Visualization of the traffic accident reduction effect

-Improvement of simulation accuracy-

Japan Automobile Research Institute

SIP-adus Workshop 2020

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Overview

Purpose of this project

【 Government policy 】

- To put vehicles with Level 2 driver assistance system into practical use on ordinary roads (in 2020)
- To put Level 3 automated vehicles into practical use on highways (in 2020)
- To put Level 4 automated vehicles into practical use on highways (around 2025) etc.

【 Society's expectations 】

Expectations are rising for the practical application and spread of automated driving technology and driving assistance technology.

【 Purpose of this project 】

Fostering social acceptance is necessary for the smooth implementation of automated vehicles and vehicles with driver assistance system in society

In this project, we use a traffic flow simulation to estimate the effect of traffic accident reduction according to the prevalence of automated vehicles and vehicles with driver assistance system.

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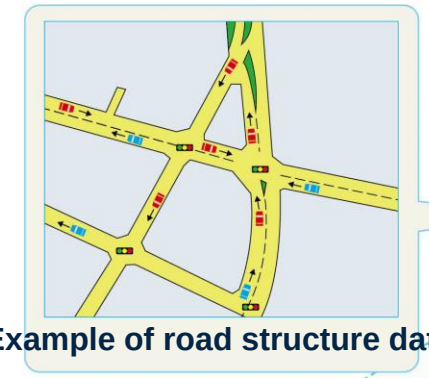
Overview of the entire simulation

Parameters for assumptions (models, dissemination scenarios, etc.)



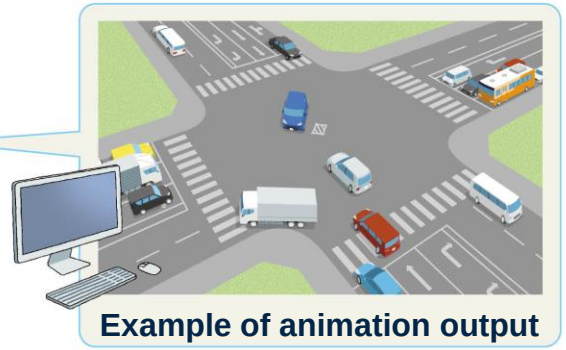
Example of road structure data

Road Structure Editor

road structure data

Simulation GUI

Simulation Module



Example of animation output

Log file

Accident Log File

Injury Assessment Module

Casualty Reduction Effect

Number of casualties, Injury level of the injured person

Simulation Module

Scenario File

Simulation Management Module

road structure data

Road Environment Management Module

Log output module

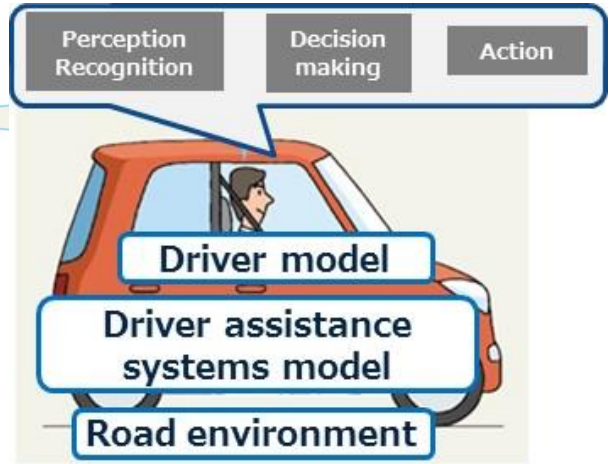
Vehicle Models

Driver model

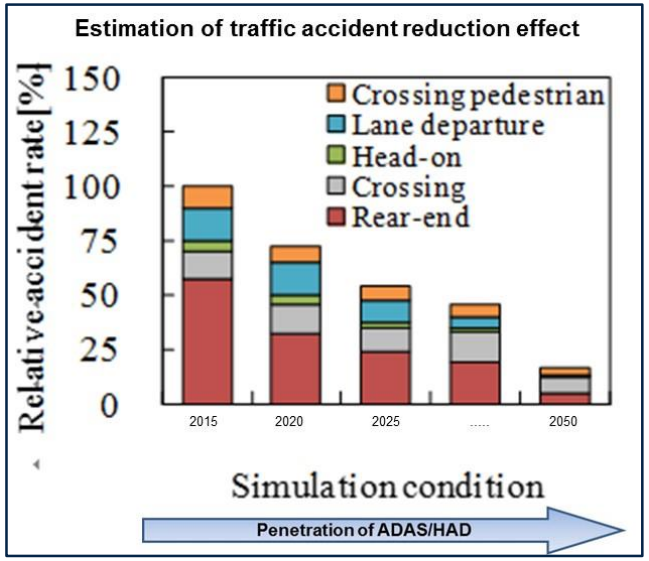
Driver assistance system model

Vehicle Models

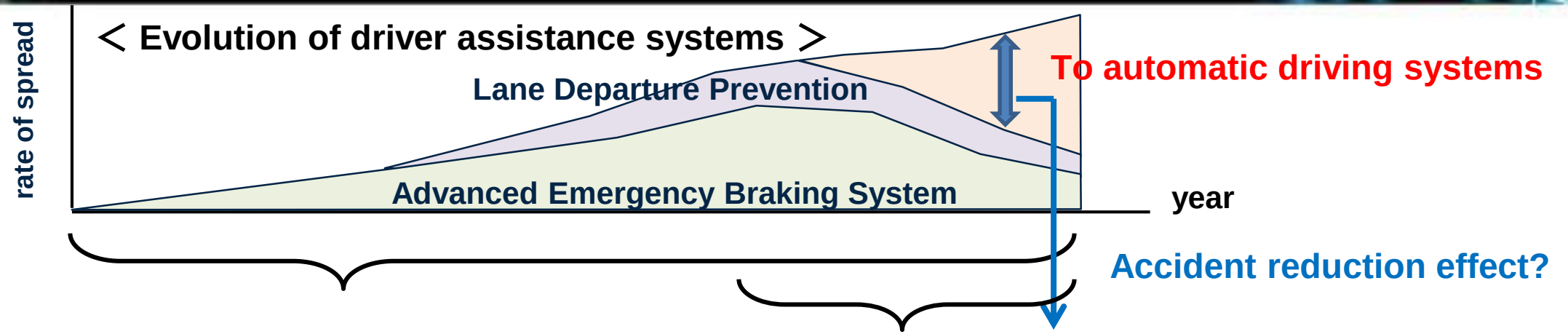
Pedestrian model



Estimation of traffic accident reduction effect



Positioning of the simulation



Existing Simulation	SIP Development Simulation
Traffic accident scene reproduction	Multi-agent traffic environment reproduction
For product Development: Competitive area (sensor specifications and control logic)	For policy making : cooperative area ⇒ Strategies for the popularization of automated driving
Micro Simulation (Reproduce a limited place and time)	Macro Simulation (Assume all areas and times)
Traffic participants act according to the predetermined scenario	1) Multi-agent Each traffic participant behaves independently and influences each other 2) Error behaviors such as looking aside are also implemented. (Causes of accidents)

