リアルタイムデータを用いた高度駐車場情報システムの動的予測モデルの研究*

Development of Dynamic Forecasting Module considering Driver's Response to Advanced PGI system using Real-time Traffic Data *

チョンヒョンチョン**，坂本邦弘***・久保田尚****

By Hyunjung Chung**, Kunihiro Sakamoto***, Kubota Hisashi****

１．Introduction

Parking Guidance and Information (PGI) Systems are amongst the most common type of ATIS currently operating in Japan as well as in Europe. PGI systems are used in two ways: first, to guide drivers in congested areas to the nearest parking facility with empty parking spaces; and second, to guide drivers, who are approaching to congested areas, to the suburbs parking lots. By assisting drivers in finding the most appropriate parking facility, the number of searching vehicles is minimized in favor of traffic safety and environment. Thus, accurate parking information is necessary for optimal use of parking facilities in a particular area. The existing PGI systems, however, provide drivers existing parking information (i.e. present information) only, which can be very different from the actual conditions which drivers may face when they approach to the destination parking facility. The difference between present parking information the one provided to drivers, and the actual traffic condition can be significant, particularly when traffic volume is high or when roads are getting congested. Because of these drawbacks of the exiting PGI systems, the research on forecasting traffic information has been hotly pursued by traffic engineers in Japan.

*Keywords：Dynamic Forecasting Module, Advanced PGI, Driver's Response, SP Experiment

**学生，埼玉大学

***正会員，工学修士，埼玉大学工学部

（さいたま市下大久保255，

TEL048-855-7833，FAX048-855-7833）

****正会員，工学博士，埼玉大学大学院理工学研究科

This Study aims to develop a dynamic forecasting module for providing Advanced PGI system using real-time traffic data and demonstrate the effectiveness of Advanced PGI through simulation analysis of tiss-NET.

Moreover, driver's response to PGI system is analyzed by using multinomial logit (MNL) model focusing on sightseeing-trip. The model is applied to predict parking choice behavior in forecasting module.

２．Stated Preference(SP) Experiment

(1) Outline of Questionnaire Survey

In June 2002, the questionnaire survey was conducted in Kawagoe city for collecting individual parking choice behaviour data (Table-1). The interview targeted drivers who use parking facilities in the center of sightseeing area. It was presented in paper and pencil surveys, transitional instrument of SP choice tasks. A total of 444 drivers had participated in the survey.

(2) Survey Context

The questionnaire consists of questions seeking socio-economic data of drivers (e.g. age, sex, number of passengers etc), information regarding parking attitudes (e.g. the reason to choice parking lot), and two hypothesized choice experiments designed by SP method.

(3) Experimental Design

The attributes and attribute levels are used to define choice tasks (Table-2). Each choice task consisted of three generic variables (i.e. travel time, waiting time, and parking fee) with 4 combination levels according to a fraction of the 2^2 full factorial design (Table-3). Thus, the respondent had to choose from 3 alternatives, which two of 16 different choice tasks designed by Fractional factorial [$L_{16}(4^{25})$].

Table-1 Outline of Questionnaire Survey

Contents	Outline
Target	The drivers who use 4 parking lots in the center of sightseeing area (sightseeing objective only)
Date	June 15(Sat), 16(Sun), 2002 10:00～16:00
Survey Contents	1) Relating to the car parks behavior • reason to choose parking lot • in-coming parks time and parking duration • direction of the origin place 2) Relating to the respondents' attributes (Socio-economic data) • age, sex, address, number of fellow passenger, whether or not including child/old people • experience of visiting Kawagoe and of extreme congestion 3) Stated Preference (SP) choice (16 kinds of hypothetical choice experiment) • two cases of hypothetical PGI per each respondent

