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THE STUDY ON IMPROVEMENT OF INFORMATION PROCESSING TO ENHANCE THE RELIABILITY OF TRAFFIC INFORMATION IN INTERRUPTED FLOW SECTION

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ABSTRACT

With regard to the way of judging the information on road traffic accurately, a spot detector method has been changed to section interval detector method recently. And the maximum, minimum and mean value of the vehicles passing the section are used as the way to determine the road traffic using traffic information collected by section detection method. But such values include the signal waiting time that causes the error in judging the traffic. To eliminate such error, the way of obtaining the information to judge the traffic and travel time, irrespective of signal cycle, is proposed. More realistic traffic condition would possibly be represented without signal effect when judging the traffic based on 85 percentile speed.

Key Words: Traffic flow,Distribution of speed, DSRC, Traffic Information Processing Algorithm

Introduction

To collect more reliable traffic information these days, Spot Detector Method has been changed to Section Interval Detector Method because a considerable error is inevitably occurred in the process of converting Time Mean Speed collected by spot detector method to Space Mean Speed. For such reason, Section Interval Detector Method has been increasingly adopted, instead of spot detector method at road information collection stage in ITS (Intelligent Transportation Systems) In Korea, Section Interval Detector Method using DSRC (Dedicated Short Range Communications) has been used for ITS. This method is known to be more appropriate to Uninterrupted Flow without traffic signal than Interrupted Flow with traffic signal. The studies on estimating the Section Travel Time Information in interrupted flow were partly conducted which still remain insufficient. Section Travel Time Information of existing detection interval detector method requires essentially using pattern data and a long-term accumulated Historical Data in data processing such as Data Smoothing. But in fact, it's difficult to secure a long-term accumulated Historical Data after installing DSRC. Thus, historical data is accumulated during a

short test operation period (1 to 2 months) and then parameters are generated based on such data to produce the section travel time information which thus remains questionable in reliability.
In this study, Traffic Information Processing Algorithm that is able to estimate Section Travel Time Information upon installing DSRC and judge the traffic situation is proposed.
This algorithm is intended to generate the traffic information on time while considering the characteristics of interrupted flow and supplementing the shortcoming of Traffic Information Processing Algorithm of existing interrupted flow. The data generated using Hi-Pass in DSRC method is used to obtain section traffic information of interrupted flow.

Review of existing Traffic Information Processing Algorithm and implication

1) Review of existing Traffic Information Processing Algorithm

Daejeon Metropolitan City has been providing section traffic information generated using DSRC as part of Advanced Traffic Model City Project since 2004 and the accuracy of information was found to have been significantly improved thanks to constant system expansion and upgrade (source: Advanced Traffic Model City Project Evaulation report, 2005, MOLTMA)

Since the case of Daejeon, Advanced Traffic Management System project in urban area using DSRC has been continued and UTIS (Urban Traffic Information System) and ATMS have been expanded to Yongin, Siheung, Namyangju, Gunpo, Goyang and Yangju. UTIS and ATMS were carried out using OBU(On Board Unit) of prove car to obtain section traffic information, which is the section interval detector method that measures travel time required to pass the distance between specific points, unlike spot detector method. According to Oh, Ki-do et al, such section traffic information is generated over total 7 steps and each step is as Table 1. Step 2 is implemented when Spot Information Collecting System exists and Step 3 corresponding to data fusion of Section based Travel Time Information and Point based Travel Time Information is implemented in a bid to enhance the reliability of traffic information

Table 1. Generation of section traffic information

Step	Description	Note
Step 1.1	Probr operation info collection	Section detectormethod
Step 1.2	Probr data Filtering	
Step 1.3	Link traffic info generation	
Step 2.1	Detector data collection	Spot detector method
Step 2.2	Filtering and Link matching	
Step 2.3	Detector traffic info generation	
Step 3	Data Fusion	
Step 4	Data smoothing	Section traffic info generation
Step 5	Statistical info generation	
Step 6	Pattern info generation	
Step 7	Fusion weight value generation	

When implementing data fusion, weighted value is given to section travel time information and spot travel time information, respectively, (Step 7) and weighted value generated is reused after fusion with the data collected after weighted value is generated.

