SIP-adus Project: Development of traffic accident simulation to evaluate safety benefits of ADAS/ADS

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Scope of SIP-adus

【Motivation】

Development of a simulation tool to evaluate traffic safety impact when ADAS/Automated Driving systems are deployed.

(I) Development and verification of automated driving system

Road Transport system

Traffic environment

Driver

Recognition | Judgment | Operation

(5) System Security

(4) Driver Model

Recognition | Judgment | Operation

(1) Dynamic Map

(2) Prediction based on ITS information

(3) Sensors

Area of Cooperation

Area of Competition

Vehicle

(III) International cooperation

(1) Open research facility
(2) Social acceptance
(3) Technology transfer

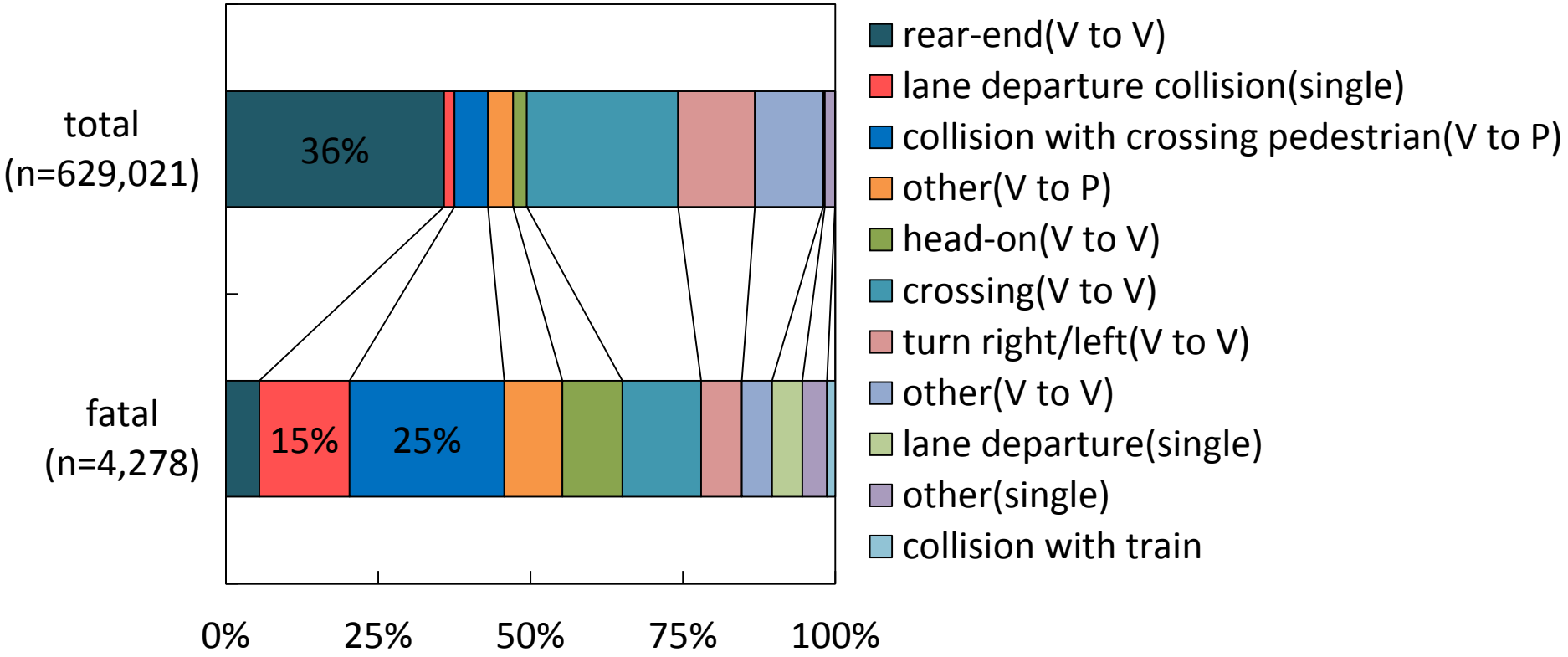
(1) Enhanced local traffic management
(2) Next generation transport system

(IV) Development for next generation urban transport

(1) Traffic fatality reduction effect estimation method & national shared database
(2) Macro and micro data analysis and simulation technology
(3) Local traffic CO_2 emission visualization technology

