Visualization of the traffic accident reduction effects through automated driving and driving assistance (FY2019-FY2020)

FY2019 Annual report summary version

Japan Automobile Research Institute

1. Purpose of research

【 Government policy 】

- Level 2 driver assistance vehicles will be put into practical use on ordinary roads (2020)
- Level3 self-driving vehicles will be put to practical use on highways (2020)
- Level 4 self-driving vehicles will be put to practical use on highways (expected in 2025) etc.

【 Society's expectations 】

Expectations are rising for the practical application and spread of automated driving and driving support technologies.

【 Object of project 】

Fostering social acceptance is necessary for the smooth implementation of self-driving and driver-assisted vehicles in society

In this project, traffic flow simulations are used to estimate the effect of traffic accident reduction according to the prevalence of self-driving vehicles and driver-assisted vehicles.

2. Project summary

Set realistic traffic environment data and check operation of simulation in FY2019 for accurate simulation estimation

This project

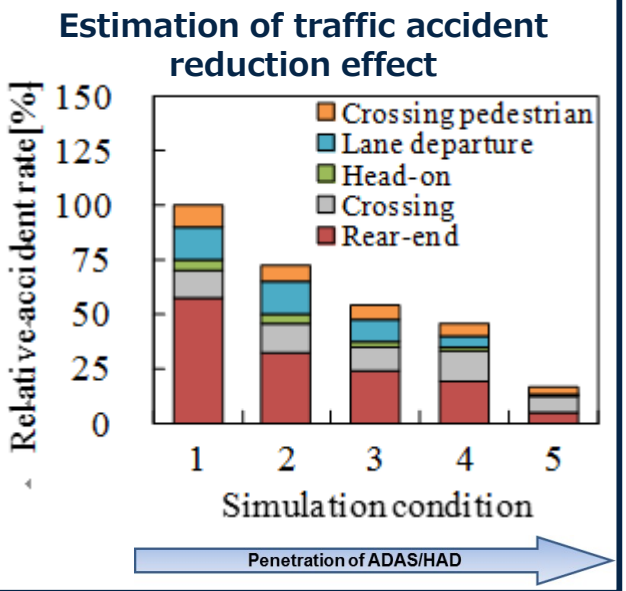
FY2019

- 3. Selection of a traffic flow simulation
- 7. Operation check
- 4. Set signal indication and traffic regulation information
- 5. Traffic flow field survey
- 6. Setting of speed information

Improve accuracy

FY2020

Simulation execution



Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others

Dissemination scenario provided

Estimation results provided

Spreading scenario of automated driving vehicle

Impact assessment

3. Selection of traffic flow simulation

【Requirements for traffic simulation that can evaluate the effects of accident reduction】

① Traffic participants, such as drivers, act autonomously (perception / recognition, judgment, operation), and interact with each other and accidentally traffic accidents occur, so that real traffic phenomena can be faithfully reproduced. (multi agent type)

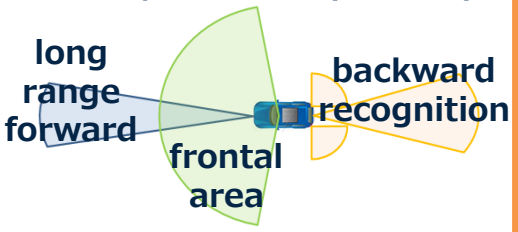
② To be able to implement the behavioral characteristics of each traffic participant (drivers, pedestrians, bicyclists) and error models (safety failures, etc.) in the simulation.

Select the traffic flow simulation developed in SIP Phase 1 project

3. Selection of traffic flow simulation (continued)

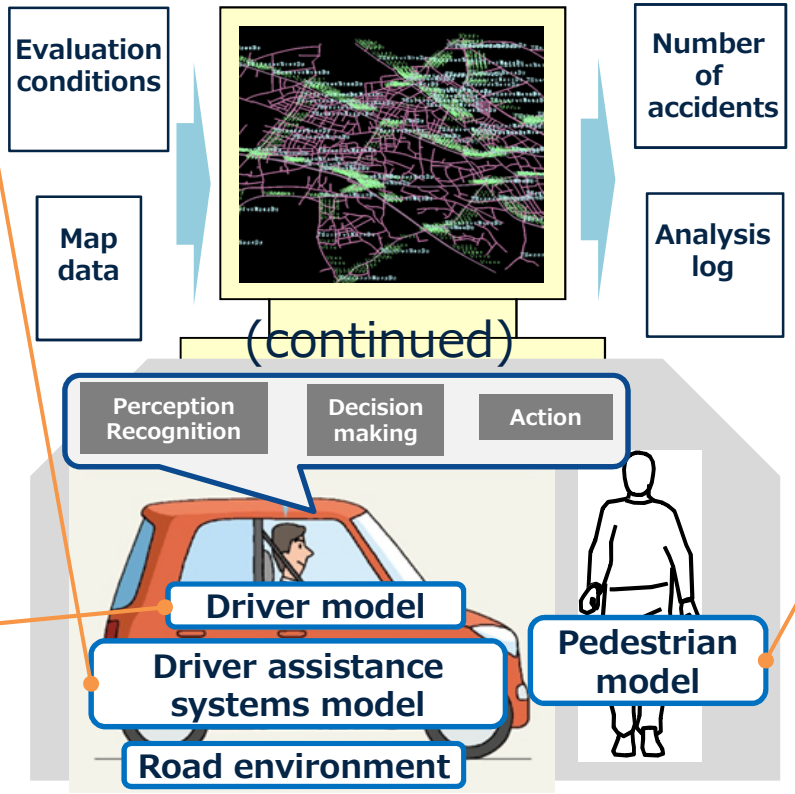
Overview of the simulation developed in SIP Phase 1 project

■ **Driving Assistance system can be set.**
- Number of perception sensors
- Performance (range, etc.)
- Control specifications (TTC, etc.)

