戦略的イノベーション創造プログラム

The second phase of SIP- Automated Driving for Universal Services

Research on Model System for Improvement of Data Accuracy of Traffic Regulation Information

Progress Report 2021

Summary

Japan Road Traffic Information Center
TOSCO Corporation
Dawn Corporation

2022 March

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1. Background and Objectives

Objectives (2021)

- To develop a model system and conduct Fields Operational Tests (FOTs) **to improve the accuracy of** police-managed **traffic regulation information data** needed by automated vehicles
- To conduct surveys and studies to introduce the system to all prefectural police

Issues related to current traffic regulation information

❶Difficulties in registering traffic regulation information	❷Structural issues with standard format data	❸Need to link traffic regulation information with road signs and marking information
• Burden of data registration of traffic regulation information and road signs and markings • Necessity of work such as correction of unregistered information to improve accuracy in systemization using standard format	• Lack of definition and recording of current standard formats (code, order of storage of coordinates, direction of regulation, decision number, etc.) • No reflection of new regulations (”Maximum speed 120km/h”) • Difficulty in providing differential data due to lack of data update status (new, changed, or solved)	• Data with no links between traffic regulation information and road signs and marking information • Road signs and marking information that has not yet been converted to data
Registration function with low workload	**Review of standard formats**	**Review of extended version of standard format**

Problem solving with model system

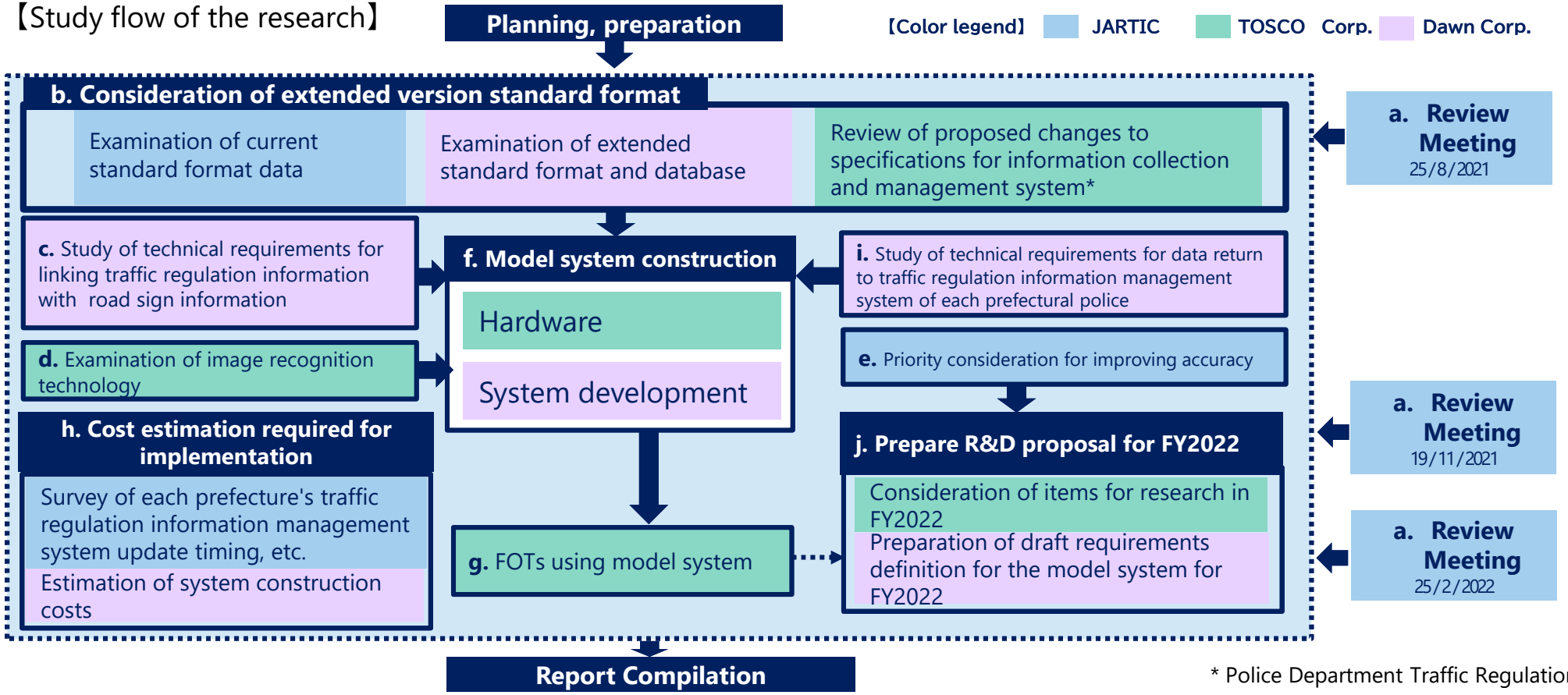
2. Outline of Research

Implementation objective (2021)

① To develop an extended standard format that links traffic regulation information with road sign information in order to improve the data accuracy of traffic regulation information required by automated vehicles.

② To construct a model system to improve the data accuracy of traffic regulation information, conduct FOTs, and prepare a system requirements definition to build a prototype system in FY2022 for social implementation.

【Study flow of the research】



* Police Department Traffic Regulation

2. Outline of Research

【Schedule of FY2021】

Research Items	Process									Remarks
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
Plannning/ preparation										
a. Impementation of Review Meeting										
b. Consideration of extended version standard format										
Analysis of current standard format data										
Consideration of extended standard format and database										
Review of proposed changes to specifications for information collection and management system										
C. Study of technical requirements for linking traffic control information with sign information										
d. Examination of image recognition technology										
e. Priority consideration for improving accuracy										
f. Model system construction										
Hardware										
System development										from December: repair
g.Demonstration experiment using model system										
h. Cost estimation required for implementation										
Survey of each prefecture's traffic control information management system update timing, etc.										
Estimation of system construction costs										
i.Study of technical requirements for data return to traffic control information management system of each prefectural police										
J. Prepare R&D proposal for FY2022										
Consideration of items for study in FY2022										
Preparation of draft requirements for the model system for FY2022										
Report Compilation										Period: March 31

3. Model System Development and FOTs

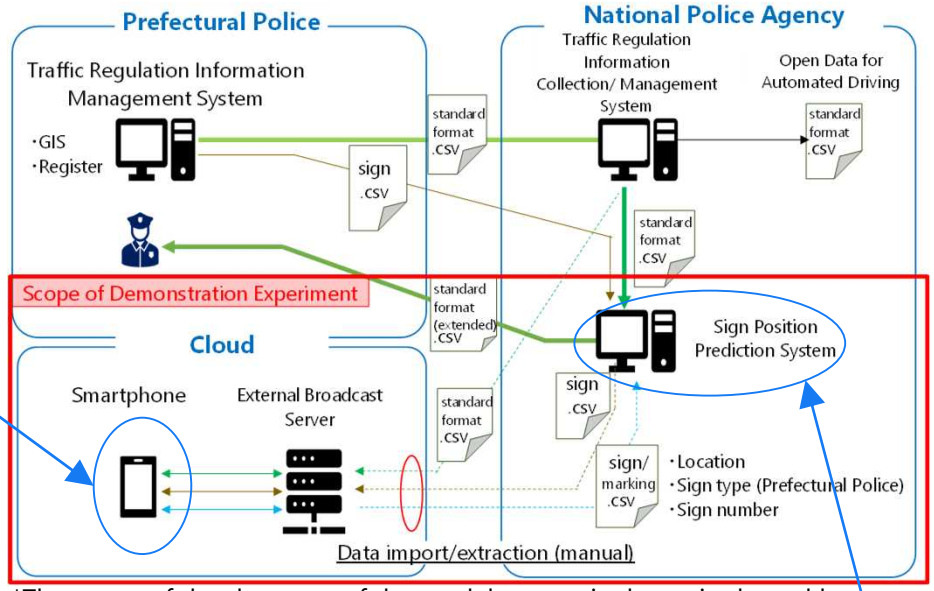
3-1. Model system development

Based on the draft requirements definition prepared in the FY2020 research, a road sign location prediction system and survey application were developed to improve the accuracy of traffic regulation information.

