Cross-ministerial Strategic Innovation Promotion Program

# 「Cross-ministerial Strategic Innovation Promotion Program (SIP)/ Automated Driving for Universal Services/ HMI and User Education」

# FY 2021 Report

Keio University
AIST
University of Tsukuba
Tokyoto Business Services

March, 2022

# Task A

## Communication method between AV and traffic participants
## Education, knowledge on such communication

**Keio University**

# Overview

## Task A

Communication method between AV and traffic participants

Education, knowledge on such communication

Safe, secure and efficient communication between AVs and traffic participants

Understanding the communication

Automated Vehicle for Rural
Rural Mobility and Logistics Service
at Low Speed Traveling

Design

- ■ Communication Intention
- ■ Communication Method
  - Vehicle Motion
  - eHMI
  - Roadside HMI
  - Road Marking
- ■ Traffic Education

Communication

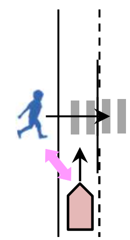
Pedestrians

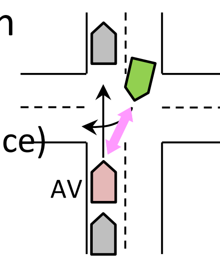
Communication

Drivers

- Basic road section
- Intersection
- Parking (shared space)

⋮




Attribute of Traffic Participant

Transportation Society

Evaluation

Social Acceptance

Sense of Security

Traffic Efficiency

Safety

# Research Flow of Task A

**1. Understanding current communication between AV and traffic participants**

Rural mobility and logistic services at low speed traveling, effects of driverless car, road traffic conditions, etc.

**Extracting Use-Case of communication between AV and surrounding traffic participant**

**2. Research on negative effect of communication between AV and traffic participants**

Communication with one participant, multiple participants, effect of vehicle motion, eHMI, road traffic conditions,

**Considering negative effect by using an eHMI**

**FY2019**

**Applying the important Use-Cases to VR/DS experiments**

**3. Research and proposal of communication method, knowledge necessary for communication**

Vehicle motion, eHMI, roadside HMI, road marking, etc.

**FY2020**

Knowledge necessary for AV, communication, limitation, etc.
(based on critical use-cases of communication)

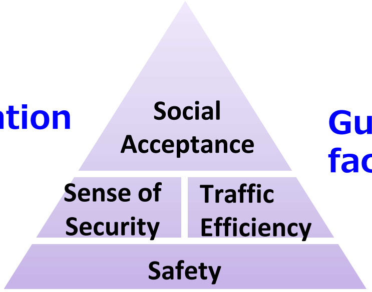
- VR/DS, Test-Track
- Questionnaire (Web, etc.)

**FY2021**

**4. Verification of communication method and education for communication between AV and traffic participant**

(In field operational tests or field observations)

**Critical use-cases of communication**
**Guidance of design factors on communication**




**Guidance of educational factors on communication**

Safe, secure and efficient communication between AVs and traffic participants

# A-i　Understanding current status of communication between AV for mobility/logistic service and traffic participants

## Video data analysis at pedestrian environment

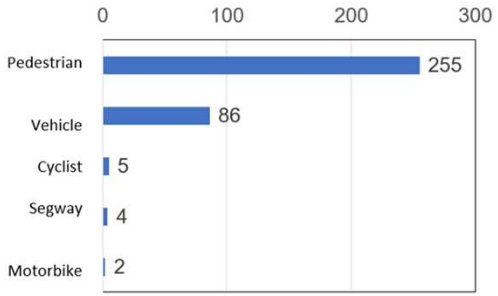
- Issue
  - Communication between low speed automated vehicle and pedestrian is not clear at real pedestrian environment.
  - The way how to reduce unsafe communication is not obvious.
- Objective
  - We aim to observe unsafe and inefficient communications between low speed automated vehicle and pedestrian.
  - We aim to discuss factors of the unsafe and inefficient communication.
  - We discuss how to reduce the unsafe and inefficient communication.
- Method
  - We used video data recorded at experiment  for eight days at Gotenba Kogen Tokinosumika in Gotenba city in Shizuoka Prefecture.
  - We focused on unsafe and inefficient communications.
  - We used data about automated vehicle, road users, and road environment.

AV

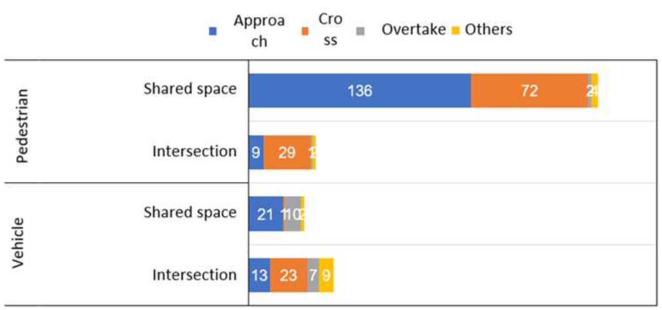

Target area
https://www.tokinosumika.com/guide/

# Video data analysis at pedestrian environment

- Frequency of communications




Frequency of each road user




Frequency of pedestrian and vehicle

- Unsafe communication with pedestrian

Pedestrian with smartphone

Communication with old person

- How to reduce unsafe and inefficient
  - Different from vehicle road environment, we observed pedestrians who were using smartphone and careless pedestrian such as old and child pedestrian in pedestrian environment. We need to discuss other ways to reduce such situations.
  - Sound may reduce unsafe communications with pedestrians who were using smartphone.
  - eHMI may reduce inefficient communications with children who did not have high cognition ability.

# Difference of communication between AV and conventional vehicle

- Issue
  - Communication between low speed automated vehicle and pedestrian is not clear at real pedestrian environment.
  - The way how to reduce unsafe communication is not obvious.
  - Communications were not clear at parking

- Aim
  - Differences of unsafe and inefficient communication between AV and conventional vehicle is analyzed

- Method
  - 16 days worth of videos(September 2020~ October ) at Akagikougen in Shimane.
  - We took the videos of parking and intersections near roadside stations where automated vehicle pass from a bird's-eye view.
  - 83 interactions of automated vehicle (all interaction) ,100 interactions of previous vehicle(50 each parking and intersections at random).

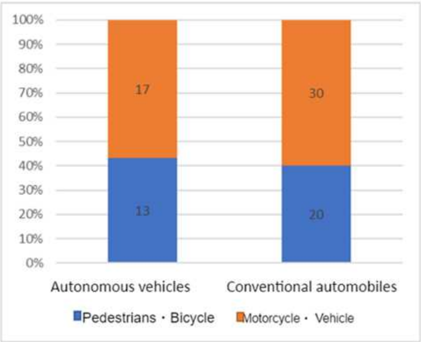
AV

Parking

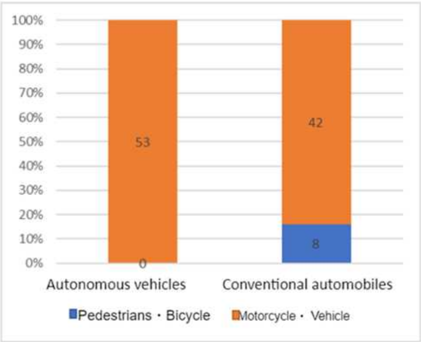
Intersection

# Difference of communication between AV and conventional vehicle

- Result




Parking area




Intersection


AV's inefficient communication: Facing


AV's inefficient communication: Overtaking

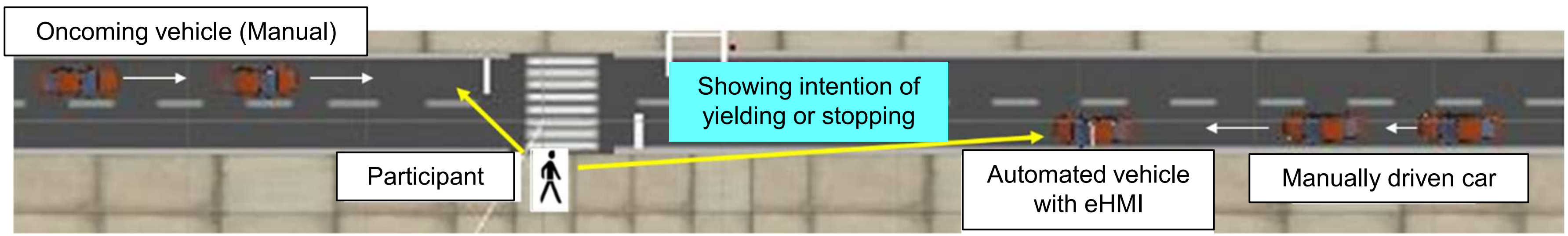
- Conclusion
  - AV's fixed trajectory and low priority in traffic caused ineffient at overtaking pedestrian.
  - When AV faced to other road users, low priority in traffic caused different vehicle behavior and confused other road users.
  - AV recognize road environment by sencer, therefore sometimes could not understand several vehicles was running continuously, and about to collision.

# A-ii Study on negative effect of communication between AV and traffic participants

Applying a method to mitigate negative effects by eHMIs on automated vehicles

- To examine impacts of a mitigation method of negative effects by pedestrians' inappropriate reliance and trust towards eHMIs on low-speed automated vehicles

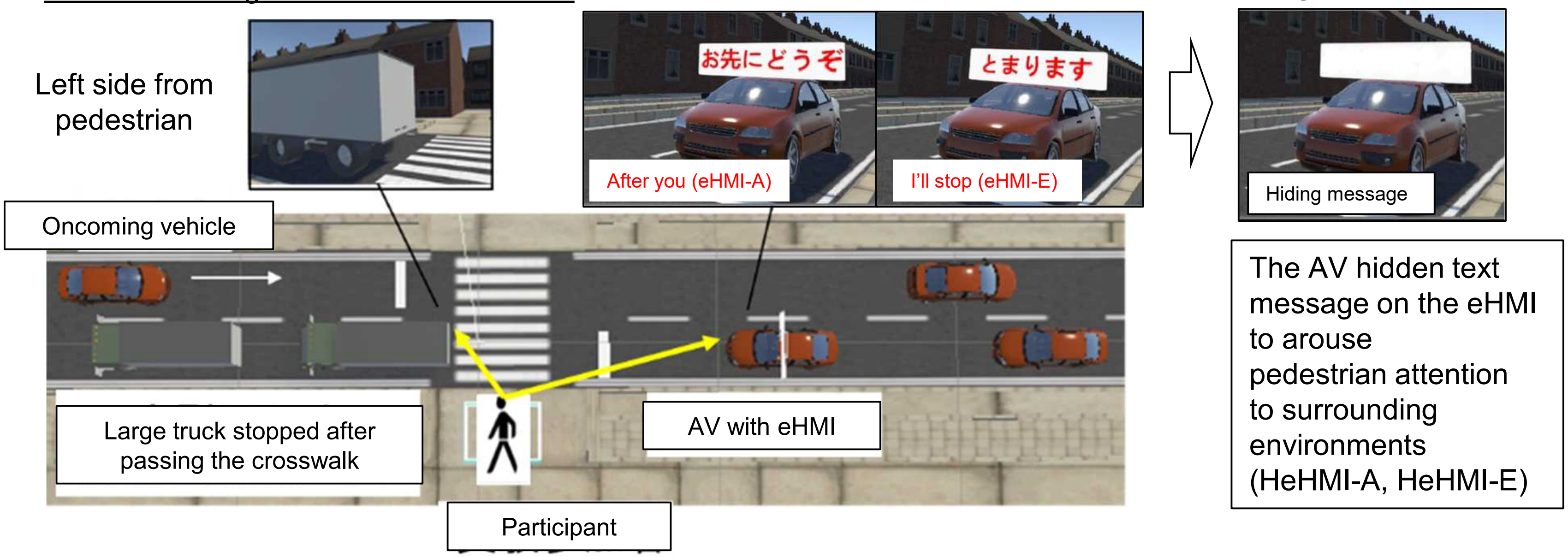
Traffic scenarios for the eHMI experience （1st~10th trial）



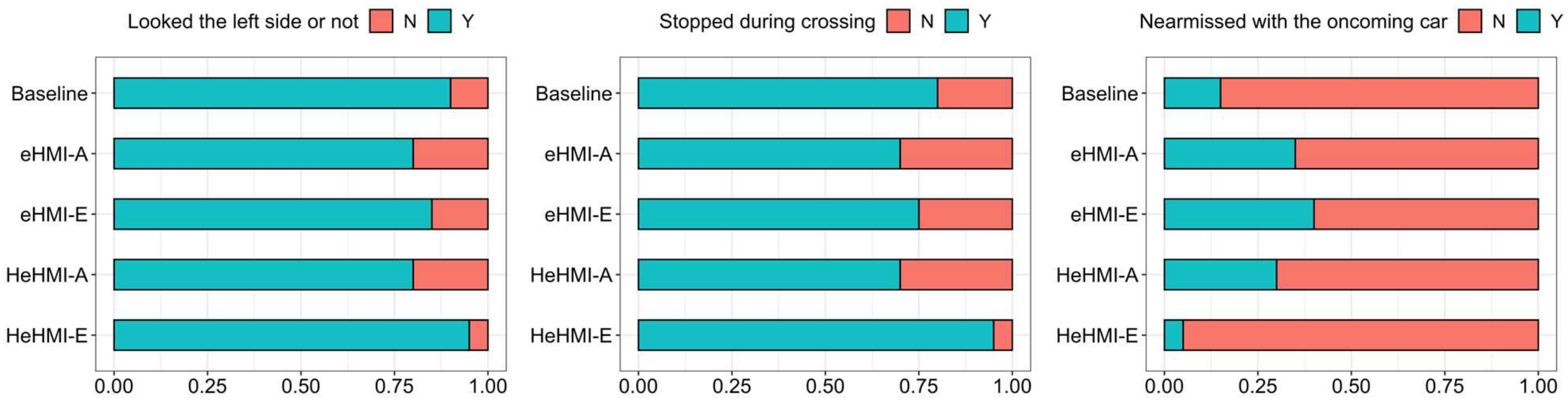

Scenario for negative effect（11th trial）

Message type

Mitigation method



# Results: Pedestrian behavior during pedestrian−AV communication via eHMIs




Note: Baseline (no eHMI)

- For each condition, twenty participants undertook the VR experiment (overall, 100 participants)
- Pedestrians in the eHMI-A, eHMI-E, and HeHMI-A paid less attention to encountering environments compared to others
- Pedestrians who undertook the eHMI-E and HeHMI-E were more likely to stop on the zebra crossing with vigilance against traffic risk than those of the eHMI-A and HeHMI-A
- The number of near misses with the oncoming car in the HeHMI-E was the lowest among all conditions
- In general, giving egocentric messages via the eHMI could lead pedestrian exploratory behaviour rather than allocentric messages
- The method of negative effect mitigation (hiding text messages on the eHMI) is effective at pedestrian attention arousal, but limited to automated vehicles which provide egocentric text messages

## A–iii Production of a low–speed, driverless experimental vehicle assuming Level 4 and implementation of eHMI

### Preparation for external human machine interface used in Field Operational Test

- Information provision and contents from automated driving golf-cart to surrounding traffic participants
  - Information provision to following traffic participants

    Automated driving golf-cart always displays by using external human machine interface during automated driving

    “Automated vehicle”, “Driving at low-speed“, “Pass with care”
  - Information provision to surrounding traffic participants in front

    Automated driving golf-cart displays messages by using external human machine interface when decelerating or stopping, in order to yield to surrounding traffic participants.

    “I’ll stop”, “After you”, “In automated driving mode”


External HMI (front)

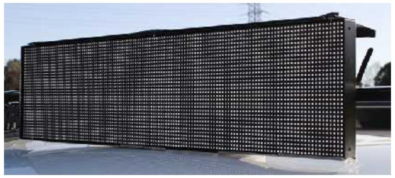

External HMI (rear)

# Automated driving golf-cart, external human machine interface, attachment tools

- Automated driving golf-cart (Yamaha Motor Co., Ltd., Model: YG-ML)
  - Six passengers, with license plate (road-going vehicle)
  - Automated driving based on electromagnetic induction wire (controls vehicle speed by using RFID buried in the road)
  - Max speed: 20km/h in manual driving:, 12km/h in automated driving

- External human machine interface (eHMI)
  - Vehicle exterior display device (LED display panel, Koito Electric Industries, Ltd.)