Table-2 Attributes and Attribute levels of the different characteristics

Attributes and Attribute levels		Alternatives		
		Park & Rail-ride (PRR)	Park & Bus-ride (PBR)	Sightseeing Area (SA)
Travel Time (min) (PGI⇔Parking lot)	Level 1 Level 2	5	(PRR)+10 (PRR)+15	(PRR)+20 (PRR)+45
Waiting Time (min)	Level 1 Level 2	Spaces (0 min)	Spaces Full(5 min)	Spaces Full(10 min)
Parking Fee (yen/4h)	Level 1 Level 2	1000	(PRR) +100 (PRR) +500	(PRR) +1000 (PRR) +1500

Table-3 Generic Variables and Combination Levels

Travel Time (TT)			Waiting Time (WT)			Parking Fee (PF)		
Level	PBR	SA	Level	PBR	SA	Level	PBR	SA
0	(PRR) +10	(PRR) +20	0	S	F	0	(PRR) +100	(PRR) +1000
1	(PRR) +10	(PRR) +45	1	S	S	1	(PRR) +500	(PRR) +1000
2	(PRR) +15	(PRR) +45	2	F	S	2	(PRR) +500	(PRR) +1500
3	(PRR) +15	(PRR) +20	3	F	F	3	(PRR) +100	(PRR) +1500

3. Modeling of Parking Choice Behavior

(1) Assumption of the model

The model is used to predict the parking choice behavior of sightseeing-trip response to PGI system, which is based on a number of assumptions, including;

i) choice tasks include Park & Ride(PnR) Systems as alternatives parking facilities

ii) Parking Guidance and Information (PGI) service;

iii) all drivers observing the PGI sign believe the information to be accurate;

iv) drivers make their parking choice at the location of the PGI boards;

(2) Modeling with SP data

After removal of outliers and cases with missing values, the data file contains 752 observations. The multinomial logit (MNL) model of the SP data was generated by statistical routines in Fortran program referring the source from JSTE[1]. This model was used to predict parking choice behavior of sightseeing-trip when drivers would be given information from Advanced PGI.

(3) Estimation Results

Table-4 summarizes the results of estimation. All the coefficient estimates have the expected sign. Most of the coefficient estimates (except for constant of prr, age, and specific sex value of prr) are significantly different from zero at the usual 5% levels of significance. Overall the model has a ρ^2 of 0.3452 identifying goodness-of-fit measure.

Table-4 Estimation Results of Parking Choice Model for sightseeing-trip

Variable number	Variable name	Coefficient estimate	Standard error	t statistic
1	Park & Rail-Ride (prr) constant	1.170768	0.6625658	1.7670
2	Park & Bus-Ride (pbr) constant	1.780475	0.5513748	3.2292
3	Travel Time (tt, min)	-0.037843	0.0104713	-3.6139
4	Waiting Time (wt, min)	-0.044404	0.0222502	-1.9957
5	Parking Fee (pf, yen)	-0.00135	0.000375	-3.6043
6	Age (specific to prr)	-0.4516	0.275546	-1.6389
7	Age (specific to pbr)	-0.343	0.309426	-1.1085
8	Sex (specific to prr)	-0.218048	0.3218696	-0.6774
9	Sex (specific to pbr)	-0.891636	0.4009185	-2.2240
10	Passenger number (specific to prr)	-3.488825	0.3068595	-11.3695
11	Passenger number (specific to pbr)	-3.95336	0.3456971	-11.4359

Summary statistics

Number of observations =752

Chi-square = 682.3331 d.f. = 11

L(0) = −784.0141

L(c) = −442.8476

ρ^2 = 0.4352

$\bar{\rho}^2$ = 0.4310

Hit-ratio = 71.94149 = 541 / 752

4. Dynamic Forecasting Module

(1) Simulation Forecasting Method

Many researchers have endeavored to develop travel time forecasting models using various methods. Simulation-based traffic prediction is one of the general forecasting methods and used for evaluating traffic systems[2)-3)]. In this research, tiss-NET (i.e. microscopic simulator developed by Saitama University) was suggested and improved as a tool for forecasting as well as processing of traffic data. A schematic structure of the role of tiss-NET in the flow of traffic information was developed as a tool of processing and forecasting of information (Fig-2).