Survey App

The survey application was developed as an application with the following functions, including registration of survey results, to support field surveys of road signs and markings.

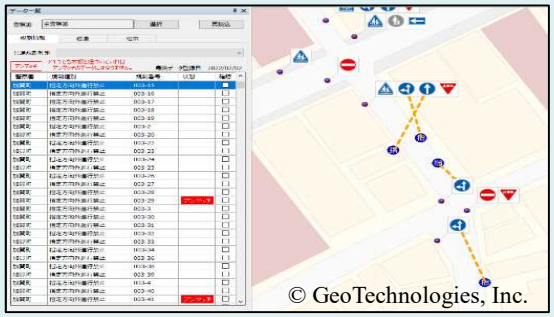
Administrator function(PC)	User function (smartphone)
Login function	Login / user authentication function
User authentication and management function	Traffic regulation information display function
Traffic regulation information registration function	Traffic regulation information correction function
Traffic regulation information mapping function	Survey information registration function
Correction history function	Operation manual display function
Data output function	-



*The scope of development of the model system is shown in the red box.

Road Sign Position Prediction System

System to support linking traffic regulation data with road sign data



Basic function
Traffic regulation information and road sign screen display function
Survey application acquisition information screen display function
Search function for traffic regulation information and road signs
Road sign position prediction function
Function to link traffic regulation information with road signs
Function to display unmatched
Function to output traffic regulation information to a file

[Examples]

Prediction of point regulation

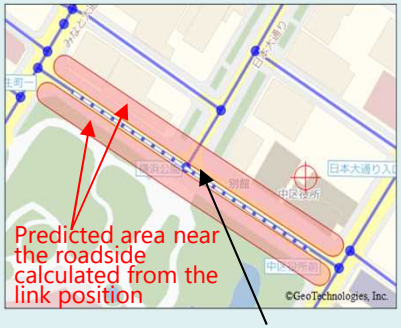
Example of predicted area of point regulation employing node information

Location of point regulation

Prediction area based on node position

Predicting Line Regulations

Example of predicted area of line regulation on a two-way road



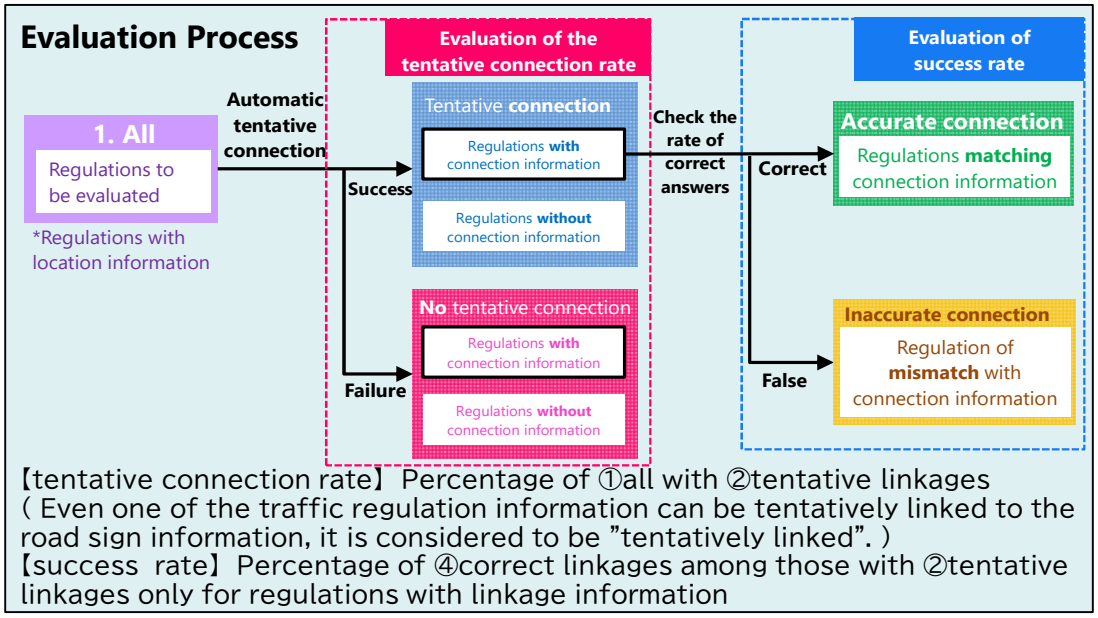
Line regulation location

3. Model System Development and FOTs

3-2. FOTs

FOTs using the developed model system were conducted within the three districts of Kanagawa Prefectural Police stations.

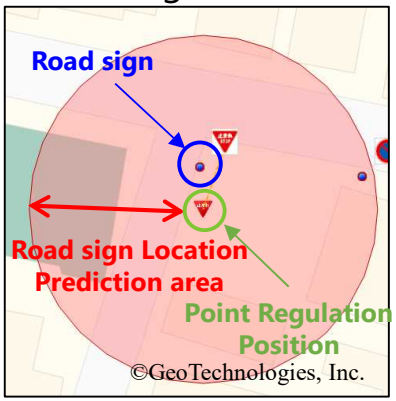
Item	Outline
Period	January 2022- February 2022
objective	Road Sign Position Prediction System & Survey App
Area	The three districts of Kanagawa Prefectural Police stations (Kagacho, Yamate, Isezaki)
Data	・Standard format data (28 types/ 4,113 cases) ・Road sign and marking data
Process	1. Register the standard format data and road sign data of the implementation area in the road sign position prediction system, and tentatively link them together. 2. Reviewed the prediction method based on the results of Step 1 and verified the optimal prediction method. 3. Verify the accuracy of the matching by comparing with the connection information at Kanagawa Prefectural Police. 4. Repeat Steps 2 and 3. 5. Confirm the results of the mapping, and conduct a field survey using the Survey App for areas where the accuracy is low. 6. Verify the tentative linkage rate and the correct answer rate.
Other	There were 41 regulation types existing in the test area, of which "regulation types that do not require road sign under traffic regulation standards " and "regulation types for which no location information is registered in the test data" were excluded.