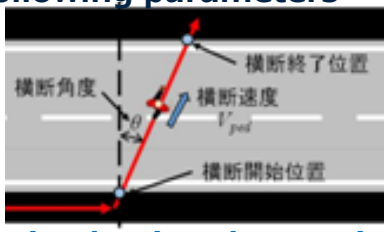


■ **Express the driving characteristics of each driver with the following parameters**
- (A) Compliance with traffic law
- (B) Driving skill
- (C) Information process ability
- (D) Wakefulness level
- (E) Trust in the system

■ **Set errors such as inattentive and careless driving**

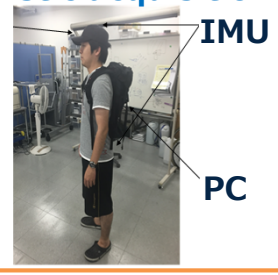


■ **Pedestrian crossing characteristics with following parameters**



①Fixed point observation

②Experiment of test course crossing characteristic acquisition



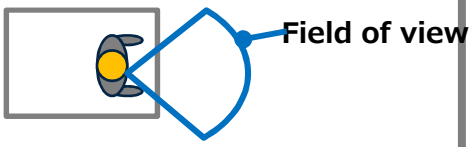
3-1. Driver behavior model

(using the model developed in SIP Phase 1 project)

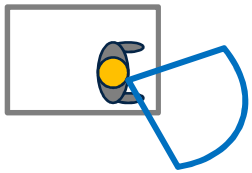
Development of Perception, Recognition / Judgement/ Operation / Error model according to the driver characteristics

Perception Recognition

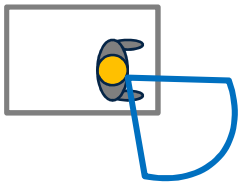
Preceding vehicle recognition



Head shaking

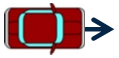


Looking aside



Duration and timing is set randomly

Judgement

Ego Vehicle 

Preceding Vehicle 

Based on relative speed and inter-vehicular distance, driving mode is judged.

Relative velocity		Relative distance
Alienation	Acceleration	Far
	Constancy	
	Following	
	Idle running	
	Deceleration	
	Abrupt Deceleration	
Approach		Near

Driver error

- **Innattentive/aimless driving**
- **Misjudgment**
- **Inadequate operation**

etc.

Operation

Based on judgement achieve the operation

- **Accelerator pedal**
- **Break pedal**
- **Steering wheel**

Parameters related to operation

- **Brake change time**
- **Accelerator change time**

Change by wakeness level decline etc.

Driver attributes

(A) Compliance with traffic law
(B) Driving skill
(C) Information process ability
(D) Arousal level
(E) Trust in the system

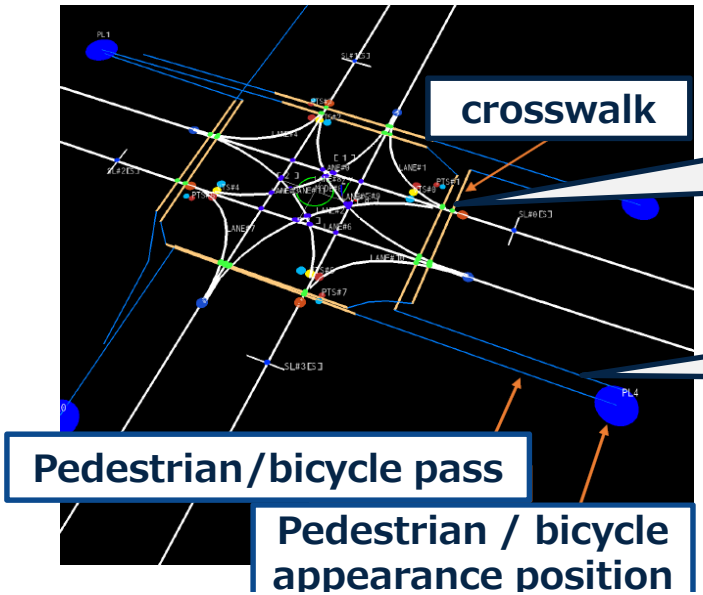
Randomly set by statistical distribution

3-2. Pedestrian / bicycle behavior model

In addition to expanding the simulation of pedestrian accidents, a new behavioral model for bicyclists has been created 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	Single road crossing + Crossing signal intersection (only second party)
bicycle	-	Head-on, Left turn involved, and right straight accidents(only second party)

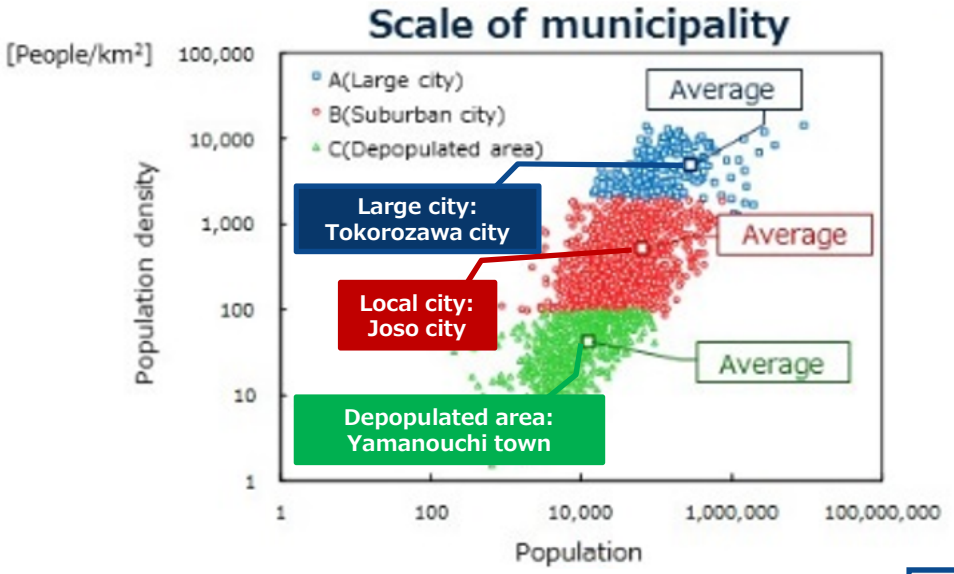


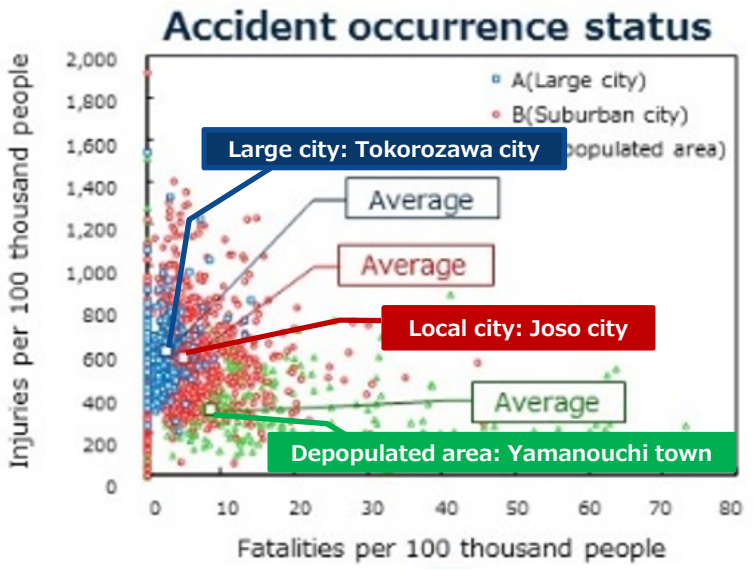
Set the signal for pedestrian at the intersection