  "Select Color" display device, Model: CS1302



AC100V
4.0kg

- Attachment tools for external human machine interface
  - Made of steel, screwed or sandwiched method at the time of installation

Front, on the dashboard
Made of steel 1.8kg

On the roof
Made of steel 2.2kg

Rear, in the luggage space
Made of steel 5.0kg

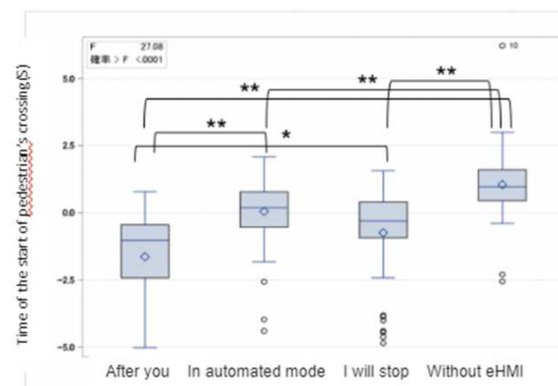
# A−ⅳ Examination and proposal of basic communication method between low-speed AV for mobility/logistics services and surrounding traffic participants in single roads and intersections

## Crossing experiment at real road environment

- Issue
  - Inefficient communications were observed when pedestrian crossed at crosswalk.
  - Appropriate eHMI message is not clear.
- Objective
  - We aim to explore eHMI which reduces inefficient and unease crossing.
  - We aim to analyze influences of vehicle behavior, driverless, pedestrian’s age and sex on eHMI.
- Method
  - Test track in Keio University was used.
  - Participants were tested various trials, such as vehicle behavior, and eHMI.
  - 32 participants were collected.
- Result
  - “After you” made crossing earliar（p<0.001）
  - “Early decceleration” made crossing earliar（p<0.001）
- Discussion
  - “After you” reduced inefficient crossing, however, negative influences could be observed.
  - “I will stop” increased yielding, and reduced inefficient crossing.
  - “In automated driving” did not reduce inefficient crossing.
  - eHMI reduced unease crossing.

AV

Target area




**<0.01 *<0.05

Decision of crossing in each eHMI

# Overtaking experiment by Driving Simulator (Examination of message)

- Issue
  - Unsafe communication were often observed when vehicle overtook automated vehicle.
  - The way how to reduce the unsafe communication has never been examined.

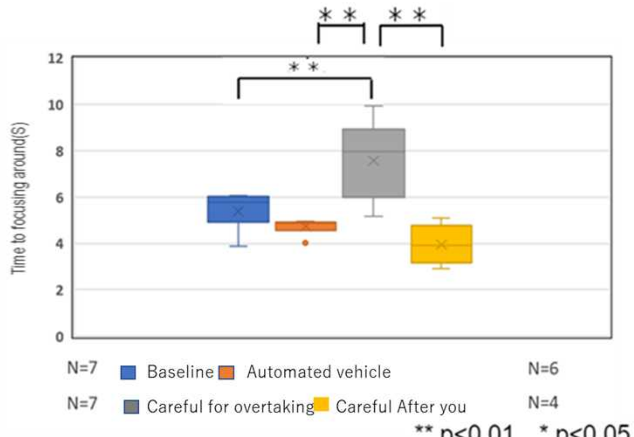
- Objective
  - We aim to explore eHMI reduce unsafe communication at overtaking.

- Method
  - We conducted Driving Simulator experiment.
  - 32 participants were collected.
  - We used four eHMI scenario: “Without eHMI”, ”In automated mode | In low speed”, ”Careful for overtaking”, and ”Careful | After you”

- Result
  - ”Careful for overtaking” made driver careful ($p<0.05$)

- Discussion
  - ”In automated mode | In low speed” increased yielding, and decreased time to focusing around environment, and driver could be careless.
  - ”Careful for overtaking” increased attention and reduced annoying, and made low yielding, and made longer focusing, and driver could be careful.
  - ”Careful | After you” increased yielding, and reduced focus time on road environment.


Experiment in Driving simulater




Overtaking decision in each eHMI

# Overtaking experiment by Driving Simulator (Examination of vehicle behavior)

- Issue
  - When operating an automated vehicle, it deviates from the track of the automated vehicle and stops on the shoulder of the road to encourage the overtaking of the following vehicle, but it takes a lot of time and effort for the operator.

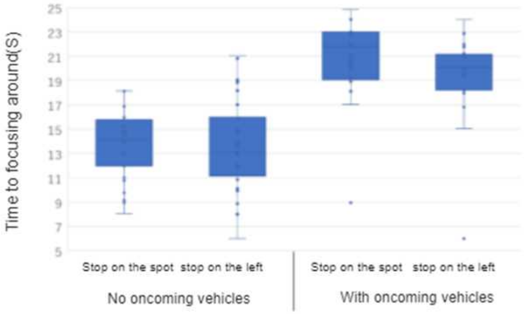
- Objective
  - Analyze whether unsafe scenes are observed when stopping in orbit

- Method
  - We conducted Driving Simulator experiment.
  - 32 participants were collected.
  - Set 4condition in the combination of (stop on the spot, stop on the left)×（No oncoming vehicles, With oncoming vehicles ）
- Result
  - There is no difference about focus time on road environment between the case of stop on the spot and stop on then left.

- Discussion
  - Stop on the spot increased somewhat annoying regardless of presence of oncoming vehicles or not.
  - Stop on the left could made yielding.
  - There is no big difference about focus time on road environment between the case of stop on the spot and stop on then left.

→ There may be an operation that encourages overtaking by stopping on the spot.


Experiment in Driving simulater

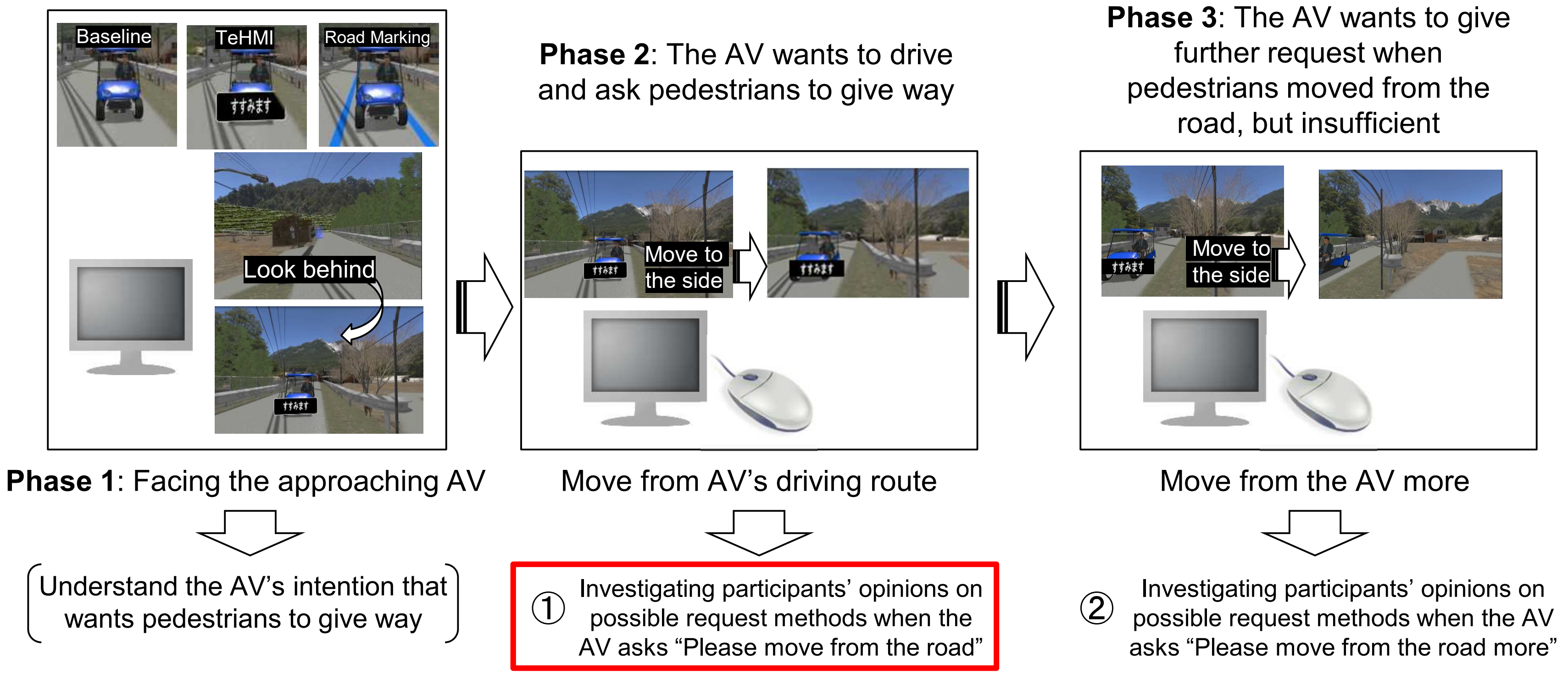



time to focusing around

# A-v Proposal of communication assistance method between low-speed AV for mobility/logistics services and surrounding traffic participants at shared space

- In a case that an AV approaches behind of pedestrians, pedestrians possibly do not know what they should do. As such unsafe and inefficient use cases occurred at shared space such as narrow road without roadside-belt in Michi-no-eki areas, assistance methods for pedestrian-AV communication should be considered
- This study carried out a video watching experiment targeting the cases of "approaching/avoiding" to seek possible communication assistance methods with 9 participants

**Experiment procedure: use case of “AV approaching-Pedestrian avoiding” at shared space such as narrow road without roadside-belt**



# Results: Video watching experiment for approaching–avoiding case at shared space such as narrow road without roadside-belt

- **Phase 1**: Facing the approaching AV; Participants' perception of AV's intention
  - Participants in the Baseline condition answered the AV thinks pedestrians as an obstacle of their driving route (e.g., "the AV wants move straightly", "The AV has stopped due to a pedestrian", or "I don't know what the AV want to do")
  - As the AV showed a text message of "Now moving" in the text-based eHMI (TeHMI), 8 of 9 participants responded the AV wants to go straight. One participant answered almost same response with the detailed request from the AV, "The AV wants me to move from the road because the AV wants to move straightly"
  - In the road marking condition, participants provided various answers compared to the TeHMI condition. More specifically, "the AV wants move straightly (45%)", "the AV wants you to move from the road (33%)", "The AV wants you to move from the blue road marking (11%)", and "the AV wants to park on the shoulder of road (11%)"

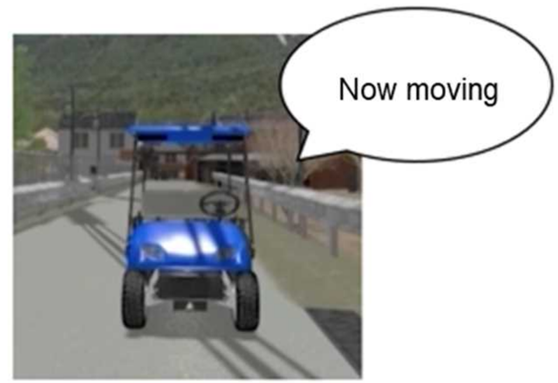
- **Phase 2**: How to lead participants to move from the road
  - In general, participants gave almost same responses to all conditions. The method using voice message was most suggested, and "Please move (from the road)" was the most suggested message content in all conditions.
  - Text messages via the TeHMI: **"Please move from the road"**, "In automated driving", "Now moving", "The AV cannot move (due to you)"
  - Voice messages from the AV: "Please move from the road (to the shoulder of road)", "Now moving", "Warning", "The AV cannot move (due to you)"
  - The message of "Please give way" was suggested as a possible venue in the Baseline unlike other two conditions.

- **Phase 3**: How to lead participants' further move from the road
  - In general, participants' responses were almost identical to those of Phase 2. Giving voice message of "Please move from the road" was the most preferred method
  - Providing specific number (e.g., X meters) and repeating the message might be helpful for making further move.

# Examination of communication assistance method between low-speed AV for mobility/logistics services and surrounding traffic participants at shared space such as narrow road without roadside-belt

- Efficient communication methods should be designed for a better communication between pedestrians and AVs at shared space such as narrow road without roadside-belt in Michi-no-eki areas where encompass several unsafe and inefficient interactions between road users and AVs
- The current study designed a communication assistance method based on results of video watching experiment and simulated this in VR environments
- This study aimed to investigate impacts of giving auditory message from AVs to pedestrians on their first impression and perception of AVs

**VR experiment with "AV approaching-Pedestrian avoiding" use case at shared space such as narrow road without roadside-belt**


**Participants**
- 4 females & 3 males

**Mixed-experimental design**
- 1st, 6th trials – between-subject (VeHMI)
- 2nd~5th trials – within-subject (Baseline, TeHMI, Road Marking)

**Voice message**
- First: "Now moving"
- When the AV asked pedestrians to further movement: "Please move from the road a little more"

# Results: Subjective ratings after experimental trials targeting at shared space such as narrow road without roadside-belt

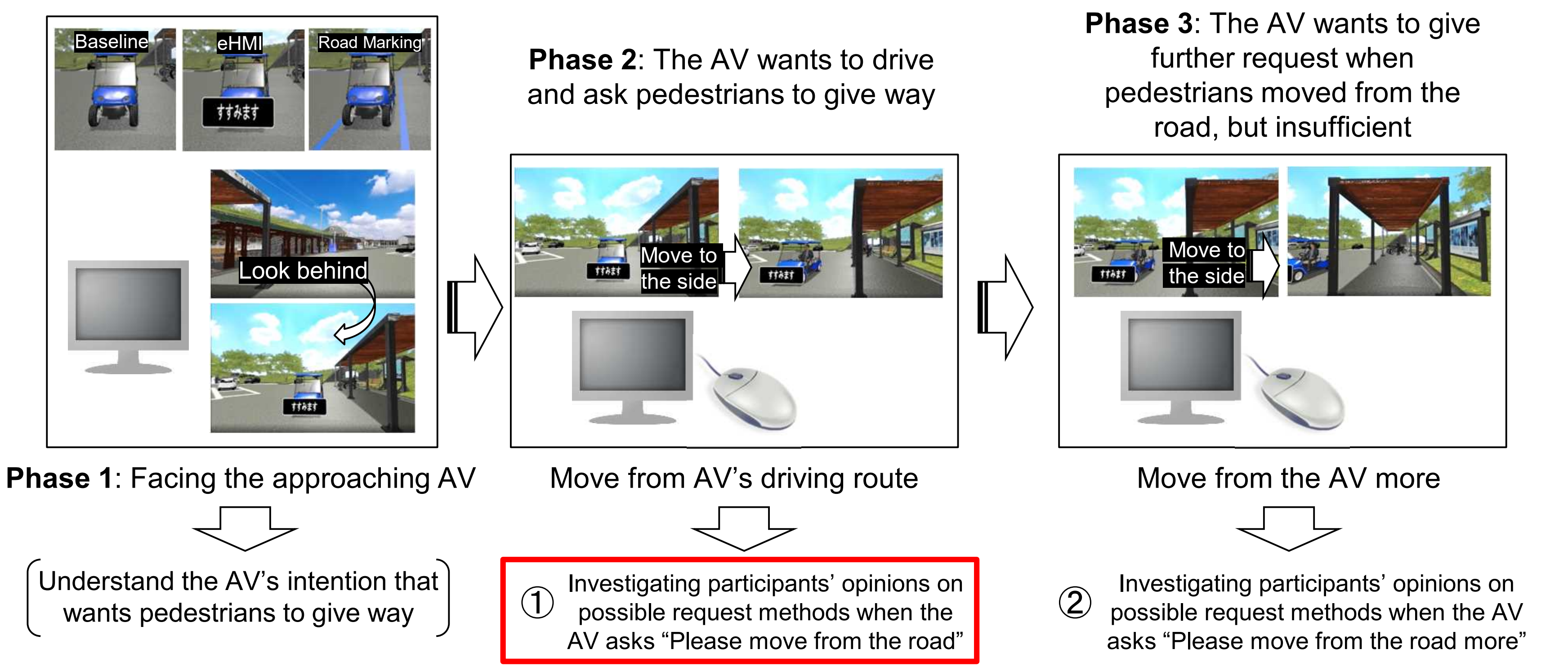
| Trial | Perception | Trust | Anxiety | Feeling of Safety |
|---|---|---|---|---|
| 1st | 2.29 (1.7) | 2.86 (1.57) | 2.58 (1.4) | 3 (1.53) |
| Last | 1.72 (0.95) | 3.29 (0.76) | 2.72 (0.95) | 3.74 (1.38) |

- One participant did not move from the road when facing the approached AV in the 1st trial, but the participant moved from the road in the 6th trial
- Whilst some participants did not move from the road in conditions simulating communication assistance methods (i.e., road marking, text-based eHMI), almost all participants moved from the road in the VeHMI condition
- Participants' ratings on the perception of AV's intention were lower in the 6th trial than the 1st trial
- Participants felt more anxiety of the AV in the last trial compared to the initial trial
- The ratings on participants trust and feeling of safety toward the AV were increased with the experience of trials (Trust: 2.86 -> 3.29; Feeling of Safety: 3 -> 3.74)
- As the 7 Likert scale was used, giving voice message might be somewhat limited to lead participants' appropriate perception of AV's intention as well as to shape favourable attitude towards the AV
- Note: direct comparison between the VeHMI and other conditions was difficult because different type of questionnaire was used in two VR experiments

# Examination and proposal of basic communication method between low-speed AV for mobility/logistics services and surrounding traffic participants at shared space (parking lot)

- Use cases that pedestrians have difficulty in communicating with approaching AVs behind of them in several locations of Michi-no-eki areas.
- Parking areas do not have an explicitly distinguished zone for road users, thus assistance methods for pedestrian-AV communication should be considered with the characteristics of such area
- This study carried out a video watching experiment targeting the cases of "approaching/avoiding" to seek possible communication assistance methods with 9 participants

**Experiment procedure: use case of “AV approaching-Pedestrian avoiding” in a parking area**



# Results: Video watching experiment for approaching–avoiding case in parking areas

- **Phase 1**: Facing the approaching AV; Participants' perception of AV's intention
  - Participants in the Baseline condition reported "the AV wants move straightly", "The AV has stopped due to a pedestrian". Also, they responded "I don't know what the AV wants to do" and "The AV just stopped"
  - As the AV showed a text message of "Now moving" in the text-based eHMI (TeHMI), 8 of 9 participants responded the AV wants to go straight. One participant reported "The AV wants a pedestrian to move from the road."
  - In the road marking condition, participants most responded "The AV wants move straightly" and "The AV wants a pedestrian to move from the road." They reported opinions relevant to road marking – e.g., "Please move from the line", "The AV wants to drive along with / on the line."