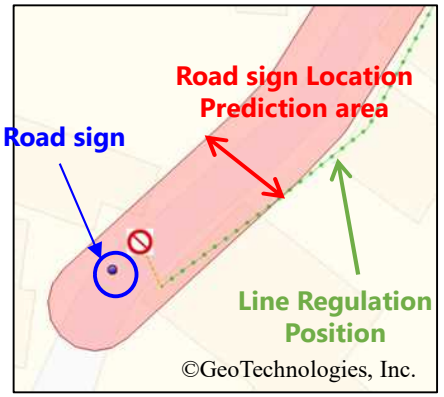
【tentative connection rate】Percentage of ①all with ②tentative linkages
(Even one of the traffic regulation information can be tentatively linked to the road sign information, it is considered to be "tentatively linked".)
【success rate】Percentage of ④correct linkages among those with ②tentative linkages only for regulations with linkage information

Evaluation Method

- ✓ Evaluation of the "tentative rate" and "correct answer rate" of traffic regulation data was conducted using the flow shown in the figure above.
- ✓ The evaluation was conducted a total of five times while improving the prediction method.
- ✓ Traffic regulation data that could be tentatively linked to one or more road sign data was treated as successful data.



[Point Regulation] Successful examples



[Line Regulation] Successful examples

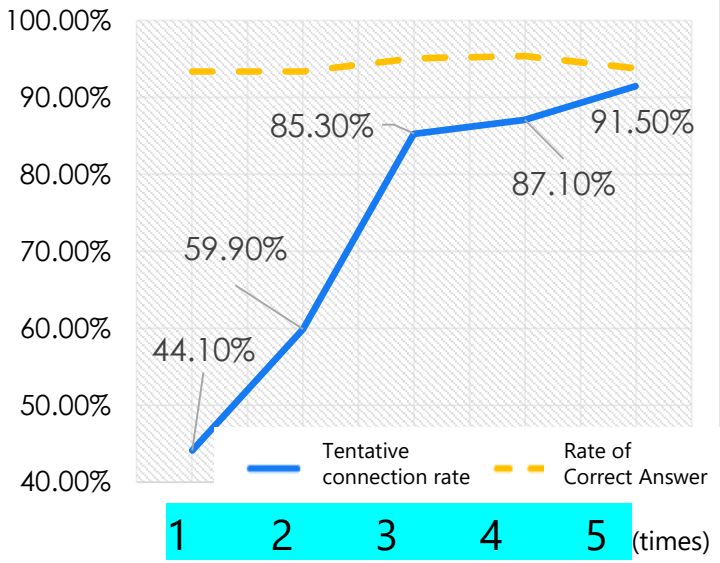
3. Model System Development and FOTs

3-3. Verification of road sign location prediction system

The final tentative connection rate using the road sign location prediction system was 91.5%, and the correct answer rate was 93.8%.

No.	Number of regulations	Number of exclusions	Number of tentative connections	Number of no tentative connections	Rate of tentative connections	Number of correct answers to be evaluated	Number of correct answers	Rate of correct answers
1	4,113	0	1,812	2,301	**44.1%**	1,554	1,452	**93.4%**
2	4,113	1,090	1,812	1,211	**59.9%**	1,554	1,452	**93.4%**
3	4,113	1,090	2,580	443	**85.3%**	2,227	2,118	**95.1%**
4	4,113	1,090	2,634	389	**87.1%**	2,287	2,181	**95.4%**
5	4,113	1,090	2,767	256	**91.5%**	2,389	2,240	**93.8%**

The relationship between tentative connection rate and rate of correct answers



Cause of failure

	Major Factors	Cause of failure to connect
①	Connects to other road signs	Pedestrian road regulations are tied to the "Bicycle and Pedestrian Roads (325-3)" road sign.
②	Insufficient predict area	Prediction aera is too narrow or insufficient.
③	Method to managing coordinates	When prediction is based on a node in the road network, there is no relevant road sign data in the surrounding area.
④	Concentration of the same traffic regulation	One-way traffic regulations are concentrated
⑤	Processing method	Near intersections, multiple road signs are linked to one previously processed out-of-direction regulation, so subsequent out-of-direction regulations cannot be linked and processed.

Analysis of correct rate

	Main factors	Details
①	Concentration of the same traffic regulation	Information that cannot be matched as well as the original connection information based solely on the location of the regulation and road sign (e.g. Designated direction outside the passage is prohibited, pedestrian crossing)
②		Regulations that have been connected to another regulation due to overlapping predicted areas
③	Incorrect coordinate information	The location coordinates of the regulation are inaccurate.
④	Inconsistencies in connection information	The location of the road sign to which it is connected is at an exceptionally distant location.
⑤		The combination of the connected road sign type and regulation type does not comply with the traffic regulation standards.

3. Model System Development and FOTs

3-4. Verification of Survey Apps

Field surveys were conducted on 27 targeted cases using the Survey App, and all were tentatively connected.

Overview of the FOTs Using the Survey App

Of the 211 traffic restrictions in the entire Yamashita-cho area in the model region, 27 could not be tentatively linked with the road sign position prediction system, and a FOTs was conducted using the Survey App.

Target regulation	Number of regulations	Type of regulation
Point	23	Pedestrian crossings, temporary stops, no traveling outside the designated direction
Line	4	Pedestrian walkways, maximum speed 30km/h, No turning

No.	Number of regulations	Number of exclusions	Number of tentative connections	Number of no tentative connections	Rate of tentative connections
1	27	0	27	0	100%

Tests procedure using the Survey App

(1) Search and confirm data that could not be tentatively connected by the road sign location prediction system.

" No proceeding outside the designated direction" road signs are not found.

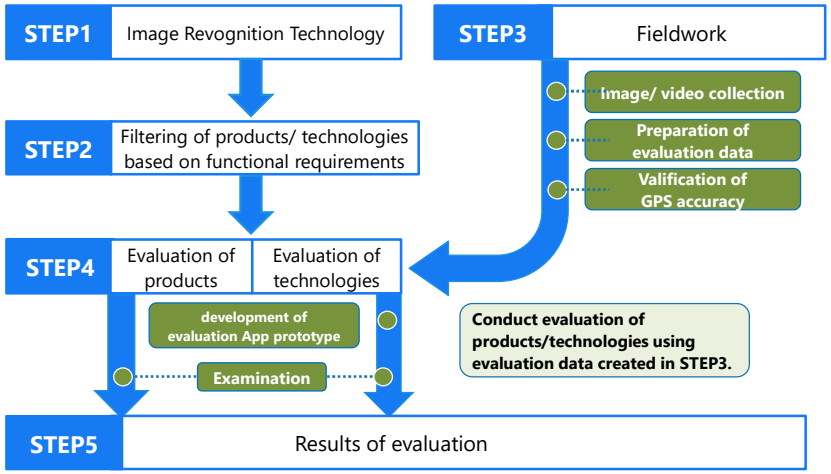
(2) Register facility data and photos at the site, and set up a tentative connection with the traffic regulation to be connected.

(3) Import survey data by the prediction system

Confirmed that the marking is newly displayed. Also confirmed that "unmatched" data has been resolved.