Set pedestrian/bicycle path at the intersection

3-3. Selection of model areas (same as SIP Phase 1)

A representative model area was selected from the perspective of the size of the city and t heoccurrence of traffic accidents. (Large city: Tokorozawa city, Local city: Joso city, Depopulated area: Yamanouchi town)





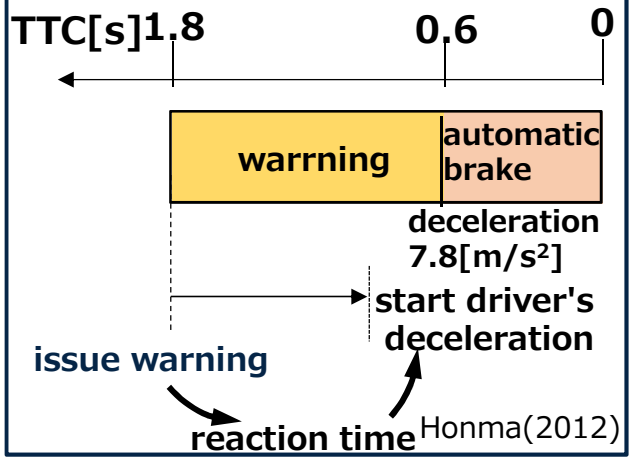
Simulations were run to estimate the effect of traffic accident reduction in the selected model areas.

Estimated nationwide reduction in traffic accidents based on simulation results

3-4. Specifications of the system

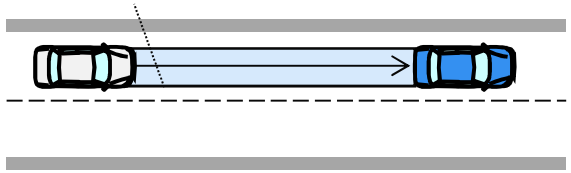
(developed in SIP Phase 1 project)

Advanced emergency braking system



Adaptive cruise control

Time head way (THW): 1.8s

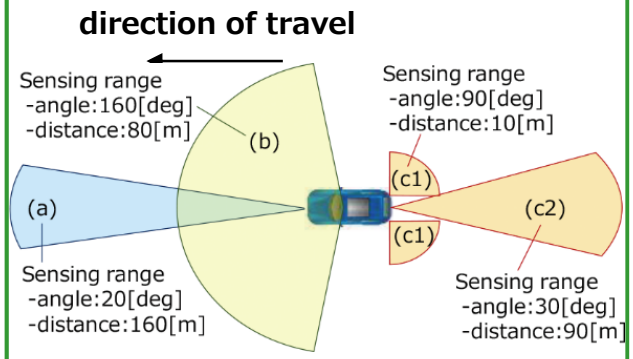


Longitudinal acceleration
- Maximum deceleration 3.5[m/s²] (Maximum jerk 2.5[m/s³])
- Maximum acceleration 2.0[m/s²]

JIS D 0801(2012)

AD System [Lv.3-5]

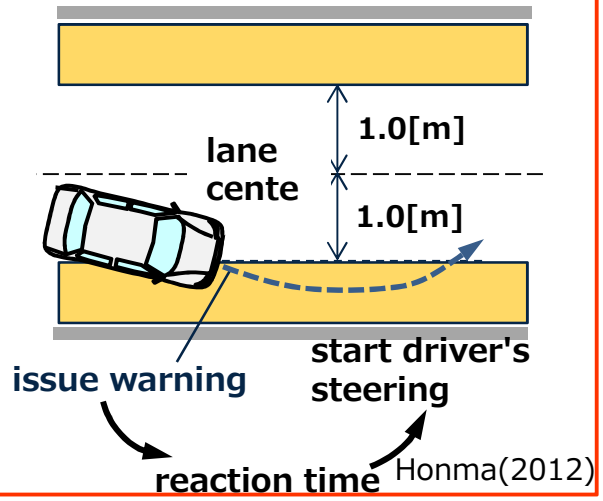
- **Recognition:** Sensors always recognize the surrounding environment



METI Projects in FY2017
Smart Mobility System Research, Development and Demonstration Project

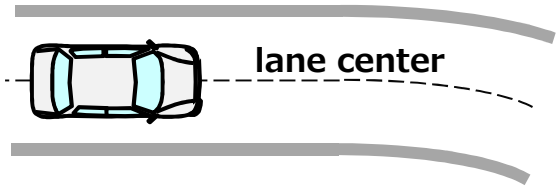
- **Judgement:** Excellent driver model without mistakes.
- **Action:** No delay in reaction and pedal change.
- **Delegation and handover of driving authority (Lv 3 only):**
  (i) Departure from ODD
  (ii) System failure occurred

Lane departure warning



Lane keeping assist

Detect the lane and keep driving on the center of lane



Lateral acceleration
- Maximum acceleration 2.3[m/s²]

JIS D 0801(2012)

3-5. Vehicle models based on spread scenario

The vehicle model to be used in this project is based on the vehicle categories of the scenario provided by the "Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others", a separate project.

Vehicle classification of spread scenario

Classification	Usage	Car model	Purpose
Private Cars	Passenger car	Normal passenger	Private
		Small passenger	Private
		Mini vehicles	Private and business
	Sharing	Normal sharing	Private
		Small passenger	Private
Transfer service	Passenger car	Normal passenger	Business
		Small passenger	Business
	Sharing	Normal sharing	Business
		Small sharing	Business
Logistics services	cargo	Ordinary cargo	Business
			Private
		Small cargo	Business
			Private
		Mini vehicles	Private and Business

