INTRODUCTION OF SECTION TRAFFIC DETECTION SYSTEMS FOR ADVANCED ROAD MANAGEMENT

S. LEE
Expressway & Transportation Research Institute, Korea Expressway Corporation, Korea
SAMUELLEE@EX.CO.KR
N. KIM
Overseas Project Division, Korea Expressway Corporation, Korea
NAKJOO.KIM@EX.CO.KR

ABSTRACT

A traffic detection system can be deemed as a traffic data and information collection system to serve traffic policies, traffic management, and user services. The system plays a crucial role in verifying whether or not the current traffic system has issues or problems by checking out traffic data. In addition, the system does so in finding out a point or a section where an issue or a problem has occurred, if any, and in examining the causes of the issue or problem, the extent of its impact that has occurred and spread, and a method for resolving it.

However, the existing point detection system of Korea has too many flaws. In order to fix the flaws, in this paper, the theoretical characteristics of the section detection system were researched in relation to the calculation of travel time. In addition, the travel time of probe cars was obtained by field survey, and it was compared to that of spot and section detection data. Then, simulation was performed to determine the optimal section detection interval.
In conclusion, introduction of optimal section detection system was examined in order to achieve the advanced road management including traffic policy, traffic management, and user services.

1. BACKGROUNDS AND OBJECTIVES

A traffic detection system can be deemed as a traffic data and information collection system on roads. The system plays a crucial role in verifying whether or not the current traffic system has issues or problems by checking out traffic flow data on a road in the current state, which include a congested or uncongested traffic flow state and more specifically, the quality of a traffic flow state expressed as LOS A to F, after collecting data on traffic volume, travel speed, and occupancy rate on the road. In addition, the system does so in finding out a point or a section where an issue or a problem has occurred, if any, and in examining the causes of the issue or problem, the extent of its impact that has occurred and spread, and a method for resolving it [1].

This can be described in terms of traffic policies, traffic operation and management, user services as follows:
First, in terms of traffic policies, if a road traffic policy crucial for national growth is made, the construction of new roads, the extension of existing roads, the formation of a principal road network, and the establishment of a link system for roads with different levels should be reviewed first. In order to do so, data on current traffic flow, the level of traffic volume, traffic characteristics, and the state of traffic flow should be accurately examined, and traffic prediction should be performed as well. In this case, only with a well-established traffic detection system, valid and accurate data will be able to be collected. By performing analysis, assumption, and prediction based on the data, a road traffic policy will be able to be effectively made and worked on [1].

Secondly, in terms of traffic operation and management, efforts for reducing recurrent congestion and keeping the current traffic system sound by traffic operation and control in the ITS method without large-scale facility improvement are the most important. In this case too, the roles of a traffic detection system are crucial. Until the current traffic flow state, which means data on traffic congestion and the quality of the traffic flow state, is accurately examined, a method for improving the state and a means of comparing the future improved traffic flow state to the current one in quantity can be found. Thus, the roles of a traffic detection system that offers information and data on traffic congestion and the quality of a traffic flow state are very important [2-3].

Thirdly, in terms of user services, unless a traffic detection system is established on a road, the current traffic state will not be able to be known and no types of traffic information and data will be able to be created. Thus, user services can be provided in any form only if a traffic detection system is established. In addition, the current traffic data are collected from roads in the current state. To short-distance users, helpful information on the current driving road sections or forward traffic situation is provided. To long-distance users who drive for more than one hour, however, updated information on changes in traffic situation cannot be provided. Thus, information provided to users should be able to help the users predict future traffic situation. In order to do so, a traffic detection system with improved user services should be established [4].

In Korea, traffic detection systems have focused on traffic management since the Freeway Traffic Management System (FTMS) was adopted in 1993. The existing spot detection system enables the collection of data on traffic volume, speed, and occupancy rate. The system also has an advantage of checking changes in traffic situation on the main line of a freeway. In order to serve purposes in terms of traffic policies and user services in addition to traffic operation and management on the main line of a freeway, however, the current spot detection system needs to be improved.

In this regard, in this paper, based on the awareness of a need to find the issues or problems of the current traffic detection system and to improve the system in a positive light traffic policies, traffic operation and management, and user services for freeways, the roles and functions of a traffic detection system are conceptualized. Through them, the direction of adopting a section detection system is proposed in order to implement freeway traffic policies, traffic operation and management, and user services.

2. REVIEW OF THE ROLES AND FUNCTIONS OF TRAFFIC DETECTION SYSTEMS

2.1. Roles of detection systems [5]

The spot detection system collects traffic volume, travel speed, and occupancy rate as data. The system enables the detection of any and all vehicles and vehicles on each lane; however, it collects section slightly inaccurate data. In comparison, the section detection system collects data on the traffic volume and travel time of only vehicles equipped with an On Board Unit (OBU), and enables providing drivers with information on each section, which is more accurate than spot detection. Since the section detection system enables the detection of only vehicles equipped with an OBU, however, the system cannot examine all vehicles. It also causes time lag, which means that data on travel time become past ones; thus, it cannot offer information on future traffic. This is a limitation of the system.