4. Examination of Image Recognition Technology

A method for gathering and selecting location information of road signs and markings easily from image information collected by prefectural police during installation and inspection work of road signs and markings was examined.



4-1. Research of product and technology

A total of 40 products and technologies were listed, mainly those that are publicly available.
They were selected in terms of their ability to extract road signs and markings, to recognize road signs and markings, and to estimate distances to road signs and markings.

(1) Research of products

The availability of products that can realize the extraction, recognition, and location estimation of road signs and markings from video and images was investigated.

Breakdown of the number of research（total：28）

Number of selection	Number of recognition (road signs)	Number of recognition (markings)	Predicted location
23	9	6	5

※ Specifications for three products that support extraction, recognition of road signs and markings, and location estimation were confirmed with the companies. However, accuracy is unknown because verification was not possible due to unavailability of loan.

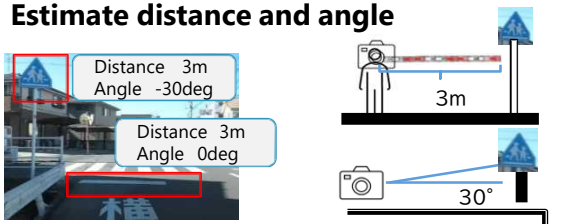
(2) Research of technology

The process for research of selection, recognition and predicting distance technologies is below.

Breakdown of the number of research（total：21）

Number of selection	Number of recognition (road signs)	Predicted location
12	13	5

Process Overview of Extraction, Recognition, Distance Estimation

Selection	Identifying areas from videos and images that are considered to be road signs or markings, and extracting images from these areas.	**Identify the area and extract the image** 
Recognition	Judging whether the area image obtained by the extraction is a correct road sign or marking, and specifying the regulation type.	**Recognize by regulation type** 
Estimation of distance	Estimating the distance and angle of objects (road signs or markings) in the image from the captured position.	**Estimate distance and angle** 

4. Examination of Image Recognition Technology

4-2. Evaluation and verification of technology (1/3)

Of the selection and recognition technologies surveyed, 4 were template matching and 12 were machine learning. It was estimated that machine learning has become a mainstream technology for image recognition in recent years. Therefore, evaluation software was prototyped and evaluated using three techniques: selection = YOLO v4, recognition = VGG16, and distance estimation = MiDaS.

a: Selection【YOLO v4】

●Road Sign（main/sub）

12,000 learning cycles per shapes (6 classes) and creation of main/sub road sign selection models （number of images:2,647）

[Image] Results of selection of main/sub road signs

	Class	Number of road signs	Number of Images	Rate of selection
Main road sign	Circle	206	197	96%
	Triangle	13	12	92%
	Pentagon	23	23	100%
	Square	55	49	89%
	Total	297	281	**95%**
Sub road sign	Normal	128	126	98%
	Circle	3	3	100%
	Total	131	129	**98%**

[Video] Results of selection of main/sub road signs

	Class	Number of road signs	Number of Images	Rate of selection
Main road sign	Circle	156	156	100%
	Triangle	7	7	100%
	Pentagon	30	30	100%
	Square	26	21	81%
	Total	219	214	**98%**
Sub road sign	Normal	108	107	99%
	Circle	4	4	100%
	Total	112	111	**99%**

Type of data	Number of images processed	Time (total)	Time
Image	200	70s	**0.35s / one image**
Video	60，930 frames（33m 53s）	15m 18s	**15ms / one frame**

Example of Failure

Marking range is incorrect

- ✓ **Over 95%** of main and auxiliary road signs can be extracted for both still and moving images.
- ✓ Video is processed **23 times faster** than images.
- ✓ Since the same road sign is extracted several times, it is necessary to consider a method to select the best image when extracting from video.

●Marking

Learning for each shape (4 classes) and creation of marking selection model
（Number of images：200）

Results of selection of markings

Class	Number of markings	Number of selected points	Rate of selection
Stop line	78	70	90%
Crosswalk	66	65	98%
Direction	106	102	96%
Max speed	55	49	89%
Total	261	248	**95%**

Number of videos processed	Time (total)	Time
42,930 frames （23m52s 30FPS）	10m 46s	**15ms/ one frame**

- ✓ Only the maximum speed was below 90%, but the average of the four classes is **more than 90%** extractable.

Example of Failure

Mis-extracted as direction indication

4. Examination of Image Recognition Technology

4-2. Evaluation and verification of technology (2/3)

b: Recognition【VGG16】

●Road Sign (main)

Learning for each shape (20 classes), and Development of a model for extracting the main road sign (Number of images: 2,000)

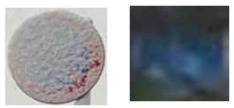
Results of recognition of main road sign (top 6 out of 20 types)

Class	Number of road signs	Number of recognition	Rate of selection
Parking prohibition	106	106	100%
Max speed: 40km	15	15	100%
Crosswalk and crossing lane for bicycles	14	14	100%
Prohibit outside the designated direction	13	13	100%
Distinguish between directions of passage	11	3 (11)	27% (100%)
Max speed: 50km	11	11	100%
Total	297	274	**92.3%**

Examples of successful

Examples of failed

occlusion



Examples of misidentification

Number of images	Time (total)	Time
297	14s	**21ms/one image**

*Numbers in parentheses ( ) are measured data after relearning.

- ✓ Most of the 20 classes of this road sign were generally recognized.
- ✓ In some classes, the recognition rate was about 30%, but they were confused with other similar road signs. Therefore, it was realized that the recognition rate could be improved by re-learning the road sign with more variations in size, shooting direction, and so on.

Change in recognition rate of "traffic classification by direction of travel" using training data

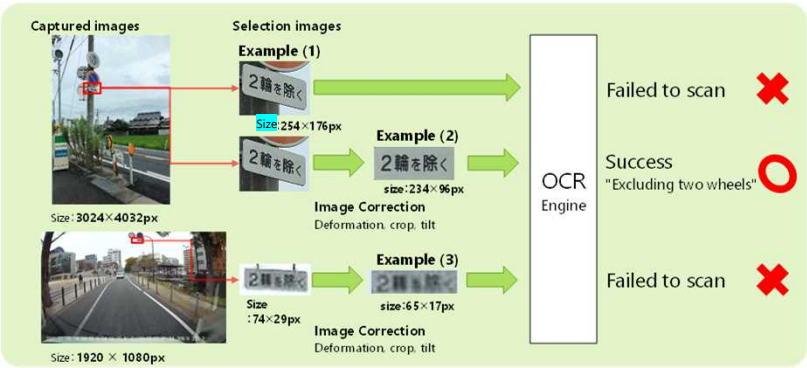
Re-learning	Number of road sign	Number of recognition	Number of selection
Before	11	3	27%
After	11	11	**100%**

Distinguish between directions of passage 

One-way pass (vertical type) 

●Road sign (sub)

The scanning of letters from sub road sign images in the OCR engine was verified.



- ✓ Sub road signs expressed in graphic form could be recognized as well as the main road sign.
- ✓ Sub road signs expressed by letters have various patterns. Therefore, as a result of reading and evaluation by OCR, it was confirmed that recognition was possible by performing image correction. (Recognition approximately fails when one side is less than 200 px.)