Vehicle models in simulation

Private Cars:Sedan 5 Number

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

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

Commercial Cars:Over 30 people

	unit	value
length	[m]	11,99
width	[m]	2,490
weight	[kg]	13,180

Commercial Cars:11~29 people

	unit	value
length	[m]	6,995
width	[m]	2,065
weight	[kg]	3,710

Heavy Trucks:Under 3.5ton

	unit	value
length	[m]	5,380
width	[m]	1.880
weight	[kg]	1,000

Heavy Trucks:Over 3.5ton

	unit	value
length	[m]	5,280
width	[m]	2,080
weight	[kg]	2,770

Small Trucks:Under 3.5ton

	unit	value
length	[m]	4,275
width	[m]	1.675
weight	[kg]	800

Small Trucks:Over 3.5ton

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

Small Trucks:Mini truck

	unit	value
length	[m]	3,395
width	[m]	1,475
weight	[kg]	350

Motorcycle

	unit	value
length	[m]	1,990
width	[m]	0,710
weight	[kg]	167

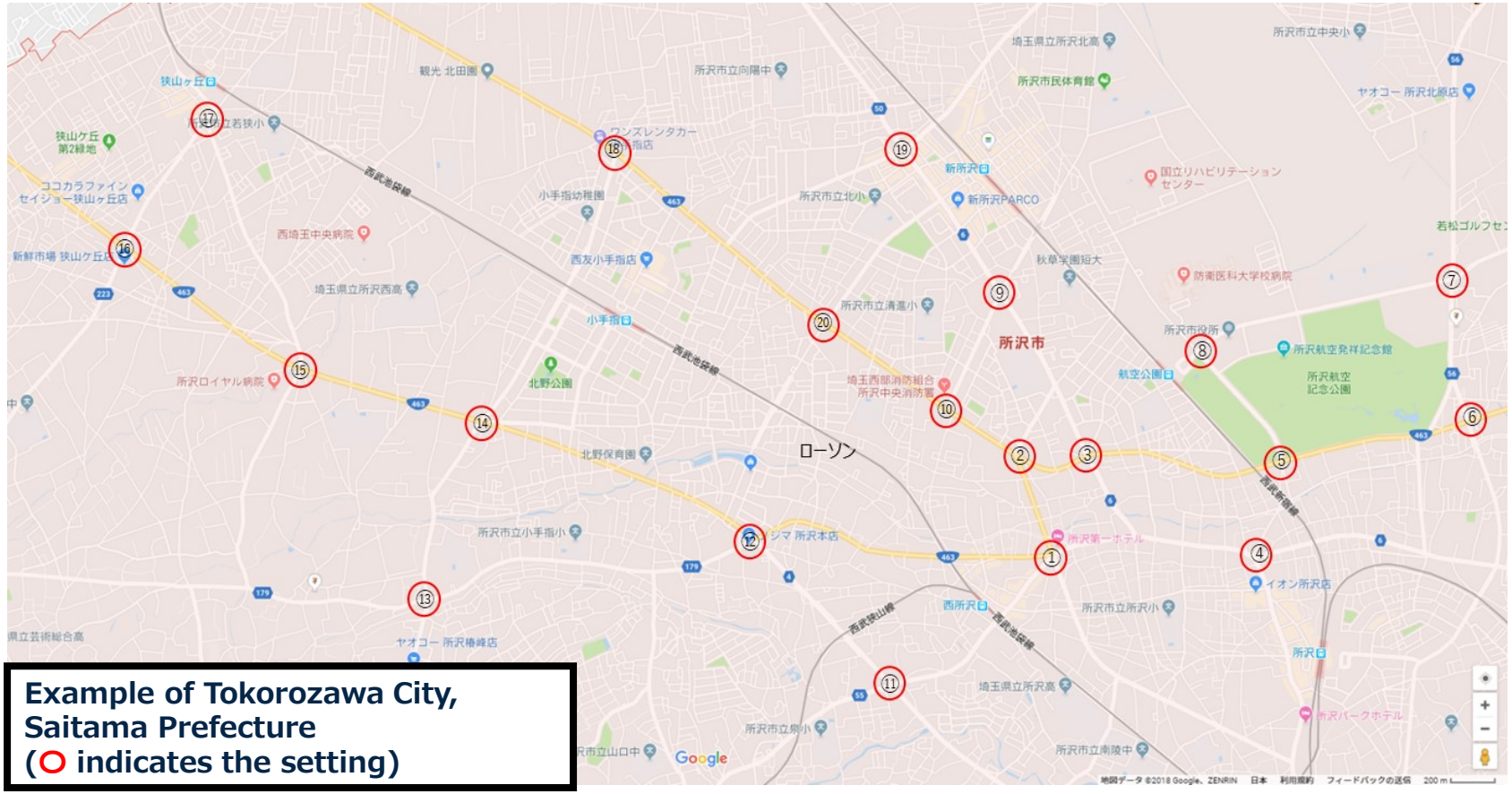
Bicycle

	unit	value
length	[m]	1,850
width	[m]	0,580
weight	[kg]	20

4. Set traffic signal/traffic regulation information

In order to perform more accurate simulations, traffic regulation information (①) and signal display information (②) in the target model area are reflected in the map data

①Signal display information (including pedestrian signals)

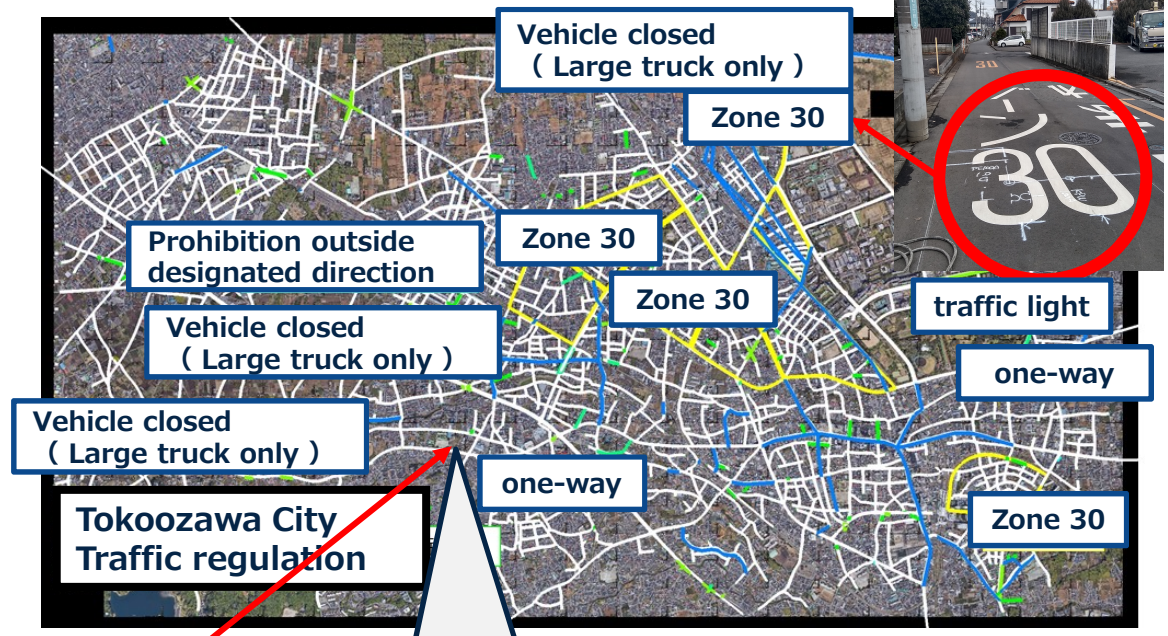


Example of Tokorozawa City, Saitama Prefecture
(O indicates the setting)