Project summary

SIP Phase 1（2015～2018）	SIP Phase 2（2019～2020）
“Development and substantiation of simulation technology for estimation of detailed traffic accident reduction effects”	“Visualizing the Effects of Traffic Accident Reduction “
・Establish simulation technology ・Develop behavioral models for traffic participants ・Validation of the simulation technology (Preconditions are tentatively defined)	Improvement of simulation accuracy ①Enhance the accuracy of the behavioral models ②Establish preconditions

①Enhance the accuracy of the behavioral models

Expand the pedestrian behavior model and establish a new bicycle behavior model

②Establish preconditions

A. Set dissemination scenarios (＊)
B. Set signal indication and traffic regulation information
C. Pedestrian and bicycle models and traffic settings
D. Set speed information

(＊)From the “Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others”

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Research in the SIP Phase 1 project

Research in the SIP Phase 1 project

① Development of Multi-Agency Traffic Environment Simulation

② Building a behavioral model for traffic participants

- Driver Model
  Driving process, driver error, and parameter settings based on driver attributes
- Pedestrian Model
  model pedestrian behavior based on fixed point observations and experiments
- Automatic driving system model
  Set parameters such as sensor recognition range and control specifications

③ Validation of the developed simulation technology

- Selection of model areas (one each for large cities, local cities and depopulated areas)
- Confirmation of reproducibility of traffic flows and accidents in the model areas
  (Compare actual traffic volume and traffic accident statistics with simulation results)

④ Calculation of reduction effects on a nationwide scale based on tentatively defined preconditions

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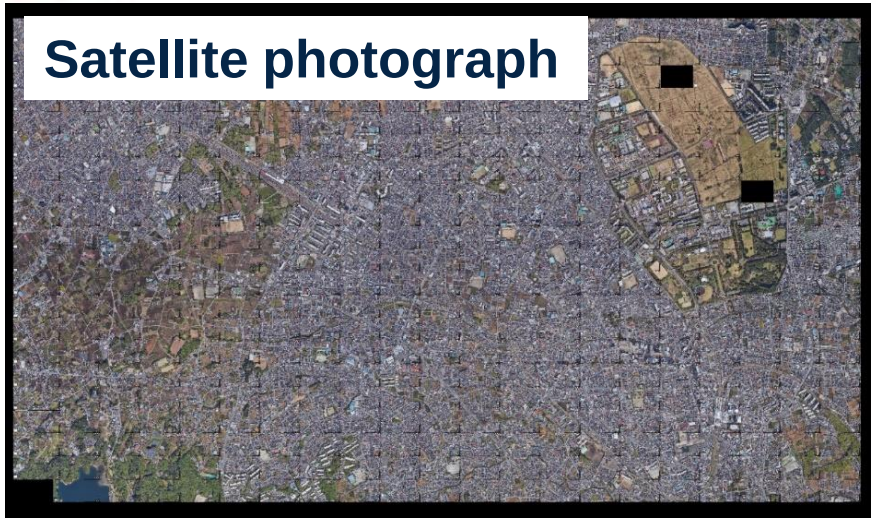
(Reference) Large city ：Simulation image of Tokorozawa City



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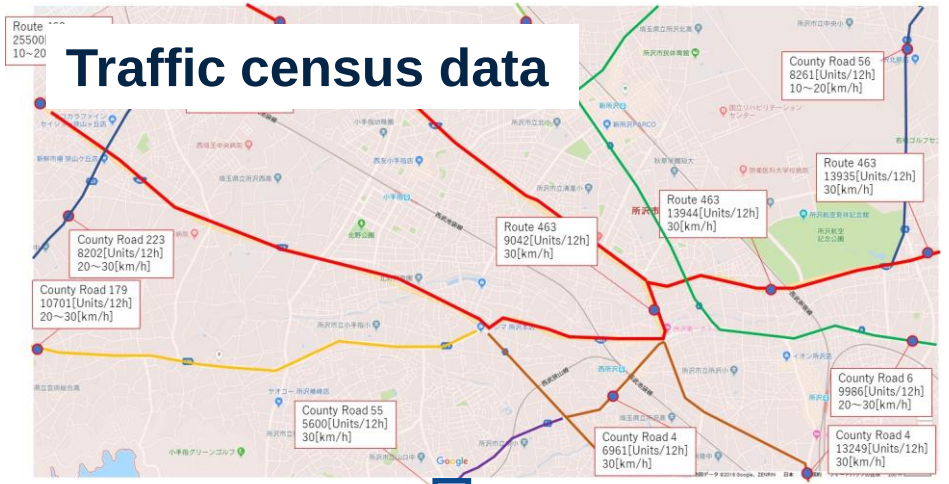

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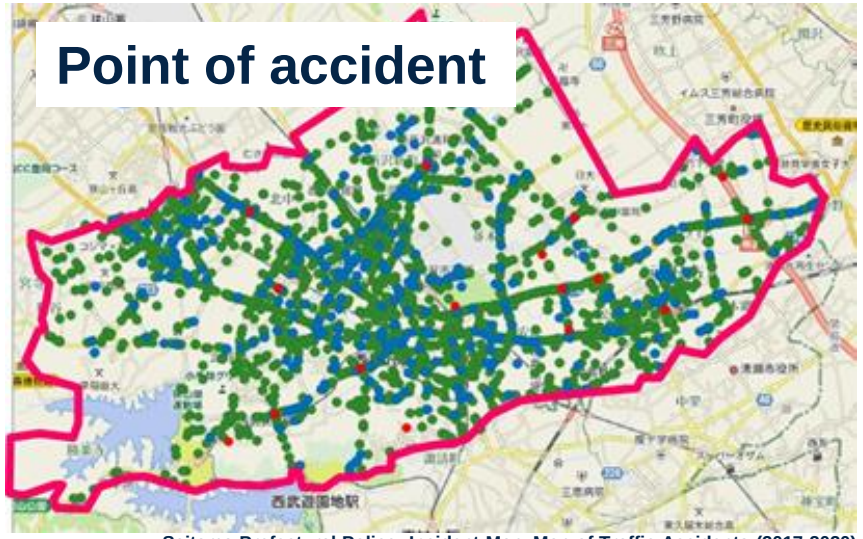

Saitama Prefectural Police: Incident Map_Map of Traffic Accidents (2017-2020)

Major road networks in each model area were built to reproduce traffic flows and traffic accidents.