●Marking

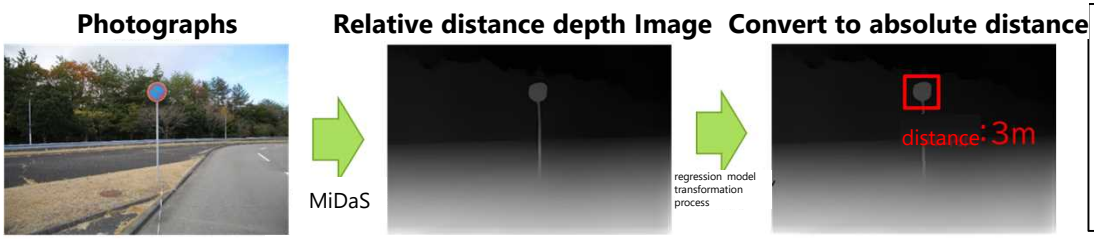
The markings were excluded from the evaluation because they can be extracted including their shapes by the extraction process.

4. Examination of Image Recognition Technology

4-2. Evaluation and verification of technology (3/3)

c:Predected Distance【MiDaS】

An evaluation of position estimation was conducted using MiDaS, a monocular depth estimation model using machine learning, and a regression equation model.



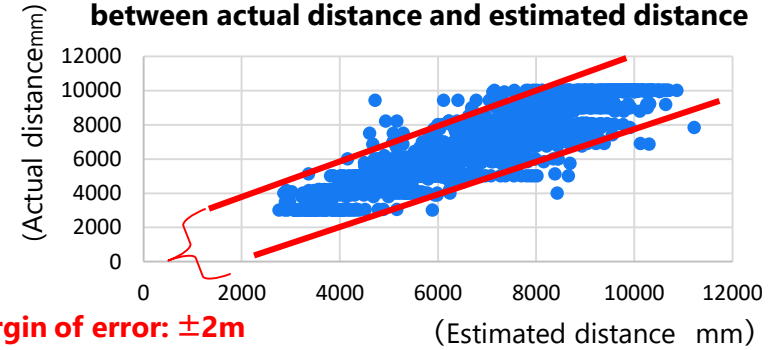
*white : short distance ~ black : long distance

Learning Data

●MiDaS:
None (using pre-learned model, no additional learning)

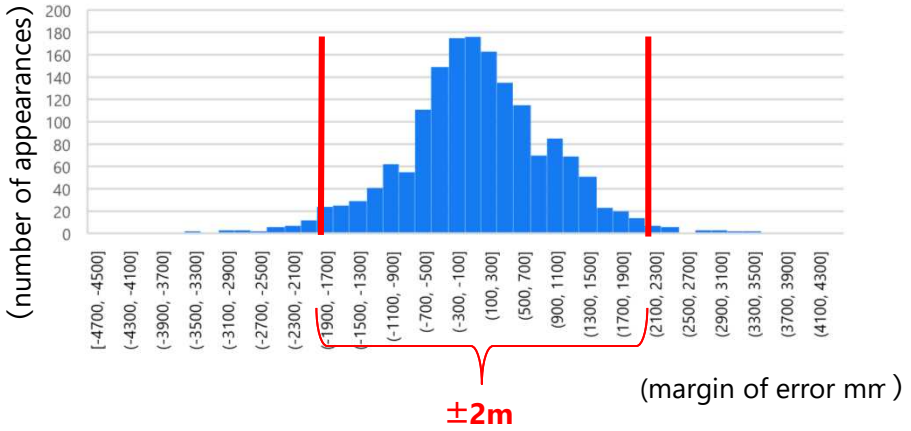
●Regressive model：
500 images including distance data (2m-10m)

Diagram of the relationship between actual distance and estimated distance



Margin of error: ±2m

Error Distribution



Error range classifications	Result of evaluation (1600 images)	
Within 2m	1539	96.2%
More than 2m – Within 4m	59	3.7%
More than 4m	2	0.1%

Number of images processed	Time (total)	Time
200	94s	**0.47s/one image**

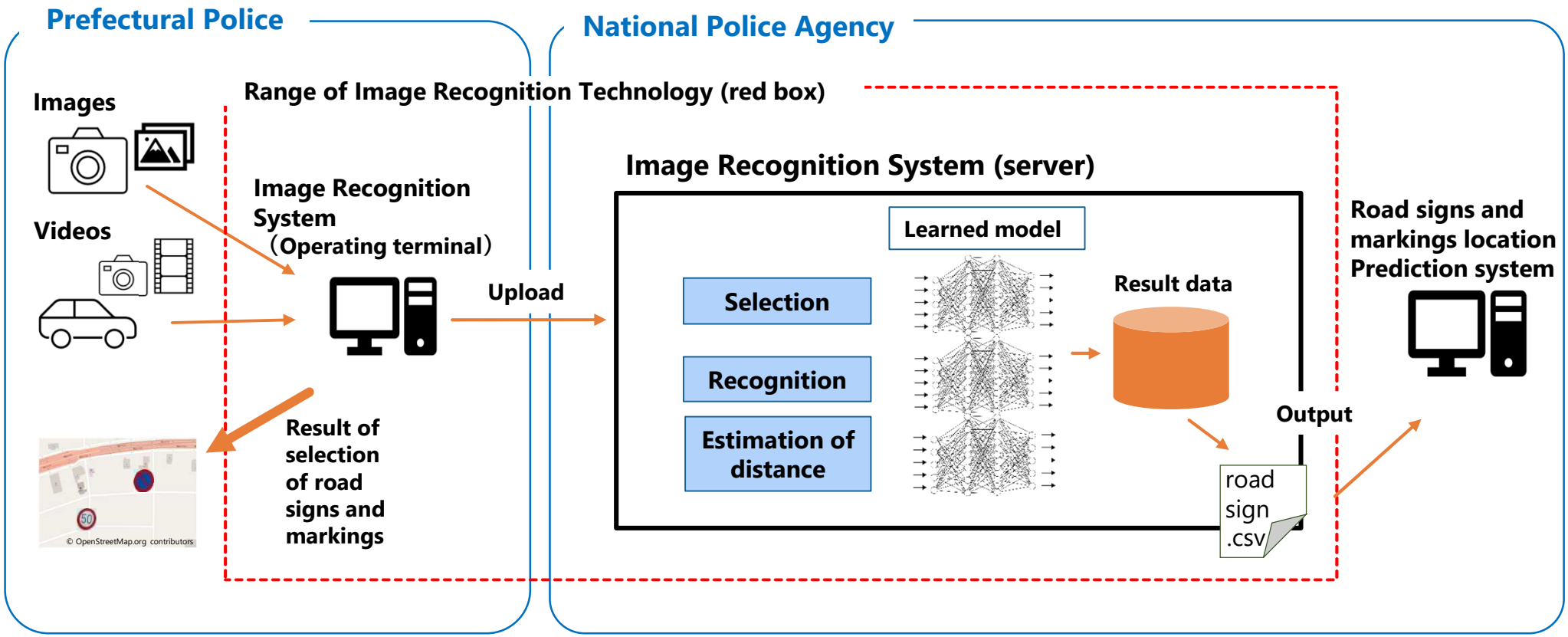
- ✓ When the distance from the shooting point to the road sign is within 10m, the distance can be estimated with an error of 2m or less (the maximum error is 4.7m).
- ✓ Distance estimation can be performed at any point in the image, so it can be applied to both main and sub road signs and markings.
- ✓ Conversion to latitude and longitude is possible by combining the shooting point, shooting direction, and estimated distance in the image.

