SIP Human Factors Research Project

Task B:
Assessment of driver states in automated driving and Investigation of driver controllability in transition from automated to manual driving

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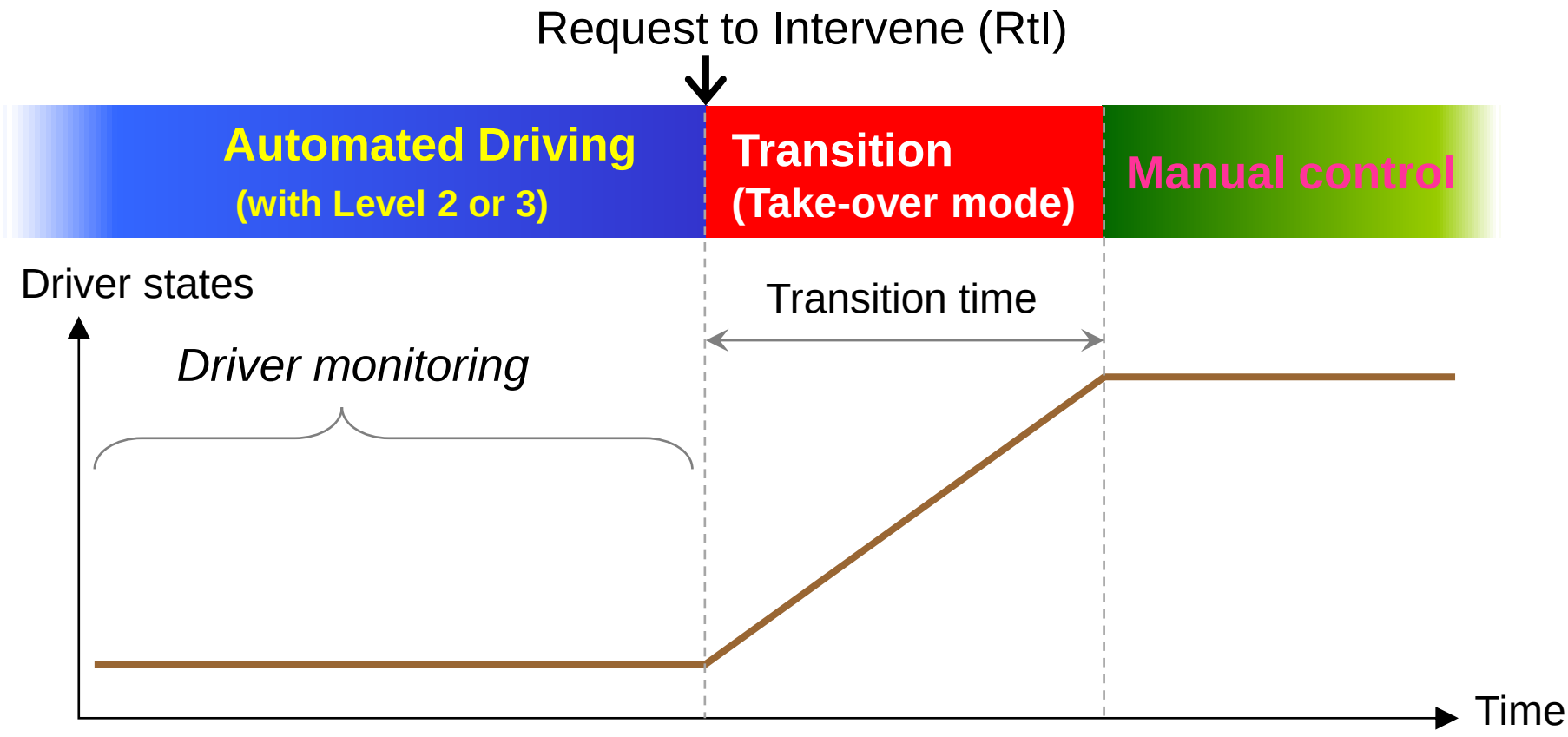
Main topics of the 3-year studies in Task B