Thus, the spot detection system is expected to play its given roles at small sections among the entrance/exit and main sections of freeways. The section detection system is deemed to be efficient to play its role in finding route diversion traffic volume or route travel time by detecting vehicles from freeway Interchanges (ICs) or Junctions (JCs) in terms of networks [4]. As described above, the spot and section detection systems have their strengths and weaknesses. A scheme for establishing a detection system that can complement the weaknesses of the other system while taking advantage of the strengths needs to be made. By working on the scheme, traffic data collected from the spot and section detection systems can be processed and used better in terms of traffic policies, traffic operation and management, and user services.

2.2. Functions of detection systems [5]

The functions of traffic detection systems can be exemplified as follows [4]: In terms of traffic policies, the systems can be used to monitor the main section to be managed and to make policies by predicting future demands for traffic. For instance, in light of traffic operation and management, the systems can be used to manage traffic-congested sections where recurrent congestion occurs, for instance as basic data for performing ramp metering strategies. In terms of user services, the systems can help users perform route diversion by finding route travel time and offering information.

As shown in Figure 1, data collected from the spot and section detection systems are deemed as data mainly on sections and corridors based on the spot detection system in terms of traffic operation and management. In terms of user services, the data focus on traffic networks based on the section detection system. In addition, in terms of traffic policies, the data contain traffic networks as well as sections and corridors. Thus, data collected from both of the spot and section detection systems are helpful.

Thus, in order for traffic detection systems to perform their functions properly when the functions are expanded to traffic operation and management, user services, and traffic policies, basic traffic data about traffic volume, travel speed (or travel time), and occupancy rate at sections and corridors needs to be collected in terms of traffic operation and management, which is at the lowest level. Additionally, traffic data at the level of a network for user services and the one at a wider spatial range for traffic policies need to be collected. Traffic data appropriate for each functional purpose can be created by collecting the traffic data.

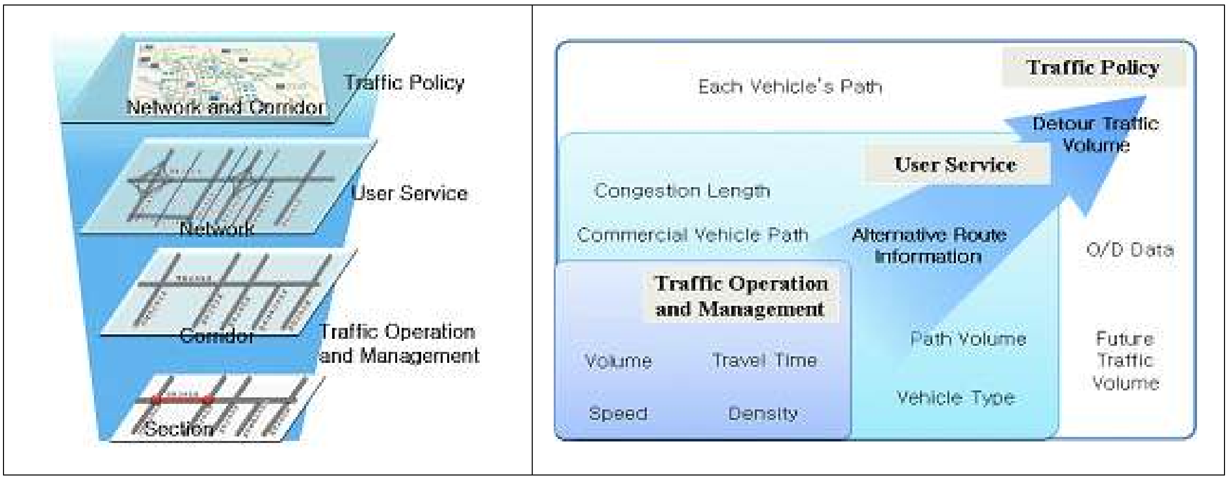

Figure 1 - Roles and functions of traffic detection systems

3. STATUS OF TRAFFIC DETECTION SYSTEMS

3.1. Installation status of spot detection systems on freeways

In Korea, the FTMS was established in 1993 as the first traffic detection system. Loop detectors are mainly installed on concrete pavement roads, and image detectors are done on asphalt pavement roads depending on road pavement types. 2,425 detectors in total are installed on freeways as of January 2009. 1,666 loop detectors (69%) are installed most. 710 image detectors (29%) and 49 magnetic detectors (2%) are installed.

