SIP-adus Human Factors and HMI research (on-going project)

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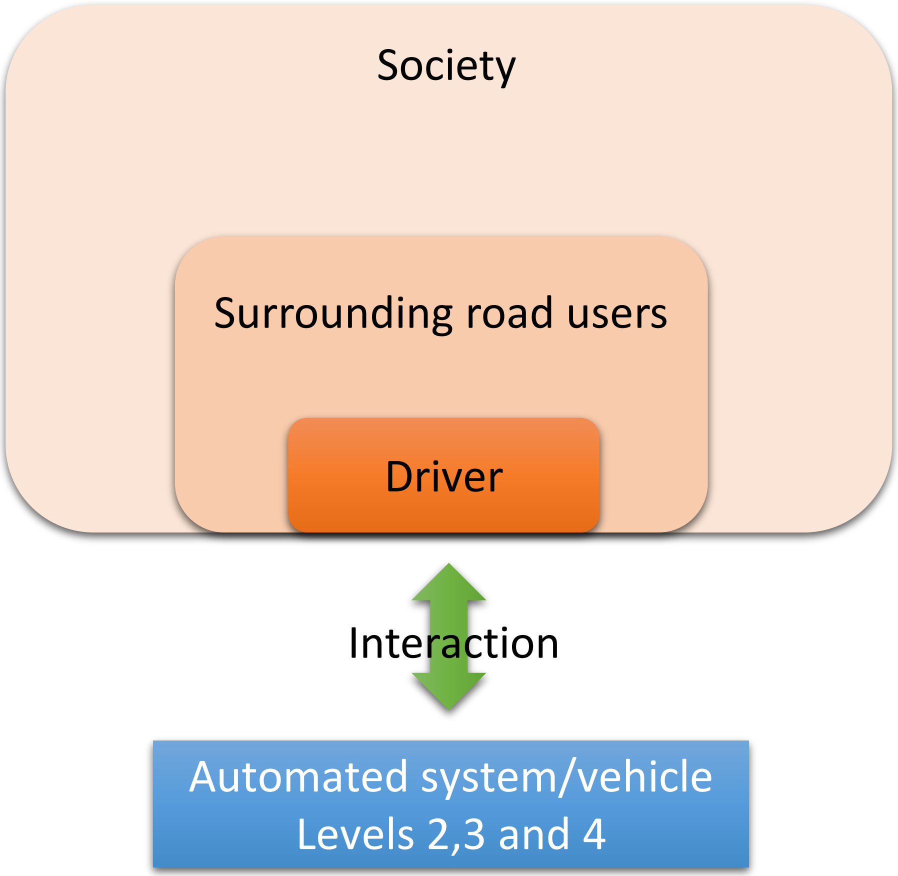
AIST, University of Tsukuba, Keio University, DENSO CORPORATION, and Tokyoto Business Service Co. Ltd.

Framework for extraction of HF problems



Overview of potential HF problems / research questions

<table>
<tr><td colspan="3" rowspan="2">Interaction between vehicle and driver/surrounding road users/society</td><td colspan="4">Level of automation (NHTSA, 2013) and research questions</td></tr>
<tr><td>Level 1</td><td>Level 2</td><td>Level 3</td><td>Level 4</td></tr>
<tr><td rowspan="9">Vehicle - Driver</td><td colspan="2">Understanding of system</td><td colspan="4"></td></tr>
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<tr><td>A-4</td><td>Understanding system behavior</td><td colspan="4">How to avoid worries and discomfort for system's driving manner differing from driver's manner?</td></tr>
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<tr><td>B-2</td><td>Transition from automation to fully manual</td><td></td><td colspan="2">How to avoid degraded response action of the driver unready to take over the vehicle control?</td><td></td></tr>
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Overview of potential HF problems / research questions

Interaction between vehicle and driver/surrounding road users/society			Level of automation (NHTSA, 2013) and research questions: Level 1	Level 2	Level 3	Level 4
Vehicle - Driver		Understanding of system				
	A-1	Understanding system functions	How to avoid over trust, over reliance, misunderstanding of functional limitations?			A
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Vehicle - Surrounding road users	C-1	Communication between the automated vehicles and surrounding drivers		How to functionalize the automated vehicles to be communicative with other drivers at intersections, merging, lane change and others?		C
	C-2	Communication between the automated vehicle and surrounding vulnerable road users		How to functionalize the automated vehicles to be communicative with pedestrians in crossroads, parkings, shared space and others?		
	C-3	Mediation between formal rules and traffic efficiency			How to mediate yielding with priority, difference between speed limit and traffic speed, and other conflicts?	
Vehicle - Society	D-1	Social value and acceptance of the automated vehicles			How to design functional deployment over time to raise social acceptance?	
	D-2	Liability			Who has the liability for crashes and legal violations caused by the system?	
	D-3	Licensing			Does licensing need to be changed for automated vehicles?	

Task A (3 years)

❑ Objectives

1. To investigate effects of static information of the system (knowledge) on drivers' behavior in transition from Levels 2 and 3 to manual. ← FY2016
2. To investigate effects of dynamic information of the system state on drivers' behavior in transition from Levels 2 and 3 to manual.
3. To identify fundamental requirements of the HMI displaying the dynamic information of the system state (prototyping included).