Chung, Min-cheol et al suggested to use mean value of individual vehicle as representative value for section traffic information using DSRC to incorporate traffic characteristics by signal waiting in urban road. That is, data such as travel speed of individual vehicle with a large deviation needs to be a single representative information to provide traffic information. Such a single information for service shall be the value representing the traffic situation. When making a single representative value from many data, mean value, mode or median value is used. When the data is in accordance with normal distribution, all of mean value, mode and median value become equal. But the data of urban road tends to be concentrated because of signal effect or so and as the deviation is large, data rarely follows the normal distribution. When the mode or median value is used as representative value, travel characteristic of each vehicle can hardly be incorporated but data distortion is highly likely. And data distortion tends to be increased when the traffic is smooth and thus the mean value is more appropriate as representative value. Thus, when setting the representative value to provide the space mean travel speed using section interval detector method, it shall be generated as Equation (1) below for the service.

$$V_{12} = \frac{\frac{\sum D}{(T_2 - T_1)}}{n} \qquad (1)$$

$V_{12} = Space\ mean\ speed\ from\ secton\ 1\ to\ 2$

$T_n = Time\ to\ pass\ Node\ RES\ by\ Probe\ Car$

$D = Distance\ between\ Node\ RSE\ 1\ and\ 2$

2) Review of issue on characteristics of interrupted flow

As suggested in the study by Bongsoo Son et al, 4 types of delay including stopped delay, approach delay, travel-time delay and time-in-queue delay are occurred in interrupted flow. In Uncongested Situation, average section travel time is used as representative value to provide the service of traffic condition which however leads to underestimate of traffic condition because of stopped delay included. When judging the traffic condition while waiting time at the intersection is included in travel time under Uncongested Traffic Condition, stopped delay is included in delay time causing extension to actual delay. But under congested condition, average section travel time incorporating all cases of delay serves the representative value which enhances the reliability. The problems occurred in Uncongested Situation are same as those pointed by in the study by Chung, Min-cheol et al in which however the solution was not proposed. When using a simple mean value, traffic condition would possibly be underestimated as pointed in the study by Bongsoo Son etal.

This study this is intended to develop the traffic information processing algorithm that will supplement such problem and have shorter calculation time than existing algorithm without the need for correcting the parameters by accumulated historical data

3) Establishment of traffic information processing algorithm

Traffic information algorithm proposed in this study has the following development principle. To process more accurate traffic information than existing algorithm in interrupted flow, traffic condition shall be judged for congested situation and uncongested situation separately and the travel time shall be calculated. Mean value shall be used to calculate average section travel time but the measure to deal with the underestimate in uncongested traffic flow shall be introduced.

Algorithm for section traffic information was developed separately for Average Section Travel Time and Average Space Mean Speed. Space travel speed is used to determine the traffic condition while traffic time is used for calculating the time required to the destination by the user. In calculating the section travel time in uncongested situation, stopped delay shall be excluded as far as possible while all delay shall be included in congested situation. This study this is intended to propose the measure to calculate the average space mean speed and section travel time separately.

Development of traffic information processing algorithm

1) Average section travel time processing algorithm

Travel time processing is implemented in 2 ways. For travel time to provide the users with the information, Equation (1) shall be applied and Node RES passage time of all vehicles excluding outlier shall be used for processing. Because section travel time including stopped delay is more important for th users than the information without stopped delay. From the general statistical viewpoint, the probability of stopping at intersection (probability to reach the intersection while red signal is on) shall be in accordance with Poisson ratio. But as the number of cases is increased indefinitely, distribution and average become equal and follows the normal distribution and thus it's more feasible to calculate the section traffic information by applying the mean value.

When judging the traffic condition using DSRC section traffic information, average space mean speed is calculated using average section travel time and from the average section travel time used for calculating the average space mean speed, outlier is removed and 85 percentile time shall be applied as Fig 1. With regard to the base for using 85 percentile, the travel speed which is commonly used (80th%~90th% of the vehicle travelling: Usually 85th%) is applied after investigating the travel speed in free traffic flow as proposed by Ji, Woo-seok et al and the method to confirm appropriate limit speed from traffic engineering viewpoint and the value applied in such a case was used. That is, when using mean value in uncongested situation, 85 percentile of travel time of all vehicles passing the section during information processing time (usually 5 minutes) is applied to exclude the delay by signal (including stopped delay) Such application is based on theory that 85 percentile travel time of the vehicles including signal delay is more reasonable than applying the mean value in case the vehicles mostly experience the signal delay time due to increased traffic.