- **Phase 2**: How to lead participants to move from the road
  - In general, participants gave almost same responses to all conditions. The method using voice message was most suggested, and "Please move (from the road)" was the most suggested message content in all conditions.
  - Text messages via the TeHMI: **"Please move from the road"**, "In automated driving", "Now moving", "The AV cannot move (due to you)", "Warning"
  - Voice messages from the AV: "Please move from the road (to the shoulder of road)", "Now moving", "Warning", "The AV cannot move (due to you)", "Please move X meters away from the road (with specific number)"
  - The message of "Please give way" was suggested as a possible venue in the Baseline unlike other two conditions.

- **Phase 3**: How to lead participants' further move from the road
  - In general, participants' responses were almost identical to those of Phase 2. Giving voice message of "Please move from the road" was the most preferred method
  - Providing specific number (e.g., X meters) and repeating the message might be helpful for making further move.

# Examination of communication assistance method between low-speed AV for mobility/logistics services and surrounding traffic participants in parking areas

- Efficient communication methods should be designed for a better communication between pedestrians and AVs at parking lots in Michi-no-eki areas where encompass several unsafe and inefficient interactions between road users and AVs
- The current study designed a communication assistance method based on results of video watching experiment and simulated this in VR environments
- This study aimed to examine impacts of giving auditory message from AVs to pedestrians on their first impression and perception of AVs

**Experiment procedure: use case of "AV approaching-Pedestrian avoiding" in parking areas**


**Participants**
- 5 females & 4 males

**Mixed-experimental design**
- 1st, 6th trials – between-subject (VeHMI)
- 2nd~5th trials – within-subject (Baseline, TeHMI, Road Marking)

**Voice message**
- First: "Now moving"
- When the AV asked pedestrians to further movement: "Please move from the road a little more"

# Results: Subjective ratings after experimental trials targeting a parking area

| Trial | Perception | Trust | Anxiety | Feeling of Safety |
|---|---|---|---|---|
| 1st | 1.5 (0.53) | 3 (1.07) | 3.38 (1.51) | 4.25 (0.46) |
| Last | 1.63 (0.74) | 3.75 (0.88) | 2.25 (0.89) | 4.25 (0.46) |

- Compared to other designs, giving voice messages was highly rated by participants throughout the experiment
- Except for ratings on the feeling of safety, changes in ratings between the first and last trials were observed
- The perception levels of the AV's intention were slightly increased
- Participants got trusted the AV with the the experiment
- The experience of interaction with the AV reduced the anxiety levels
- As the 7 Likert scale was was used, giving voice message might be somewhat limited to lead participants' appropriate perception of AV's intention as well as to shape favourable attitude towards the AV
- Note: direct comparison between the VeHMI and other conditions was difficult because different type of questionnaire was used in two VR experiments

# Examination of two communication assistance method between low-speed AV for mobility/logistics services and surrounding traffic participants at shared space such as narrow road without roadside-belt

- Following results obtained from previous studies (video watching and VR experiment studies), this study designed two methods with two messages for an efficient pedestrian-AV communication with pedestrians' pleasure
- Considering the actual need and frequency of use case occurrence in the Michi-no-eki area, shared space such as narrow road without roadside-belt was selected
- The objective of this study was to examine impacts of four communication designs on pedestrian-AV communication

**VR experiment with "AV approaching-Pedestrian avoiding" use case at shared space such as narrow road without roadside-belt**


**Participants**

- 21 females & 20 males

**Mixed-experimental design**

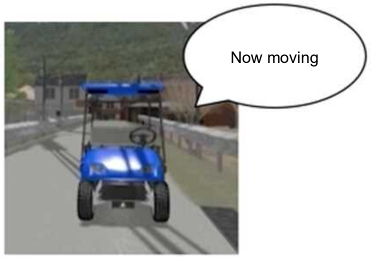
- 1st, 6th trials – between-subject
- 2nd~5th trials – within-subject


Baseline

TeHMI-R

TeHMI-I

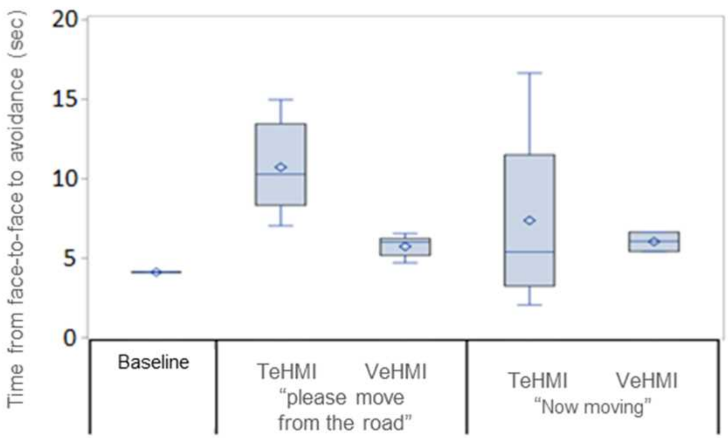
VeHMI-R

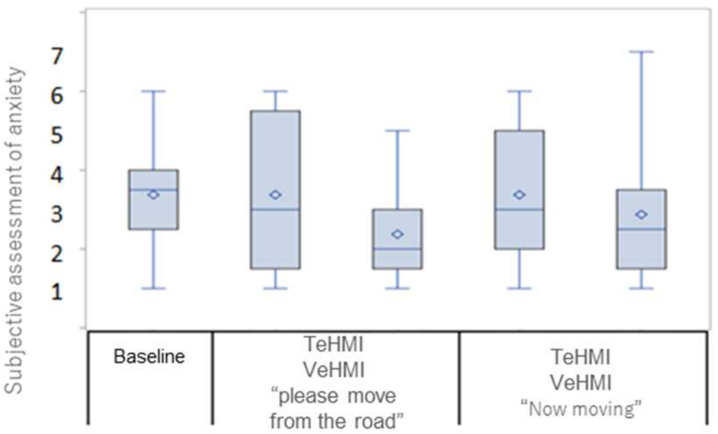


VeHMI-I

# Results: Pedestrian behavior and attitude after the initial trial targeting at shared space such as narrow road without roadside-belt

| Avoidance Type ¥ Number | Baseline | TeHMI-I | TeHMI-R | VeHMI-I | VeHMI-R |
|---|---|---|---|---|---|
| No avoidance | 1 | 0 | 1 | 3 | 2 |
| Avoidance but insufficient | 4 | 1 | 1 | 2 | 2 |
| Sufficient Avoidance | 1 | 4 | 6 | 3 | 5 |




- Participants showed sufficient avoidance leading AV's redriving when the AV provided information to pedestrians compared to the Baseline
- Voice messages from the AV led quicker avoidance from the road than text-based eHMIs
- Likewise, participants felt the higher levels of anxiety in the TeHMI than VeHMI conditions
- Results indicate giving a voice message of "please move from the road" is the most effective at leading pedestrians' quick perception of AV's intention and reducing the anxiety level in their initial interaction

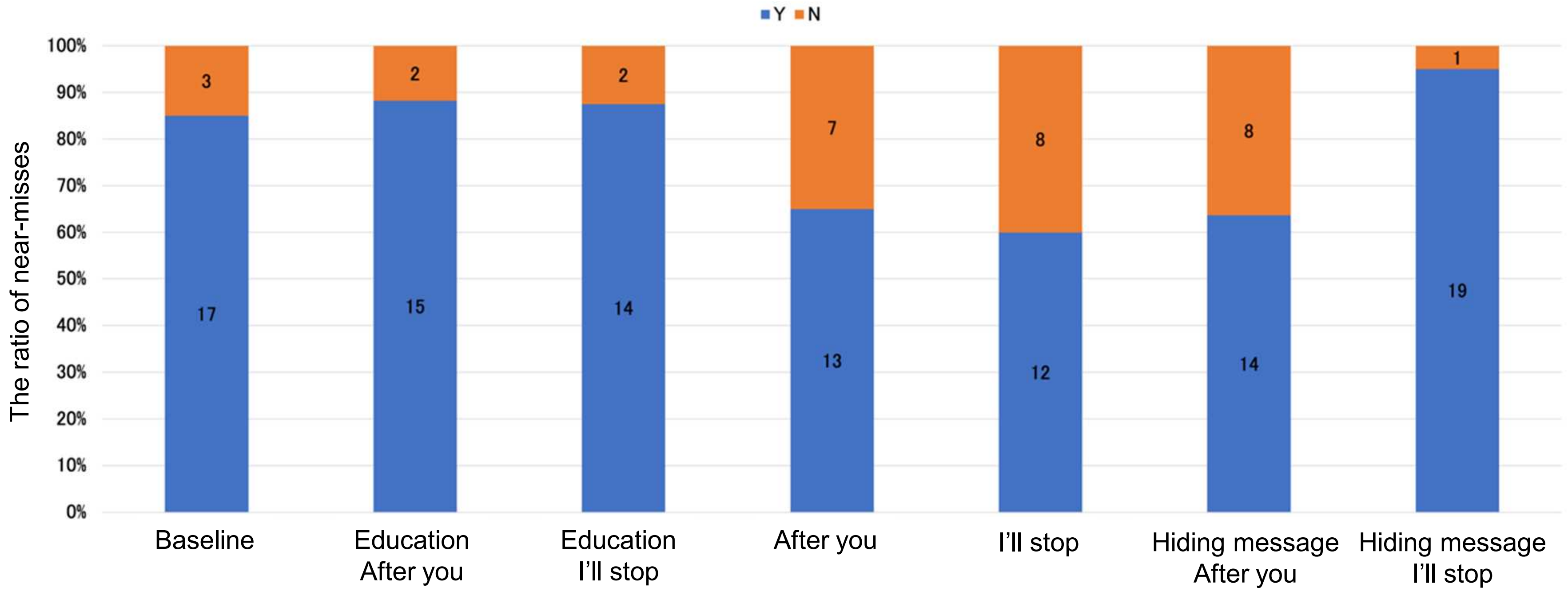
# A–vii Education for mitigating negative effect of communication between AV and traffic participants

Giving prior education for participants to mitigate negative effects by eHMIs on automated vehicles

- To examine impacts of prior education on mitigating negative effects by pedestrians' inappropriate reliance and trust towards eHMIs on low-speed automated vehicles
- This VR experiment used the same traffic scenarios to those of A-ii
- Before undertaking the VR trial, all participants completed education materials and quiz based on this

**Participants**
**I'll stop:** 9 females & 8 malees; **After you:** 8 females & 8 males

# Results: Pedestrian behavior during pedestrian–AV communication via eHMIs




- Negative effects were observed in both eHMI types
- Prior education reduced the number of near-misses with a manually driven car on the opposite driving lane compared to hiding text messages in the eHMI
- Effects of hiding a text message was limited to when the AV projected "I'll stop", but the prior education influenced both types of messages
- Prior education led not only pedestrians' attention arousal but also enhanced traffic safety

# Summarized results of Task A in FY2021(1)

We examined unsafe and inefficient communication between AV and other road users at pedestrian area

- Different from vehicle road environment, we observed pedestrian who were using smartphone and careless pedestrian such as old and child pedestrian in pedestrian environment. We need to discuss other ways to reduce such situations.
- Sound may reduce unsafe communications with pedestrian who were using smartphone.
- eHMI may reduce inefficient communications with children who did not have high cognition ability.

# Summarized results of Task A in FY2021(2)

Examination of methods to mitigate the negative effects to pedestrians caused by communication using eHMI of low-speed AV

- Hiding text messages of eHMIs on AVs leads the mitigation of negative effects caused by continuous experience of interaction with AVs. More specifically, the method possibly arouses pedestrians' attention to encountering situation and careful behavior. But, the effect may be limited to when the AV projects the message indicating their behavior, such as "I'll stop".

Proposal of communication assistance method between low-speed AV for mobility/logistics services and surrounding traffic participants in single roads

- Results from video watching experiments indicate giving information in auditory can be considered as the most preferred method to lead pedestrians' movement from the road when they face approached AVs behind of them. "Please move from the road" can be one possible venue to lead participants perception of AV's intention. Giving voice message with specific numerical numbers is expected to lead further movement.

Examination of communication assistance method between low-speed AV for mobility/logistics services and surrounding traffic participants in single roads

- Providing voice messages from AVs indicating what the AV will do leads pedestrians' movement from the road. The continuous interaction with the AV leads an increase in pedestrians' levels of trust in the AV. Other types of messages should be considered to shape positive attitude towards AV in the future study.

# Summarized results of Task A in FY2021(3)

We examined eHMI which reduced inefficient and unease crossing

- “After you” reduced inefficient crossing, however, negative influences could be observed.
- “I will stop” increased yielding, and reduced inefficient crossing.
- “In automated driving” did not reduce inefficient crossing.
- eHMI reduced unease crossing.

We examined eHMI which reduced unsafe overtaking

- ”In automated mode | In low speed” increased yielding, and decreased time to focusing around environment, and driver could be careless.
- ”Careful for overtaking” increased attention and reduced annoying, and made low yielding, and made longer focusing, and driver could be careful.
- ”Careful | After you” increased yielding, and reduced focus time on road environment.

# Summarized results of Task A in FY2021(4)

Examination of two communication assistance method between low-speed AV for mobility/logistics services and surrounding traffic participants at shared space

- Giving voice messages leads quicker movement of pedestrians and lower anxiety levels than text-based eHMIs. When the AV requests pedestrians to move from the road, pedestrians can make sufficient movement compared to when the AV tells what they will do. Giving requesting voice message can be the most effective method to lead pedestrians' appropriate behavior with reducing the anxiety.

Proposal of communication assistance method between low-speed AV for mobility/logistics services and surrounding traffic participants in parking areas

- In related vein to video watching experiment results targeting a single-narrow road, giving voice message requesting participants to do specific behavior, such as "Please move from the road", can be considered as the most preferred method to keep pedestrians away from the road. Likewise, giving voice message with specific numerical numbers is expected to lead further movement in parking areas.

Examination of communication assistance method between low-speed AV for mobility/logistics services and surrounding traffic participants in parking areas

- Like the result obtained from the narrow road, the voice message of "Now moving" from AVs leads pedestrian movement from the road. The continuous interaction with the AV leads a slight increase in pedestrians' levels of perception and trust, with reducing the anxiety level.

# Summarized results of Task A in FY2021(5)

Education for mitigating negative effect of communication between AV and traffic participants

- Prior education with a quiz is designed to enhance pedestrians' understanding of AV's capability and limitation then mitigate negative effects. Unlike limited effects of hiding the eHMI's message, the prior education are likely to mitigate negative effects in both message types (I'll stop, After you). More specifically, the education is effective at preventing pedestrian careless behavior shaped by over-reliance on the AV's capability.