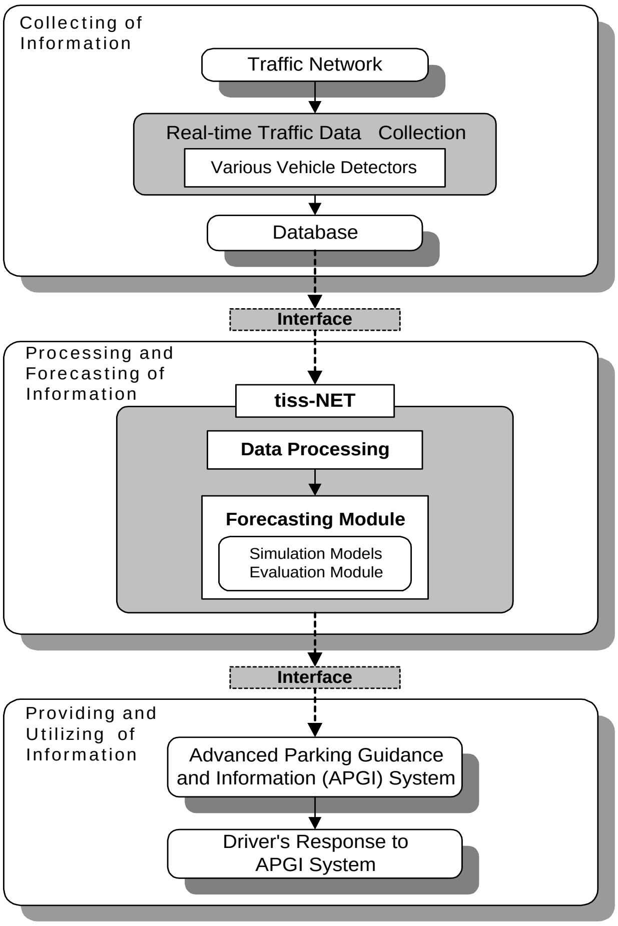
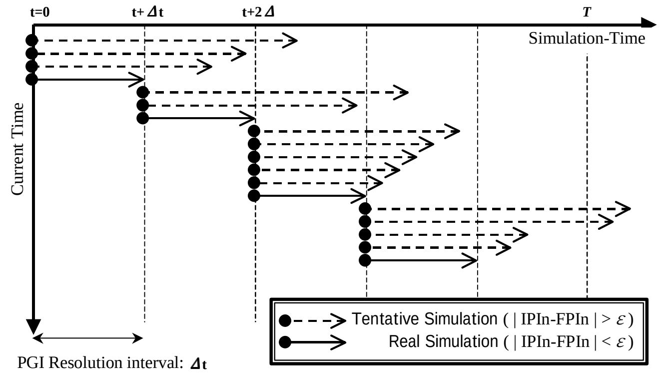


Fig-2 A Schematic structure of the role of tiss-NET in the flow of traffic information

(2) Framework of Forecasting Module

The developed forecasting module is capable of providing Advanced PGI system as well as evaluating any of traffic systems. It estimates future traffic conditions by simulating car-following movements of individual vehicles, driver's route choice, and response to information models (Fig-4).



(IPI: Initialized Parking Information, FPI: Forecasted Parking Information)

Fig-3 Rolling Horizon Simulation Framework for predicting parking guidance and information

The outcome of this dynamic forecasting module includes travel time from the position of Advanced PGI system to the each parking facilities and waiting time of each time period within the PGI resolution interval (Δt).