3.2. Installation status of section detection systems on freeways

The electric toll collection system of Korea Expressway Corporation called Hi-pass enables the automated collection of tolls from driving vehicles without stopping at tollgates in wireless communication made between the ID card inserted into the OBU and Road Side Equipment (RSE). The freeway section detection system of Korea uses the Hi-pass system. The section detection system is being built in order to collect data on section traffic by installing the RSEs at sections other than tollgates. The wireless communication radius of an RSE installed on the roadside of a freeway is about 100m, and the RSE operates in Dedicated Short Range Communications (DSRC).

The RSEs of section detectors for vehicles equipped with Hi-pass terminals are being installed at freeway tollgates. In 2009, 11 RSEs in DSRC were built and have operated on a trial basis on the Yangjae IC-Anseong IC section of Gyeongbu Expressway in addition to tollgates. RSEs for section detection systems enable the detection of 8-lane to 10-lane roads. Since they enable the detection of two-way traffic flow from roadside, they can be installed and operated more cost-effectively on sections with many lanes.

4. THEORETICAL STRUCTURE AND CHARACTERISTICS OF TRAFFIC DETECTION SYSTEMS

This section describes the characteristics of the spot and section detection systems. The most distinct feature of the systems can be easily found from the definitions of the systems. That is, the spot detector is installed at spots. It collects only traffic data on detection range in an about 10m radius of the installation location. Thus, the spot detection system can reliably create average traffic data on the entire section if traffic flow is stable and a steady state without changes continues for a long period of time. If traffic demand fluctuates or capacity changes due to accidents or construction work as time passes by, the state of traffic flow will change depending on time zones or sections. Thus, the spot detector has limitations in examining the state of traffic flow with dynamics. In order to overcome the limitations, an interval among spot detectors is short. Since this method requires a large amount of budget realistically, people become to doubt the effectiveness of the method in comparison to the budget spent [5-6].

Section detectors are installed at the given interval just like spot detectors. Traffic data such as traffic volume, speed, and occupancy rate are not collected from the installation location of a section detector. The ID of a vehicle that passes the first section detector is recognized.

Then, the ID is recognized when the vehicle passes the next section detector. The travel time of the two detection moments is calculated by matching the ID. This is the same method as the recording of the time when the given section is passed in athletic or ice sports. Thus, section detectors have an advantage as follows: They can accurately collect data on travel time at a section between two detectors regardless of changes in traffic flow at the section. Thus, more accurate travel time or speed can be calculated than section detectors. In terms of user services, however, it is important for users to provide the users with information on traffic before driving or accurate travel time required to go from the departure location to the destination. Section detectors cause the inaccuracy of travel time since they provide drivers who are about to start with past information on forward vehicles. As the inaccuracy gets higher, the drivers who receive traffic information complain more.

The characteristics of section and spot detectors are summarized below:

- Spot Detectors: Spot detectors cannot collect accurate information on any and all sections where drivers pass. They collect and offer information on current time.
- Section Detectors: Section detectors collect accurate information on any and all sections where drivers pass. They collect and offer information on past time.

Thus, the best integrated detection system needs to be established by considering the features of the two kinds of detectors. The features are described below through an instance of Figure 2:

Assuming that Vehicle A starts from IC-1 and drives five IC sections to IC-6,
First, if section detectors are installed only at IC-1 and IC-6, the travel time of Vehicle A will be measured to be two hours as shown in Figure 2. If a section detector is installed at each IC and travel time between the ICs is measured under the same situation, the travel time taken to go from IC-1 to IC-6 will be calculated at one and half hours, which are the addition of (a) to (e), which are the travel time of each section. In this case, travel time is not the actual travel time of Vehicle A but the addition of travel time collected from each of the five sections at the same time interval.

If Vehicle F starts to drive at the time when Vehicle A arrives IC-6, Vehicle F will obtain the calculation result of section travel time from IC-1 to IC-6 as follows: two hours or one and half hours. As shown in Figure 2, however, the travel time of Vehicle F is only one hour owing to the improvement of traffic flow. Information on past travel time provided from the section detector becomes inaccurate. An important thing in this case is that travel time close to real time can be collected as the interval of the section detectors gets shorter. That is, as the installation interval of the section detectors gets closer, the characteristics of travel time collected from the detectors get closer to real time than past data. Despite, although section detectors are installed at all road sections, data on future traffic other than real-time data cannot be collected. Redundancy with spot detectors installed at an interval of about 1km and the effectiveness and cost-effectiveness of section detector installation at an interval of less than 1km are the limitations of section detectors. If spot detectors are installed at a short interval of 100m or 10m, real time and data accuracy can be ensured by spot detectors, but the issues of effectiveness and cost-effectiveness will occur.