(II) Basic technologies to reduce traffic fatalities and congestion

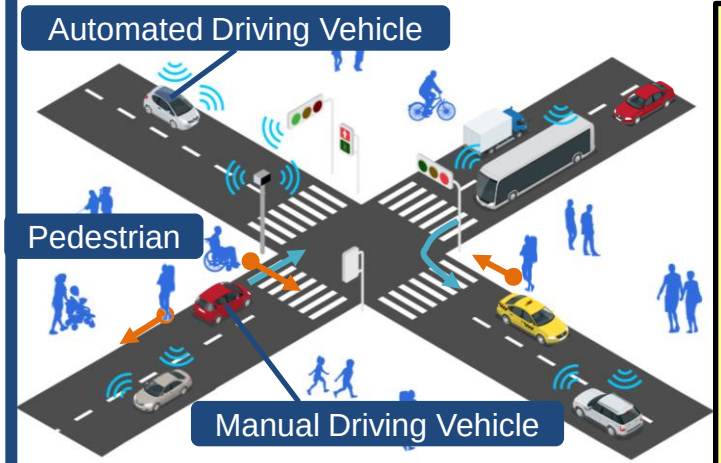
Major Crash Types in Japan



Quantitative analysis of accident reduction

1. Traffic flow simulation → 2. Traffic accident analysis → 3. Estimation

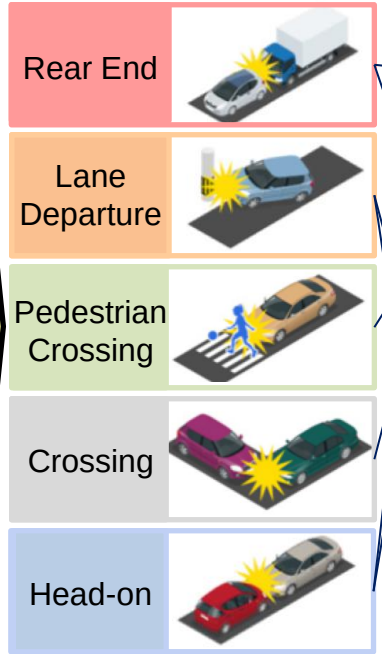
Traffic accidents reduction simulation “Multi Agents”



[Simulation Parameters]
- Levels of Automation
- Diffusion of Automated Driving Vehicles
- Error Action (driver/pedestrian)

etc.

Major crash types in Japan



- Collision Warning
- Autonomous Emergency Braking
- Lane Departure Warning
- Lane Keeping Assistance

Contributions by ADVs

Simulation result

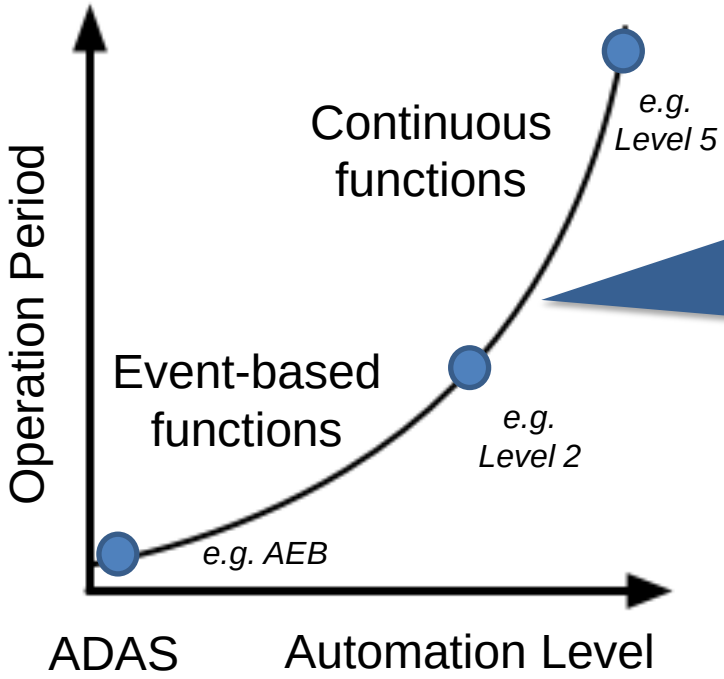
	W/	W/o
ADV	60%	40%
Man.DV	50%	10%
Ped.	30%	25%
…	…	…

Traffic Accident Reduction

Number of:
- Fatalities
- Traffic jams due to accidents, etc.

Type of functions in ADAS/Automated driving systems

"Event-based functions" and "Continuous functions"



Traffic simulation with virtual road environments and multi agent traffic participants is needed for assessment of both Event-based and Continuous functions.

Impact Assessment Methodology

Assessment Methods for "Continuous Functions"（Long Operational Period）

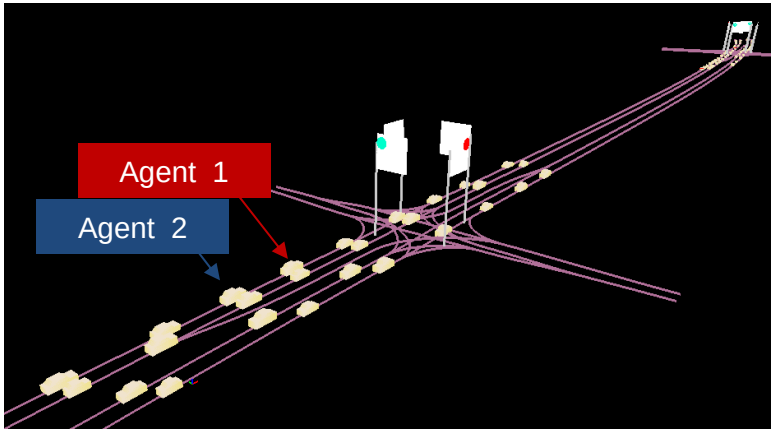
Field Operational Test

Real traffic flow

Implementation challenges

Cost
Acceptance
.....
Data
(Accident)