# Task B

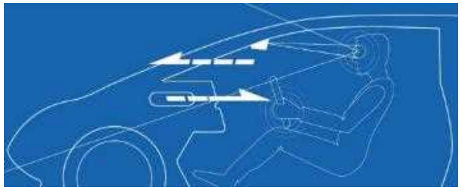
# Development of evaluation methods of driver's OEDR (Object and Event Detection and Response) and HMI for enhancing driver' take-over in a transition from automated to manual driving

National Institute of Advanced Industrial Science and Technology (AIST)

The University of Tokyo

# SIPHF Task B Outline

**Define and detect an appropriate driver states for transitions from automated to manual driving**



- Seating position
- Posture：hands（On/Off the wheel）
  seat（slide，back angled）

SIP 1st phase

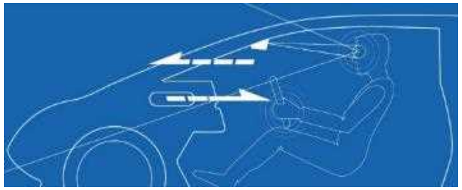
- NDRA(Non-driving related activities) engagement
  －visual・manual load
  －cognitive load
- Drowsiness level
- Mind wandering
- Situation awareness
- Functional limitations awareness

SIP 2nd phase

NDRA: Non-driving related activities (e.g., watch a video)

# SIPHF Task B Outline

**Define and detect an appropriate driver states for transitions from automated to manual driving**



1st phase：development of driving state monitoring system

－Monitoring of driver states during L2, L3 automated driving
－The effect of cognitive/visual distraction and drowsiness on takeover performance, and their detection methods

2nd phase：design guidelines to realize proper transitions

－Driver state monitoring during system-initiated transitions from L3 to manual driving
－HMI principles for successful driver-initiated transitions from L2 to manual driving
－Design guidelines of UN Regulation No. 157 (2021)

How to define and assess driver's readiness for transitions ?

RtI: Request to Intervene

# Assumed output(1/2)

## System-initiated (with RtI) transition from automated to manual driving

Promoted mainly by AIST

**Evaluation methods of driver's situation awareness that satisfy the requirements for safe transitions from NDRA to manual driving (Metrics that can define a proper situation awareness state)**

To be reflected in JAMA's experimental specifications

### Design guidelines for being attentive (R157 regulation)

<Before transitions>

Reification of "what to detect, when to detect, and how to determine the driver's state"

①evaluation metrics(gaze, head movements)
②threshold values of a proper situation awareness
③necessary time for the driver to build situation awareness
④confirm the validity of the evaluation metrics (comparison with standard metrics)

### Promote driver's attentiveness

<Before transitions >

Proposal and verification of transition process that promotes attentiveness

⑤HMI principles that promote situation awareness

Potential standardization ISO TS5283

# Assumed output(1/2)

Driver initiated transition from automated to manual driving

Promoted mainly by Univ. of Tokyo

**Evaluation methods of driver's understanding on system functional limits, and examination of HMI principles that enable appropriate system understanding and quick response**

## Assess driver's understanding on system functional limits

<During automated driving>

Reification of "what to detect" → Evaluation metrics of driver's system understanding status (gaze)

①general roads

②signalized intersections

## Promote driver's understanding on system functional limits

<During automated driving>

Proposal and verification of what information to display and where to display →

HMI principles to improve driver understanding of system functional limits

③ general roads

④ signalized intersections

HMI principles to promote driver's response

⑤ general roads

⑥ signalized intersections

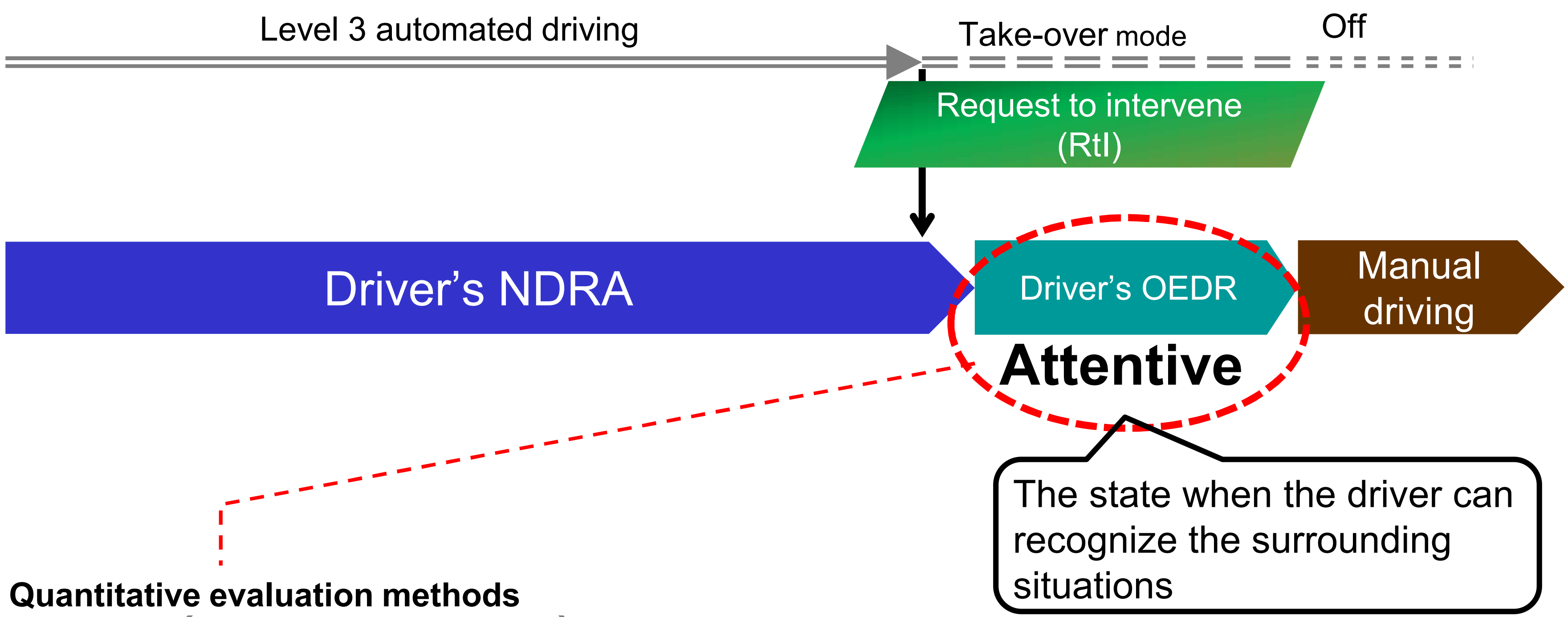
To be reflected in JAMA's HMI design considerations

## System-initiated (with RtI) transition from automated to manual driving

NDRA: Non-Driving Related Activities
OEDR: Object and Event Detection and Response

**System-initiated transitions from automated to manual driving**

# Evaluation methods of attentiveness



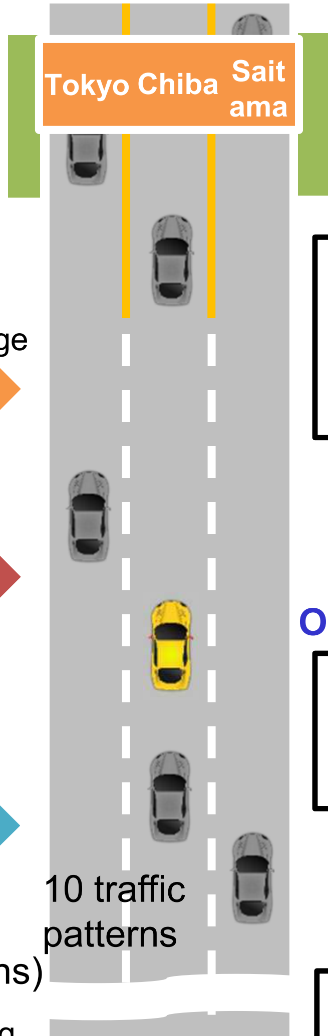

**Quantitative evaluation methods**
**－metrics** （gaze, head movements）
**－threshold indicating an appropriate OEDR** （70% or more gaze-on-front）
**－time duration for an appropriate OEDR**
(The rate of gaze-on-front tends to increase 5 to 20 seconds after the monitoring request）

**（　）represents the results of present experiments**

# DS experiment scenario

ODD: Operational Design Domain
RtM: Request to Monitor

Typical driving scene: other vehicles exist in the straight section of the highway




Manual driving

Lane change

RtI
(ODD transition)

Automated driving

RtM

(about 3 mins)

Start driving

**Participant's task (after transition)**
「Please drive toward Tokyo」

Change to the right or left lane

**OEDR before the transition**

**Participant's task**
「Please monitor the environment」

Experiment factor: with/without OEDR

**Participant's NDRA**
「Please play Tetris」

**<Measures>**

**Before the transition**
- ✓ Gaze
- ✓ Head movements

**After the transition**
- ✓ RT of steering
- ✓ RT of blinkers
- ✓ Crash rate
- ✓ Rate of cutting the yellow line
- ✓ etc.

System-initiated transitions from automated to manual driving

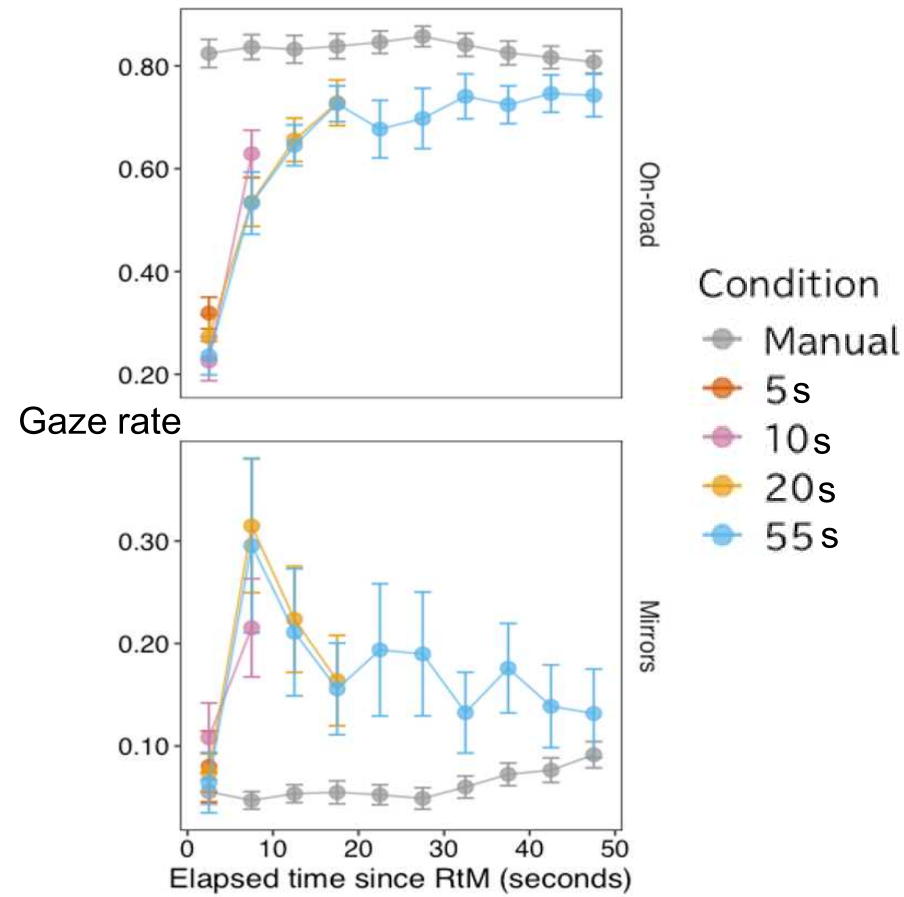
## Evaluation methods of attentiveness

Experiment under conditions where the driver's OEDR time was changed

# Results：gaze（gaze rate per 5-second window）

- **Gaze-on-front rate increased as time elapsed from the start of monitoring.**
  After about 30 seconds, gaze rate became stable, and was comparable to the manual driving condition
- **Gaze-on-peripheral increased to a peak value after about 5~15 seconds and then began to decrease**
  After about 30 seconds, gaze-on-peripheral was about 0.1~0.2 (about 0.1 both during manual driving and before the transition)

Mean and standard error of all 30 participants



**System-initiated transitions from automated to manual driving**

## Evaluation methods of attentiveness

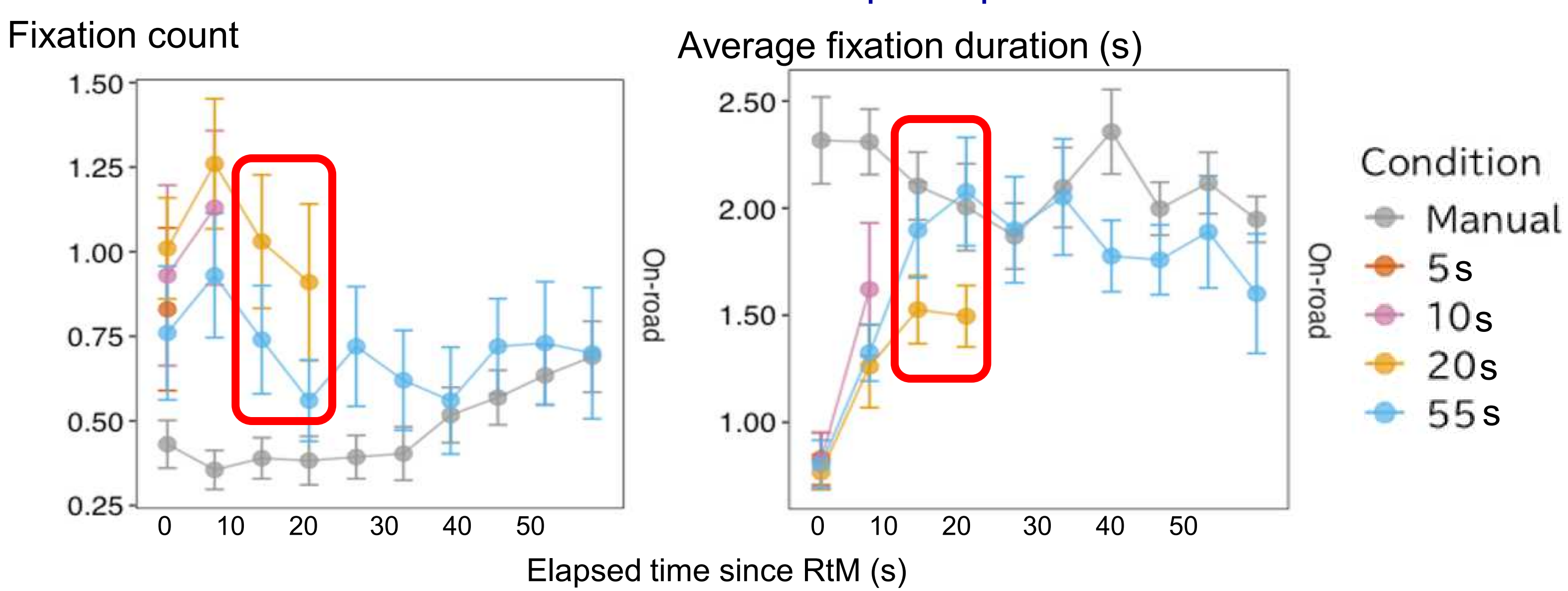
<u>Experiment under conditions where the driver's OEDR time was changed</u>

# Results：fixation count and duration per 5-second window

## ■ Difference between 20s and 55s monitoring condition

- The 20s monitoring condition had a larger number of fixations and a shorter fixation duration than the 55s monitoring condition →while the gaze rate was the same (previous slide), the 20s condition elicited <u>frequent short gaze</u> between the front and the mirror.

Mean and standard error of all 30 participants



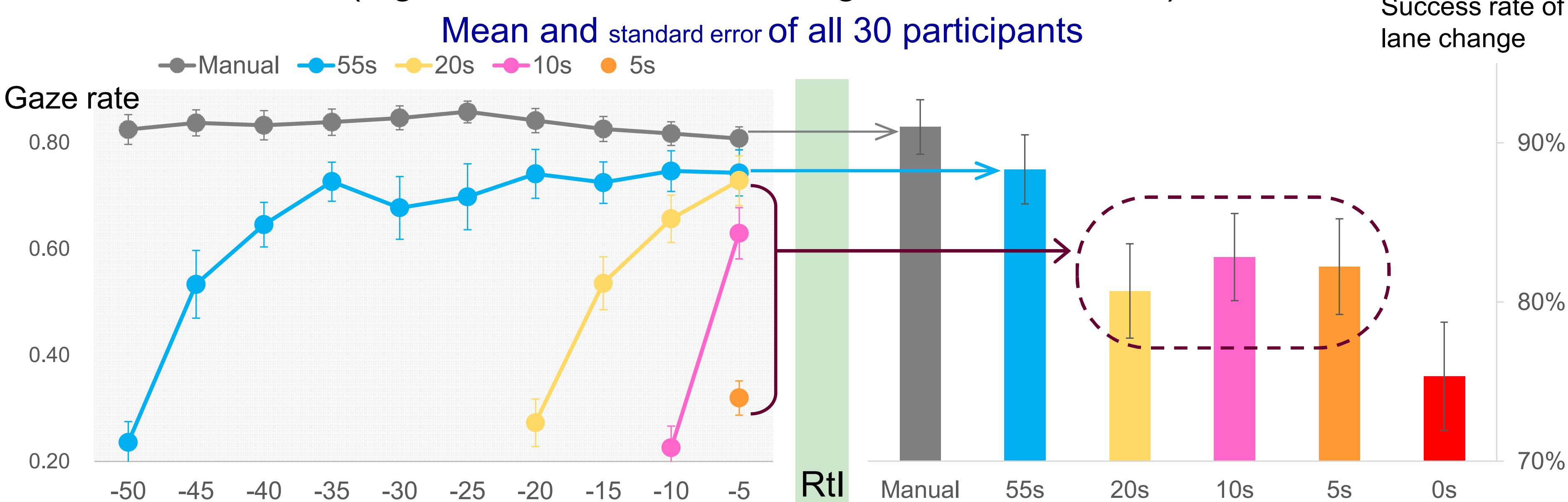
**System-initiated transitions from automated to manual driving**

## Evaluation methods of attentiveness

Experiment under conditions where the driver's OEDR time was changed

# Results：from monitoring start to the transition

- **Success rate of lane change**
  - The 55s condition elicited a stable gaze-on-front rate of about 70% before the RtI, and the success rate of lane change was comparable to the manual driving condition (highest success rate among all the conditions).