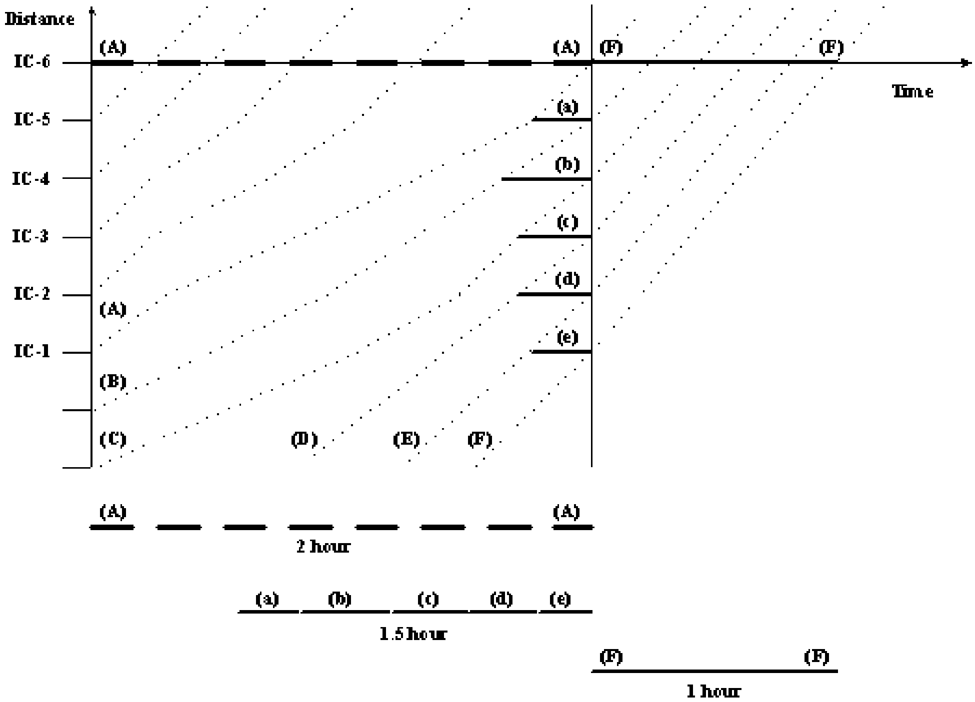

Figure 2 - Theoretical characteristics of section detection system based on travel time

The characteristics of spot and section detectors in a different light are as follows:
As the interval of section detectors gets shorter, short or instant travel time is collected just like spot detectors (approximately 10m). Thus, the data is close to real time. In this case, the collected data on vehicles is calculated by adding up or averaging data on vehicles collected under the same collection cycle at several spots rather than data on one vehicle or a platoon. It is important to calculate travel time by detecting vehicles from the five sections of IC-1 to IC-6 simultaneously or at the same collection cycle. In light of traffic flow at IC-6, data detected from vehicles at IC-1 is data on future traffic flow at IC-6. Vehicle data collected from IC-6 is data on real-time (current-time) traffic flow, which will be completed soon. A method for collecting traffic data by dividing sections into several can create data on future traffic flow.

The characteristics of section distance and changes in travel time in spot and section detection methods are summarized below:

- In the spot detection method, inaccurate traffic data on all sections may be collected because spot detectors perform detection from limited spots. Real time is ensured by collecting traffic data from more than one spot at the same time. In terms of traffic, data on the past traffic of vehicles that started earlier is integrated with data on the future traffic of vehicles that started later. Then, travel time closer to real time (current time) can be calculated. This is deemed to give a hint about changes in future traffic flow.

- In the section detection method, data on sections is highly accurate since data on all sections is collected. Due to real time and the inaccuracy of future prediction, the effectiveness of the method is poor. Thus, real time needs to be ensured by shortening the interval of section detectors.

In this paper, a section detection distance that complements the existing spot detection system and that can create accurate data and ensure cost-effectiveness is set.

5. FIELD SURVEY AND DATA CHARACTERISTICS OF EACH TRAFFIC DETECTION SYSTEM

5.1. Overview of field survey

A field survey was performed in order to research the characteristics of spot and section detection systems by comparing the error rate and travel time of the data collected from traffic detection systems to those of actual data collected by driving on roads. As the target section for comparison and analysis, a section where traffic situation changes depending on time zones, bus lanes exist, and each lane has different operation methods was selected. The target section for the field survey is Yangjae IC to Osan IC on Gyeongbu Expressway, which connects Seoul and its satellite cities. The survey was performed from 6 AM to 10 PM on October 7, 9, and 12, 2009.