4. Set traffic signal/traffic regulation information (continued)

① traffic regulation

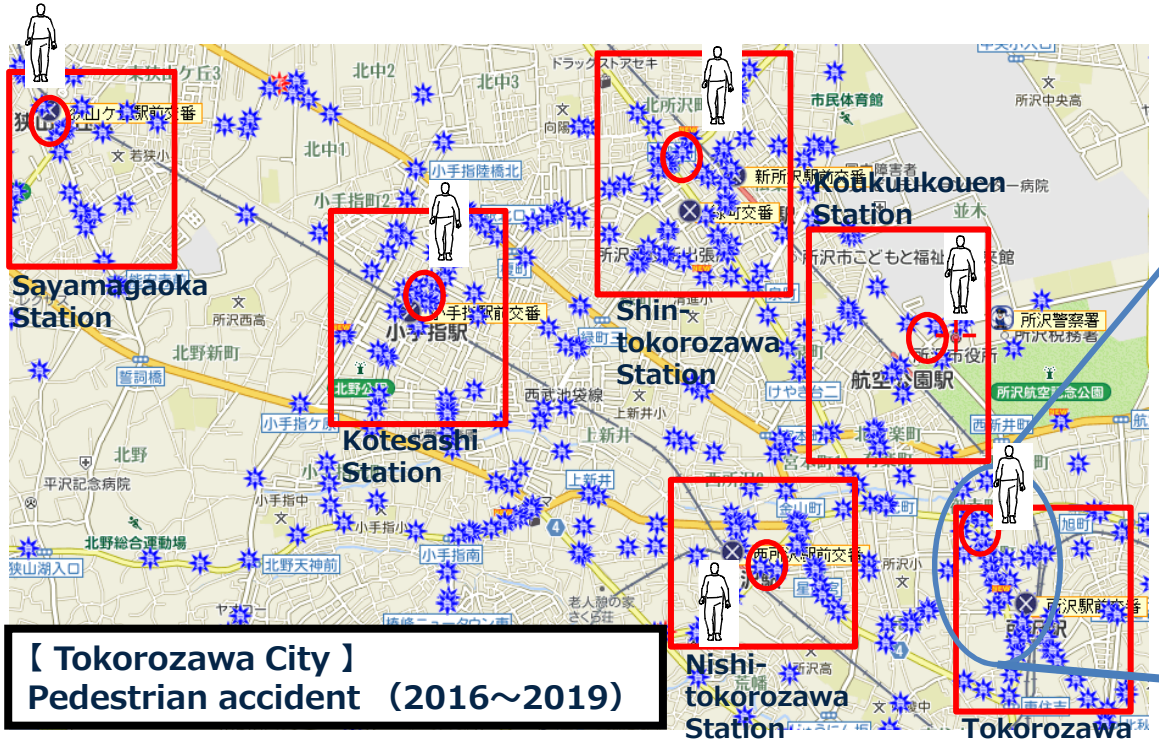
- Traffic regulation
- Pedestrian road
- Bicycle road
- Bicycle and pedestrian roads
- Road closed
- Vehicle closed
- Prohibition outside designated direction
- One-way
- Pause
- Traffic light
- Zone 30 (Max. speed 30km/h)



Example : Vehicle closed (only large trucks)

5. Conducting traffic volume surveys and setting up information on pedestrians and bicycles

Traffic volume surveys were conducted in each model area, mainly at the points where accidents occur, and the traffic volume of pedestrians and cyclists was set on the map.



【 Tokorozawa City 】
Pedestrian accident （2016～2019）

Survey pedestrian and bicycle behavior at intersection

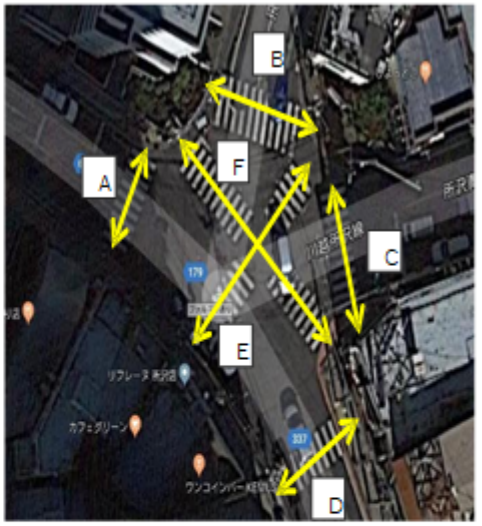
: Location of field surveyors

: Location of the field survey

Status of Field Surveys in Tokorozawa City (large city), Saitama Prefecture
*** Based on the incidence of pedestrian accidents (2016-2019)**

5-1. Conduct a traffic volume survey.

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



歩行者合計(※合計は自転車を除く)

	子供		大人		高齢者		自転車		合計	
	青/点滅	赤	青/点滅	赤	青/点滅	赤	青/点滅	赤	青/点滅	赤
A	0	0	51	1	25	0	28	2	76	1
B	0	0	89	1	21	0	27	1	110	1
C	0	0	154	0	40	0	81	2	194	0
D	0	0	75	1	22	0	44	0	97	1
E	0	0	50	0	19	0	64	0	69	0
F	0	0	281	0	40	0	102	0	321	0

標準偏差(※合計は自転車を除く)

	子供		大人		高齢者		自転車		合計	
	青/点滅	赤	青/点滅	赤	青/点滅	赤	青/点滅	赤	青/点滅	赤
A	0	0	1.186	0.152	0.789	0	0.678	0.213	0.96	0.089
B	0	0	1.789	0.152	0.932	0	0.811	0.152	1.475	0.089
C	0	0	2.146	0	0.898	0	1.163	0.213	2.053	0
D	0	0	1.145	0.152	0.545	0	0.872	0	1.048	0.089
E	0	0	1.029	0	0.586	0	1.349	0	0.841	0
F	0	0	4.003	0	0.872	0	1.62	0	3.785	0