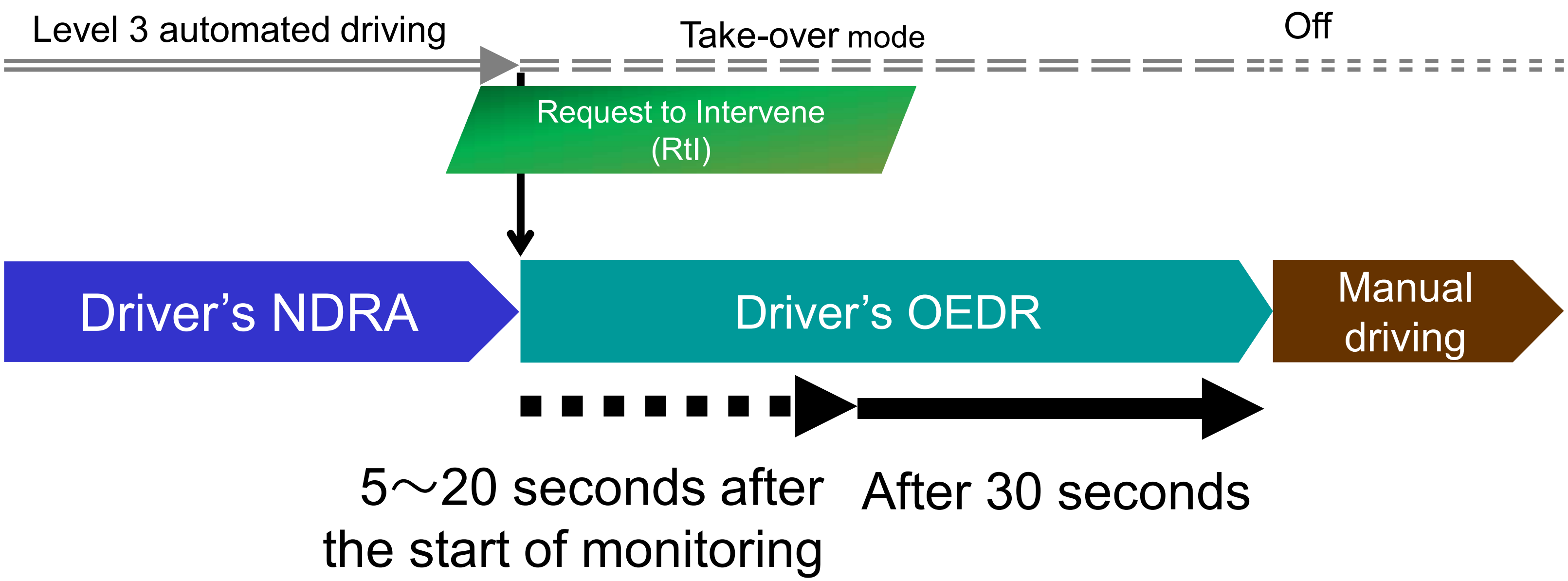



**Gaze-on-front**

**Success rate of lane change** ( no crash, no yellow line cut, no without lane change )

After the transition, reaction time (begin to steer or brake or accelerate) was about 2.2s for 5s, 10s, 20s, and 55s conditions

# Summary




・Frequent gaze shift between front and mirrors
・Gaze-on-mirrors was high
・Gaze-on-front gradually increased
・Success rate of lane change was low

**Drivers attempted to build situation awareness by frequent gaze on peripherals**

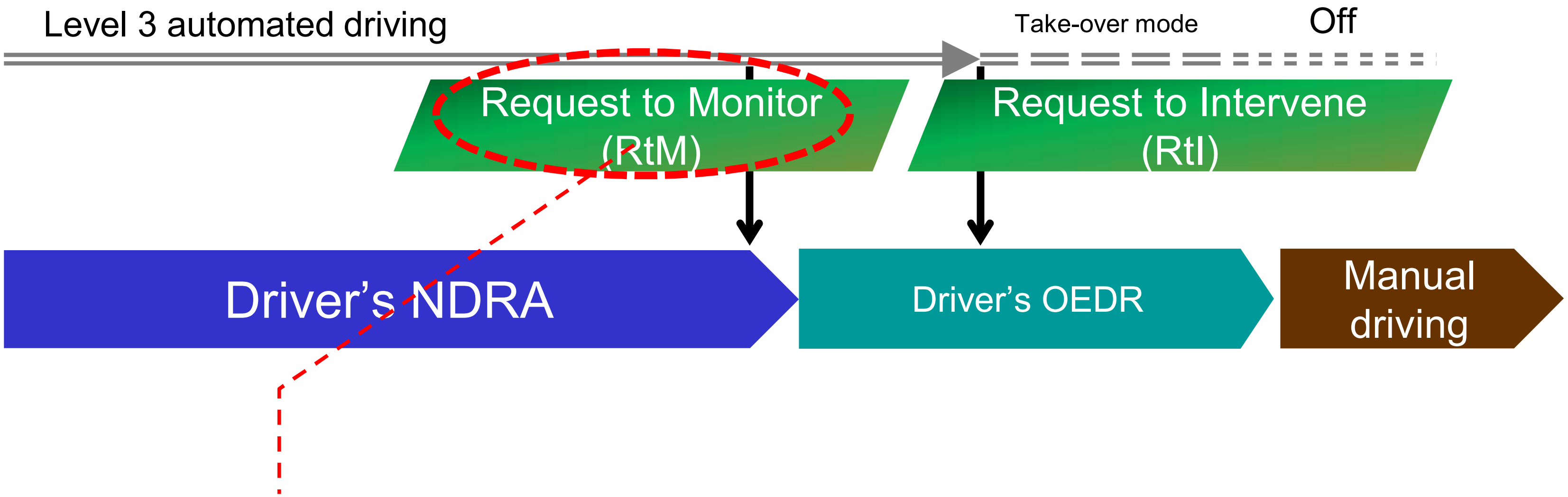
・Gaze rate and fixation count did not change too much
・After about 30 seconds, gaze rate and fixation count were comparable to manual driving

**Appropriate situation awareness was built and began to prepare for the lane change task**

System-initiated transitions from automated to manual driving

# HMI principles of RtM to promote driver’s attentiveness

RtM: Request to Monitor




**Previous findings:**
an OEDR phase shortly before an RtI improved driver’s performance
(Success rate of lane change was higher with an OEDR)

**Research questions:**
How the drivers would response to a request to monitor and whether they would monitor the environment constantly
(Will their performance be affected by their monitoring behaviors)

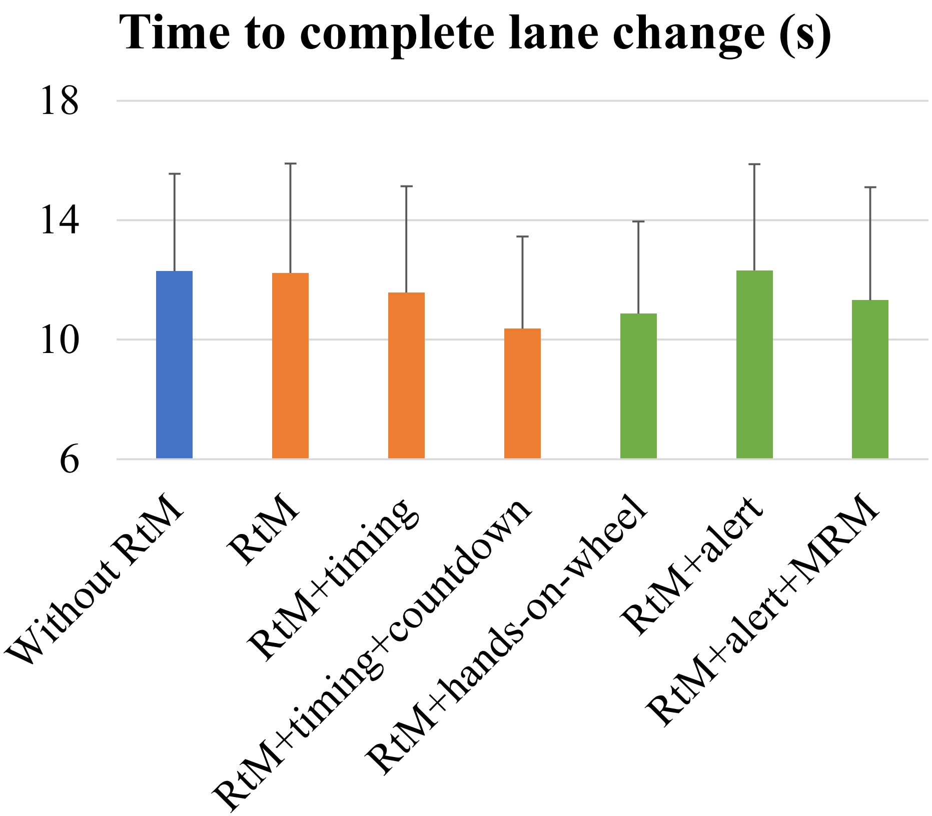
# Experiment design

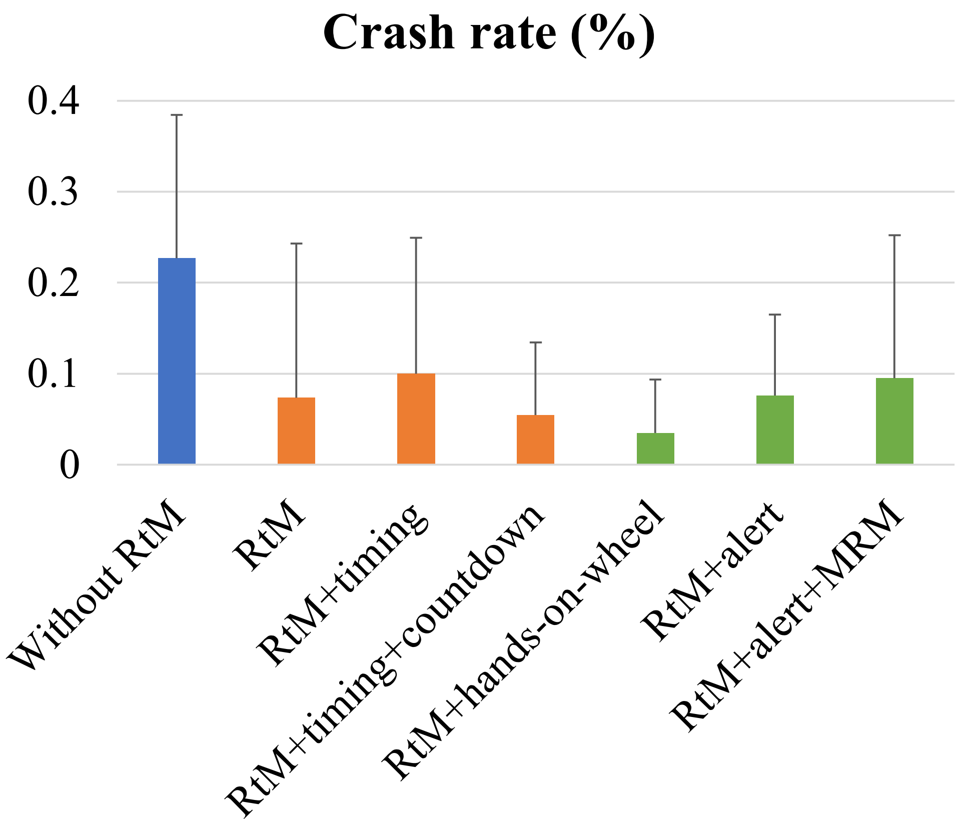
| | |
|---|---|
| Condition 1 | • RtM = 'the automation will turn off soon, please monitor the environment' |
| Condition 2 | • RtM = 'the automation will turn off after 60 seconds, please monitor the environment' |
| Condition 3 | • RtM = 'the automation will turn off after 60 seconds, please monitor the environment' + '30 seconds alert' + '5,4,3,2,1' |
| Condition 4 | • RtM + hands-on-wheel |
| Condition 5 | • RtM + real-time alert (buzzer when not monitoring) |
| Condition 6 | • RtM + real-time alert + potential MRM implementation |

- Instructions to participants
  - Drive in your daily manner. You can continue NDRA after RtM if you consider it is safe
  - You would win additional compensation (Money) if you achieved higher score of NDRA
- Experiment scale
  - Participants: 120 (between subject design, 20 *6 conditions)
  - 20～64 yeas-old, male: female = 1:1

# Results

| | |
|---|---|
| Condition 1 | RtM = 'the automation will turn off soon, please monitor the environment' |
| Condition 2 | RtM = 'the automation will turn off after 60 seconds, please monitor the environment' |
| Condition 3 | RtM = 'the automation will turn off after 60 seconds, please monitor the environment' + '30 seconds alert' + '5,4,3,2,1' |
| Condition 4 | RtM + hands-on-wheel |
| Condition 5 | RtM + real-time alert (buzzer when not monitoring) |
| Condition 6 | RtM + real-time alert + potential MRM implementation |




- With RtM (OEDR phase), the crash rate was significant lower
- RtM + timing + countdown brought lower crash rate and faster lane change
- Hands-on-wheel brought lowest crash rate
- Neither buzzer nor MRM led to better lane change performance

# Summary

**The positive effect of an RtM was re-confirmed**

- More successful lane changes and less crashes

**The information of RtM matters**

- Accurate timing together with a countdown led to better performance

**HMIs promoting monitoring behavior**

- Hands-on-wheel brought highest success rate of lane change
- Real-time alert and MRM did not affect driver's performance

## Driver initiated transition from automated to manual driving

## Research of Human Machine Interface for Driver Initiated Take-over

Driver-initiated transition from automated driving to manual driving mainly occurs in level 2 driving. To expand the level 2 driving, which is currently limited to expressways, to general roads with many hazards, it is necessary to show that drivers can respond appropriately based on an appropriate understanding of the system and achieve a quicker reaction.

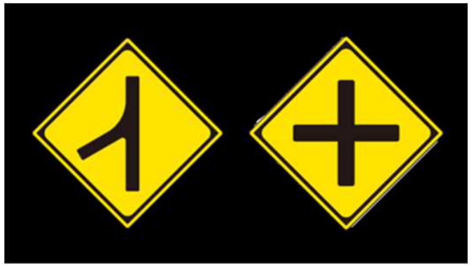
To enable the safe application of level 2 driving on general roads, especially near signalized intersections, human machine interfaces (HMIs) were proposed to improve drivers’ attention levels and responses to risks. Driving simulator experiments were performed to investigate the influences of the proposed HMIs on driver behaviors.

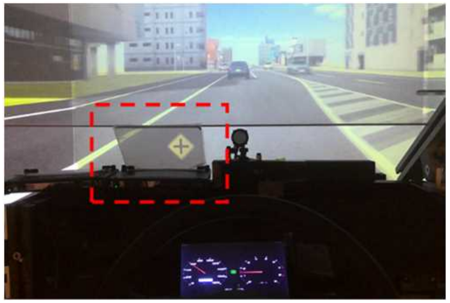
# Experiment 1: HMIs for interacting with the change of traffic signal

When traffic signal recognition is not included in the level 2 automated driving, drivers need to take over and stop the vehicle by themselves if the signal turns yellow when the vehicle is approaching a signalized intersection while following the preceding vehicle with ACC.

Two kinds of HMIs were proposed, of which static HMI is to notify the approach to intersections and confluences based on static map information and dynamic HMI is to present information of traffic signal and lane regulation based on dynamic information from the infrastructure. The presented traffic signal information is the predicted color of the oncoming signal when the ego vehicle reaches the signalized intersection.