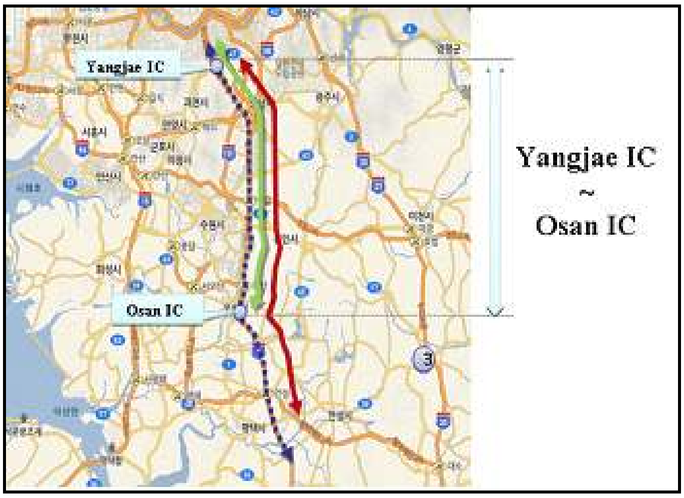

Figure 3 - Field survey site

The collected traffic data is categorized into actually measured data on travel time and data on detectors. Surveys about travel time by actual measurement are categorized into surveys about driving vehicles for examining the travel time of regular vehicles and surveys about bus boarding for examining that of buses. Data on detectors is categorized into data using spot detectors and data using section detectors.

5.2. Analysis Results

Table 1 shows data on the field survey performed at the section of Osan IC to Yangjae IC on October 7, 2009 and the average travel time of spot and section detectors. Data on the field survey and spot detection from each lane exists. The travel time of bus lane can be differentiated from that of the other lanes. Data on the travel time of all the lanes, including the bus and other lanes, exists. Data on section detection cannot be categorized into data on each lane, but only data on the travel time of all lanes exists.

The result of comparing the field survey data to the data on section detection is as follows: The latter is more accurate than the former in terms of bus lane. The section detection data on the lanes other than bus lane as well as all the lanes were more accurate than the spot detection data. The result shows the characteristics and performance of detectors about section data. In general, the accuracy of section detectors is higher than that of spot detectors. In case of traffic congestion, however, on bus lane whose traffic flow gets different highly from the one on regular lanes, the accuracy of spot detector data, which can be categorized into data on each lane, is higher than that of section detector data.

Travel time error rate and travel time at each section and all sections from Osan IC to Yangjae IC are shown in Tables 1 and 2. The tables show the comparison of the values between the spot and section detection data and the field survey data.

Table 1 - Comparison of average travel time between spot and section detection data and field survey data

Section	Travel Time (second)						
	Field Survey			Spot Detection			Section Detection
	Bus Lane	Other Lanes	All The Lanes	Bus Lane	Other Lanes	All The Lanes	All The Lanes
Osan IC → Giheung IC	347	390	385	327	397	374	371
Giheung IC → Suwon IC	189	216	214	192	214	208	218
Suwon IC → Singal JC	90	112	111	79	98	92	106
Singal JC → Pangyo IC	474	627	616	421	441	436	513
Pangyo IC → Yangjae IC	308	598	571	315	348	339	369
Osan IC → Yangjae IC	1,409	1,941	1,896	1,333	1,497	1,449	1,577

Table 2 - Comparison of error rate of average travel time between spot and section detection data and field survey data

Detection Type	Bus Lane	The Other Lanes	All The Lanes
Spot Detection	5.4%	22.9%	23.6%
Section Detection	11.9%	18.8%	16.8%

6. INSTALLATION INTERVAL SETTING OF SECTION DETECTION SYSTEM

6.1. Setting of traffic status

In order to research the characteristics of calculating the travel time of the section detection system and to set the optimal detection distance, a simulation was performed. This was a macroscopic simulation. In this simulation, travel time depending on detection distances was calculated by setting the traffic state of the analysis section.

For the simulation, the section length was set to 32km. Simulation duration was set to two and half hours. As an index for simulation effects, Mean Absolute Percent Error (MAPE) was used. An interval of section detection, which minimizes the MAPE, was found. Traffic status was set to be close to regular traffic for going to work on freeways. That is, before noon, traffic for going to work occurs and traffic congestion starts. After the peak hour for going to work, demand for traffic starts to decrease and traffic congestion does not occur. In this case, mean travel speed was set to 72km/h before traffic volume increased, to 36km/h in the event of traffic congestion, and to 108km/h in the event of free flow after traffic congestion. Traffic volume was not set, and traffic volume can be assumed to be approximately 1,500vph before the before-noon peak hour, to be 1,800vph at the peak hour, and to be 800vph after the peak hour according to the macroscopic speed-flow relationship.

As a bottleneck section where traffic congestion will occur, IC 2 which is 22km away from the starting point was set. The time interval of simulations was set to five minutes.