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Research in the SIP Phase 2 project

Project summary

SIP Phase 1（2015～2018）	SIP Phase 2（2019～2020）
“Development and substantiation of simulation technology for estimation of detailed traffic accident reduction effects”	“Visualizing the Effects of Traffic Accident Reduction “
・Establish simulation technology ・Develop behavioral models for traffic participants ・Validation of the simulation technology (Preconditions are tentatively defined)	Improvement of simulation accuracy ①Enhance the accuracy of the behavioral models ②Establish preconditions

①Enhance the accuracy of the behavioral models

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②Establish preconditions

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(＊)From the “Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others”

A. Set dissemination scenarios

Dissemination scenarios from another project "Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others" and vehicle models to be used in this project

11~29 people	Commercial Cars
Over 30 people	Commercial Cars
Mini Car	Private Cars
Sedan 5 Number	Private Cars
Sedan 3 Number	Private Cars
Mini	Truck
Small	Truck
Havery	Truck
Special Vehicle	
motorcycle	
bicycle	

example）

Private Cars: Mini Car

	2015	2020	2025	2030	2035	2040	2045	2050
Level0	97.64%	73.19%	40.81%	18.29%	6.23%	1.48%	0.23%	0.02%

Private Cars:Sedan 5 Numbe

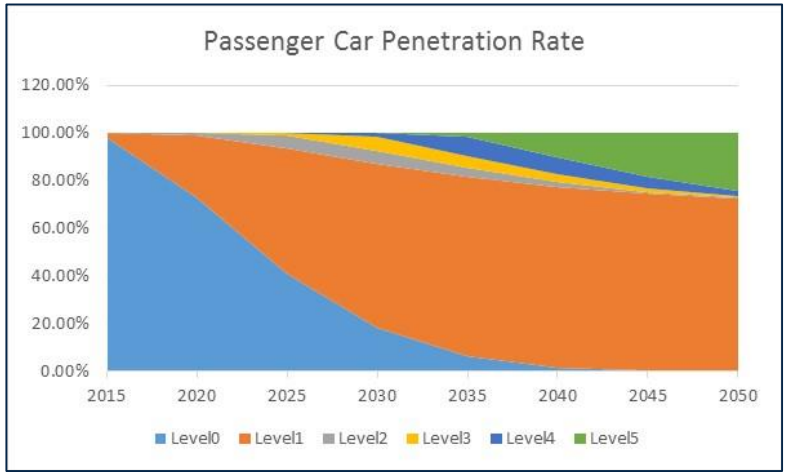
	2015	2020	2025	2030	2035	2040	2045	2050
Level0	97.76%	73.73%	45.54%	22.93%	7.31%	1.87%	0.45%	0.10%

Private Cars:Sedan 3 Numbe

	2015	2020	2025	2030	2035	2040	2045	2050
Level0	97.41%	71.85%	39.04%	16.75%	4.83%	1.11%	0.25%	0.05%
Level1	2.59%	26.96%	51.99%	66.55%	71.34%	69.83%	67.13%	65.16%
Level2	0.00%	1.19%	7.31%	6.41%	4.71%	2.14%	0.53%	0.12%
Level3	0.00%	0.00%	1.66%	8.19%	6.70%	4.80%	1.87%	0.43%
Level4	0.00%	0.00%	0.00%	2.10%	10.23%	8.44%	6.09%	2.41%
Level5	0.00%	0.00%	0.00%	0.00%	2.20%	13.68%	24.12%	31.82%

61%
14%
55%
96%
58%
12%
09%
38%
31%
12%

■ Dissemination scenarios



Note: Prepared using data provided by the " Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others ". These figures are provisional and are currently undergoing revision.