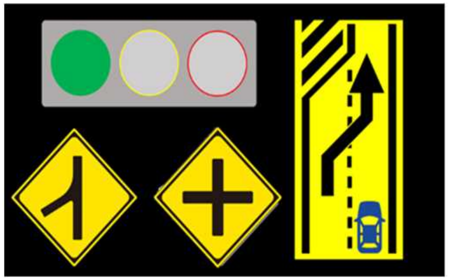
Static HMI





Presented by HUD

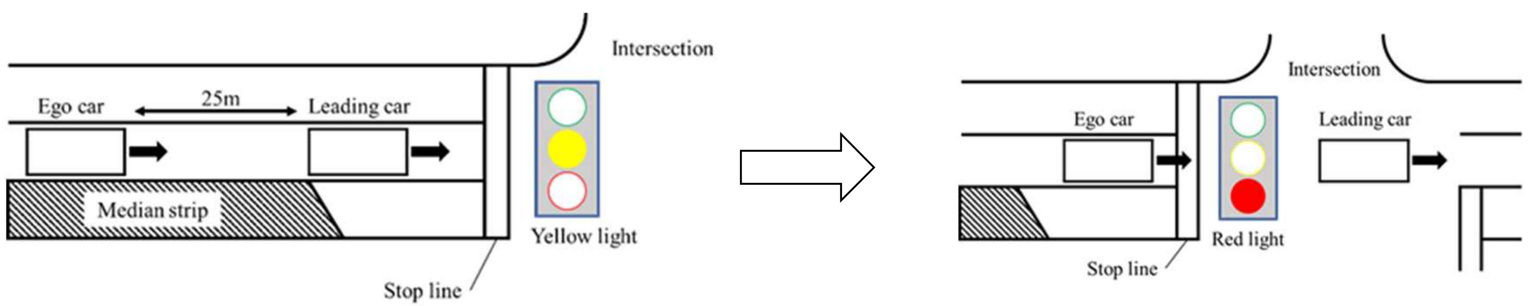
Dynamic HMI



## Experiment

During the experiment, the signal turns yellow when the ego vehicle and the preceding vehicle approach the signalized intersection where the actual risk occurs. The preceding vehicle passes through the signalized intersection without stopping, while the ego vehicle will confront a red signal if drivers do not take over.

Driving simulator experiment was conducted with 16 participants under four conditions (manual operation, level 2 + without HMI, level 2 + static HMI, level 2 + dynamic HMI).




Signalized intersection where the actual risk occurs

# Result

✓ Success rate of risk avoidance

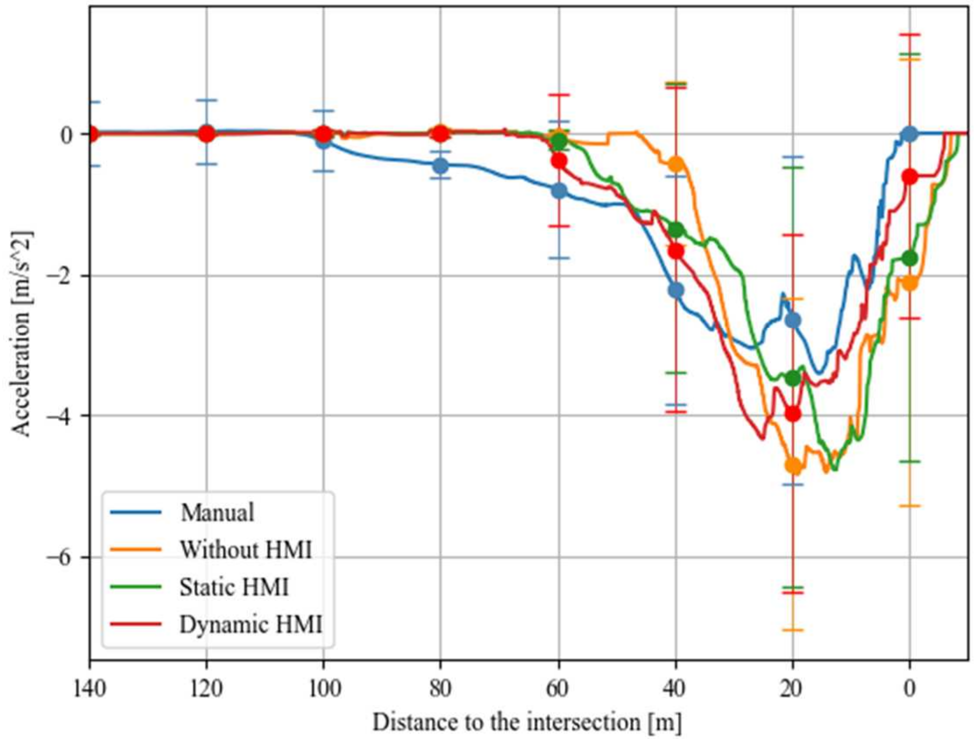
| | Success | | Fail | |
|---|---|---|---|---|
| | Stop before the stop line | Parts of the vehicle cross the stop line | Stop inside intersection | Traffic light ignorance |
| Manual | 16 | 0 | 0 | 0 |
| Level 2 + without HMI | 7 | 3 | 1 | 3 |
| Level 2 + static HMI | 10 | 4 | 0 | 1 |
| Level 2 + dynamic HMI | 10 | 1 | 2 | 0 |

Before the experiment, the participants were informed that the level 2 and the signal recognition system operate independently, while it is possible that they misunderstood that the predicted traffic signal by the dynamic HMI and the vehicle control by the level 2 system were linked.

- Manual operation had the highest success rate
- Level 2 + without HMI had the highest failure rate
- With level 2 + static HMI, the stop line was often overhanging, while the success rate was high
- With level 2 + dynamic HMI, no traffic light ignorance occurred

# Result

- ✓ Acceleration during the risk scene



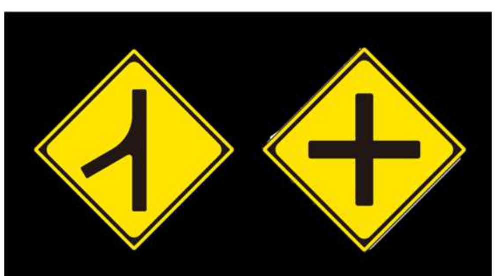

The results show that the information of the traffic signal presented by dynamic HMI may reduce sudden deceleration while facing the change of traffic signal at intersections.

## Experiment 2 : HMIs to avoid vehicle-to-vehicle accidents at intersections

The purpose of this experiment is to investigate the requirements of HMI to prevent vehicle-to-vehicle accidents near signalized intersections by appropriate driver-led takeovers while applying level 2 driving.

Two kinds of HMIs were applied, of which one is the static HMI used in the experiment 1, and the other is sensor HMI which presents real time results of image recognition by the level 2 automated driving system.

Static HMI



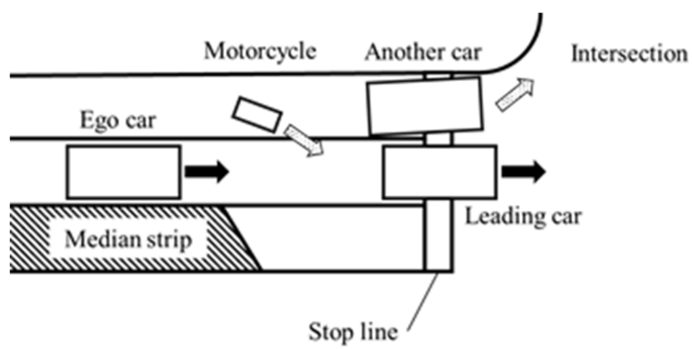
Presented by HUD

Sensor HMI

# Experiment

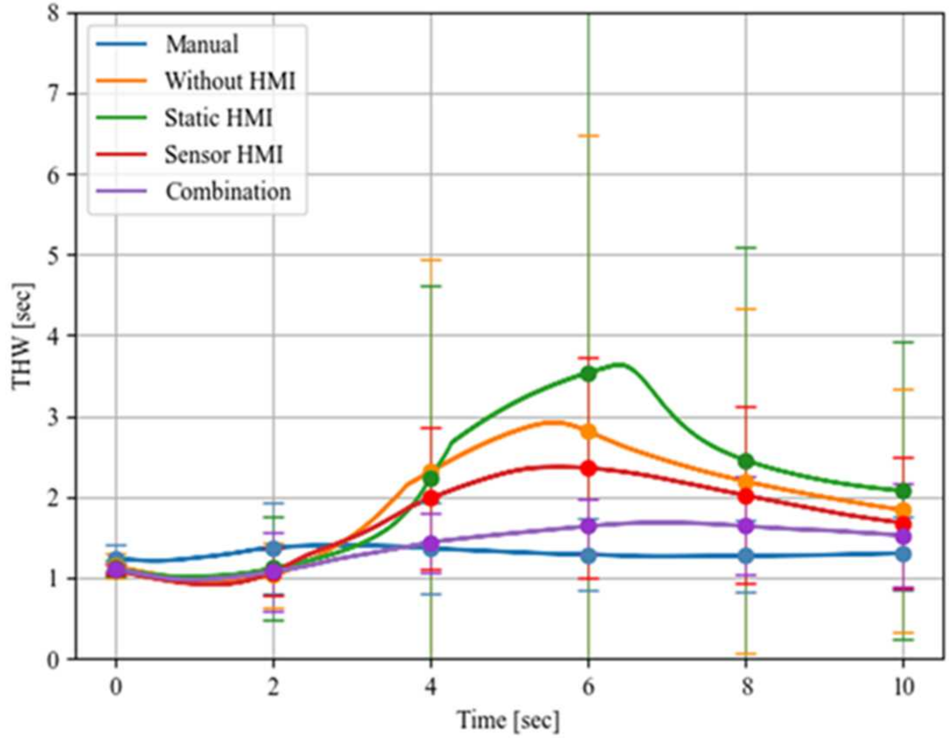
During the experiment, the ego vehicle follows the preceding vehicle in the second lane at 60 km/h. A motorcycle in the first lane suddenly interrupts in front of the ego vehicle near the signalized intersection, and a collision will occur if the drivers do not take over.

Driving simulator experiment was conducted with 15 participants under 5 conditions (manual operation, level 2 + without HMI, level 2 + static HMI, level 2 + sensor HMI, level 2 + combination of static HMI and sensor HMI).



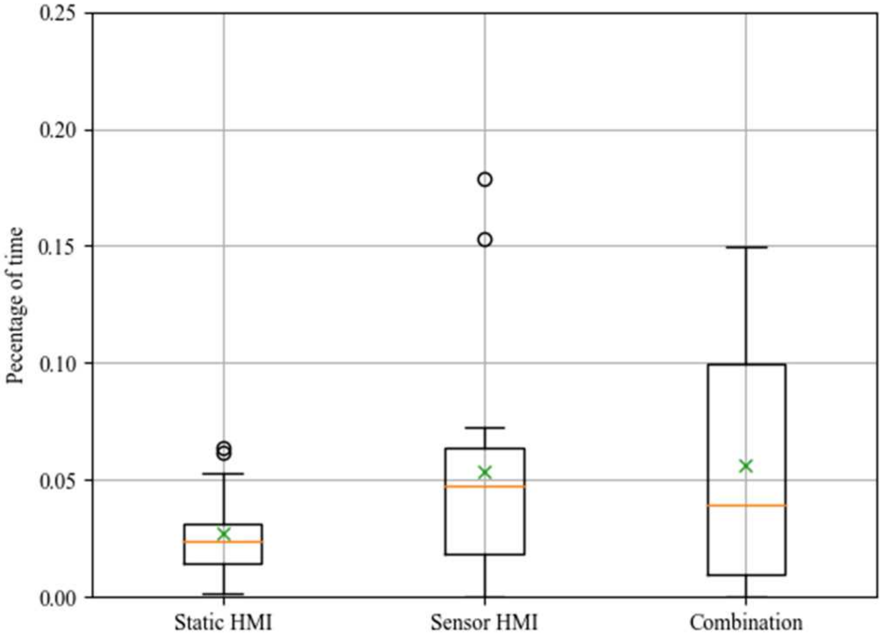

Risk scene near the signalized intersection

# Result




The results show that under the HMI combination condition (static HMI + sensor HMI), the time headway (THW) was maintained relatively close to the reaction in manual operation.

# Result




For the percentage of gaze time to the HMIs near the intersection, it was observed that the gaze time during the conditions that include sensor HMI was longer than that with static HMI.

# Task C

# Education and Training for Users

University of Tsukuba

# **Educating approach for general knowledge on the DA Civ**

## Purpose

Based on the achievement of SIP-adus (2016~19), the study aims to propose different types of educating approach of driving automation (DA), and verify the effects on taking over vehicle's control and comprehending system's function.

## Hypotheses

1. Giving specific examples while educating the general is effective to user utilizing and comprehending the ADS.
2. Experiencing the request to intervene (RtI) is helpful to user utilizing and comprehending the ADS.

* DA: Driving automation

# Educating approach for general knowledge on the DA Civ

## Method

Independent variable

– Educating approach

| Between-subject | | Giving specific examples | |
|---|---|---|---|
| | | With | Without |
| Experiencing RtI | Done | Done/with | Done/without |
| | None | None/with | None/without |

– Functions (fixed within-subject factor)
equipped v.s. unequipped lane change assist function (LAC v.s. uLCA)

Participants

– 40 who have been not educated general knowledge about DA

| Condition | Number | | Average age | | |
|---|---|---|---|---|---|
| | Female | Male | Female | Male | Total |
| Done/with | 4 | 6 | 28.3 | 39.7 | 35.1 |
| Done/without | 6 | 3 | 33.3 | 22.0 | 29.6 |
| None/with | 5 | 3 | 45.2 | 22.0 | 36.5 |
| None/without | 4 | 6 | 34.8 | 27.5 | 30.4 |

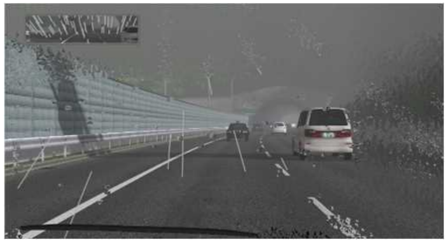
# Method

Dependent variables

- Rate of successful intervention
- Takeover time
- Responding behavior

Scenarios

– Scenes in which RtI is issued



Heavy raining

Approaching PA

Stopping car*

– Scenes in which LCA is only issued

Stopping car

Slower car

* RtI will be not issued in LCA.