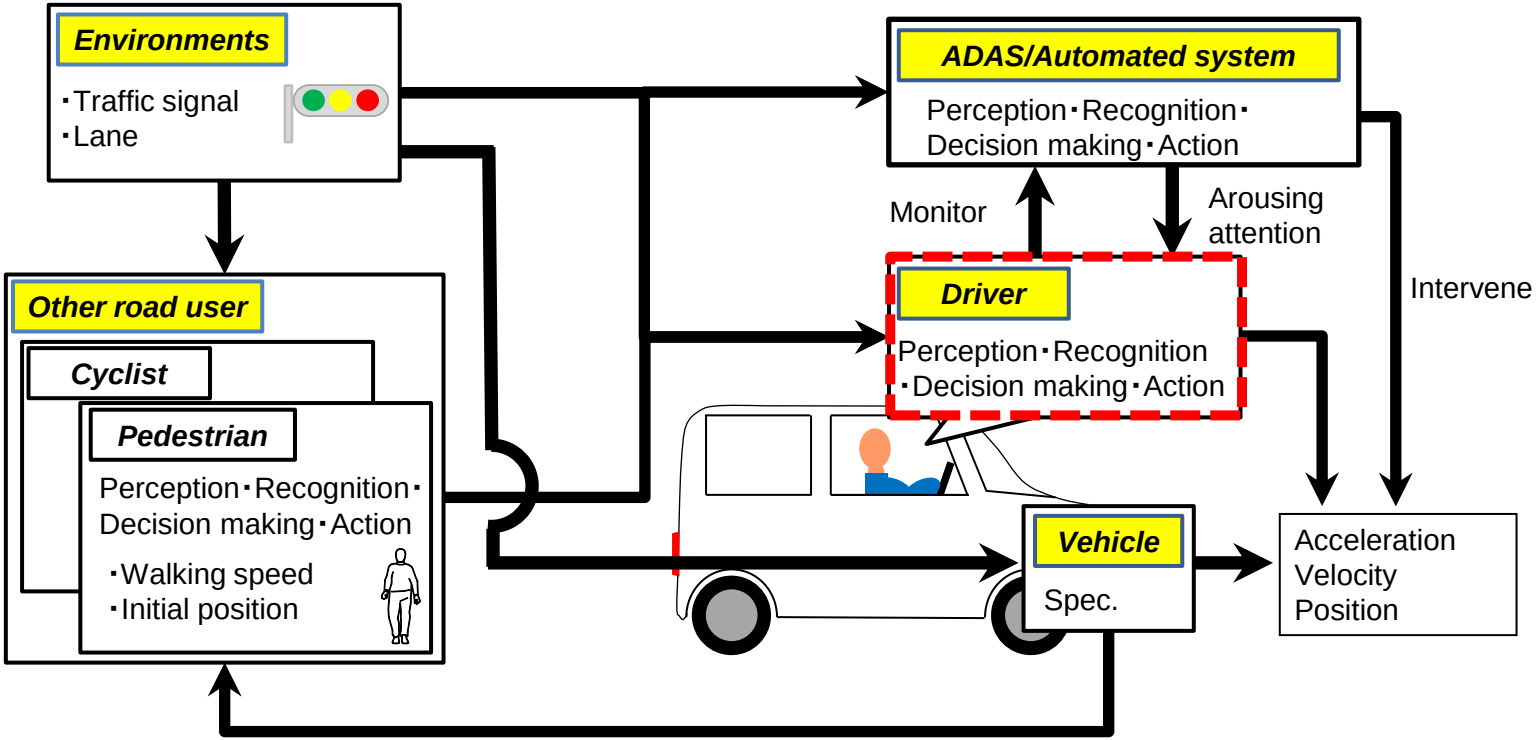
Traffic Simulation



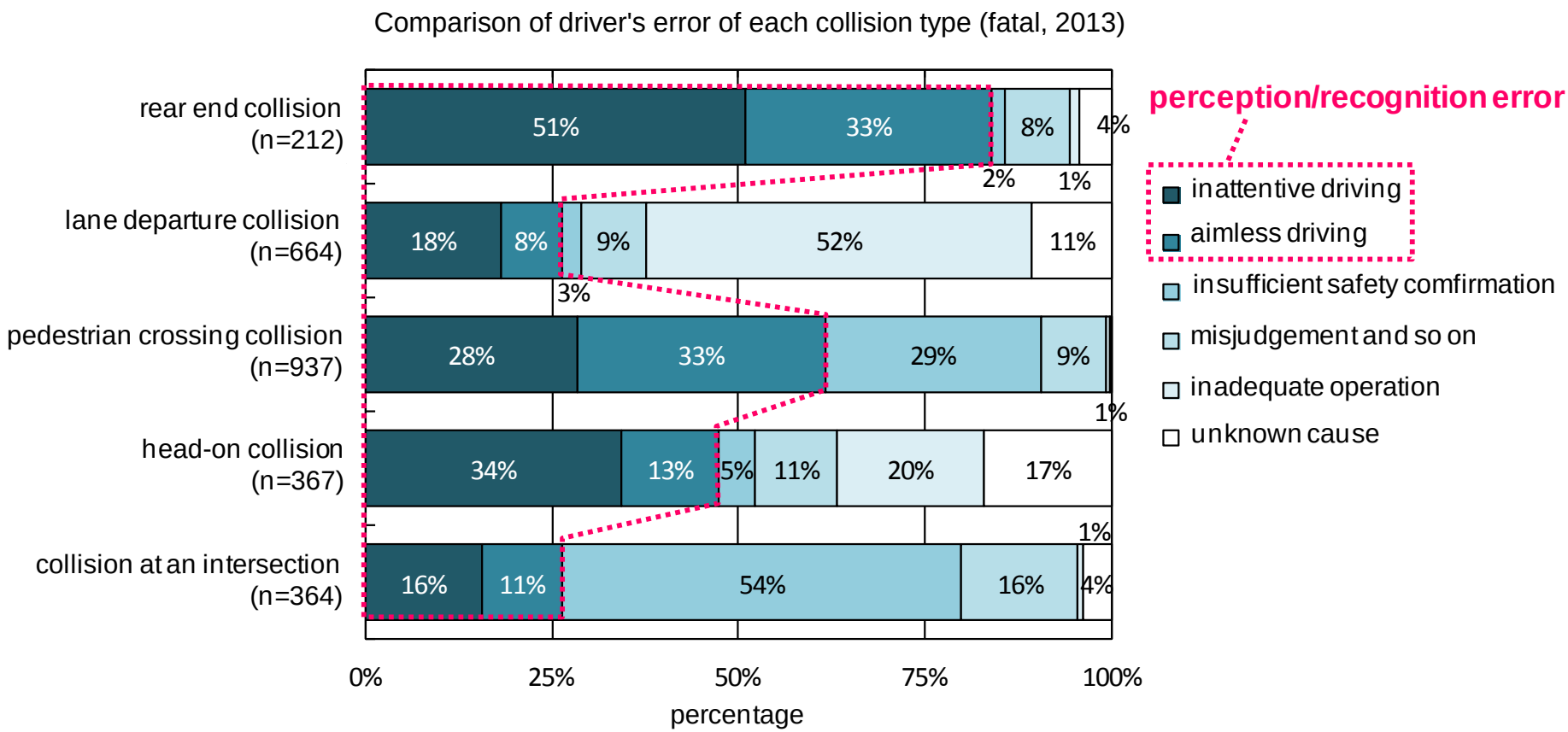
Virtual traffic flow

Composition of models

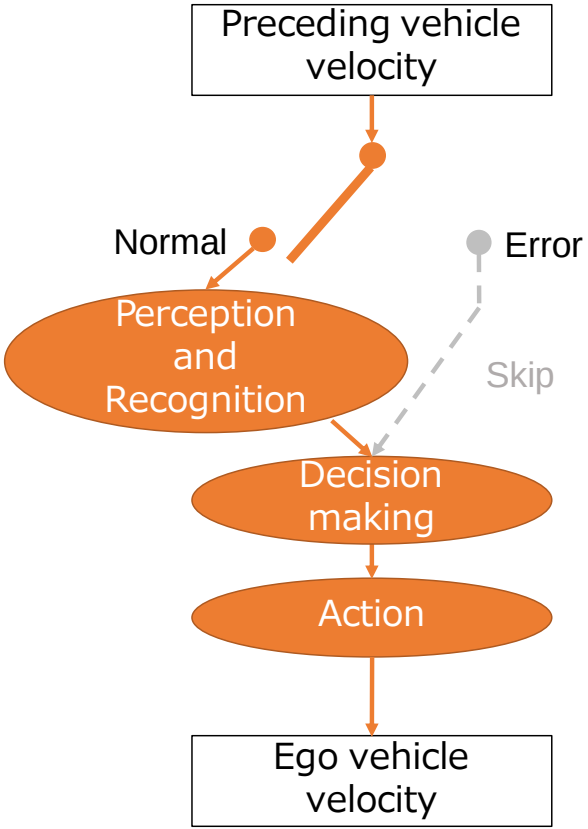
To evaluate ADAS/Automated vehicles, it is necessary to have at least 5 components.



Driver errors in major crash types in Japan

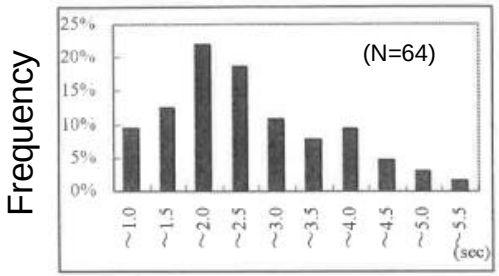


Simulated driver inattentive error



Normal state
Driver agent recognizes a current preceding velocity and react to changing it.

Perception & Recognition error state
Driver agent DOES NOT recognize a current preceding velocity. And, Continue error state in few seconds.