■ Vehicle models

Commercial Cars:11~29 people

	Unit	value
length	[m]	6.995
width	[m]	2.065
weight	[kg]	3,710

Private Cars:Sedan 3 Number

	Unit	value
length	[m]	4.495
width	[m]	1.745
weight	[kg]	1,310

Private Cars: Mini Car

	Unit	value
length	[m]	3.650
width	[m]	1.665
weight	[kg]	910

Heavy Trucks

	Unit	value
length	[m]	5.280
width	[m]	2.080
weight	[kg]	2,770

Motorcycle

	Unit	value
length	[m]	1.990
width	[m]	0.710
weight	[kg]	167

Special Vehicle

	Unit	value
length	[m]	4.910
width	[m]	1.800
weight	[kg]	1,690

Commercial Cars:Over 30 people

	Unit	value
length	[m]	11.99
width	[m]	2.49
weight	[kg]	13,180

Private Cars:Sedan 5 Number

	Unit	value
length	[m]	4.910
width	[m]	1.800
weight	[kg]	1,690

Small Trucks

	Unit	value
length	[m]	4.690
width	[m]	1.695
weight	[kg]	2,000

Mini Trucks

	Unit	value
length	[m]	1.475
width	[m]	2.065
weight	[kg]	350

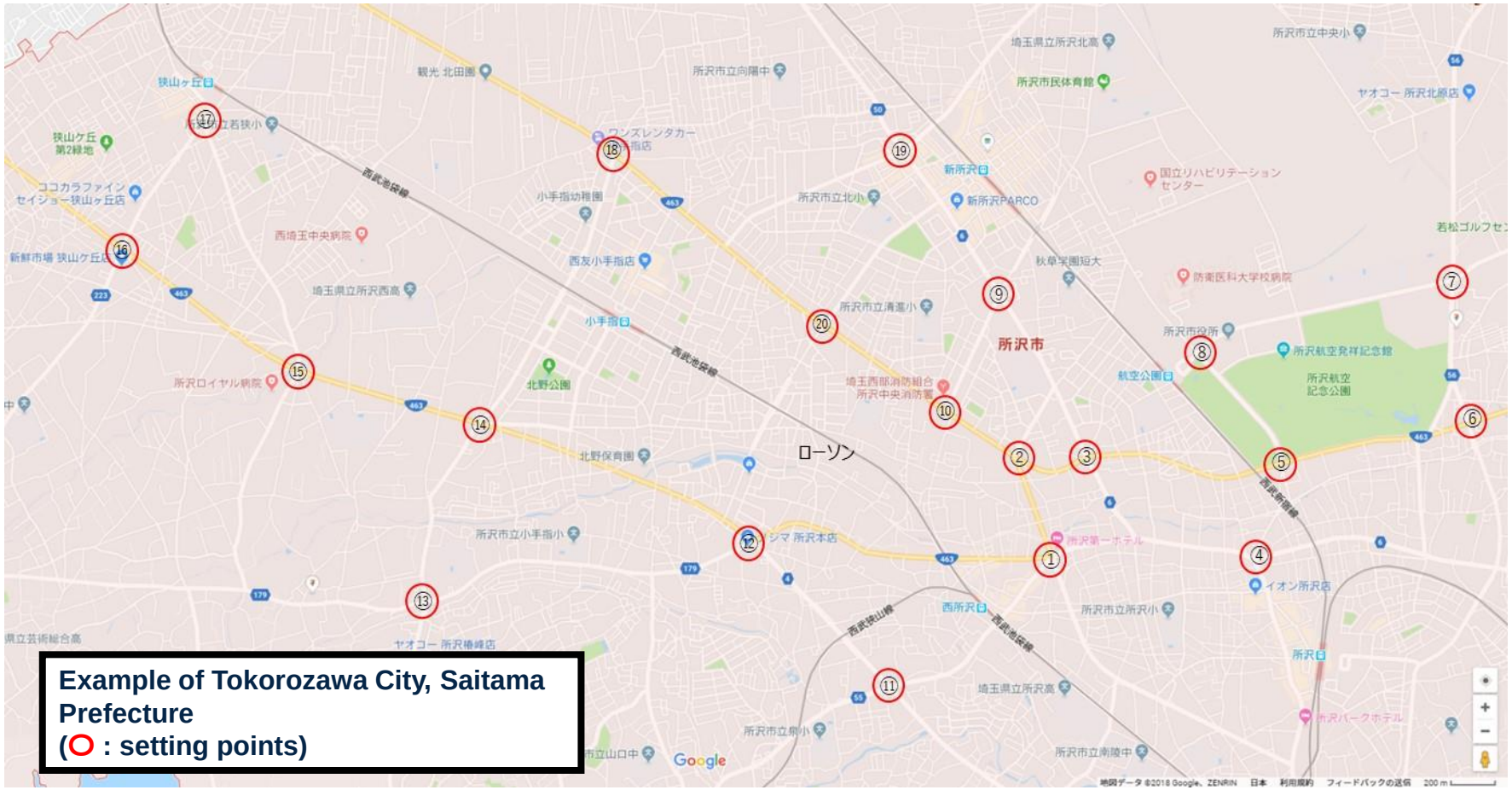
Bicycle

	Unit	value
length	[m]	1.850
width	[m]	0.580
weight	[kg]	20

B. Set signal indication and traffic regulation information (1/2)

For more accurate simulation,
set signal indication information and traffic regulation information on the map

①Signal indication information (include pedestrian signals)

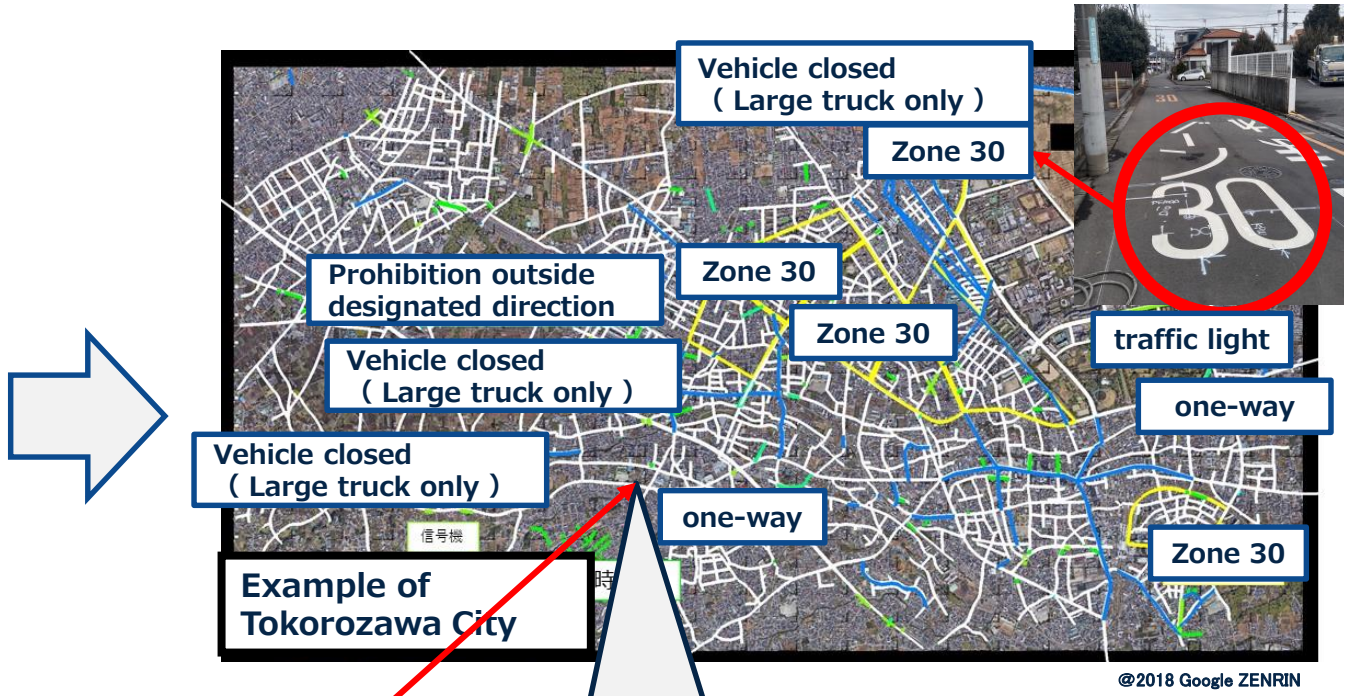


Example of Tokorozawa City, Saitama Prefecture
(○ : setting points)