4-3. Examination of image recognition systems

Based on the results of the technical survey, the construction of a system to collect and select a large mount of location information on road signs and markings from videos and images in a batch process was considered.

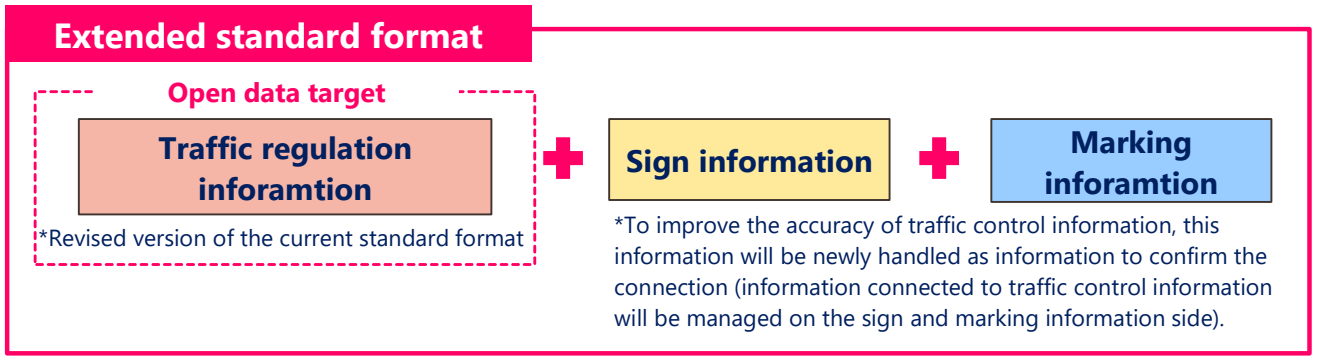
Features

- Simple and easy operation
- A batch system with server



5. Examination of Extended Standard Format

Since the current standard format has some structural problems, an "extended standard format" was considered to solve these problems. In order to improve the accuracy of traffic regulation information, it is necessary to centrally manage the information associated with the corresponding road signs and markings. Therefore, the extended standard format is structured as follows.



(1) Review of regulation types

- Based on the results of the review, which also took into account the registration status of the standard format data of prefectural police, it was considered to consolidate the current **103 regulation types to 74 types.**
- Until all prefectural police forces are able to use the extended standard format, the data will be operated in parallel with the current standard format data for the time being. Therefore, in order to avoid confusion of common regulation type code numbers (numbers that identify regulation types), it was decided that the relevant numbers for the changed regulation will be deleted and reassigned starting from 110.

(2) Review of current standard format

- Based on the opinions of users on the current standard format, measures were discussed.

Opinions of users		Counter measure
A：Provision of difference data	•Providing difference data like the old 11 types	Supports difference update (adds update flag)
B: Addition of data items	•Addition of data items required to accurately represent regulations	Addition of missing code, mandatory header line and double quotes, support for holding version information
C: Clarification of use	•Clarification of standard format to prevent various interpretations	Consolidation of similar items, scrutiny of unknown items, clarification of input definition by manual (for 2022).
D：Improving the accuracy of data	•Providing consistent data without duplication of unique keys, etc.	Unique keys are always defined as uniquely identifiable numbers.
E: Providing necessary data	•Providing information indicating the direction of regulation and one-sided / two-sided codes	Clarified the direction input method, recommended registration of one-sided / two-sided code
F: Providing all traffic regulation information	•Providing all traffic regulation information that is not currently provided	Not subject to extended format

5. Examination of Extended Standard Format

(3) Examination of items of road sign and markings

Issue

- Current standard format consists of "traffic regulation information" only
- Unclear status of connection due to the management of road signs and markings information by each prefectural police

Measure

- Confirm data consistency by linking with corresponding road sign and marking information with traffic regulation information to improve the accuracy of the formation
- Consider data formats for managing the connected information

(4) Questionnaire survey of prefectural police

- A questionnaire survey was conducted from November 26 to December 13, 2021 to prefectural police departments regarding the review of the current standard format, etc. The following issues were collected and measures were discussed.

Opinion of the provider (prefectural police)		Counter measure
A: The definition of the data item is unclear	•Specific content to be entered is unknown •It is unclear how to use each item properly. •There is no item to be entered and it is registered in the remarks column. •There are data items that are not included in the decision information.	Scrutiny of data items / Investigation of the registration status of prefectural police in the current data items for the preparation of the 2022 manual
B: Insufficient number of bytes	•Some items cannot be registered due to the limited number of characters.	Less restrictions on data items
C: Duplicate code content	•Duplicate content can be seen due to excessive code subdivision.	Scrutiny of code contents
D: Cannot be registered due to attribute mismatch	•Cannot be registered with code due to management by character information	Provide items that allow character input as needed

(5) Extended standard format (2021 ver.)

Preparation 2021ver

- Based on the results above, extended standard format was prepared.

Image of Extended standard format

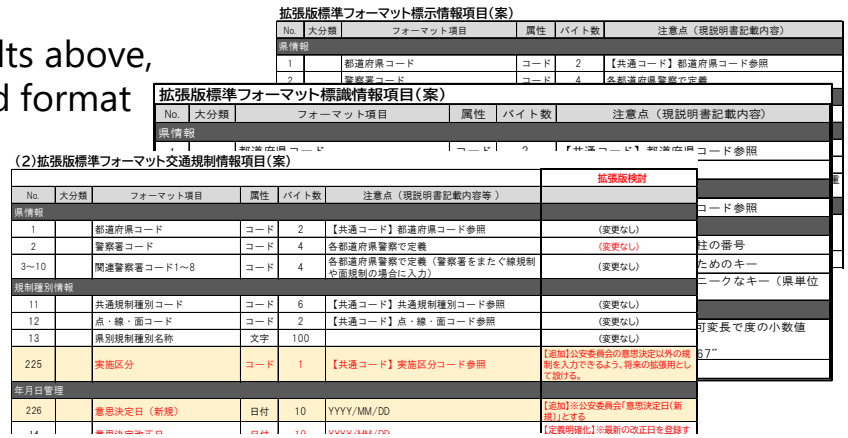
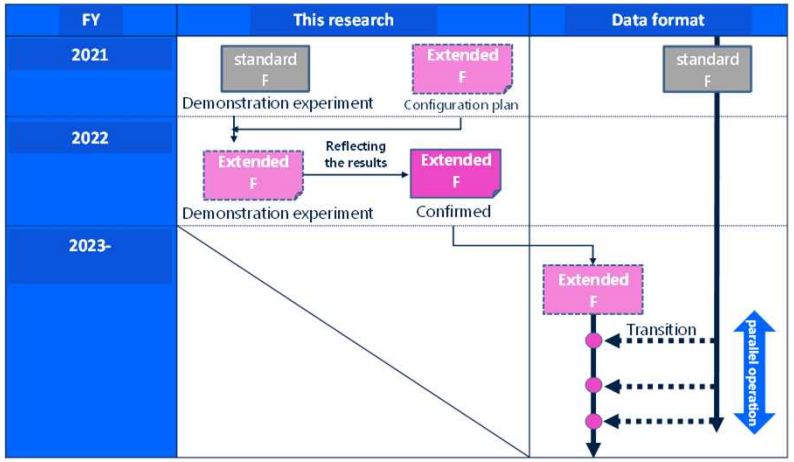


Image of operation



6. Examination Priorities for Improving Accuracy

Prioritization of ways to improving the accuracy of traffic regulation information in prefectural police were discussed.

