「Development of GIS based Vehicle Dispatch and Delivery Planning Support System」

1. Abstract

Most of the plannings for dispatching and delivering of public merchandises are still manually carried out by the expert planners of the transportation agencies in Japan. However, it is difficult to maintain the efficiency if there is a sudden change of the specified time and locations of the deliverables due to excessive demands. Realizing this, we decided to develop a GIS based Vehicle Dispatch and Delivery Planning Support System that analyzes location and road network information.

The result of this is the automation of the creation of distribution plans that had drawn on experience and intuition, opening the way to shorter working hours and cost reductions.

2. System Outline

(1) Objectives of the System

This system was developed to support the distribution plan.

Support of the distribution plan involves the preparation of the optimum distribution route map and the distribution timetable.

The optimum distribution route map can be created through an analysis of the road network data and the destination information for distribution, using the ESRI NetEngine. For the distribution timetable, lists of the course numbers, destinations, items, arrival times etc., can be drawn up by calculating the time required from the traveling speed and distance for each course, based on the distribution route map data. In addition, the accuracy of the optimum distribution route map and the distribution timetable can be improved by accumulating data on past distribution performance, and comparing the plans with past performance.

(2) System Features

This system has the following features:

- The destination information is imported from the host computer, in order to dispense with the task of manual entry.
- The total time of distribution work is forecast through network analysis, using such parameters as the working time at each destination, the location of the destinations and traveling speed.

- The working time at a destination can be forecast with higher accuracy by creating a database of the actual working time taken at each destination and the time taken to reach the destination.
- When there is a sudden change of destination, the route can be revised by entering the new destination from the map.
- When security is necessary, a route can be set by inputting optional waypoints through which the route will pass.

（3）System Functions

① Import of destination location

The destination information is extracted from the host computer and imported in the form of text data including the address. The destination information is geo-coded on the basis of its address to obtain the latitude and longitude coordinates, and the location is plotted on the map. The person in charge can confirm the location and correct it if necessary. The address system in Japan is different from the rules used in the U.S., so that the geo-coding function of ESRI could not be used. Therefore, PASCO developed its own geo-coding function (GeoCodingServer). At present, the geo-coding function allows pin-point matching using an address table listing about 30 million addresses throughout Japan.

As shown in Fig. 1, for example, destination locations (black squares) are automatically plotted on the map on the basis of the text-format list of destinations. The red flag at the centre of the screen is a distribution base.

配送先	配送先住所
パスコA	東京都目黒区東山X-X-X
パスコB	東京都渋谷区本町XX-X-X
パスコC	東京都世田谷区太子堂XX-XX-XX
	⋮
パスコZ	東京都新宿西新宿X-X-XX

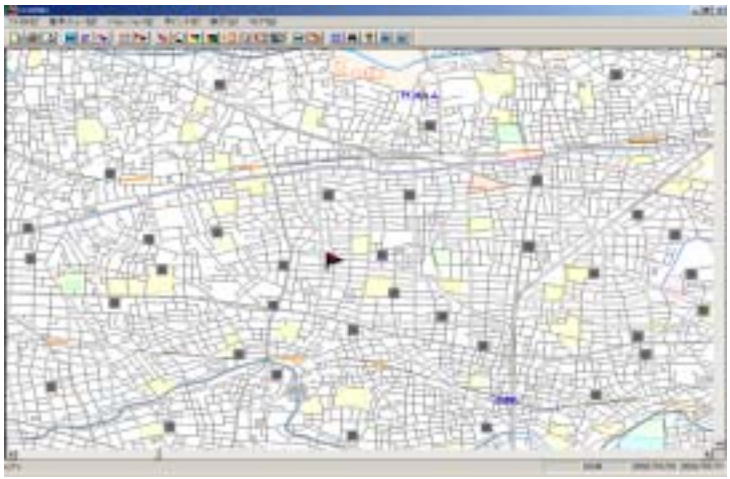

Fig. 1　Example of geo-coding of destinations

②Setting parameters to forecast working time

1）Setting traveling speed

The traveling speed for each area is set for each road type (expressway, national highway, prefectural highway, etc.) using a wizard. However, as there is a large margin of error on roads that are frequently congested, an area on the map may be specified as shown in Fig. 3 (by enclosure in a white dotted line), and a one-time-only traveling speed set within the area.