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

5-2. Setting up information on pedestrians and bicycles

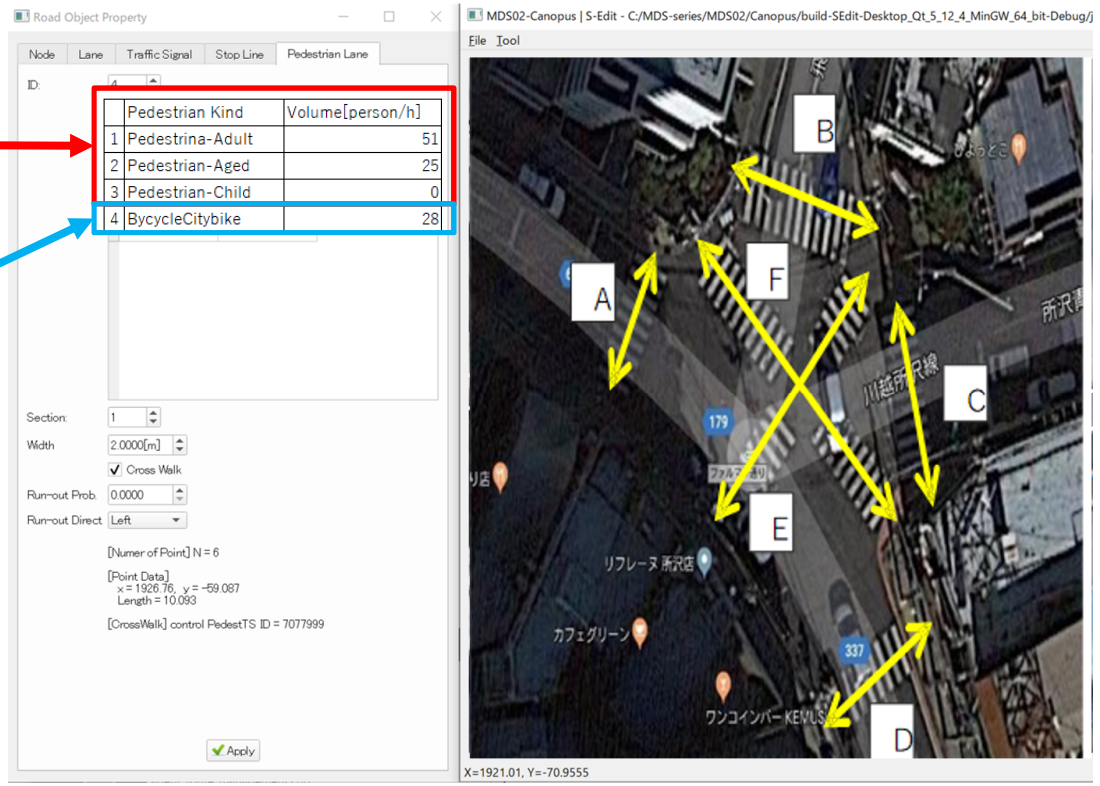
Pedestrian and bicycle traffic volume based on the results of the field survey

歩行者合計

	子供		大人		高齢者		合計	
	青/点滅	赤	青/点滅	赤	青/点滅	赤	青/点滅	赤
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

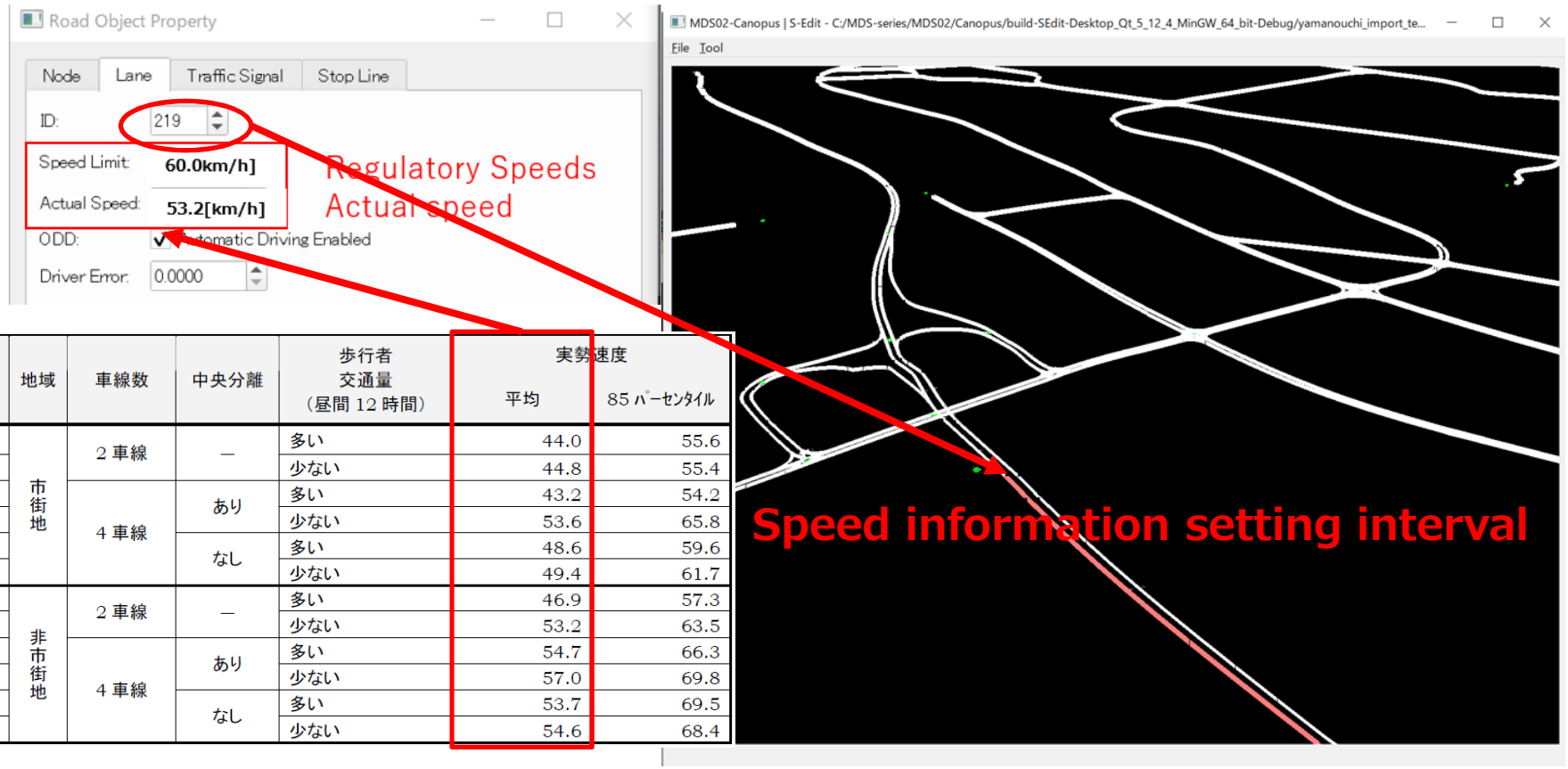
自転車合計

	自転車	
	青/点滅	赤
A	28	2
B	27	1
C	81	2
D	44	0
E	64	0
F	102	0



Setting of speed information

Set the regulated speed (specified or legal speed) and actual speed on the map data.