(Takubo, 2001)

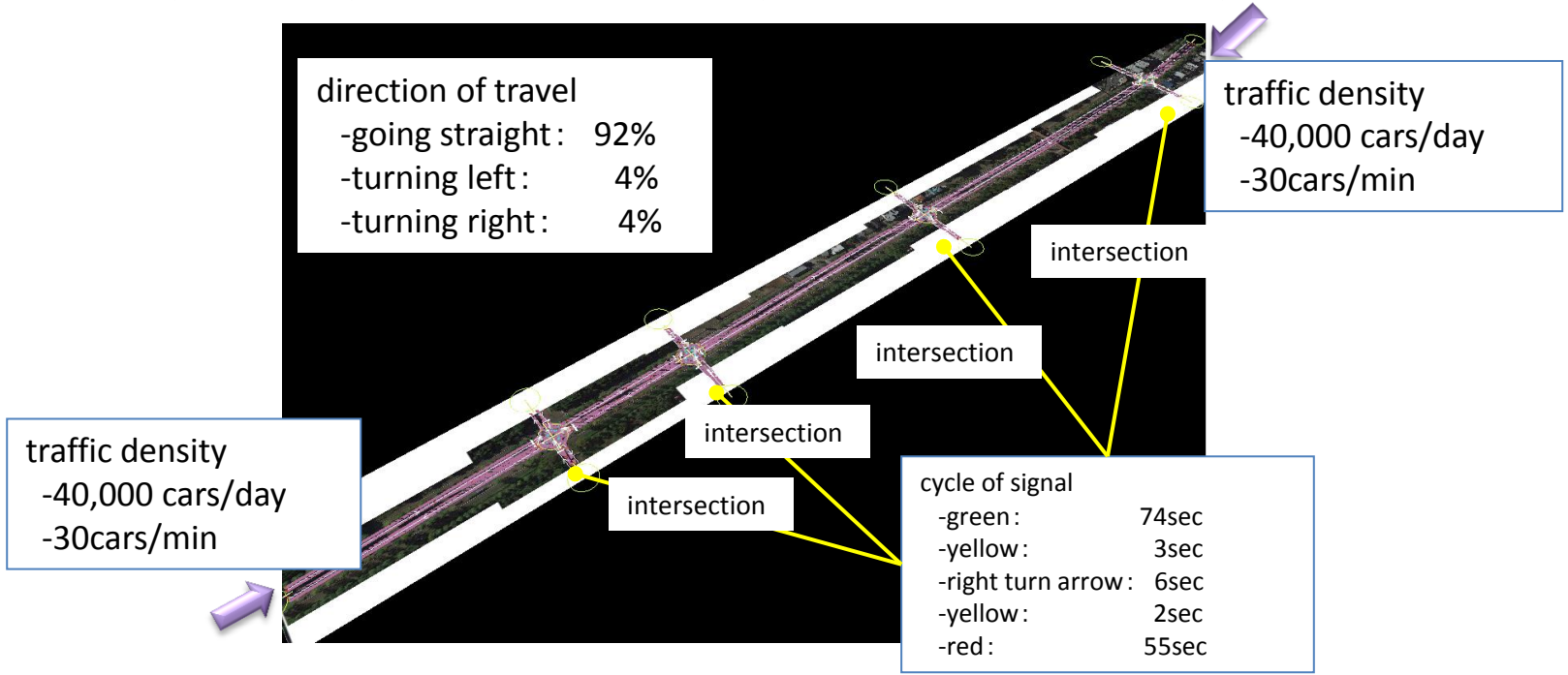
Assumptions in the simulation

- ADAS warning and braking always work completely.
- Whenever ADAS warn to driver, he or she always return to driving.
- Drowsiness and fatigue for the driver don’t considered.

Safety impact assessment via traffic simulation

Simulation setup for verification for verification

Road segment: straight road section with four signalized intersections (total length:1,400m)



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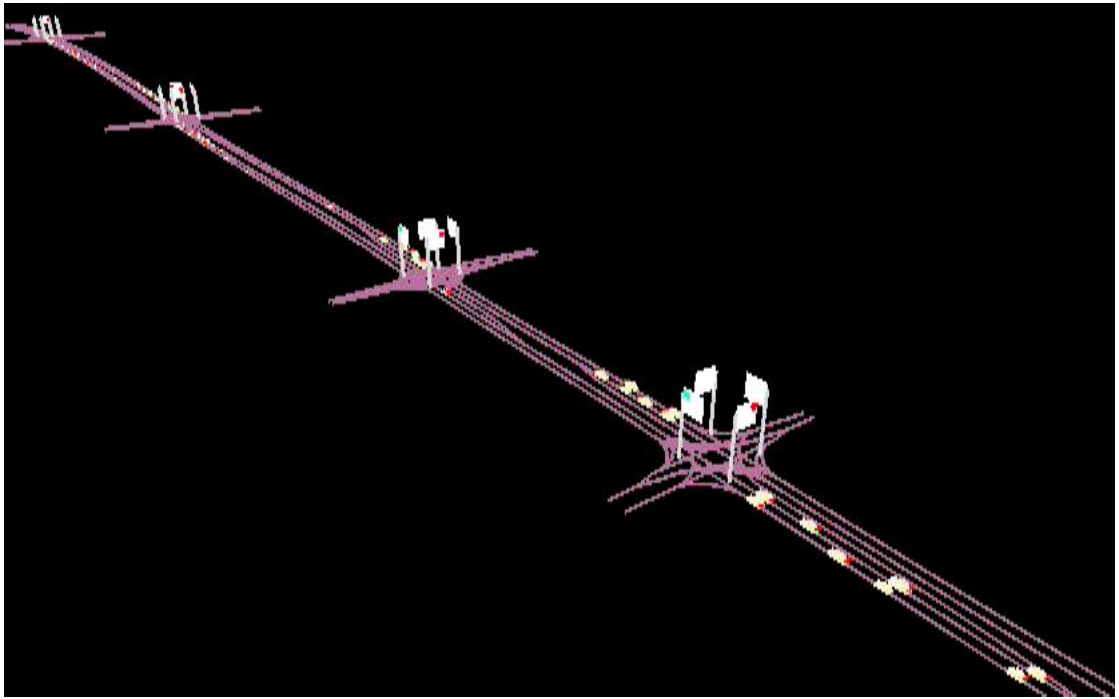
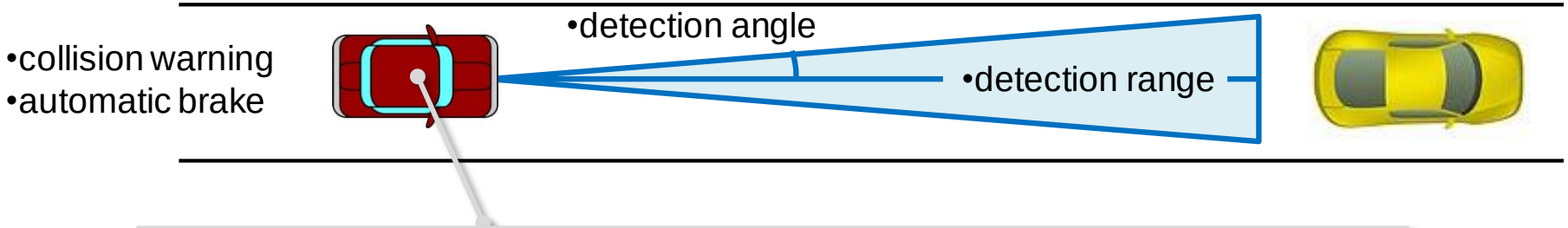