Year 1 (FY2016): To identify evaluation indices for driver' readiness in automated driving
Year 2 (FY2017): To define transition time as a function of the driver's readiness and to identify fundamental requirements of Human Machine Interfaces for supporting the driver to stay with the appropriate readiness
Year 3 (FY2018): To confirm the findings of Year 1 & 2 on a test truck and real highways

Purpose in Year 1 (FY2016)

– **To investigate effects of driver state with automated system on his/her behavior in transition from automated to manual driving**

– **To extract metrics of the driver's readiness for driver monitoring system**

- Driving simulator study (81 drivers)
- Focused on "Cognitive load", "Visual-manual load", and "Arousal level"
- Investigating several physiological metrics while using the automated system
- Analyzing the relationship between the driver state *before* the RtI and the driving performance *after* the RtI

Method (1/2)

Automated — RtI — Transition — Event — Manual

Driver states *Controlled*
- Cognitively loaded by N-back tasks
- Visually & manually loaded by SuRT#

RtI

Physiological metrics
- ☐ Brain activity
- ☐ Head movements
- ☐ Eye movements
- ☐ Autonomic nerve

Driving performance at the event
- ■ Reaction time
- ■ Longitudinal and lateral control of the vehicle
- ■ Space margins to the hazard

#SuRT: Surrogate Reference Task (ISO/TS 14198)

Method (2/2)

Event

TTC=6s TTC=5s TTC=3s TTC=0s

- System terminates
- RtI presentation

Onset of lane changing of the lead vehicle

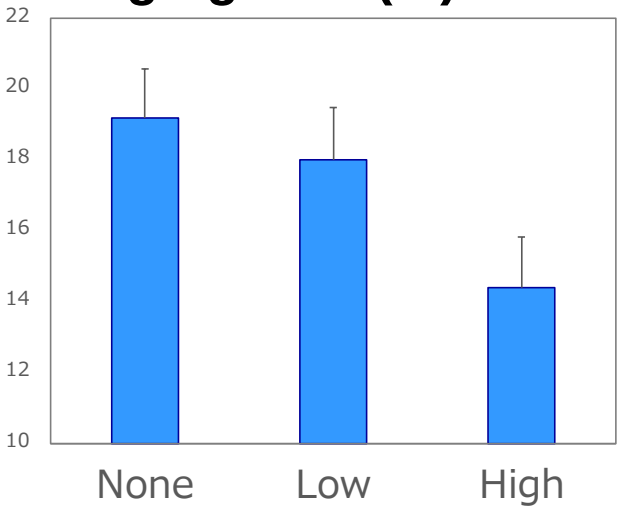
Completion of lane changing of the lead vehicle

Stationary vehicle

Results: Driving performance at the event

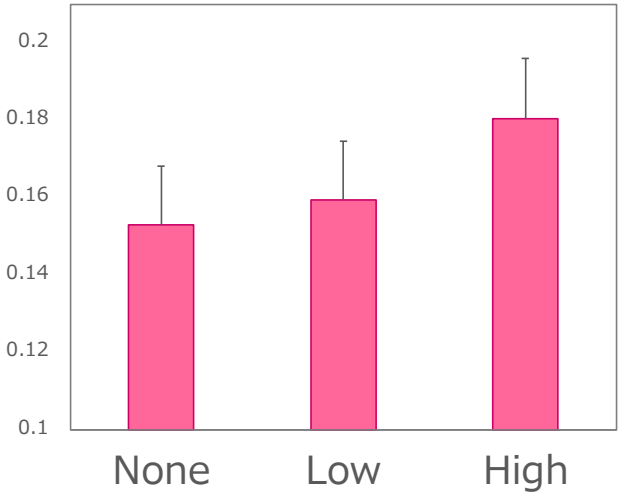
- Time spent to regain control
- Steering control measures
- Pedal application measures
- Distance to the stationary vehicle
- Lateral acceleration of driver's vehicle
- Standard deviation of the lateral position
- etc.