№	地域	車線数	中央分離	歩行者交通量（昼間 12 時間）	実勢速度 平均	実勢速度 85 パーセンタイル
①	市街地	2 車線	—	多い	44.0	55.6
②				少ない	44.8	55.4
③		4 車線	あり	多い	43.2	54.2
④				少ない	53.6	65.8
⑤			なし	多い	48.6	59.6
⑥				少ない	49.4	61.7
⑦	非市街地	2 車線	—	多い	46.9	57.3
⑧				少ない	53.2	63.5
⑨		4 車線	あり	多い	54.7	66.3
⑩				少ない	57.0	69.8
⑪			なし	多い	53.7	69.5
⑫				少ない	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".

7. Confirmation of simulation operation

In order to estimate the effect of traffic accident reduction with a higher degree of accuracy, it is necessary to set the diffusion rate of OD (Note) and automatic driving vehicles and driver assistance vehicles based on the diffusion scenario provided by the separate project "Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others".

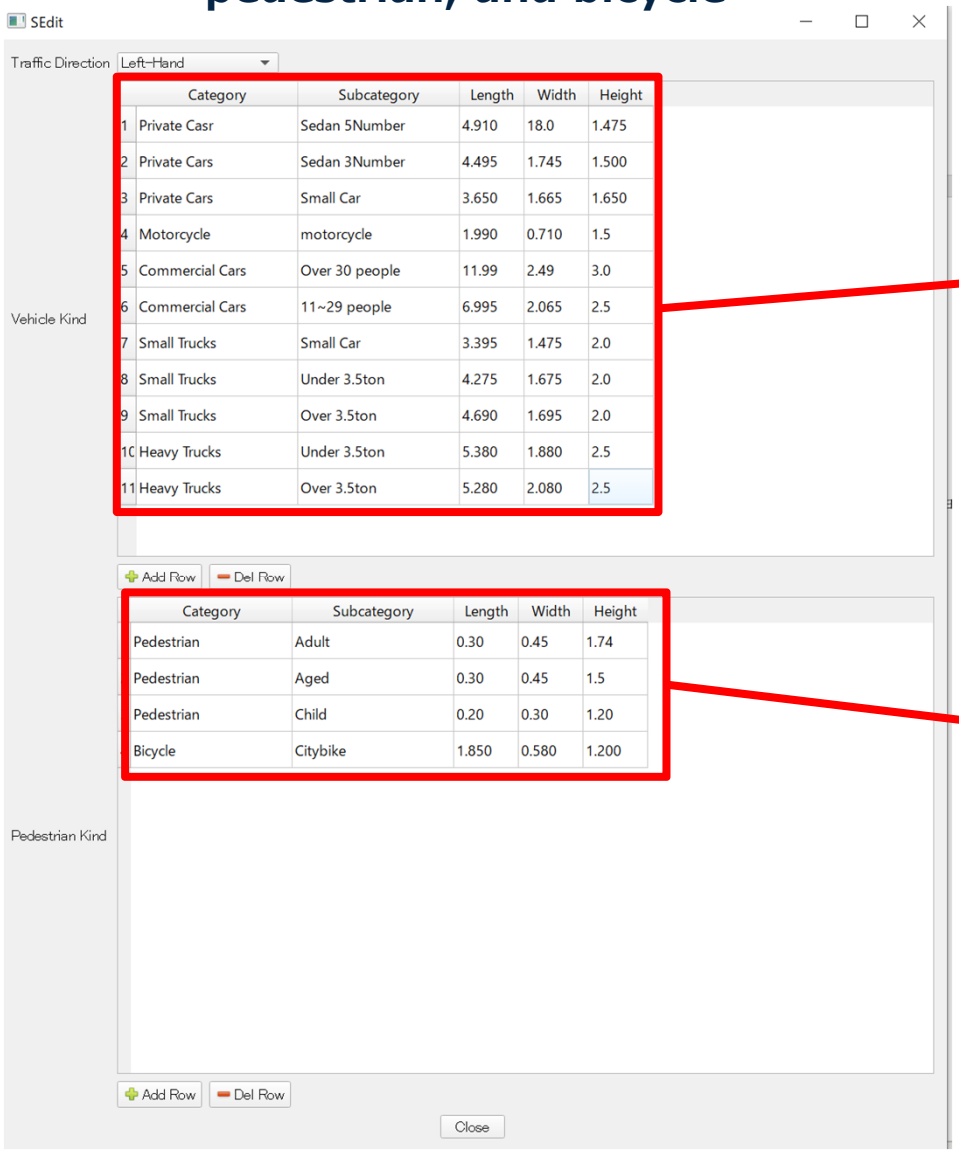
In FY 2019 implementation
①Setting the type of vehicle and the type of pedestrian and bicycle
②Establishing the probability of occurrence for each traffic participant
③Confirmation of simulation operation

note) OD: O stands for Origin and D for Destination, and refers to the point at which traffic participants (vehicles, pedestrians, bicycles, etc.) enter and exit in the simulation map.

7. Confirmation of simulation operation

(continued)

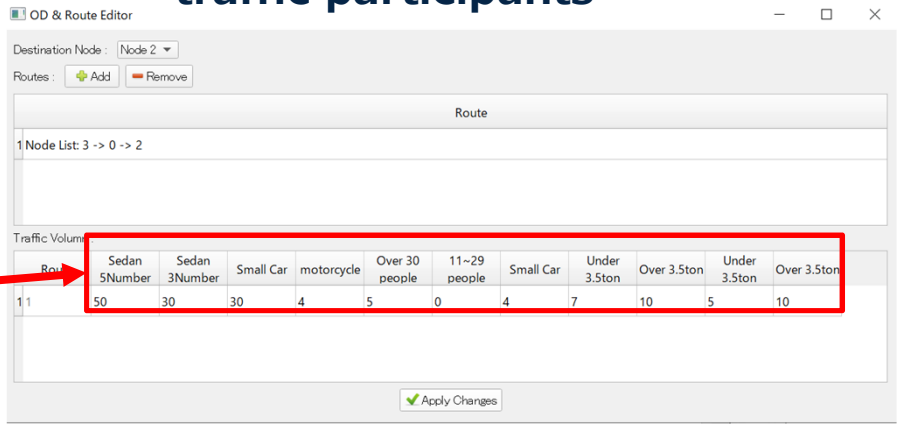
①Set the types of vehicle, pedestrian, and bicycle