Specification of AEB

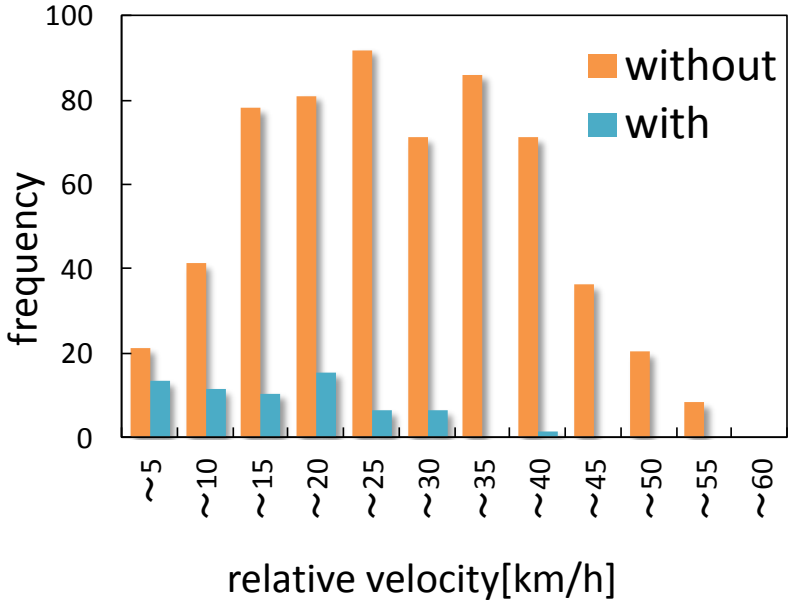


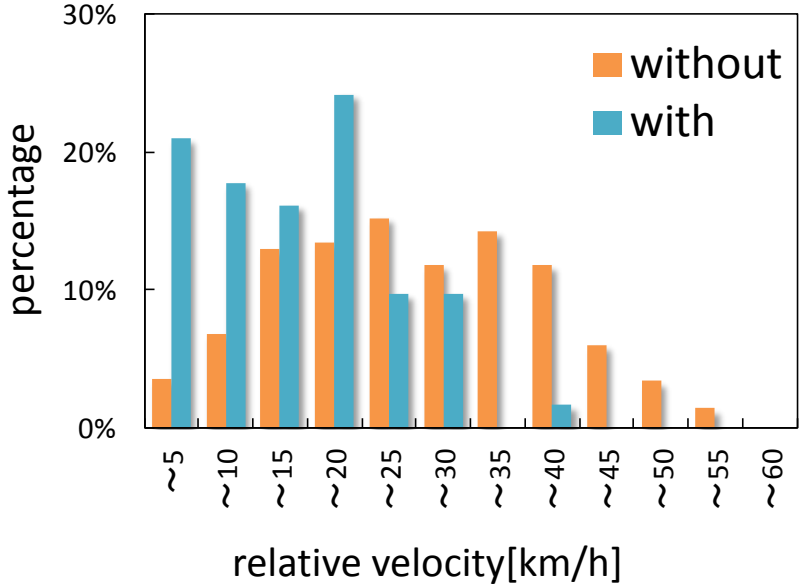
- time-to-collision for actuation of collision warning: 1.8sec
- time-to-collision for actuation of AEB: 0.6sec
- brake jerk: 2.0G/s [19.6m/s^3]
- maximum deceleration: 0.8G [7.8m/s^2]

Homma et al.(2012)