(1) Results of research of SIP (phase1)

- The results of a survey of automobile manufacturers regarding the importance of traffic regulation information by regulation type are shown in the table below.

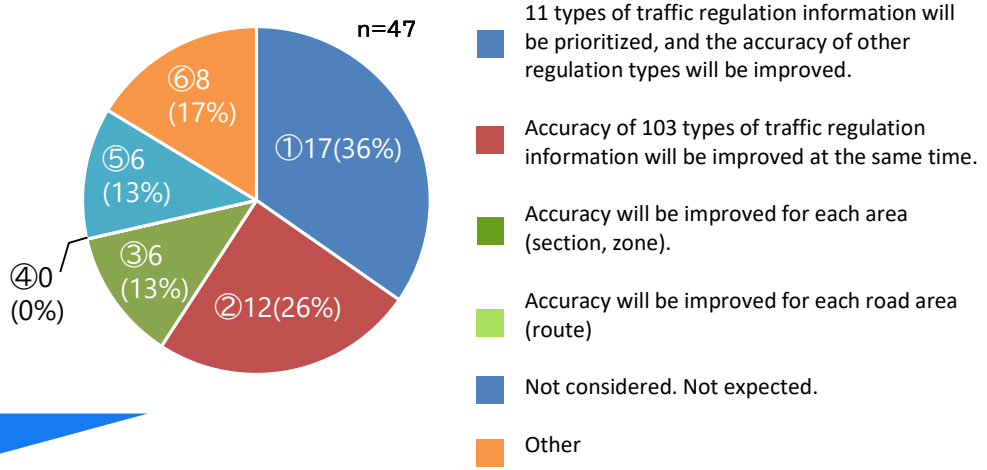
Priority ←→

High	Middle	Low
Types of information on speed and traffic regulations related to braking while driving	Type of information on parking methods and regulations related to restrictions such as no parking, etc.	Type of information related to bicycle riding and pedestrians

(2) Results of questionnaire survey of prefectural police

- Confirmed that there are different ideas of priority
- The most common response was "Prioritize the development of 11 types of regulations and continue to improve the accuracy of other types of regulations.

Q17. Priority Order for Accuracy Improvement



(3) Consideration of priorities for improving accuracy

Based on results above, priorities are considered.

High → Priority → Low

〈Priority 1：11 types of old traffic regulation inforamtion〉
Among traffic regulations related to braking while driving, 11 types of information were available until FY2020.

〈Priority 2：Type of traffic regulation information mainly for bycecle riding〉
Information types (other than 11 types) on traffic regulations and speed restrictions related to braking when driving a vehicle

〈Priority 3：Information on traffic regulations mainly related to parking for vehicles〉
Types of information on regulations related to restrictions such as parking prohibition, parking methods, etc.

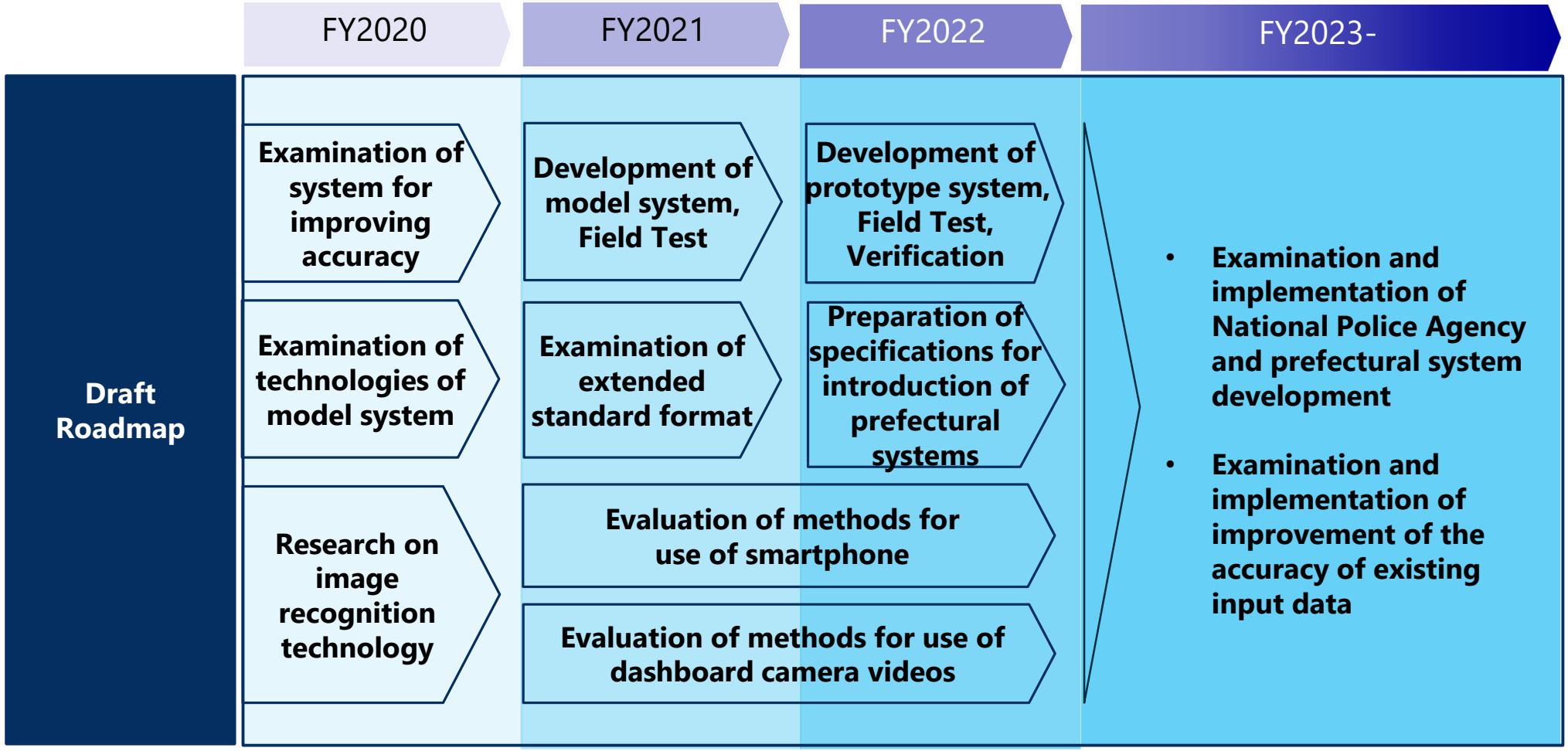
〈Priority 4：Information type of traffic regulation mainly for bicycles and pedestrians〉
Information on traffic regulations related to bicycle riding and pedestrians

6. Examination Priorities for Improving Accuracy

(4) Roadmap for improving the accuracy of traffic regulation information

A roadmap for improving the accuracy of traffic regulation information was created in consideration of (1) through (3).