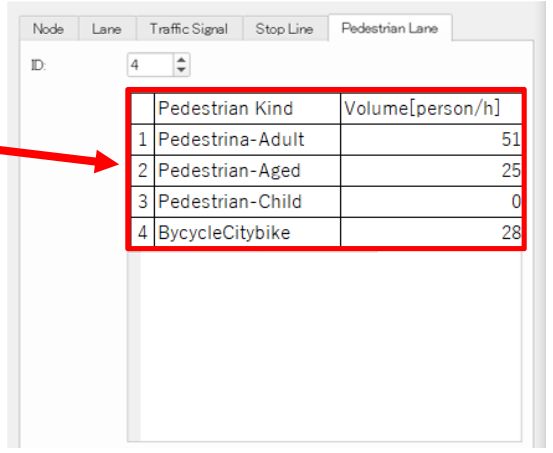
	Category	Subcategory	Length	Width	Height
1	Private Casr	Sedan 5Number	4.910	18.0	1.475
2	Private Cars	Sedan 3Number	4.495	1.745	1.500
3	Private Cars	Small Car	3.650	1.665	1.650
4	Motorcycle	motorcycle	1.990	0.710	1.5
5	Commercial Cars	Over 30 people	11.99	2.49	3.0
6	Commercial Cars	11~29 people	6.995	2.065	2.5
7	Small Trucks	Small Car	3.395	1.475	2.0
8	Small Trucks	Under 3.5ton	4.275	1.675	2.0
9	Small Trucks	Over 3.5ton	4.690	1.695	2.0
10	Heavy Trucks	Under 3.5ton	5.380	1.880	2.5
11	Heavy Trucks	Over 3.5ton	5.280	2.080	2.5

Category	Subcategory	Length	Width	Height
Pedestrian	Adult	0.30	0.45	1.74
Pedestrian	Aged	0.30	0.45	1.5
Pedestrian	Child	0.20	0.30	1.20
Bicycle	Citybike	1.850	0.580	1.200

②Set the appearance probability of traffic participants



Rou	Sedan 5Number	Sedan 3Number	Small Car	motorcycle	Over 30 people	11~29 people	Small Car	Under 3.5ton	Over 3.5ton	Under 3.5ton	Over 3.5ton
1 1	50	30	30	4	5	0	4	7	10	5	10

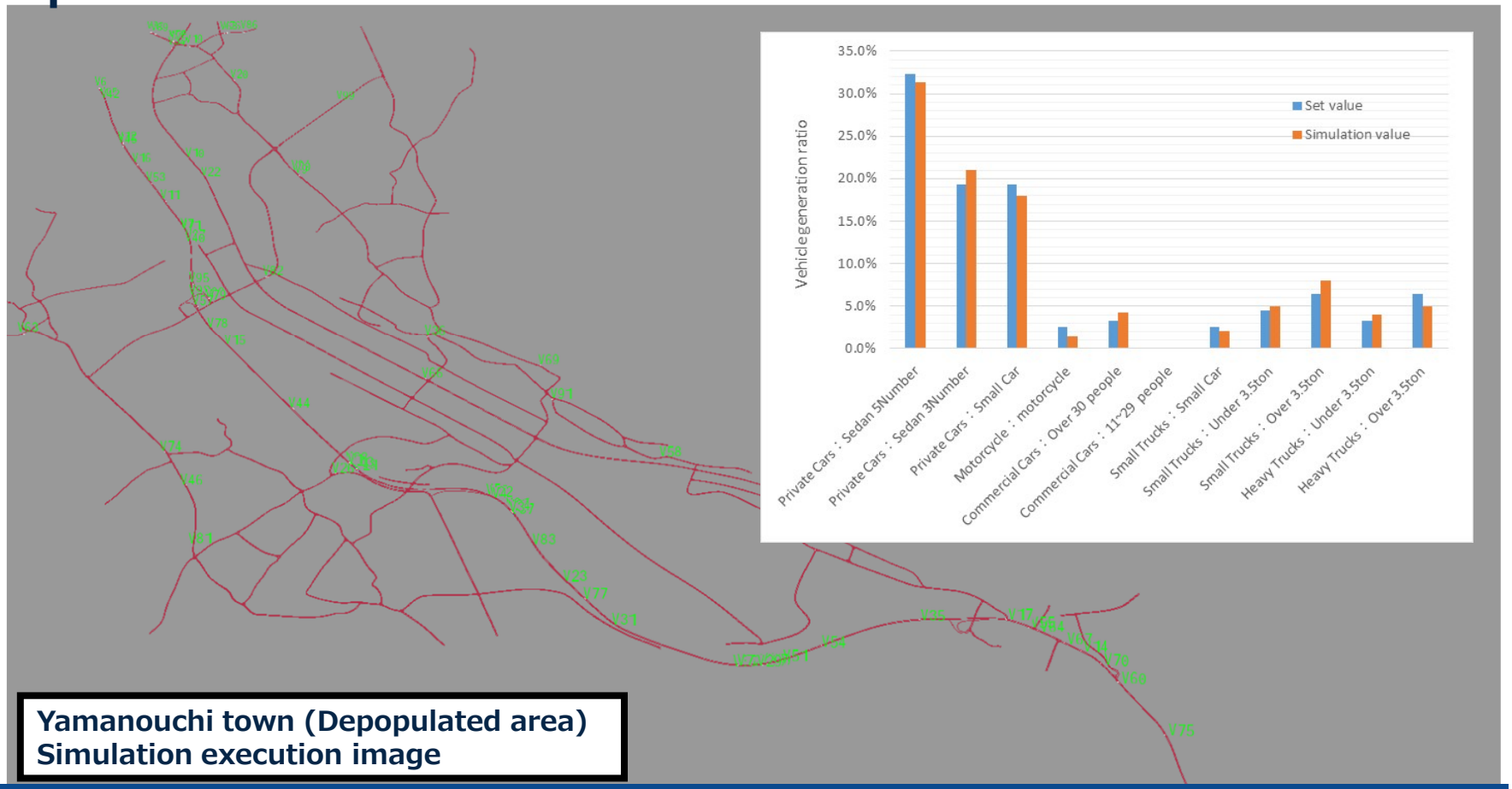


	Pedestrian Kind	Volume[person/h]
1	Pedestrina-Adult	51
2	Pedestrian-Aged	25
3	Pedestrian-Child	0
4	BycycleCitybike	28

7. Confirmation of simulation operation

(continued)

③ Operation checks of simulation



Yamanouchi town (Depopulated area)
Simulation execution image

Confirmed that the traffic participants defined in ① and ② could be reproduced in the simulation using the map of Yamanouchi Town. Also confirmed that the ratio of vehicle generation in the traffic flow could be controlled.

Conclusion

■ FY2019 Summary

In FY 2019, the traffic flow simulation was selected, and simulation data and map data were created to estimate the effect of reducing traffic accidents and operation check of simulation is achieved.

■ FY2020 Project plan

In FY 2020 project, estimate the effects of traffic accident reduction for each spreading scenario provided by the "Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others", a separate project using the simulation selected in FY 2019 and the produced simulation data and map data.

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