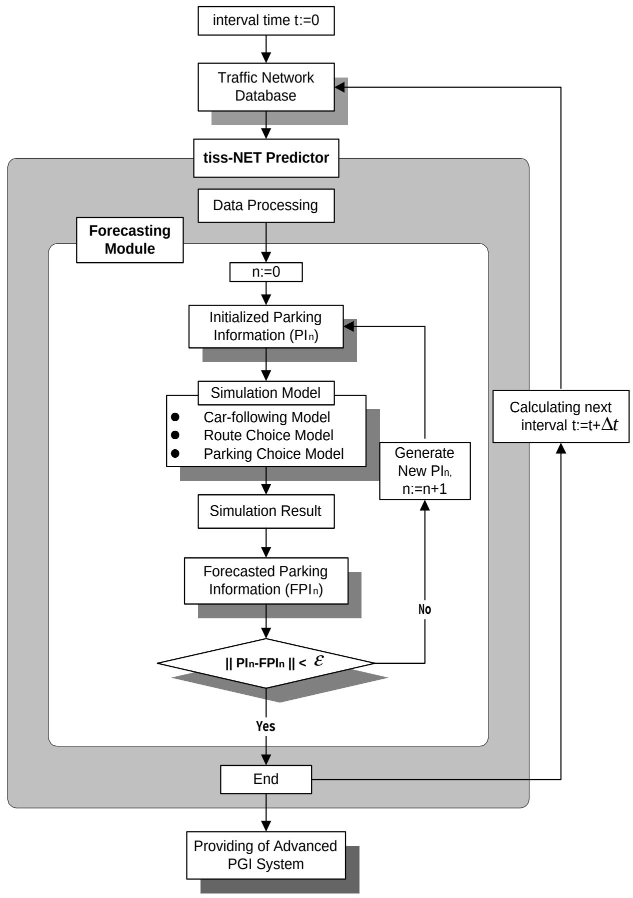


Fig-4 Structure of Dynamic Forecasting Module of tiss-NET for Advanced PGI system.

5. Conclusion and Further Study

A case study of simulation analysis with two scenarios i.e. existing PGI system and Advanced PGI system is carrying out for evaluating the effectiveness of Advanced PGI system in Kawagoe (Fig-5). A comparison of the two may reveal the effectiveness of Advanced PGI system over existing PGI system, particularly in heavy congested sightseeing area with Park & Ride system.

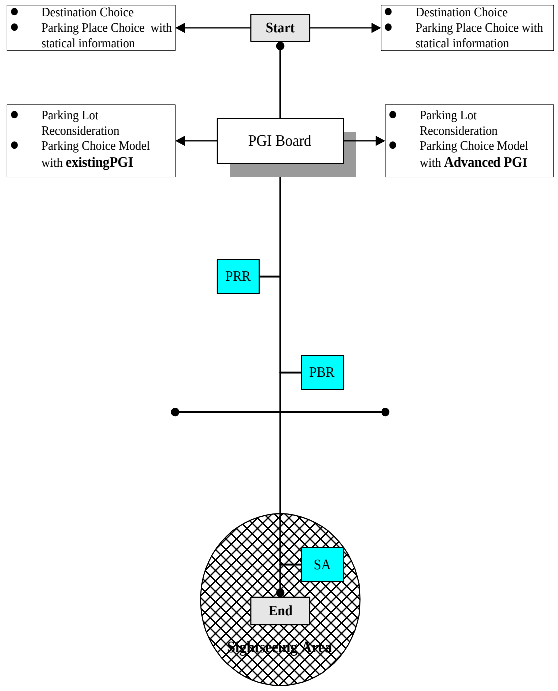


Fig-5 Hypothetical Simulation Scenarios

REFERENCES

1) JSCE(Japan Society of Traffic Engineers)：「Disaggregate Travel Demand Analysis made simple」， pp141-149，2001.
2) Q. Yang and H. N. Koutsopoulos：A microscopic traffic simulator for evaluation of dynamic traffic management systems, Transport Research C, Vol 4 (3), pp113-129, 1996
3) JSCE(Japan Society of Traffic Engineers)：「Simulation for Traffic Engineering made simple」，2000.