6.2. Analysis conditions

In order to compare collected data on travel time into the actual travel time of users who receive the data and pass, the data on travel time collected from section detectors was converted into travel speed. Then, the data was categorized into data on travel speed based on arrival and the one based on departure, and the two types of data were compared to each other. As shown in the instance of Figure 4, Vehicle A started to drive at the same as the start of the second time interval. Its actual travel speed was 72km/h. In Table 3, it is expressed as the value for the second time interval based on departure. Vehicle A' started in the middle of the second time interval and arrived at the end of the seventh time interval. In Table 3, it is expressed as the value of 70km/h for the seventh time interval based on arrival. Vehicle B or Vehicle B' started at the eighth time interval and arrived at the 14th time interval. Based on departure and arrival, it is expressed as the values for the eighth and 14th time intervals.

In this instance, one thing that should be emphasized is that vehicle data based on departure is targeted at vehicles that start at 5 minutes of time interval and that the one based on arrival is targeted at vehicles that arrive within 5 minutes of time interval. Thus, in stable traffic flow without congestion, a regular interval among vehicles is maintained, and the same number of vehicle data based on departure as the one based on arrival can be created. If vehicles pass a congested section where traffic situation changes, the travel time of the following vehicles will be longer than the forward vehicles due to traffic congestion and the following vehicles will arrive later, i.e., at a longer time interval, than the forward ones. As shown in Figure 4 and Table 3, Vehicle A and Vehicle B (or Vehicle A' and Vehicle B') showed a difference of six time intervals at departure. At arrival, however, the two vehicles showed a difference of seven time intervals. As exemplified above, when traffic congestion gets severer or slighter, the number of data on vehicles based on departure and arrival changes within the same time interval.

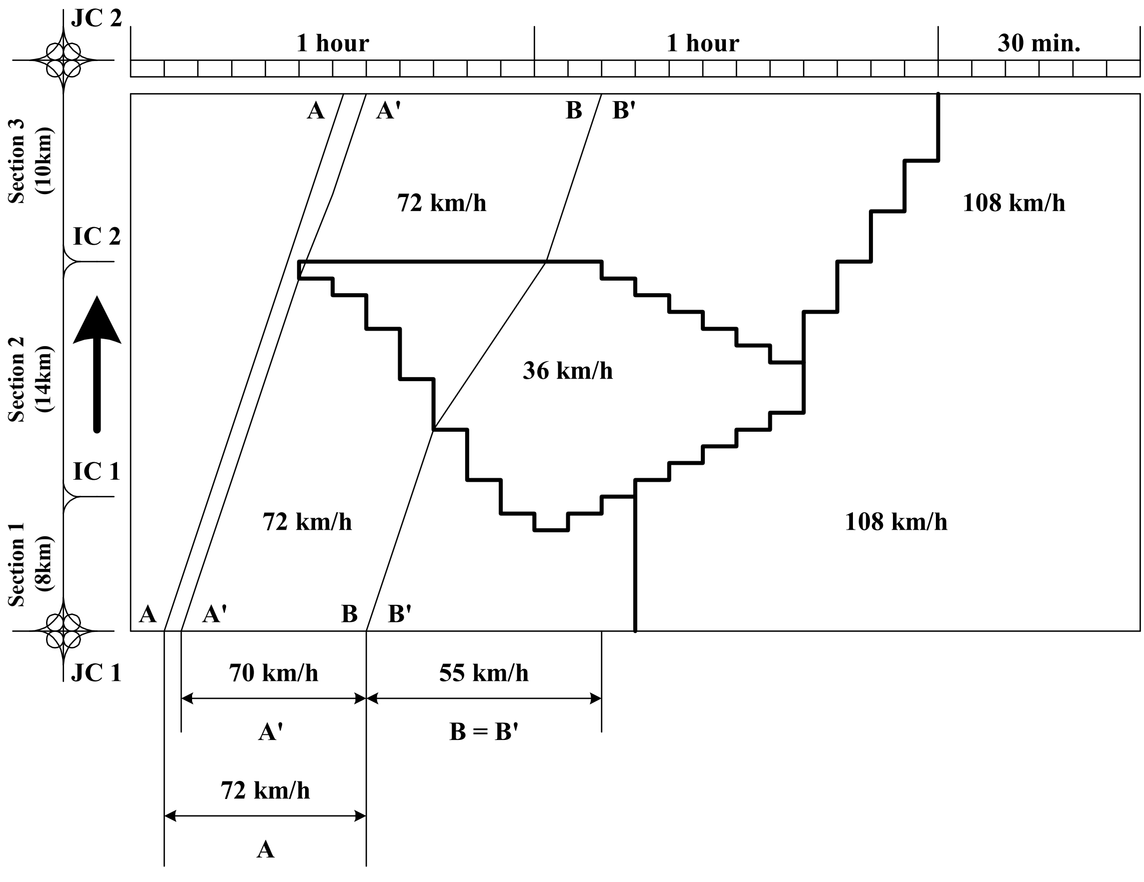

Figure 4 - Conceptual diagram on the calculation of travel speed based on departure and arrival

Table 3 - Comparison of travel speed values calculated based on departure to the values calculated based on arrival