B. Set signal indication and traffic regulation information (2/2)

② traffic regulation information

Type of traffic regulation information
Vehicle closed
Prohibition outside designated direction
One-way
Pause
Traffic light
Zone 30 (Max. speed 30km/h)



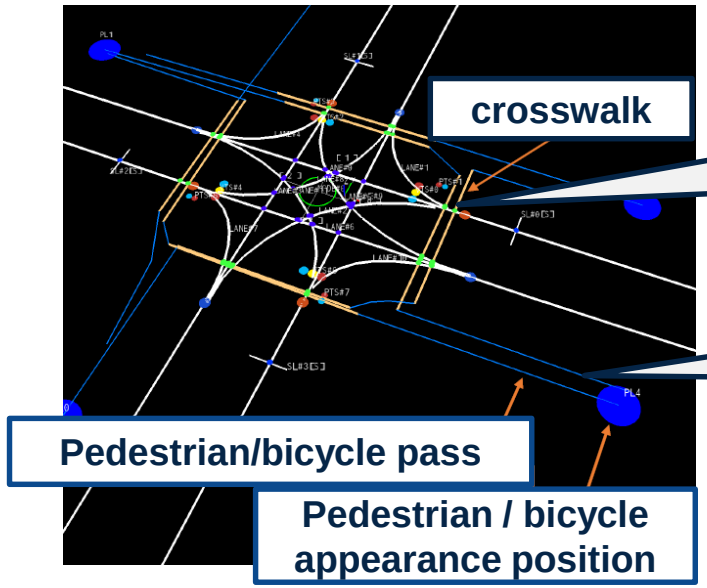
Example : Vehicle closed (large truck only)

C. Pedestrian and bicycle models and traffic settings (1/3)

Expand the types of pedestrian accidents and establish a new bicycle behavior model to reproduce major bicycle accidents

【 Types of accidents reproduced in the simulation of this project 】

Traffic participants	SIP Phase 1	SIP Phase 2 (this project)
Pedestrian	Single road crossing only	Single road crossing + Crossing signal intersection (only second party)
Bicycle	-	Head-on, Left turn involved, and right straight accidents(only second party)

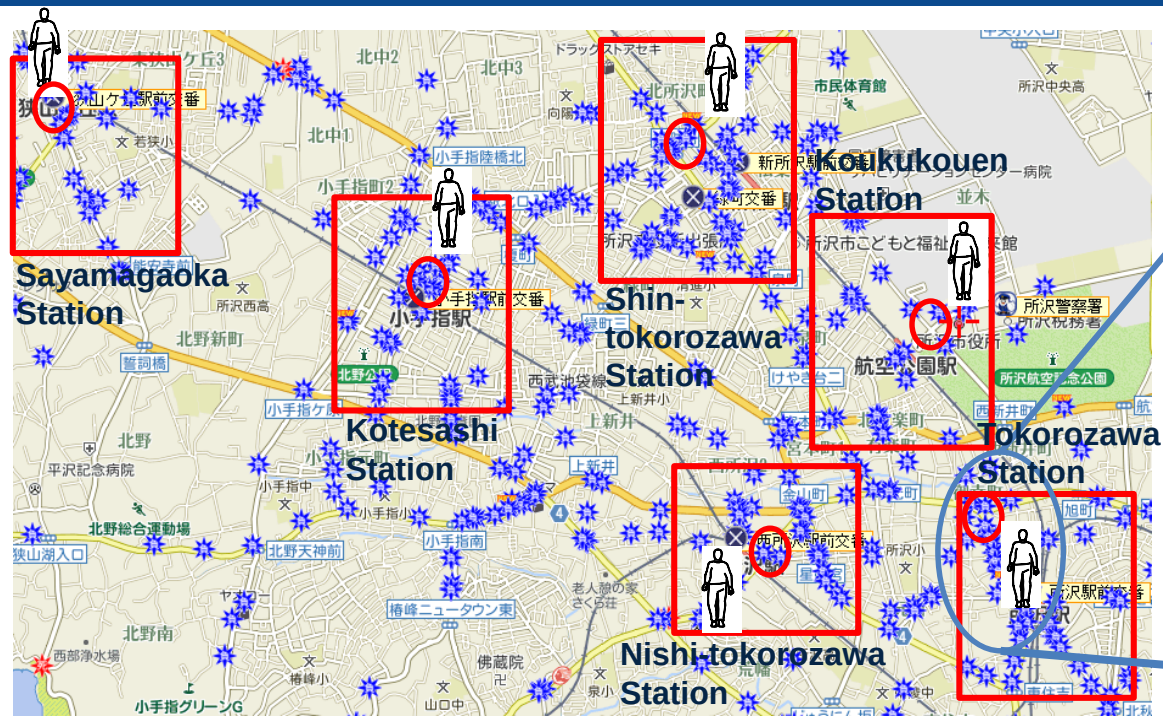


Set the signal for pedestrian at the intersection

Set pedestrian/bicycle path at the intersection

C. Pedestrian and bicycle models and traffic settings (2/3)

Traffic volume survey was conducted in each model area, mainly at locations where many accidents occur, and the traffic volume of pedestrians and cyclists was set on the map



Saitama Prefectural Police: Incident Map_Map of Traffic Accidents (2017-2020)

Survey pedestrian and bicycle behavior at intersection

: Location of field surveyors

: Location of the field survey

Status of field survey in Tokorozawa City (large city), Saitama Prefecture
* Based on the occurrence of pedestrian accidents (2017-2020)

C. Pedestrian and bicycle models and traffic settings (3/3)

The volume of pedestrian and bicycle traffic at each survey location was surveyed