Fig. 2 Setting traveling speed for each road type

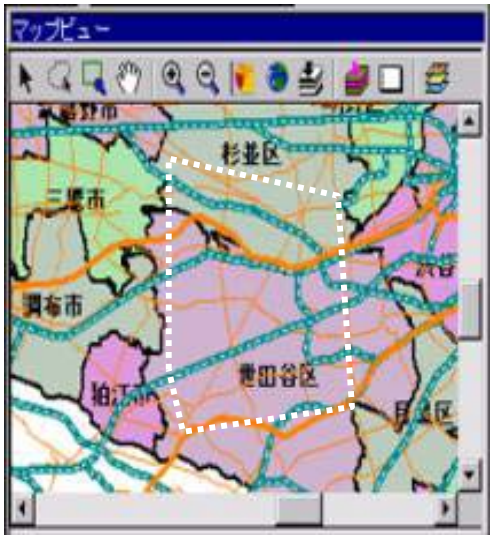

Fig. 3 Setting traveling speed for each area

2）Setting working time

The working time at each destination is set according to the type of goods to be distributed. As shown in Fig. 4, the working time from unloading to delivery at the destination can be set by the minute for each type of goods.

Fig. 4 Setting working time according to type of goods

3）Setting destinations and waypoints

New destinations or waypoints to alter the course can be plotted on the map displayed on the screen. As shown in Fig. 5, when a new destination is specified, the building icon for the destination becomes pink. (In Fig. 5, 6 destinations are specified.)

Fig. 5 Example of specifying a new destination

③Planning optimum distribution course

Since the input of parameters to obtain an optimum distribution route is done using the wizard, even personnel with little experience can easily operate the system. The parameters to be set are the departure point, distribution point, arrival point and working time at the destination.

Network analysis is done using NetEngine. The functions of NetEngine carry out a search for the shortest course and analyze the OD matrix and area, allowing multiple routes to be processed and displayed in a batch. A course change can be analyzed by entering waypoints on the map.

The popularity of car navigation systems in Japan means that road network data with a high level of accuracy are available. Because the distribution course is drawn up on the basis of this road network data, analysis with a high degree of accuracy is possible. Fig. 6 shows the results of analyzing an optimum course from one distribution base to 35 destinations using 5 vehicles.