(km/h)	Time Interval																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	·	·	·	30
Departure		72						55										
		A						B										
Arrival							70							55				
							A'							B'				

In order to determine the optimal detection distance of section detectors, a condition where the MAPE of travel speed based on departure and arrival was minimized was examined. As shown in Figure 4 and Table 3, data on the travel time of Vehicle A', which arrives at the seventh time interval, was provided to Vehicle B, which starts at the eighth time interval. Thus, a section detection distance that minimizes the travel time error of the two vehicles was determined. In this paper, as shown in Figure 4, the detection distance of a 32km-long section was set to 32km for JCs, 10km, 14km, and 8km for ICs, 8km, 5km, 4km, 3km, 2km, 1km, and 0.5km in order to calculate the optimal detection distance. Table 4 and Table 5 show the result of calculating the MAPE values of JCs and ICs. The MAPE value of ICs is shorter than that of JCs.

A formula for the calculation of a MAPE value is as follows:

$$MAPE = \frac{1}{n} \sum_{t=1}^{n} \left| \frac{S_A(t) - S_D(t)}{S_D(t)} \right| \times 100$$

where, MAPE = mean absolute percent error (%)

S_A = travel speed based on arrival

S_D = travel speed based on departure

t = time interval

n = total number of time intervals

Table 4 - MAPE calculation result (section detection distance; JC to JC)

(km/h)	Time Interval																		MAPE (%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	·	·	·	30	
Departure	72	72	70	68	64	64	59	55	55	52	51	51	54	55					14.1
Arrival	72	72	72	72	72	72	70	70	68	64	64	59	59	55					

Table 5 - MAPE calculation result (section detection distance; IC to IC)

(km/h)		Time Interval																		MAPE
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	·	·	·	30	(%)
Departure		72	72	70	68	64	64	59	55	55	52	51	51	54	55					10.3
Arrival	Section 3	72	72	72	72	72	72	72	72	72	72	72	72	72	72					
	Section 2	72	72	72	72	72	67	63	63	56	50	48	46	42	39					
	Section 1	72	72	72	72	72	72	72	72	72	72	72	64	58	64					
	Average	72	72	72	72	72	70	68	68	64	61	59	56	52	51					

6.3. Analysis results

As a result of performing the simulation of the section detection system, the MAPE was the lowest at a detector installation interval of 3km in an average. As shown in Table 6, at less than 3km of interval, the MAPE value did not change. The reason for this was that the mean travel speed of a congested section was set to 36km/h in the simulation. That is, since the simulation time interval was set to five minutes, travel speed at a congested section where a vehicle drives at 3km of speed for five minutes was 36km/h when the duration is converted to hour. In this case, although a section detection interval is set to a lower value, the calculation accuracy of travel time cannot be improved until travel speed at a congested section is lowered.

Table 6 - Simulation results of the optimal section detection distance

Section Detection Distance (Detector Installation Interval)	MAPE (%)
JC to JC (32km)	14.1
IC to IC (8km-14km-10km)	10.3
8km	8.3
5km (Last section : 2km)	7.8
4km	7.6
3km (Last section : 2km)	7.3
2km	7.3
1km	7.3

The main settings of this analysis were mean travel speed (36km/h) and time interval (five minutes) at a congested freeway section. If the two settings are changed, the result values of simulation will change as well. For instance, if a signalized intersection exists in a city, travel speed at a congested section will be 10km/h to 20km/h. In this case, criteria for a shorter installation interval of section detectors are required. If mean travel speed at a congested section is 18km/h, it will be equivalent to 1.5km/5 minutes of time interval. Thus, the optimal installation interval of section detectors will be 1.5km. If mean travel speed at the said congested section is set to 36km/h and time interval is reduced to two minutes, the optimal installation interval of section detectors will be 1.2km. The reason for this is that 36km/h of mean travel speed at the congested section is 1.2km/2 minutes and travel distance at the congested section for 2 minutes of time interval is 1.2km.

7. IMPROVEMENT OF THE TRAFFIC DETECTION SYSTEMS

7.1. Direction of improving the section and spot detection systems

A spot detection system enables the examination of traffic volume for entrance/exit to or from freeways and traffic status by performing census on traffic volume and travel speed. Thus, it can be considered as the basic traffic detection system for making traffic policies, performing traffic operation and management, and offering user services. As shown in the results of collecting and analyzing traffic data by performing field survey, however, the section detection system was more accurate than the section detection system in terms of the calculation of travel time. In addition, the section detection system enables tracing the path of a detection vehicle from a network by finding out the ID of the vehicle. This feature of the section detection system ensures making traffic policies for spacious spatial range, performing traffic operation and management, and offering user services based on more accurate information. Since traffic data from a section detection system uses the travel time of vehicles that pass a certain section, time lag occurs and past data is used. The system enables the collection of data on only vehicles equipped with the OBU; thus, it cannot examine the vehicles for census and each lane. In this regard, traffic section detection system, mainly the spot detection system, needs to be improved. In order to do so, criteria for the appropriate installation location and interval of section detection system need to be established.