# Educating approach for general knowledge on the DA Civ

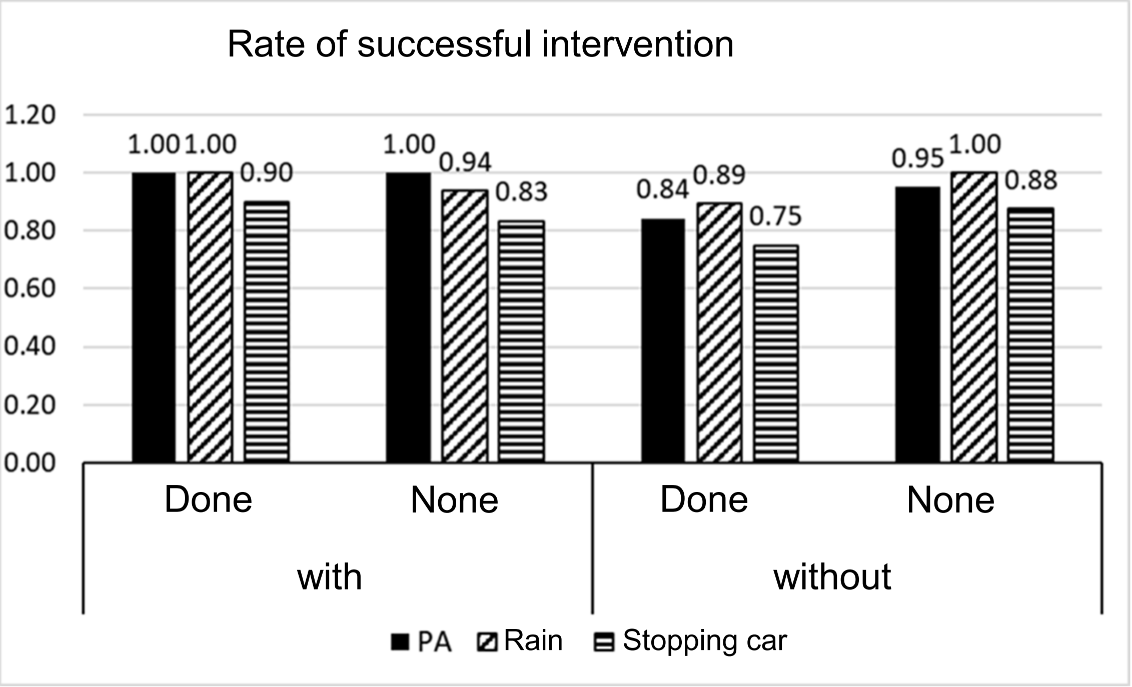
# Method

## Procedure

| Day | **Content** |
|---|---|
| 1st (Education) | Explanation<br>Inform consent<br>Education of DA<br>Questionnaire<br>Instruction of specific ADS (LCA or uLCA)<br>Questionnaire |
| 2nd (Data collection) | Questionnaire<br>Exercise<br>Explaining driving task and non-driving task<br>Data collection<br>Questionnaire<br>Instruction of specific ADS (uLCA or LCA) |
| 3rd (Data collection) | Explanation<br>Questionnaire<br>Exercise<br>Explaining driving task and non-driving task<br>Data collection<br>Questionnaire |

# Results

## - Rate of successful intervention

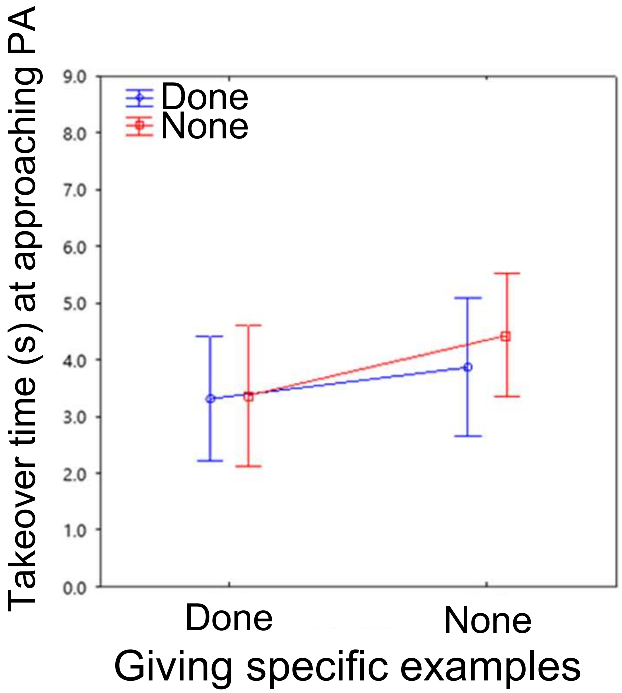


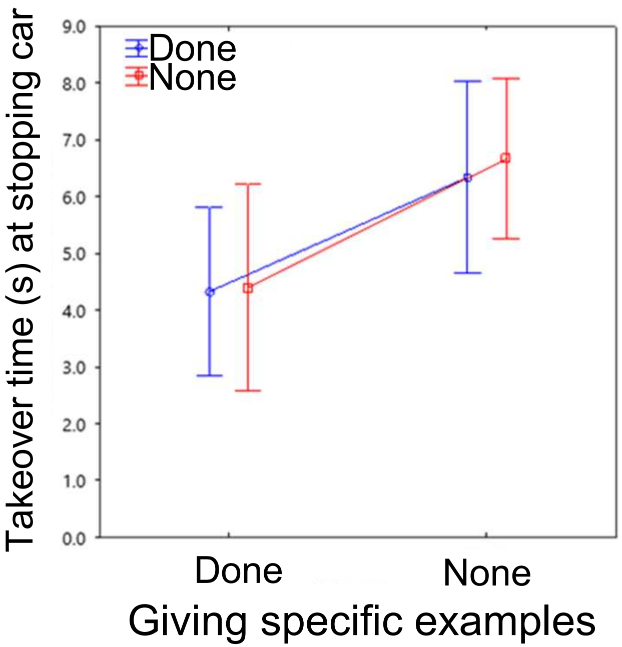

- Higher rate resulted in the condition of Done/with in any of scenes.
- In higher risky traffic scene of stopping car, highest successful rate (0.90) under Done/with implies that giving specific examples was effective on driving safety.

# Educating approach for general knowledge on the DA Civ

# Results

## - Takeover time when an RtI is issued

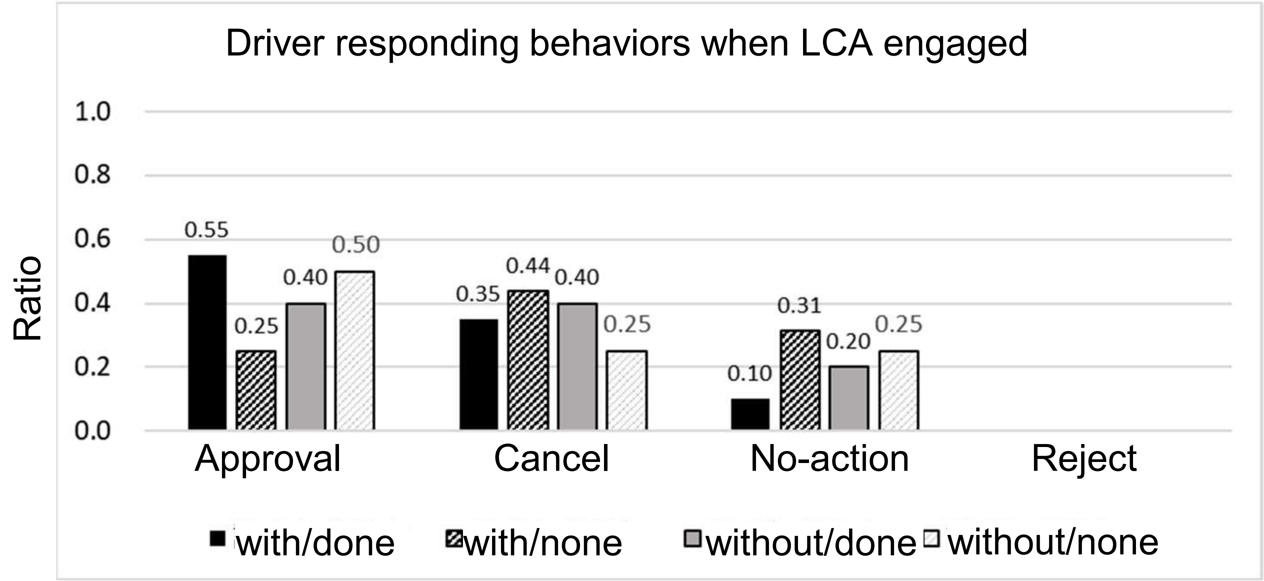



- Giving specific examples was significant in traffic scene of stopping car $F(1,28)=35.287$, $p < .05^{*}$, partial $\eta^2=.210$）, but experiencing an RtI was not.
- It is suggested that giving specific examples was effective on taking over vehicle's control from the system.

# Results

## - Driver responding behavior when LCA engaged




- Ratio of “approval” in Done/with was highest (0.55) and No-action was lowest (0.10), which indicated a tendency that drives in the group of Done/with more comprehended the function of LCA.

## Educating approach for general knowledge on the DA Civ

# Conclusion

The study focused on educating general knowledge on the driving automation, and proposed educating approaches via giving specific example and experiencing the RtI.

According to the experimental results, we found that:

- Giving specific examples was effective on taking over vehicle’s control from the system, which agrees with the hypothesis-1.
- On the other hand, the effect of experiencing the RtI was not shown. However, Experiencing the RtI while giving specific examples would be more effective.

# Feasibility study on web-based simulator experiment Cvii

Purpose： To confirm the feasibility of web-based remote experiments under COVID-19 situation

Hypotheses：

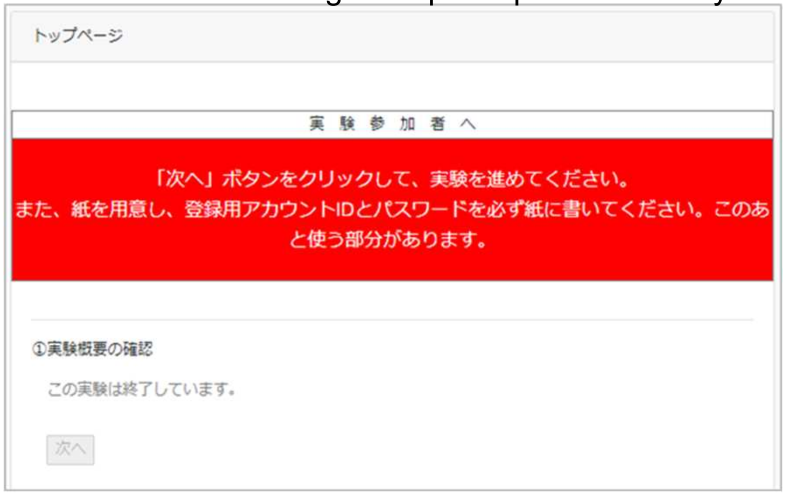
１． With the web-based experiment system, we can conduct experiments without intervention from the experimenter.

２． The experimental results show similar tendencies to the previous in-person experiment with a real driving simulator.

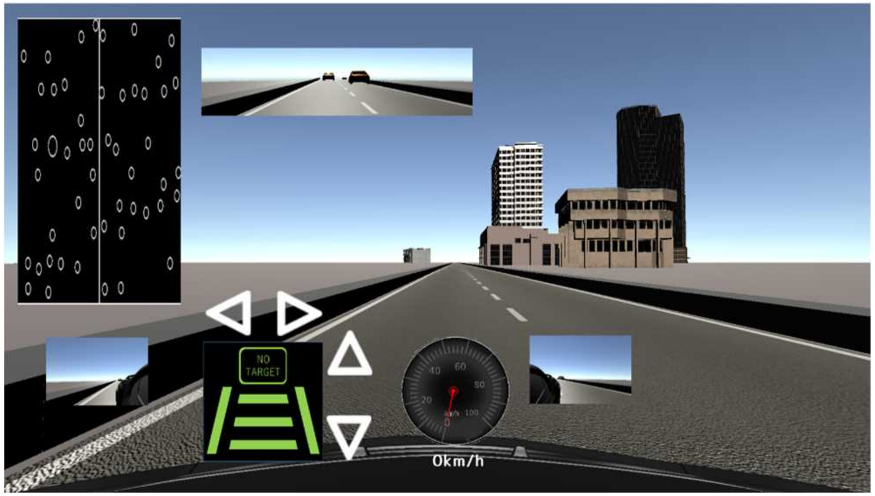
# Feasibility study on web-based simulator experiment Cvii

## The developed web system：

The web-site which guides participants smoothly.




The driving simulation scene




## Results and conclusion

1． Without the experimenter intervention, 16 out of 20 participants completed the simulation experiment.

2． Takeover was more successful if participants received knowledge on typical takeover situations, which is similar to the previous in-person experiment.

| Scene: Stopped car ahead | # participants who took over successfully | # participants who took over after system disengaged | # participants who took over before the scene | # participants who did not take over |
|---|---|---|---|---|
| With knowledge on takeover situations (7 participants) | 5 (56%) | 0 (0%) | 2 (22%) | 2 (22%) |
| Without knowledge on takeover situations (9 participants) | 7(78%) | 0 (0%) | 2 (22%) | 0 (0%) |

# Web survey about user’s learning knowledge about Driving automation Cv

## Purpose

The web survey was made for investigating user’s interest, acquired knowledge, and expecting knowledge, in order to reveal:

1. Relation between consumers attitudes and acquired knowledge
2. Relation between consumers attitudes and expecting knowledge
3. Relation between acquired and expecting knowledge
4. Difference between purchaser and seller

# Web survey about user's learning knowledge about Driving automation Cv

## Questions & respondents

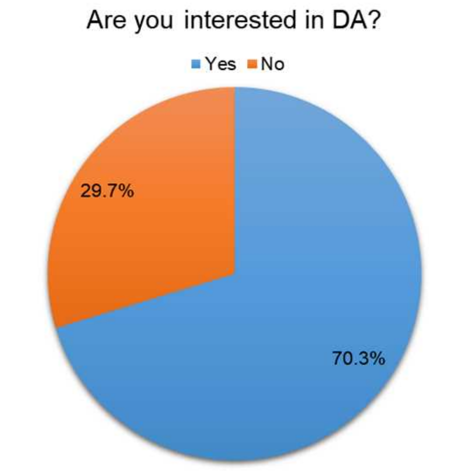
| | Questions (in Japanese) |
|---|---|
| Q1 | あなたの最終学歴をお答えください。 |
| Q2 | ご自身の日常での運転頻度についてお答えください。 |
| Q3 | ご自身の日常生活で最も多く自動車を利用するシーンについてお答えください。 |
| Q4 | ご自身の月間走行距離についてお答えください。 |
| Q5 | 自動運転に興味を持っていますか |
| Q6 | 自動運転技術の知識を知りたいですか |
| Q7 | 自動運転技術を装備する車を購入する意欲があります（ありました）か |
| Q8 | 自動運転技術を装備する車の購入について、あなたの状況に近いものをお選びください |
| Q9 | 自動運転に関する知識を習得する方法について、あなたが習得したいと思うものをお選びください |
| Q10 | 自動運転に関する知識について、現在あなたがお持ちの知識であてはまるものをそれぞれお選びください |
| Q11 | ご検討の段階で、ディーラーでスタッフにより自動運転に関する説明を受けたことがありますか。 |
| Q12 | 検討の段階で、ディーラーでスタッフから自動運転に関して以下の事を説明されましたか |
| Q13 | 検討の段階で、ディーラーでスタッフにより自動運転に関して説明を受けた際、自動運転機能の体験はできましたか |
| Q14 | ご商談の際、ディーラーでスタッフにより自動運転に関する説明を受けたことがありますか。 |
| Q15 | 商談の段階で、ディーラーでスタッフから自動運転に関して以下の事を説明されましたか。 |
| Q16 | 商談の段階で、ディーラーでスタッフにより自動運転に関して説明を受けた際、自動運転機能の体験はできましたか。 |
| Q17 | ご契約の際、ディーラーでスタッフにより自動運転に関する説明を受けたことがありますか。 |
| Q18 | 契約の段階で、ディーラーでスタッフから自動運転に関して以下の事を説明されましたか。 |
| Q19 | 契約の段階で、ディーラーでスタッフにより自動運転に関して説明を受けた際、自動運転機能の体験はできましたか。 |
| Q20 | 納車の際、ディーラーでスタッフにより自動運転に関する説明を受けたことがありますか |
| Q21 | 納車の段階で、ディーラーでスタッフから自動運転に関して以下の事を説明されましたか。 |
| Q22 | 納車の段階で、ディーラーでスタッフにより自動運転に関して説明を受けた際、自動運転機能の体験はできましたか。 |
| Q23 | 自動運転に関する知識について、どの程度知りたいかあてはまるものをそれぞれお選びください。 |
| Q24 | 自動運転に関する知識について、もっと知りたいものがあれば、どの程度知りたいかあてはまるものをそれぞれお選びください。 |
| Q25 | あなたは今後、具体的な自動運転機能の体験をしたいと思いますか |

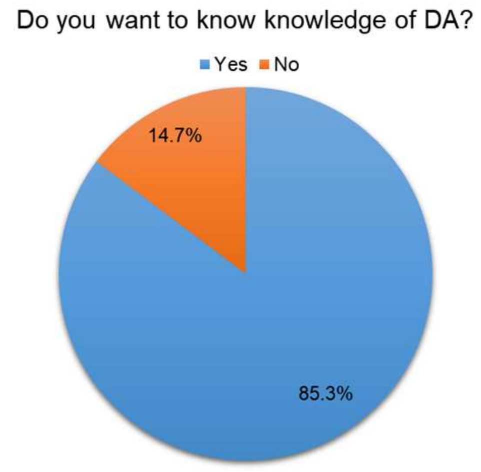
– Total 1072 (female : male = 1:1) respondents

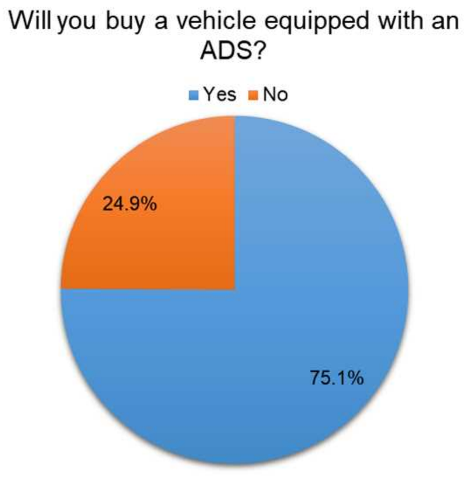
# Web survey about user's learning knowledge about Driving automation Cv

