognitively loaded state of the driver while driving with the automated system did not affect driver's response time to hold the steering wheel, whereas they degraded driving performance after holding the steering wheel. The amplitude of saccadic movements of the eyes was found to be a good measure of these two types of the state.





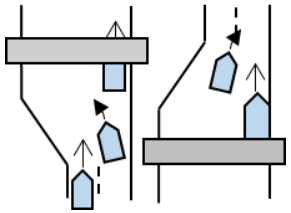
Task C

❑ Aims

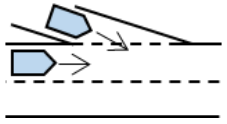
Task C studies non-verbal communication between drivers and other road users in Year 1. Fundamental requirements for the external HMI of automated vehicles for communication will be identified in Year 2 and 3. Differences in communication in different traffic cultures will be considered.

❑ Method (Year 1)

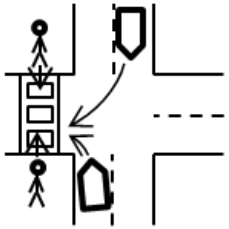
Communication behaviors between drivers and between driver and pedestrians were observed at fixed-points on public roads.



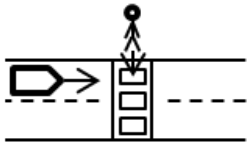
Around toll gates



Merging lane



Unsignalized intersection

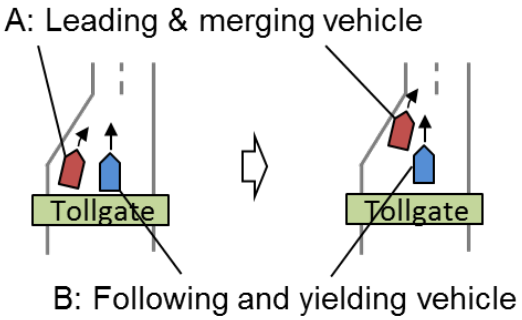


Unsignalized crosswalk

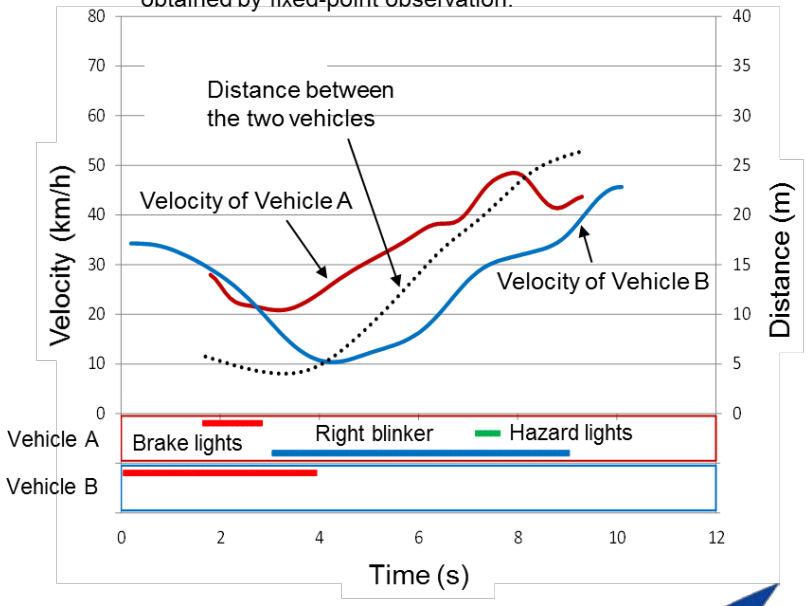
Example scenarios of fixed point observations

❑ Results as of January 2017

- Typical scenarios of driver-driver communication.
  Motorway: Merging after tollgates
  Local road: Right turning at unsignalized intersections, merging from minor roads, and negotiation with the oncoming vehicle when the lane is blocked.
- Typical scenarios of driver-pedestrian communication.
  Local road: Unsignalized crosswalk.
- Typical communication contents were “After you” and “Thank you”.
- Vehicle behavior (speed, deceleration and stopping etc.) and flashing headlights were the primary communication signals observed.
- Profiles of the vehicle behavior as the communication signal were estimated quantitatively from the video data.



❖ The data were quantified by processing video images obtained by fixed-point observation.



Next steps

- We plan to conduct research for remaining parts of each of the three tasks in Year 2 and 3.
- The next steps include validation of the Year 1 results in a test track and on roads (FOT).
- The outcomes will be used as inputs to standards, guidelines and regulations.