7.2. Improvement and installation of the section detection system

The section detection system for improving the current traffic detection system is installed at the main section, interchanges, and junctions of freeways. As shown in Figure 5, the section detection system is installed at an interval of 3km at the main section where traffic congestion occurs under the criteria calculated in the interval calculation method based on travel time. In addition, as shown in Figure 5, four RSEs are installed at JCs and two RSEs are installed at ICs. A separate section detector is installed at roads for the entrances/exits of ICs to improve the current traffic detection system.

The section detection system has features that are not shared by the spot detection system. Examples of the features include the verification of route diversion traffic volume and the accurate calculation of section travel time. Figure 6 shows the functional characteristics of the data that can be obtained from each installation location of section detection system and of offering the data.

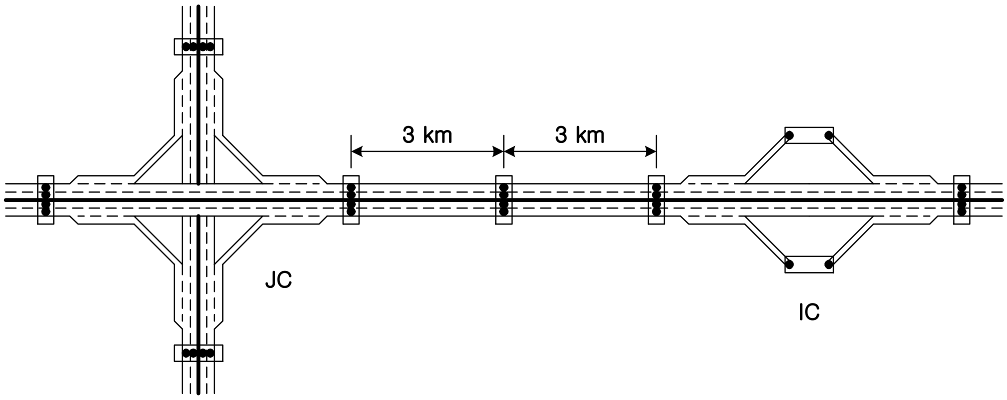

Figure 5 - Conceptual diagram of section detection system installation

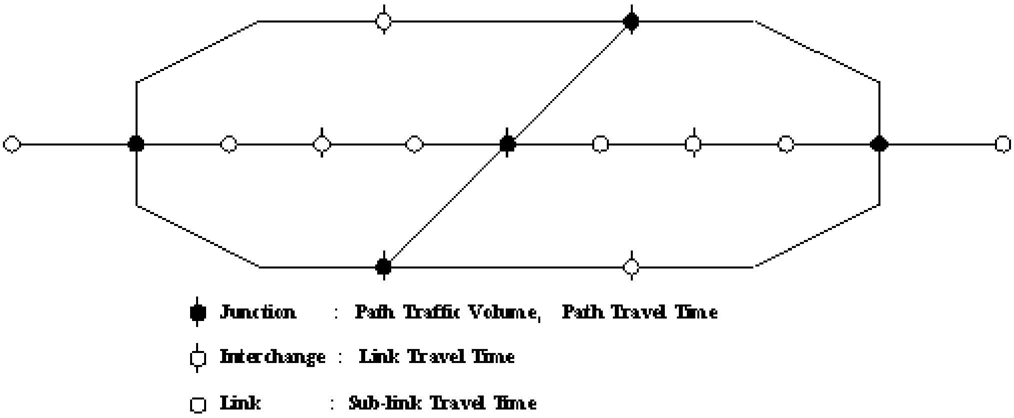

Figure 6 - Functional characteristics of section detection system depending on installation locations

8. CONCLUSIONS

In this paper, for the purpose of more advanced road management, the adoption of a section detection system for the implementation of traffic policies, traffic operation and management, and user services was reviewed. The section detection system ensures more accurate calculation of travel time than the spot detection system, and enables the calculation of route diversion traffic volume by checking the paths of vehicles and offering data on route travel time. Thus, traffic detection systems focusing on the current spot detection system can be improved by adopting a section detection system. It is expected to improve the current road management to the next level.

In order to do so, in this paper, the theoretical characteristics of the section detection system were researched. Data from the spot detection system were compared to the one from the section detection system by performing field survey. The direction of establishing a section detection system was proposed in order to improve the current traffic detection system.

In this paper, in order to calculate accurate travel time at a congested section in addition to traffic detection systems focusing on the current spot detection system, to install section detection systems at an interval of 3km, and to check route diversion traffic volume and route travel time, the installation of section detection system at the front and rear sections of JCs and ICs was proposed in order to improve the current traffic detection system.

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