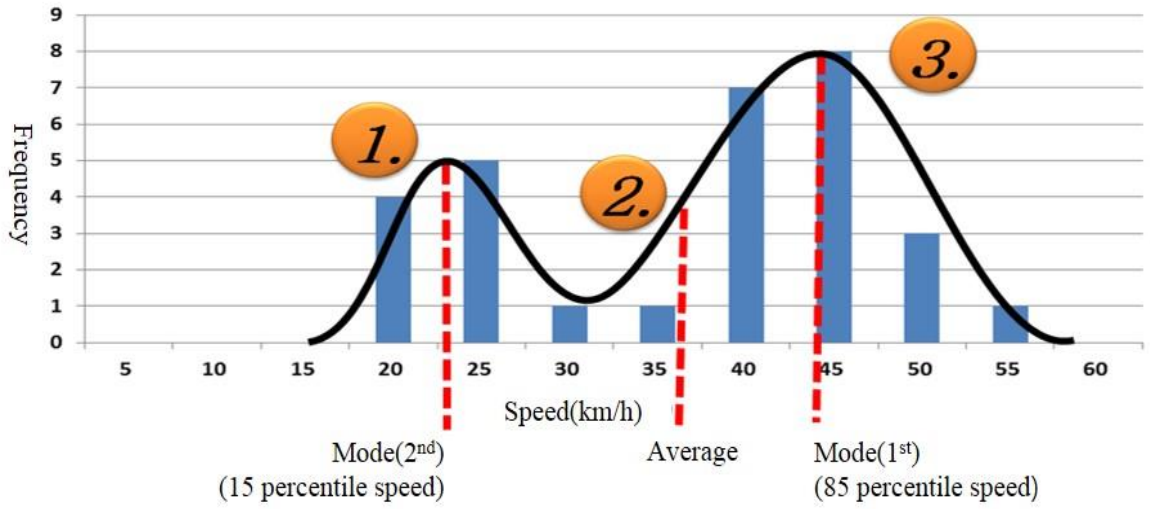

Fig1. Distribution of speed

2) Average space mean speed algorithm to determine traffic condition

Section travel time is calculated using a net Node RSE passage time after excluding delay by signal and then the average section mean speedis calculated using the interval between Node RSE to determine the traffic condition.

Judgment of traffic condition was made based on ITS project guideline and previous studies. The guideline suggested in ITS project implementation is as Table 2. According to previous studies, the base of uncongested traffic was reduced by 20km/h depending on signal operation characteristics and in the study by Chung, Min-cheol et al, 20km/h, instead of 40km/h, was suggested for the road at 60km/h or higher.

Table 2. Judgment of traffic condition

Category		speed limit	Information provision stage		
			Congest	Slow	Uncongested
Exp	Urban	80km/h≤	<30km/h	30~50km/h	>50km/h
	Exp	100km/h≤	<30km/h	30~70km/h	>70km/h
Ord	Urban	60km/h≤	<20km/h	20~40km/h	>40km/h
		60km/h >	<15km/h	15~30km/h	>30km/h
	Suburban	80km/h≤	<30km/h	30~50km/h	>50km/h
		80km/h>	<20km/h	20~40km/h	>40km/h