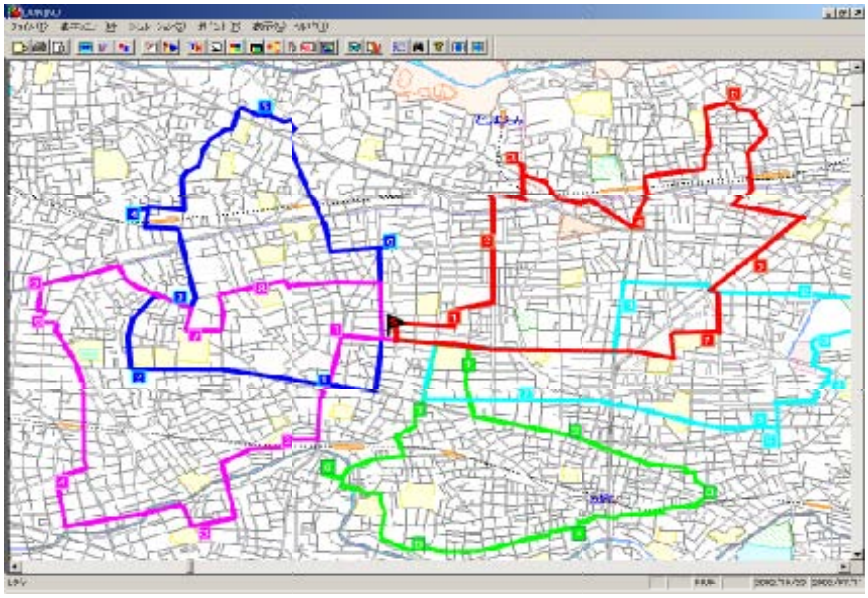

Fig. 6　Results of analyzing an optimum distribution course

④Preparation of distribution timetable

The distribution timetable, as shown in Table 1, is drawn up for each course as a list of destinations, items and times. The actual time taken is entered on the distribution timetable at each destination, in the column marked with a red circle. After distribution work is finished, the driver inputs into the system in the column circled in red the departure times and arrival times for each destination. The input data is stored in the database, and is used for the automatic calculation of working times and traveling speeds.

Table 1　Example of distribution timetable print-out

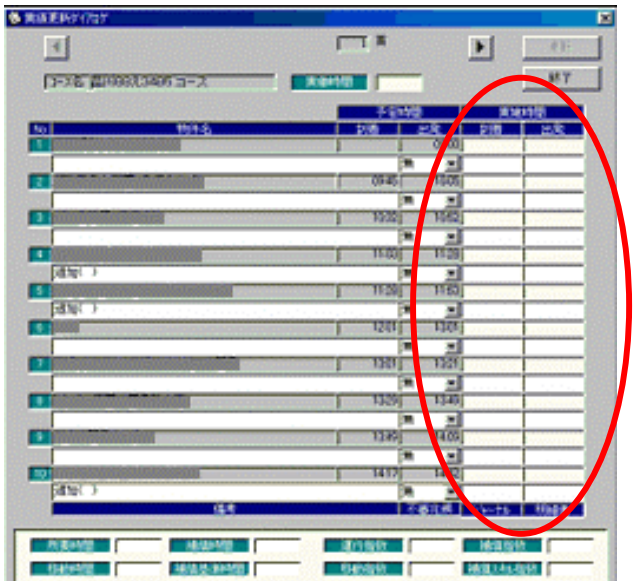

Fig. 8　Input of departure times and time taken to each destination

3．System Configuration

（1）Hardware and software

This system is designed to operate as a stand-alone system. The operating environment (recommended) is as follow:

CPU　　:Celeron 1.7GHz
Memory　:256MB
HDD　　:40GB
OS　　:Windows2000

Printer　　:Monochrome laser printer

Development environment

Visual Basic Ver. 6
MapObjects Ver. 2
NetEngine Ver. 1.2
GeoCodingServer

（2） Map database

The map database for this system contains the following data:

Background map (PascoFreshMap25000)

Coverage	:The whole of Japan
Map scale	:1/25000
Content	:Roads, railways, rivers, annotations.

Road network

Coverage	:The whole of Japan
Map scale	:1/25000
Content	:Road centerlines

Table of addresses

Coverage	:The whole of Japan
Content	:City, town, *chome*, *ku* (ward), lot number, house number

4.Effectiveness of the System

The effectiveness of this system is described below on the basis of actual results of the introduction of the system.

One copy of the system was introduced at each of 6 of the distribution bases of a private company. The distribution range for each base was about one prefecture. Hitherto, 2 experienced staff members had spent 5 hours a day drawing up the distribution plans for 10 courses. There were about 20 destinations for each course.

After the system was introduced, this time was reduced to roughly 1.5 hours, thanks to the automatic entry of destinations and batch planning of the distribution route. Any sudden changes occurring on the delivery date can be incorporated into the plan in a moment. In addition, anybody can draw up a distribution timetable simply by inputting the distribution quantity, destination information, vehicle information and road information.

5. Conclusion

PASCO has developed a system to draw up instant distribution plans, using GIS to acquire information on the location of destinations and making use of the road network. The result of this is the automation of the creation of distribution plans that had drawn on experience and intuition, opening the way to shorter working hours and cost reductions.

In the future, it will be necessary to develop a system in which a GPS receiver is installed on each distribution vehicle, in order to allow real-time monitoring of the distribution vehicle location information and of road congestion conditions via the VICS (Vehicle Information Communication System). A system to enable real-time map updating is also hoped for.

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