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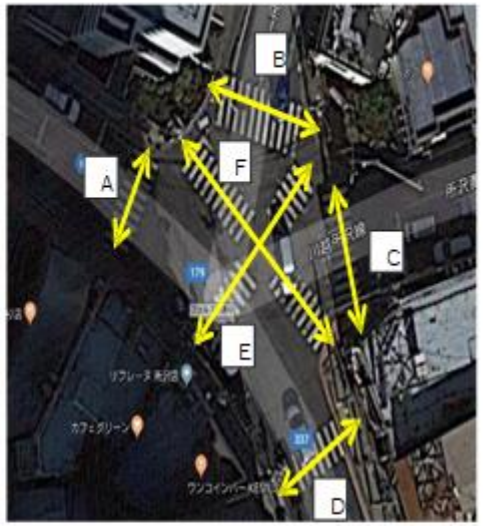


@2018 Google ZENRIN

Pedestrian totals

	Child		Adult		Aged		total	
	blue/blinking	red	blue/blinking	red	blue/blinking	red	blue/blinking	red
A	0	0	51	1	25	0	76	1
B	0	0	89	1	21	0	110	1
C	0	0	154	0	40	0	194	0
D	0	0	75	1	22	0	97	1
E	0	0	50	0	19	0	69	0
F	0	0	281	0	40	0	321	0

Standard deviation

	Child		Adult		Aged		total	
	blue/blinking	red	blue/blinking	red	blue/blinking	red	blue/blinking	red
A	0	0	1.186	0.152	0.789	0	0.960	0.089
B	0	0	1.789	0.152	0.932	0	1.475	0.089
C	0	0	2.146	0	0.898	0	2.053	0.089
D	0	0	1.145	0.152	0.545	0	1.048	0.152
E	0	0	1.029	0	0.586	0	0.841	0
F	0	0	4.003	0	0.872	0	3.785	0

Bicycle total

	Bicycle	
	blue/blinking	red
A	28	2
B	27	1
C	81	2
D	44	0
E	64	0
F	102	0

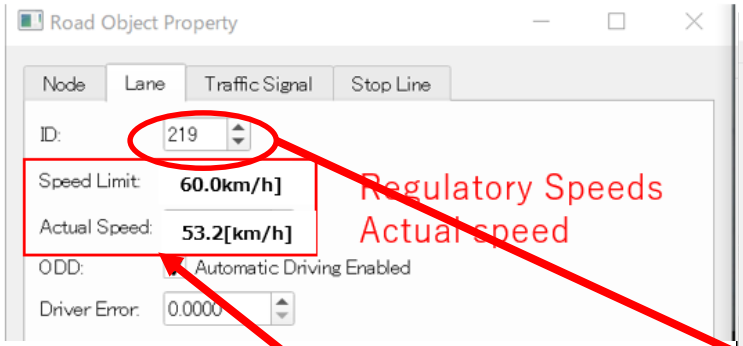
Standard deviation

	Bicycle	
	blue/blinking	red
A	0.678	0.089
B	0.811	0.089
C	1.163	0
D	0.872	0.089
E	1.349	0
F	1.620	0

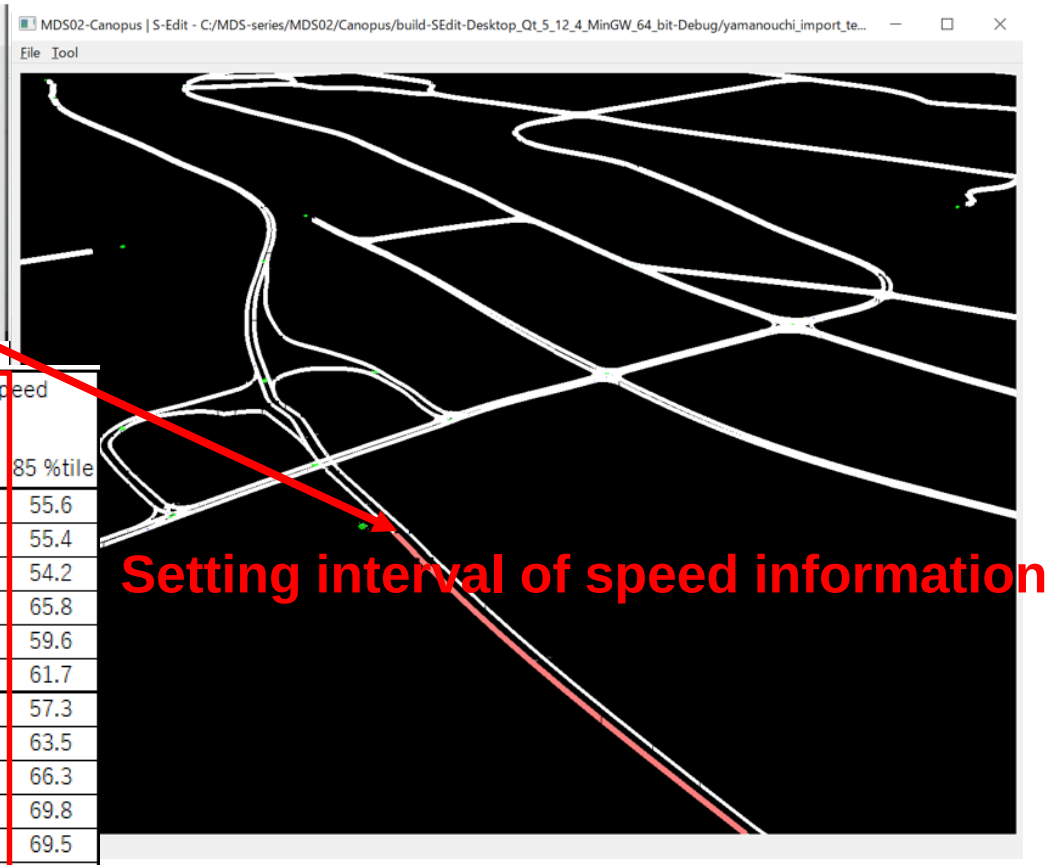
Example of Survey Implementation and results in Tokorozawa City, Saitama Prefecture

D. Set speed information

Set the regulatory speed (designated speed or legal speed) and actual speed on the map data