Relative velocity of rear-end collision

Comparison between with AEB and without AEB

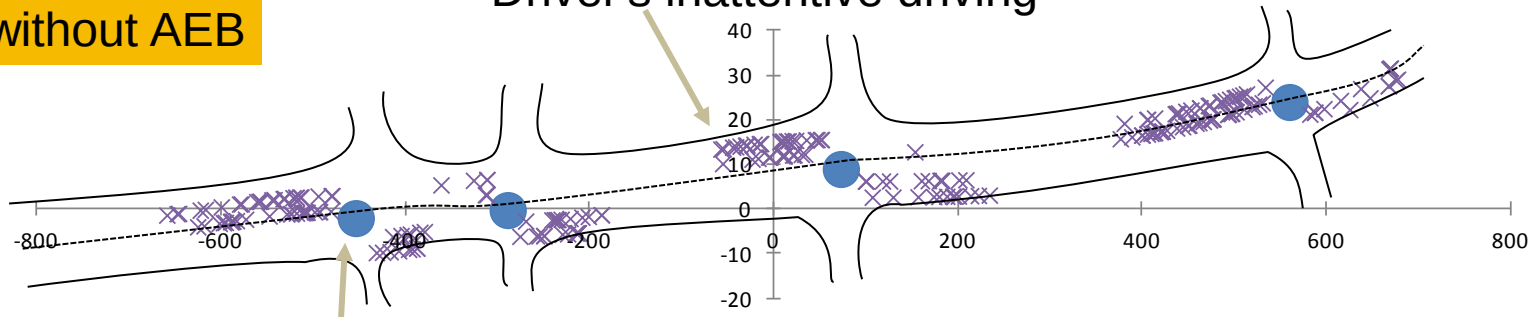




Locations of simulated accidents

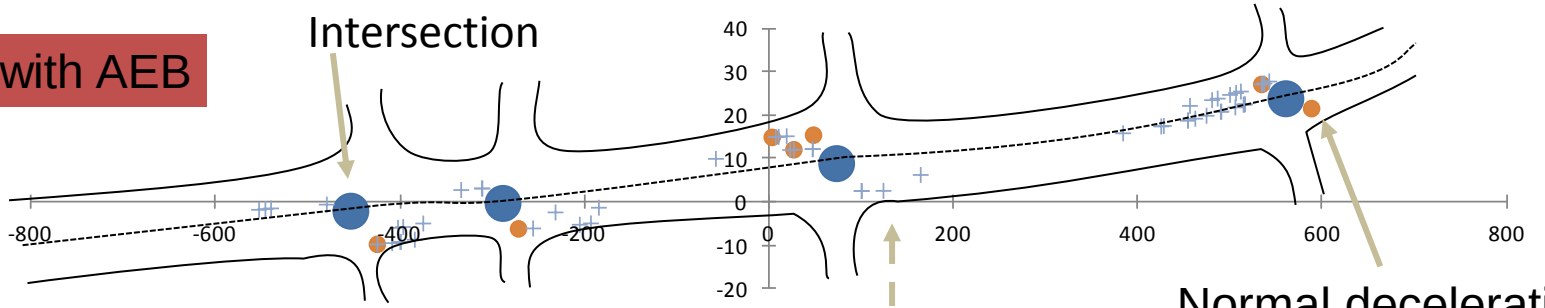
without AEB

Driver's inattentive driving



Intersection

with AEB

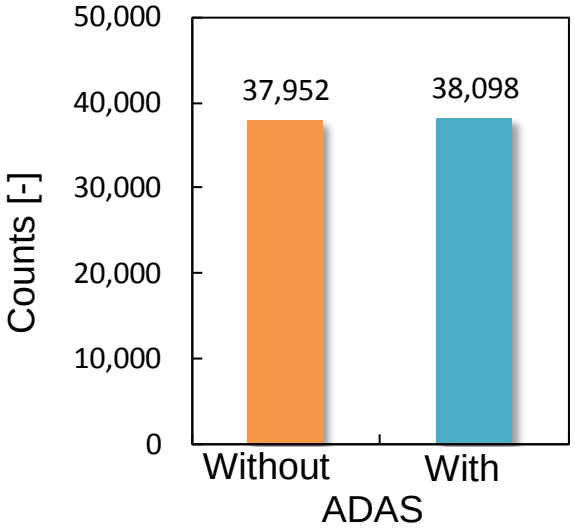


Normal deceleration of preceding vehicle

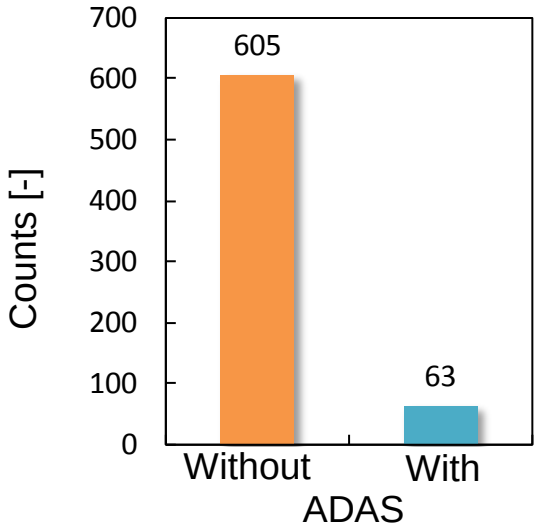
Abrupt deceleration of preceding vehicle