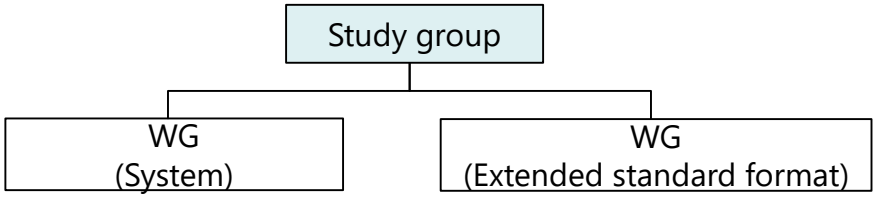
- In FY2022, build a prototype system, conduct FOTs and verification, and prepare specifications for the implementation of the systems for prefectural police.
- From FY2023 onward, the systems for National Police Agency and prefectural police systems will be studied and developed to improve the accuracy of traffic regulation information for prefectural police.



7. Study Group, WG

(1) Study group (Review Meetings)

- The "Study Group on Improvement of Data Accuracy of Traffic Regulation Information" was established and three review meetings were held.
- The members of the study group include experts, ministries and agencies related to automated driving, prefectural police, related associations, cartography companies, and private companies that handle traffic regulation information management systems.
- Two working groups (WGs) were established to build a technical review system.



No.	Date, time	Venue	Agenda
1	25/8/2021 13:00-15:00	Web	• Implementation Policy for FY2021 • Future Schedule
2	19/11/2021 14:00-16:00	Web	• Status of model system development (interim report) • Examination of image recognition technology (interim report) • Plan for FOTs (draft) • Prototype system requirement definition (draft) • Examination of extended version standard format (interim report)
3	25/2/2022 14:00-16:00	Web	• FOTs for the model system • Progress of examination of image recognition technology • Status of examination of extended version standard format • Priority to improve accuracy • Items to be examined in FY2022

(2) WG (system)

- The purpose is to study the specifications of a prototype system to be built in FY2022.
- Members are the National Police Agency, prefectural police, and private companies that have delivered traffic regulation information management systems, etc.

No.	Date, time	venue	Agenda
1	7/10/2021 10:00 -11:30	Web	• Functional requirements for the road sign location prediction system and Survey App • Requirements definition document for the 2022 Model System

(3) WG (Extended standard format)

- The objective is to resolve issues with the current standard format.
- Members are the National Police Agency, prefectural police, related associations, and cartography companies.
- Inquired opinions on the draft extended standard format and sorted out issues.

No.	Date, time	Venue	Agenda
1	14/10/2021 9:30～11:00	Web	• Identification of issues in the current standard format • Sharing of issues from the user side (cartography companies)
2	24/12/2021 13:30- 15:30	Web	• Report on the results of the prefectural police questionnaire survey (preliminary results) • Presentation of the review proposal by regulation type • Presentation of the proposed structure of the extended version standard format

8. Summary

Summary (1/2)

	Achievements in 2021	Major issues for 2022
1. model System	**Model system "Temporary linking rate / correct answer rate"** • The temporary linking rate was **44.1%** at the first time, but it improved to **91.5%** at the 5th time due to the modification of the model system. **Effectiveness** • A survey was conducted on the model area, and it took about 3 minutes at first for each case, but once you got used to the operation, you could register **in about 1 to 2 minutes**.	**Relationship between temporary linking rate and correct answer rate** • If the prediction range is wide, the temporary association rate will improve, but the correct answer rate will decrease. In addition, if the prediction range is narrow, the temporary association rate decreases, but the correct answer rate improves. • Analysis and improvement of the cause of inaccurate association, recognition and correction method of inaccurate association are issues **Prediction range** • There are differences in the forecast range not only due to the type of regulation, but also due to geographical factors and factors depending on the management method in each prefecture. Examples of geographical factors ・City center, suburbs, residential areas, mountainous areas ・Expressways, national roads, prefectural roads, city roads **Traffic regulation data without coordinate values** • There are a certain number of traffic regulations that do not have coordinate values in this year's FOTs model area. The predicted range cannot be generated without the coordinate values. **Registration of sub road signs** • When conducting a sign survey using the survey app, the main road sign can be registered, but sub road signs cannot be registered. **Repair of traffic regulation information management system of prefectural police** • The current prefectural police traffic regulation information management system does not have the function of importing and outputting the extended standard format, so PDCA for improving data accuracy does not work.

8. Summary

Summary (2/2)

	Achievements in 2021	Major issues for 2022
2. Image recognition technology	**Image recognition technology** • A machine learning method was used to create an evaluation app for extracting signs / markings from still images and videos, recognizing them, and assigning positions. The extraction rate was **95%**, the recognition rate was **92%**, and the position estimation error was **96% within 2 m**, confirming the effectiveness of the machine learning technique. It was also confirmed that moving images can be processed faster than still images. **Creation of training data** • Although the means of collecting learning data in machine learning is a problem, it was confirmed that it is effective to create learning data using **simulated road signs** printed with road sign symbols. **Sub road sign character reading** • It was confirmed that the character reading of the sub road sign can be read using OCR. It was also confirmed that there was a problem for reading.	**Improved accuracy** • It is necessary to improve the accuracy of extraction, recognition, and distance estimation. **Sub road sign character reading** • The character recognition described on the sub road sign can be read by OCR, but it is necessary to limit the image size and process the image. **Output of markings in line regulations** • It is not possible to extract markings and output data in line regulations such as the center line, vehicle traffic zone, and roadside zone.
3. Extended standard format	**Arrangement of revision proposals based on issues in the current regulation type** • The definition was unclear for some of the traffic regulation types defined by 103 types. Therefore, a review was conducted to clarify the correspondence with the regulation types indicated in the traffic regulation standards, so that different interpretations would not occur. • In addition, the regulation form of each regulation type has been arranged so as to be consistent with the traffic regulation standards. **Arrangement of revision proposals based on issues in the current standard format** • Reviewed the management method of item settings and coordinate information indicating the direction of regulation to correspond to the difference update of data, and added items that can register regulation conditions that cannot be expressed by code. As a result, countermeasures for matters that could not be handled by the current format were examined. • Arranged new road sign / marking information format proposals necessary for improving the accuracy of traffic regulation information.	**Clarification of the specifications of the extended standard format** • For the extended standard format, it is necessary to clarify the specifications so that various interpretations do not occur for each data item. **Correspondence to FOTs results (2022) and opinion inquiry results** • Add necessary improvements to the extended standard format based on the results of the FOTs conducted by expanding the area in 2022 and the results of the WG opinion inquiry. **Additional examination of annual statistical items** • Consider whether items for annual statistics should be added in order to reduce the work burden of prefectural police.

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.