Regulatory Speeds
Actual speed



Setting interval of speed information

No.	Region	Number of lanes	Central separator	Pedestrians Traffic volume (12 hours during the day.)	actual speed average	85 %tile
①	Urban areas	two lanes	-	much	44.0	55.6
②				not much	44.8	55.4
③		four lanes	With central separation	much	43.2	54.2
④				not much	53.6	65.8
⑤			No central separation	much	48.6	59.6
⑥				not much	49.4	61.7
⑦	Non-urban areas	two lanes	-	much	46.9	57.3
⑧				not much	53.2	63.5
⑨		four lanes	With central separation	much	54.7	66.3
⑩				not much	57.0	69.8
⑪			No central separation	much	53.7	69.5
⑫				not much	54.6	68.4

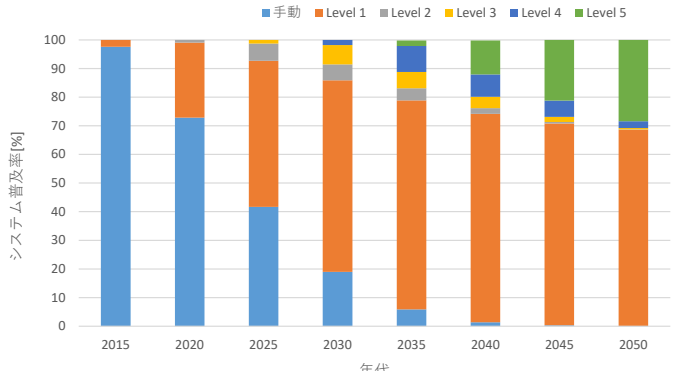
Designated speed and legal speed are set based on the actual designated speed and legal speed in each model area.
The actual speed was set with reference to the "Research and Study Report on the Determination of Regulatory Speeds in Fiscal 2008".

Estimation of traffic accident reduction effect (tentative)

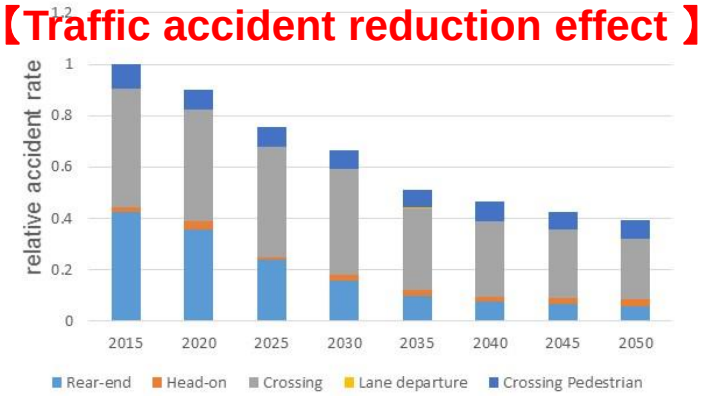
Performed simulations for each model area and estimated the effect of traffic accident reduction (Number of accidents)

Large city: Tokorozawa City in Saitama Pref.

【AV dissemination scenarios】

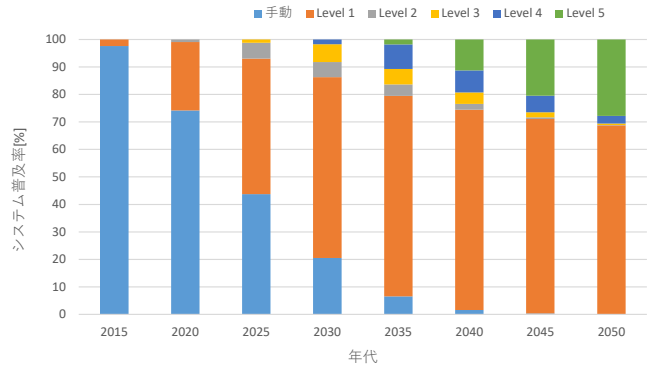


【Traffic accident reduction effect】

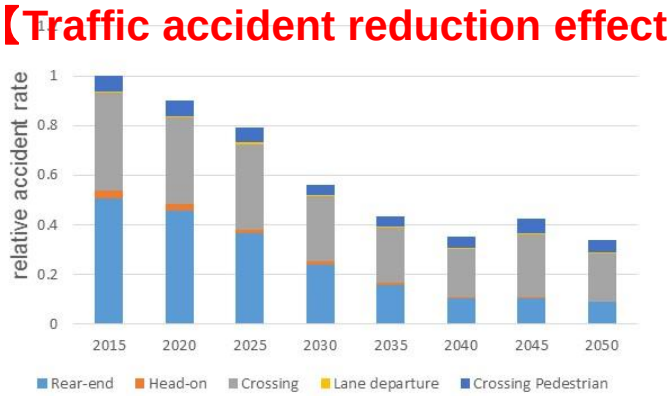


Local city: Joso City in Ibaraki Pref.

【AV dissemination scenarios】

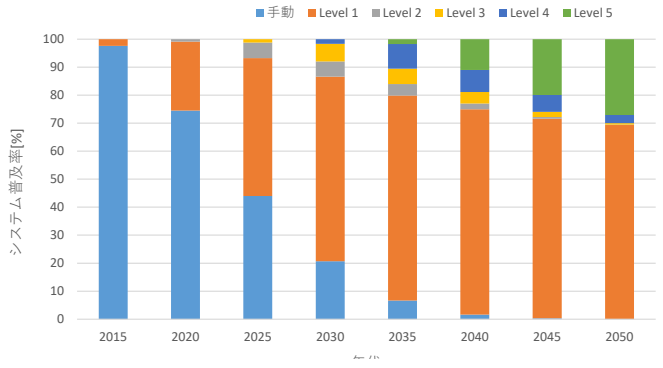


【Traffic accident reduction effect】

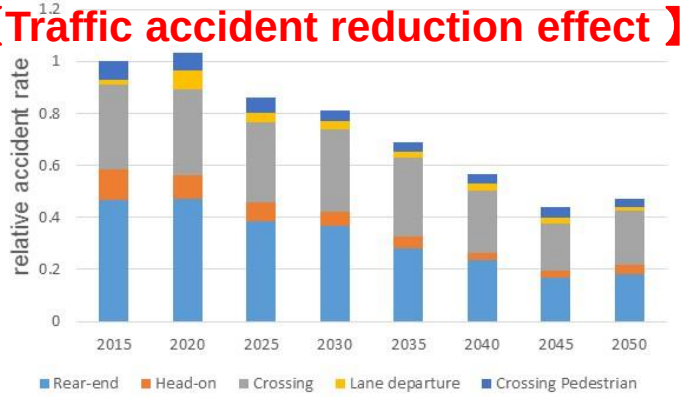


Depopulated area: Yamanouchi Town in Nagano Pref.