Accident reduction rate (Preliminary Study)

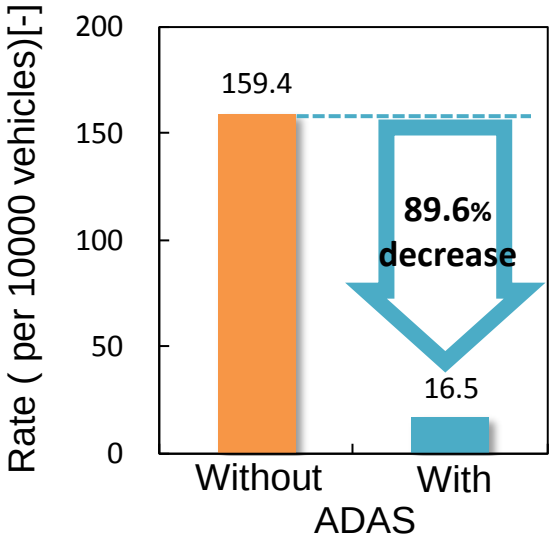
Number of Vehicles



Number of rear crash



Accident rate

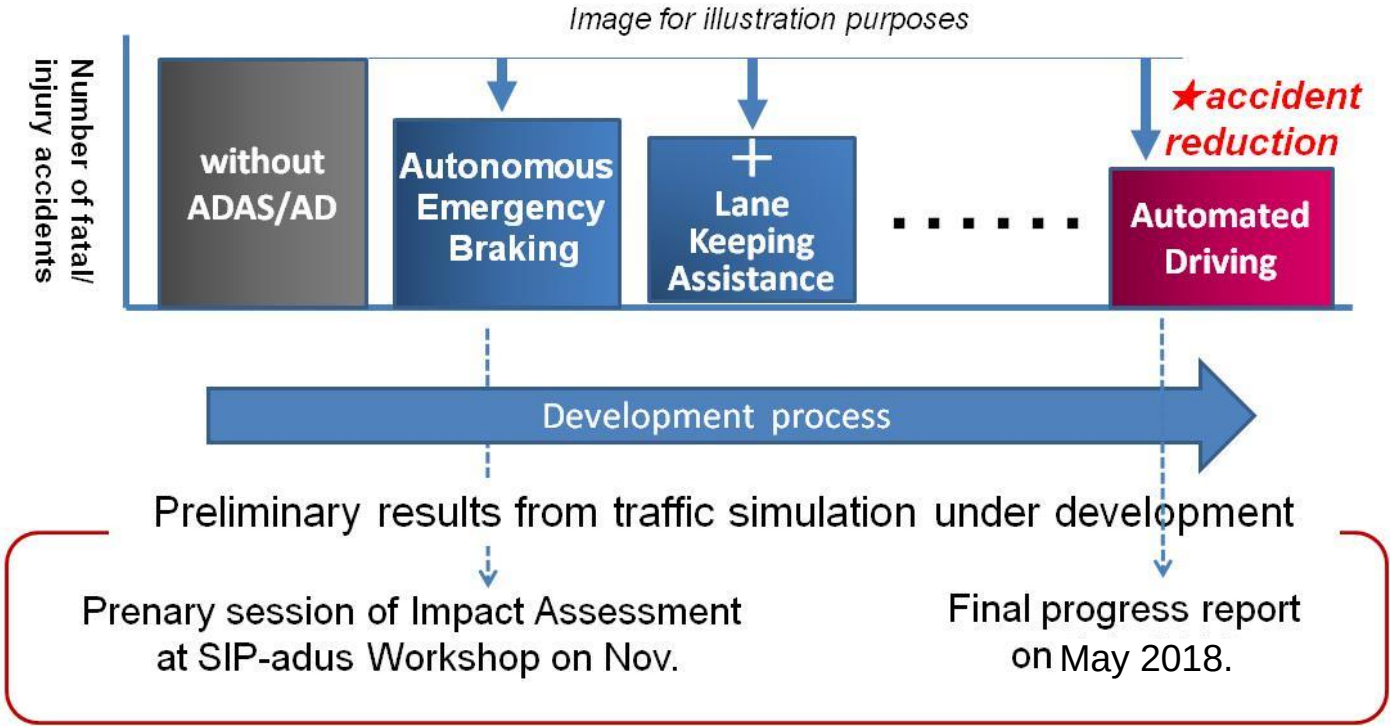


ADAS	Vehicles (A)	Rear crash (B)	Accident rate $Y = (B/A) \times 10^4$
With	37952	605	159.4
Without	38098	63	16.5

Note: Limitation and assumptions of the study must be taken into account.
These are just a preliminary value, please DO NOT cite them to other study.

Verification steps of the simulation

Target systems for safety impact assessment



Summary

- We aim at developing a simulation which can contribute to accurate impact assessment when an automated vehicle / ADAS is deployed.
- Agent based simulation is necessary to reproduce realistic traffic environments.
- Making driver models that replicate driver errors is necessary for accurate impact assessment of automated vehicles / ADAS.


Thank you
SIP-adus Workshop 2017
on Connected and Automated Driving Systems