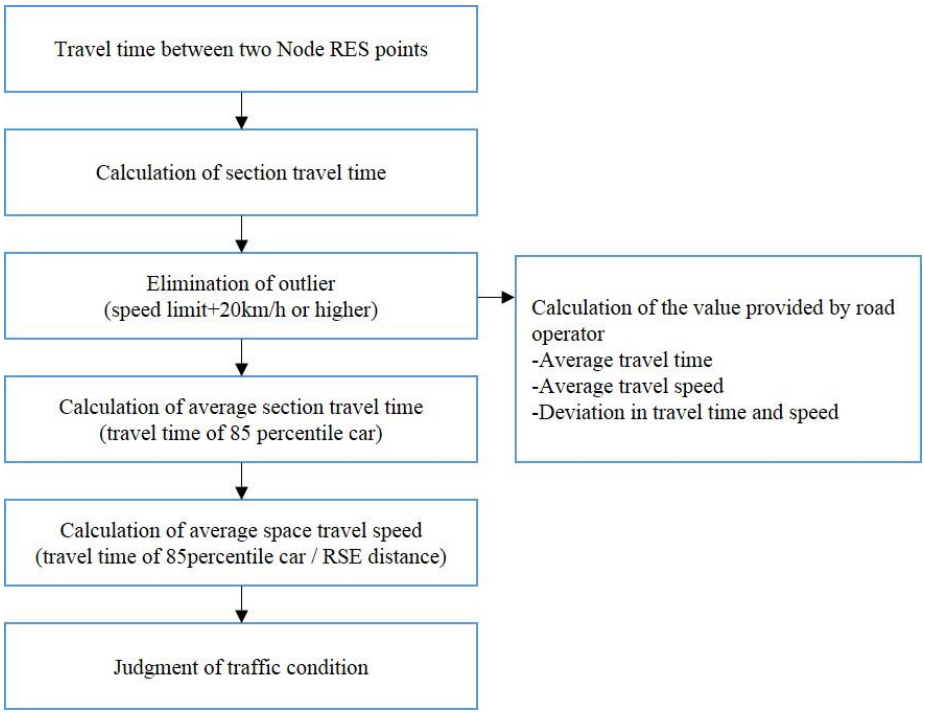

Fig 2. Traffic information processing

Such adjustment was said to be attributable to the need depending on signal operation and road condition. The effect of signal operation is accepted in uncongested situation but the vehicles subject to 85 percentile travel time are highly likely not affected by signal and the value considers such effect to some extent. This study thus used the value in ITS project guideline

Fig 2 is the diagram showing the process to calculate average space mean speed and section travel time. Calculation method proposed in this study eliminates the problem with the judgment of traffic condition in interrupted flow as well as minimizes and simplifies the process. The method proposed is expected to be applicable to any roads, irrespective of traffic flow characteristics, without the need for setting the initial value and parameter tuning process.

3) Comparison and analysis result

Comparison between traffic condition information based on data in Fig 1 and traffic condition information proposed in this study is made as Table 3. With regard to judgment of traffic condition at the section where total 30 cars have passed, it's judged as Slow based on average travel speed of 30 cars according to existing method but the average space mean speed is 43km/h by applying 85 percentile speed according to the method proposed in this study, which is categorized into smooth traffic according to Table 2. Despite of travel speed 40km/h or faster of 19 cars or 63.3% of the total cars, average speed was reduced due to signal delay by some cars. Then it's necessary to determine which information, slow or smooth traffic, is appropriate. When excluding the signal delay, average speed is 40km/h at least and smooth traffic is more appropriate. As stopped delay is not considered the uniform delay defined according to traffic engineering which is the kind of white noise and shall thus be eliminated when judging the traffic situation. Thus, the judgment based on 85 percentile speed is considered more appropriate.

Table 3. Comparison result

	15%	Mean	85%	Note
Speed	21km/h	37km/h	43km/h	Travel speed between Node RSE 1~2
Judgment	Congested	Slow	Smooth	

Conclusion and further study

As reviewed above, judgment of traffic condition using average space mean speed and average section travel time of all vehicles passed lay lead to underestimate in uncongested situation. That is, mean travel speed may be underestimated due to stoppage delay and the smooth traffic is misunderstood to slow. To minimize such error, judgment of traffic condition using 85 percentile travel time is proposed in this study, which is able to eliminate the stoppage delay in uncongested flow.

Furthermore, 85 percentile travel time value needs to be validated using actual traffic flow data and comparison with the case using a simple mean value in congested situation and the traffic by test car using GPS. When supplementing through the test car, more accurate traffic information than existing traffic information process algorithm is expected.

Acknowledgments

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