【AV dissemination scenarios】



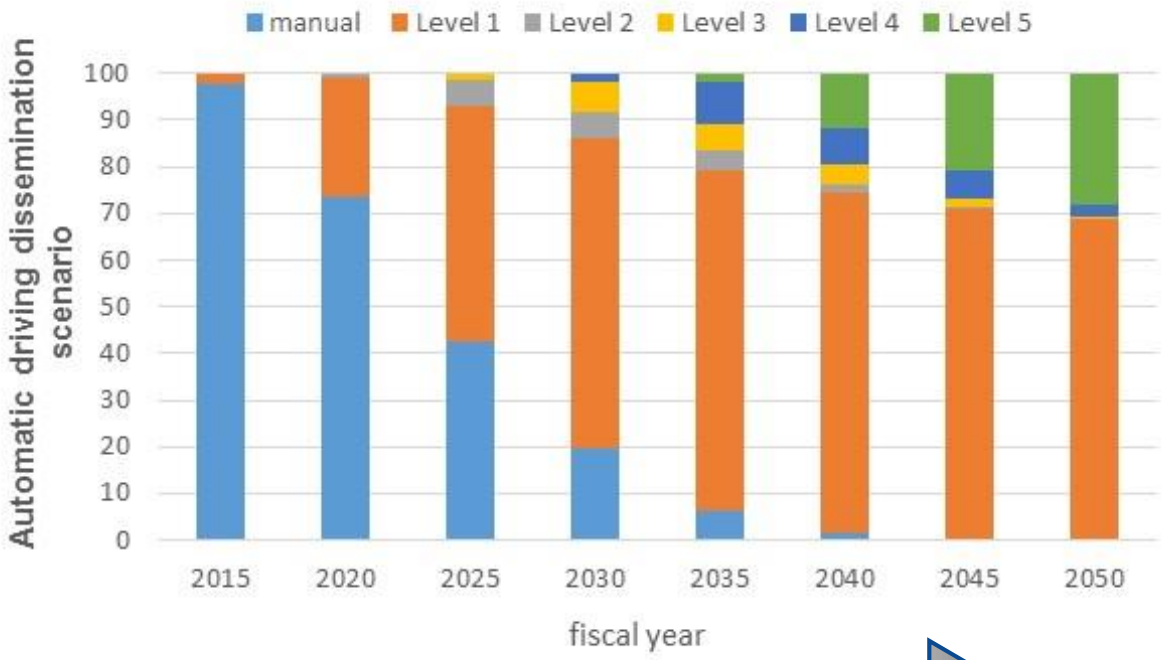
【Traffic accident reduction effect】



Estimation of traffic accident reduction effect (tentative)

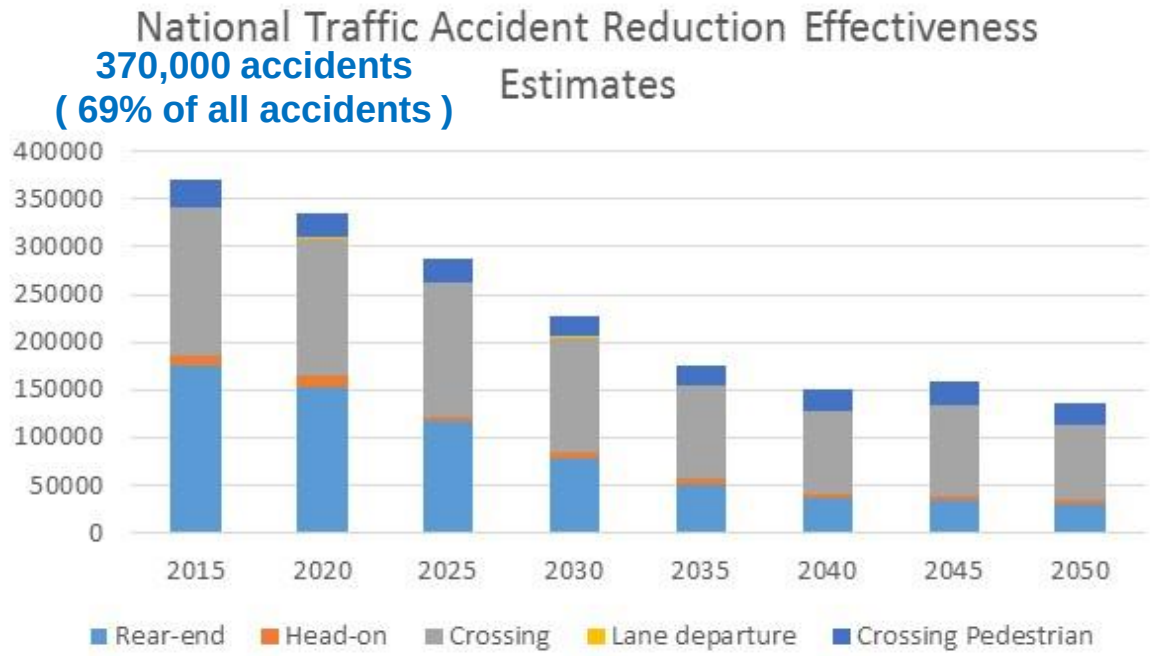
Based on the reduction effect in each model area, Estimated nationwide traffic accident reductions by using national traffic accident statistics data

【 AV dissemination scenarios (National average)】



Dissemination of ADAS/AD

【 Nationwide traffic accident reduction effect 】



Confirmed the reduction effect of dissemination, but less reduction in crossing pedestrian and crossing. This is due to the low dissmination of Level 3 and above, and the fact that automated driving system model implemented in this simulation assumes only autonomous sensors and is unable to respond to sudden jumps from out of sight.

Summary

Based on the simulation of traffic accident reduction effects developed in SIP Phase 1, the following data were incorporated to improve the accuracy.

A. Dissemination scenarios
B. Signal indication and traffic regulation information
C. Pedestrian and bicycle models and traffic
D. Speed information

In this project, a tentative accident reduction effect was estimated using a tentative dissemination scenarios provided by another project "Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others".

The effect of accident reduction will be calculated in the final dissemination scenarios towards the end of the fiscal year.

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2020
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