Minimum distance to the stationary vehicle while changing lane (m)

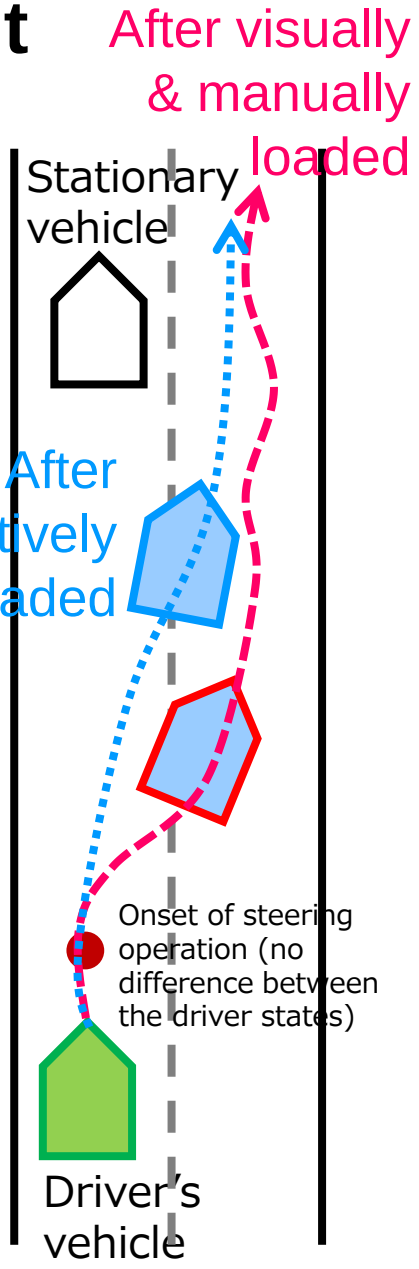


Cognitive load

Steering angle variability in 5s after lane change



Visual-manual load



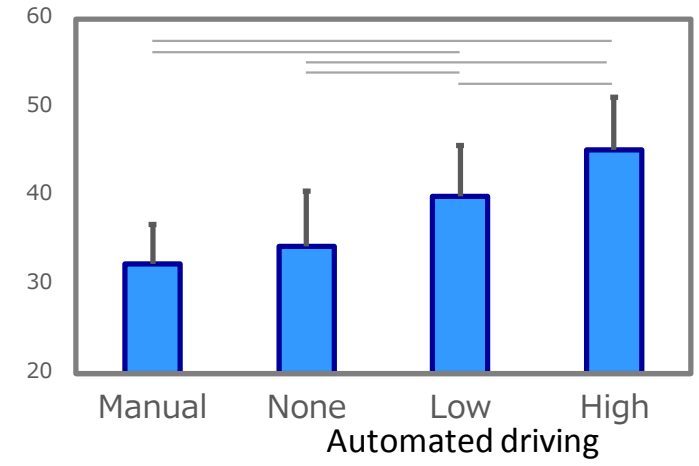
Results: Physiological metrics

Cognitive | Visual-manual load

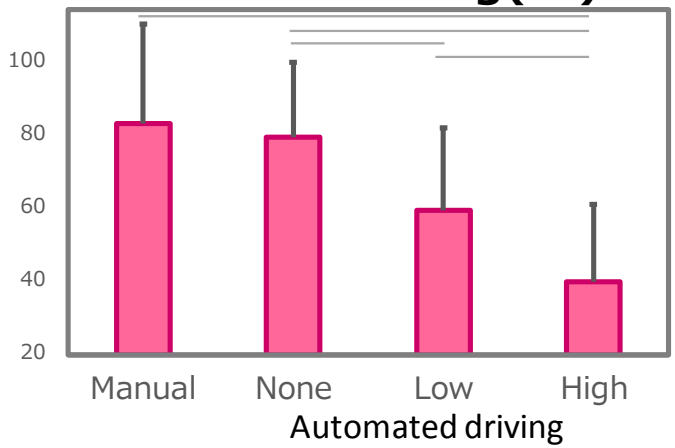
Bra
Fac
Glancing
Eye m
Eyelid m
Autono

onitoring

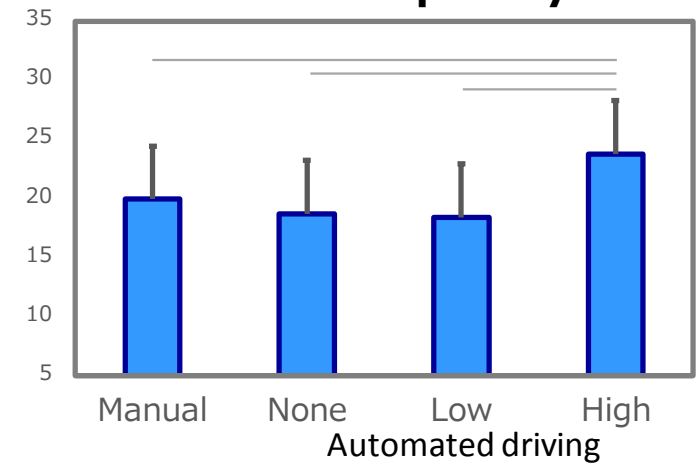
Blinking frequency (times/min)

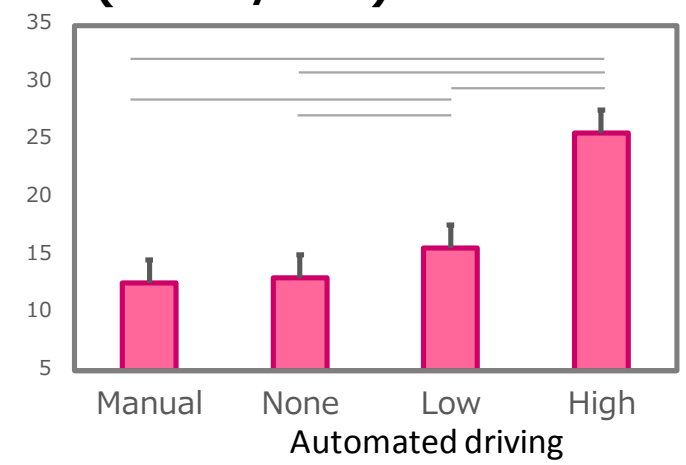


Percent time of forward looking(%)



Frequency of saccade (times/min)





Cognitive load

Visual-manual load

Prototype of driver monitoring system

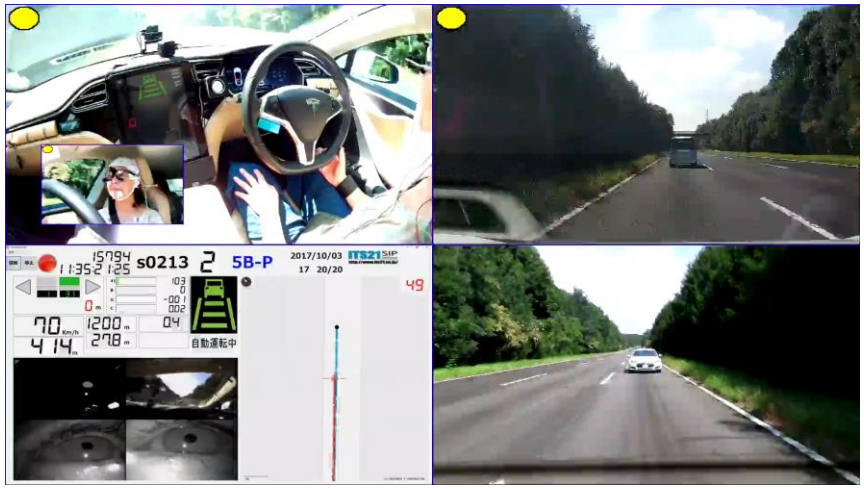
Specifications	Details
Detection objects	● Position and direction of driver's face ● Blinking ● Glancing direction ● Saccade
Distance to driver's face	600mm
Detection area	500mm
Resolution	VGA(640, 480) ～ SXGA(1280, 1024)
Frame rate	30fps ～ 100fps

Conclusions

1. Cognitive load and physical load while driving with the automated system influence driver's transition behavior in different ways

2. Physiological metrics of driver state were extracted. Metrics measurable in a vehicle in real time were frequency of the saccadic movements of the eyes, frequency of blinking, and percent time of forward looking.

Validation study in real environments



Thank you for your attention!