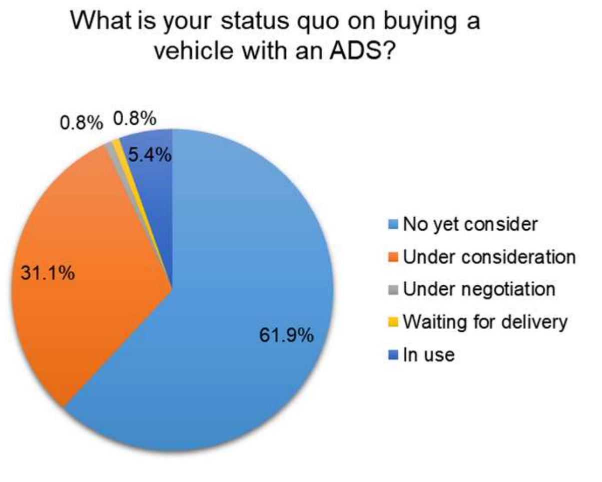
## Results and Discussions

– Consumers attitudes



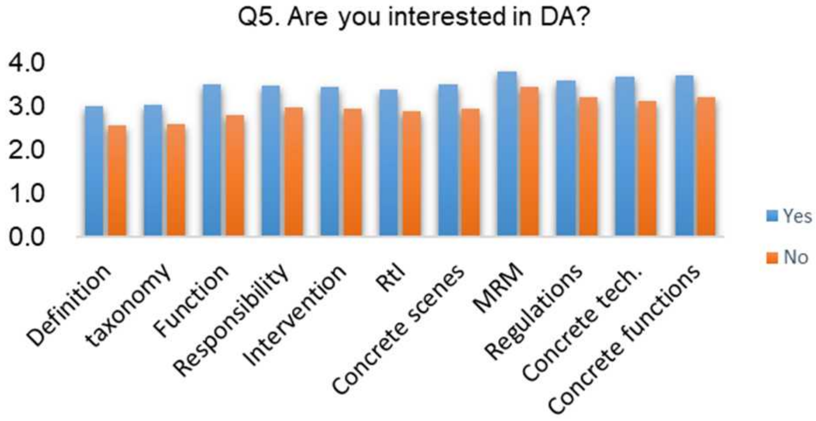



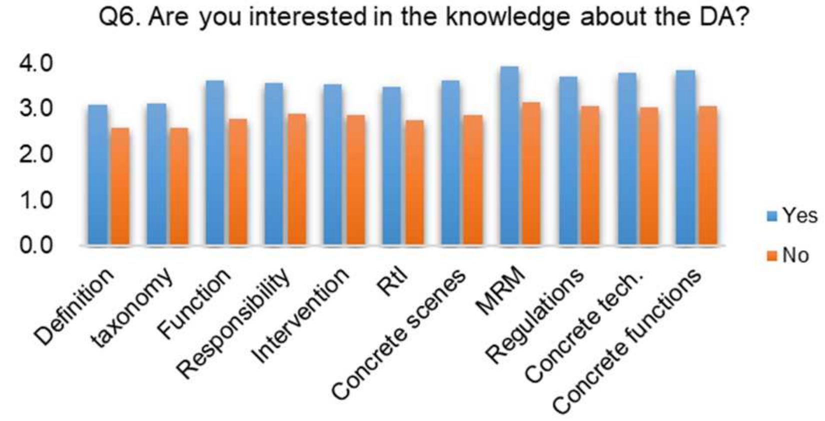



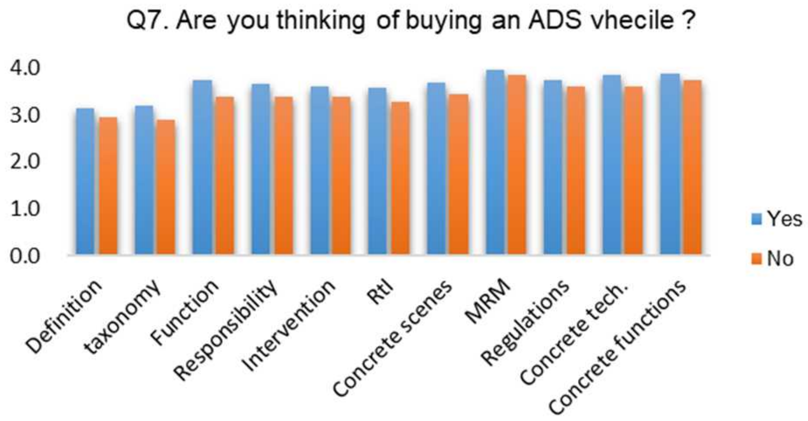
# Web survey about user's learning knowledge about Driving automation Cv

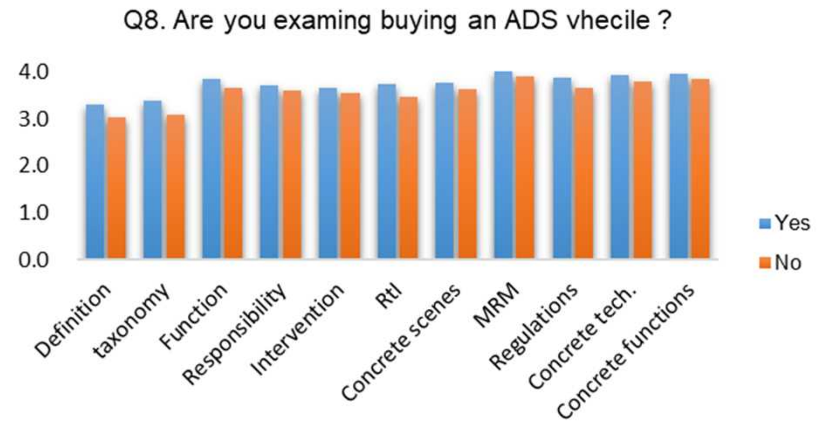
## Results and Discussions

– Relation between consumers attitudes and acquired knowledge



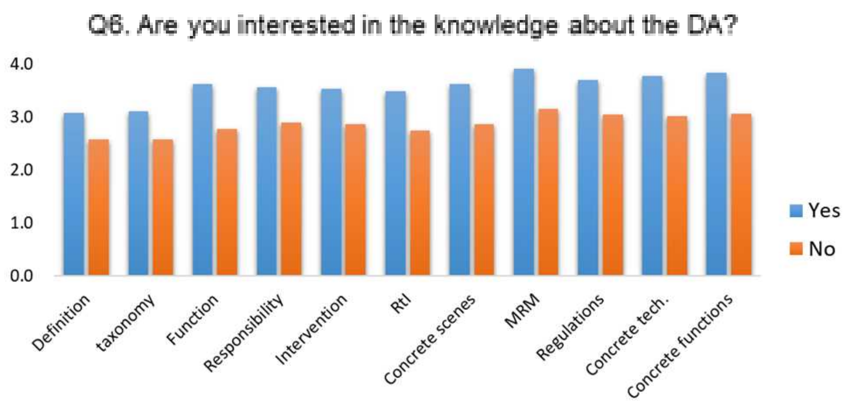



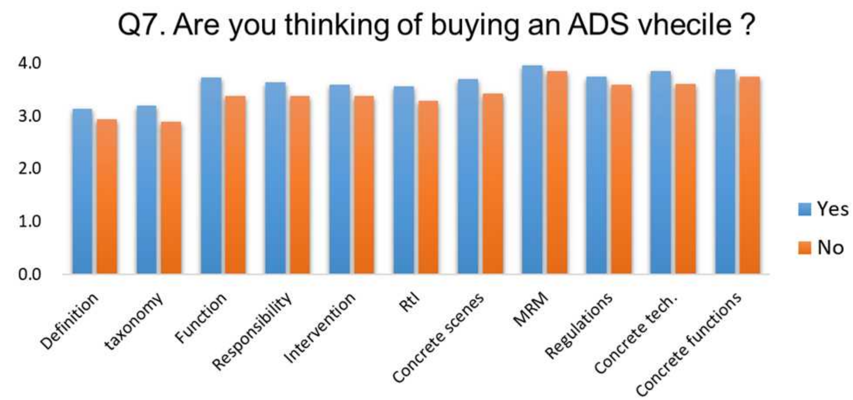

Based on t-test on each contents, difference ($p<0.05$) was shown under consumers attitudes（Q7, Q8).
It is suggested that user's acquired knowledge affected consumers attitudes.

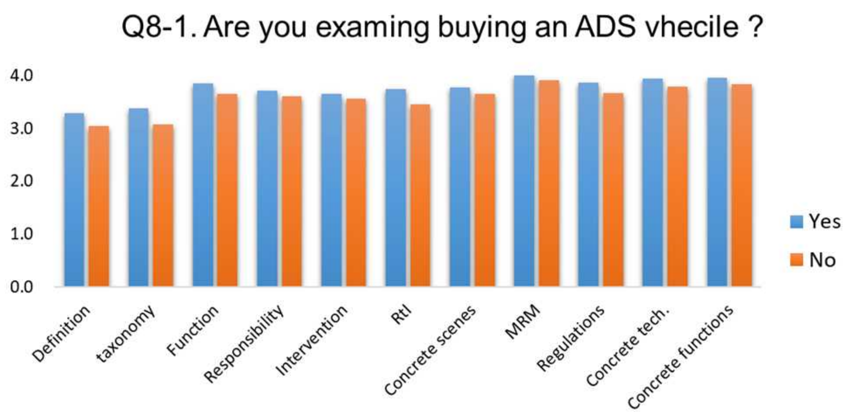
# Web survey about user's learning knowledge about Driving automation Cv

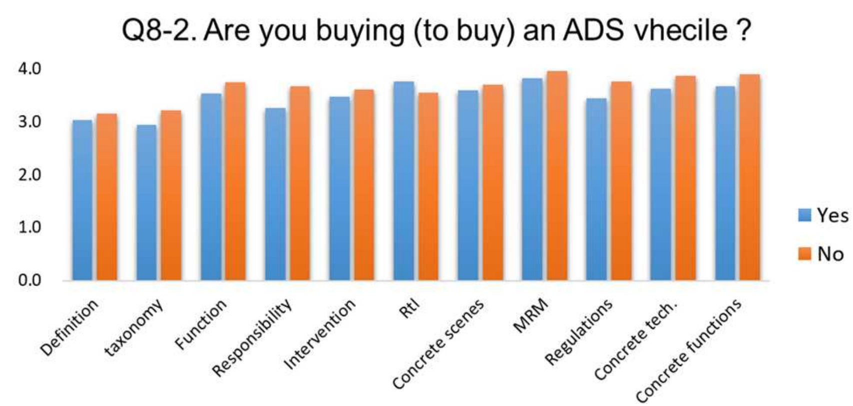
## Results and Discussions

– Relation between consumers attitudes and expecting knowledge



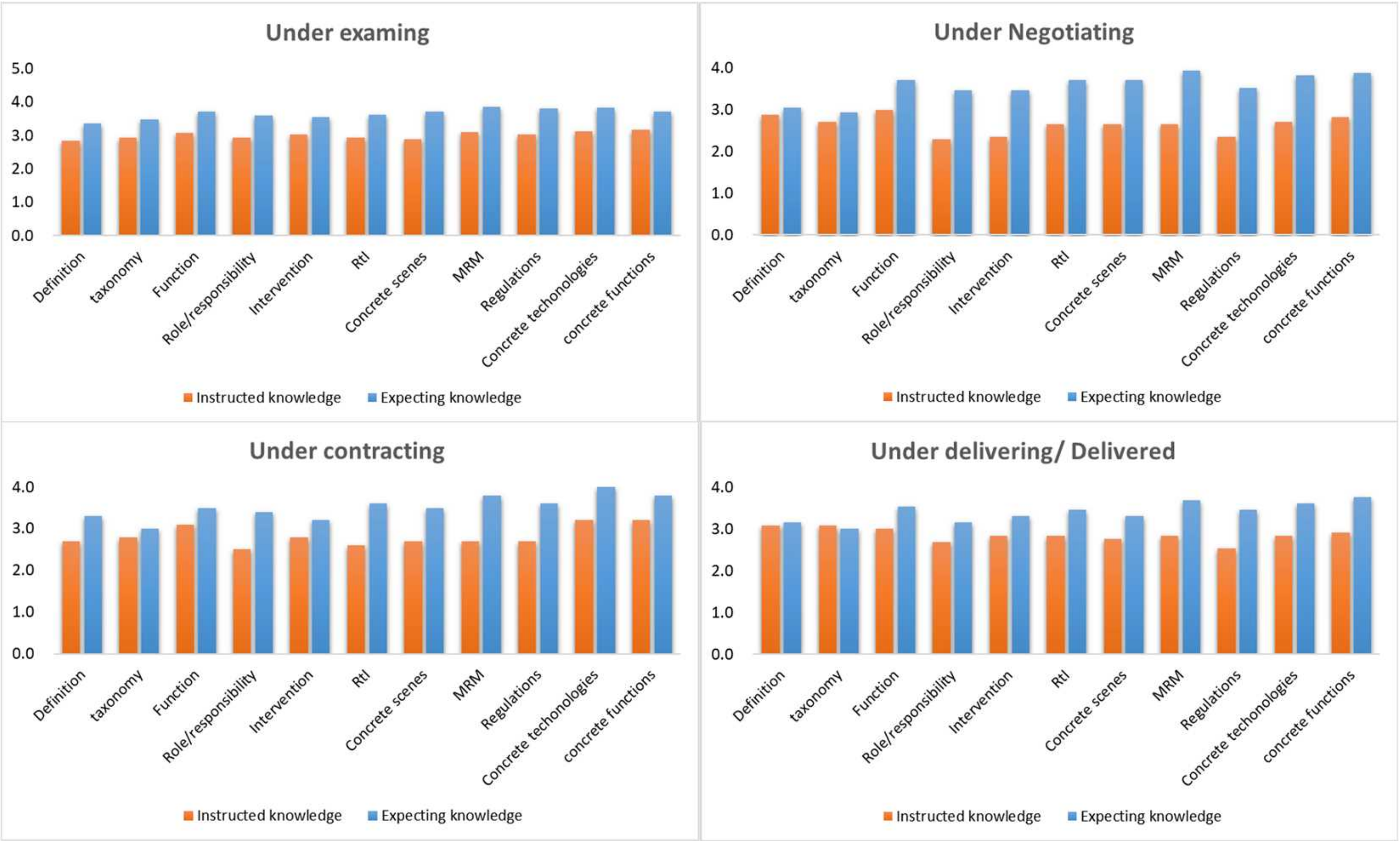




Based on t-test on each contents, difference ($p<0.05$) was shown under consumers attitudes（Q6-Q8-2).
It is suggested that user's expecting knowledge also affected consumers attitudes.

# Web survey about user's learning knowledge about Driving automation Cv

## Results and Discussions

– Relation between instructed and expecting knowledge




Users tended to expect more detailed explanations than that explained by seller, particularly at consulting and contracting stages.

# Web survey about user's learning knowledge about Driving automation Cv

## Conclusion

Based on the results on the web survey, higher consumers attitudes was, larger the difference on the acquired knowledge was.
On the other hand, the opposite tendency was shown on the expecting knowledge.
Moreover, the gap between purchasers and sellers was indicated on the instruction about driving automation.

# **Teaching method for specific knowledge on the ADS Cviii**

## Purpose

The study aims to propose teaching method for instructing specific knowledge on the ADS* and verify the effectiveness via driving-simulator(DS) experiment

Conditionally driving automated system equipped lane change Assist (LCA) function is investigated in this study.

## Hypotheses

1. User-base instruction is effective to user utilizing and comprehending the ADS.
2. Experiencing taking over vehicle's control is helpful to user utilizing and comprehending the ADS.

* ADS: automated driving system

# Teaching method for specific knowledge on the ADS Cviii

## Method

Independent variable

- Teaching method

| Between-subject | | Instruction of specific knowledge | |
|---|---|---|---|
| | | Instructor-base | User-base |
| Experiencing takeover | Done | Instructor/Done | User/Done |
| | None | Instructor/None | User/None |

Participants

- 48 who have been educated general knowledge about DA*

Scenarios

- Scenes in which RtI is issued
- Scenes in which LCA is issued

Heavy raining

Approaching PA

Stopping car

Slower car

* DA: Driving automation

# Method

## Dependent variable

- Successful takeover
- Responding behavior
- Takeover time

## Procedure

| Day | Content |
|---|---|
| 1st (web-instruction) | Explanation<br>Inform consent<br>Instruction of specific ADS<br>(Experiencing takeover )<br>Questionnaire |
| 2nd (Data collection) | Explanation<br>Questionnaire<br>Exercise<br>Explaining driving task and non-driving task<br>Data collection<br>Questionnaire |

# Results and conclusion

Because of on-going data collection, results and conclusion are not reported.

This report documents the results of Cross-ministerial Strategic Innovation Promotion Program (SIP) 2nd Phase, Automated Driving for Universal Services (SIP-adus, NEDO management number: JPNP18012) that was implemented by the Cabinet Office and was served by the New Energy and Industrial Technology Development Organization (NEDO) as a secretariat.