❑ Experimental method (FY2016)

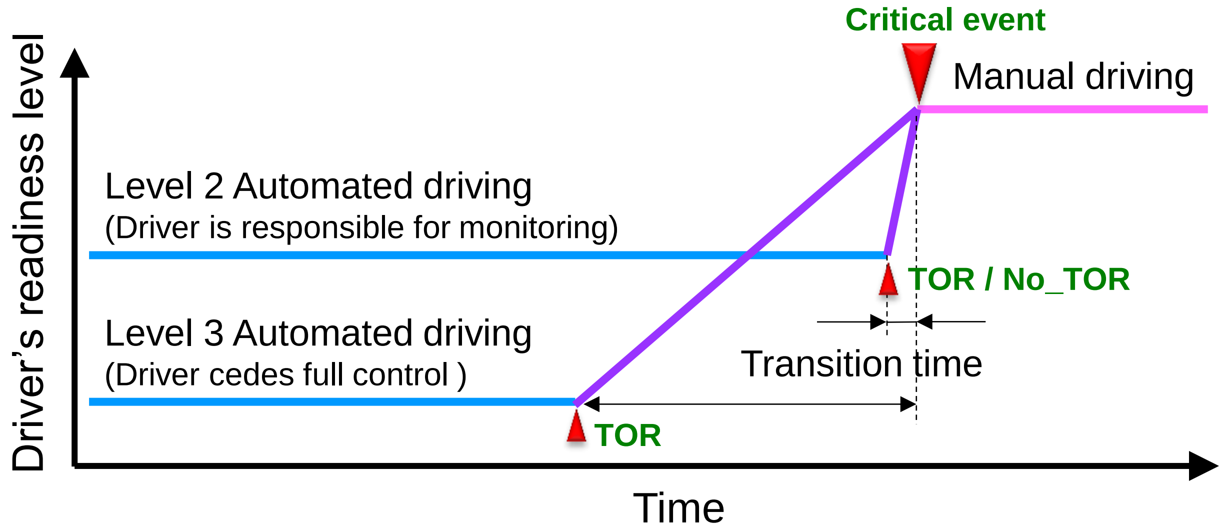
Subjects receive various levels of information about functions and limitations of Level 2 and 3 systems before driving the systems in the driving simulator. Subjects' behavior in transition is analyzed as a function of the received information levels.

Information given to the subjects
Occasional necessity of take-over
Meaning of TOR HMI
Take-over conditions
Possibility of silent failure
Driver's responsibility for monitoring

Task B (3 years)

❑ Objectives

1. To define driver's readiness and identify fundamental requirements for the driver monitoring system. ← FY2016
2. To define the transition time as a function of readiness.
3. To identify fundamental requirements of the HMIs for supporting the driver to stay with the appropriate readiness and to take-over the driving task smoothly (prototyping included).



Driver's readiness and transition

❑ Experimental method (FY2016)

Subjects drive Level 2 and 3 systems with cognitive and physical secondary tasks in the driving simulator. The scenarios include several events with low criticality. Subjects' cognitive and physiological metrics are measured to extract those correlated with performance in the events.

Driver state

- Cognitively distracted
- Physically distracted
- Low arousal
- Lack of SA
- Out of position

Controlled

Readiness

- Head orientation and visual performance
- Heart rate and blood pressure
- Body temperature
- Skin conductance
- EEG
- Posture and body movements

Performance at the event

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

Correlation

Task C (3 years)

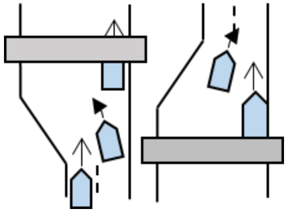
❑ Objectives

FY2016

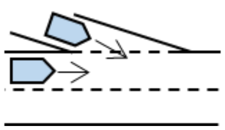
1. To study non-verbal communication between drivers and other road users.
2. To investigate the effect of ID display on behavior of surrounding road users.
3. To identify fundamental requirements for external HMIs and ID display for sending messages to surrounding road users (prototyping included).
4. To investigate effects of cultural differences on the communication (web or mail survey)

❑ Experimental method (FY2016)

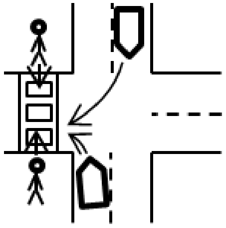
Communication behaviors between drivers and between driver and pedestrians are observed at fixed points and also in the car driven by the subject.
Communication signals to pedestrians, including older adults and children, are evaluated quantitatively in a closed field.



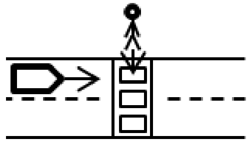
Around toll gates



Merging lane



Unsignalized intersection



Unsignalized crosswalk

Examples of fixed point observation

Conclusions

- SIP-adus Human Factors and HMI Research Project has been started in FY2016 with the support by the Cabinet Office. The project term is intended to be 3 years.
- The project includes;

  Task A: To investigate effects of system information on drivers' behavior.

  Task B: To investigate effects of driver state on his/her behavior in transition.

  Task C: To investigate effective ways to functionalize AV to be communicative.

  Several HMIs will be prototyped and evaluated to identify fundamental requirements.
- Major outcomes will be shared after each year.
- The project will use the FOT in Tokyo in the later phase to evaluate the outcomes in practical situations.