A BASE SYSTEM FOR MICRO TRAFFIC SIMULATION USING THE GEOGRAPHICAL INFORMATION DATABASE

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1 INTRODUCTION

In the recent years, with the rapid technical innovation of computer hardware and software, great progress has been made in the creation of geographical databases in Japan. These databases are often integrated by the Geographical Information System (GIS) for the utilization of spatial planning, such as city planning, land-use planning, etc.

In transportation planning, it is also desirable to incorporate the transportation facilities data and traffic flow data with a detailed geographical database. However, the research related to the application of geographical databases has not advanced to the degree that is desired. The main reason is considered to be difficulties of carrying out a simulation under the closed system environment of GIS software.

This paper will endeavour to build the base system, integrating the geographical database without depending on the existing GIS software, and look forward to the development of micro traffic simulation models using the detailed three-dimensional geographical databases for the further research.

2 THE SIGNIFICANCE AND PRESENT USAGE OF GEOGRAPHICAL INFORMATION DATABASE FOR MICRO TRAFFIC SIMULATION

2.1 Significance

Since the 1950s, a personal trip investigation and four-stage travel demand forecasting were created for transportation planning. Under the computer capability of that time, various kinds of personal information and geographical information were consolidated into traffic volumes of zones, and traffic simulation and forecasting were carried out on the daily traffic volume level. This kind of method needs a vast workload in investigation, aggregation, and transportation network data editing. Furthermore, since the traffic flows change constantly, obviously, the traffic simulation is far from the reality.

Although in 1970s, the disaggregate approach models of personal traffic behaviour were developed, they could not be widely applied in transportation planning because the
geographical databases were not available yet and also because the computer processing capabilities were very low then.
Over the last few years, with the faster computer operation and detailed social, economic and geographical data available, the circumstances are ready for creating a micro traffic model that simulates the movement of each vehicle.

2.2 Present Usage

Generally, geographical information includes spatial data and attributes data. The spatial data indicates information such as administrative districts, roads, buildings etc. through the shape and position of points, lines and polygons. Social and economic data, such as population, land utilization etc. is stored as attributes of spatial data.

The processing of such a database is not easy, because of the vast volume and various types of information and as well as the different formats and scales depending on the makers. GIS software integrates such information and supports the functions of processing, searching, viewing, static analysis, etc. Now, GIS is becoming a very useful tool for spatial planning.

In transportation planning, it is also desirable to incorporate the transportation facilities data and traffic flow data with a detailed geographical database. However, the research related to the application of geographical databases has not advanced to the degree that is desired. The three reasons for the delayed usage of GIS in transportation planning are following:
1. Before making traffic simulation studies, the researcher should buy both the right GIS software and the geographical data, which are very expensive.
2. Then, he or she should understand the GIS, which requires much time.
3. Also, even if somebody clears the above problems, he or she still faces the most difficult question: -- it is known that in transportation planning, it is needed to use the traffic facilities data or network data as well as the traffic flows in the traffic simulation. Since the source of data and program in GIS are not open for the user, it is difficult to add these data to the GIS. Even if you succeeded in adding these data to the GIS, the difficulty still exists to link the data to the land utilization and roadside information provided by GIS software.

Some researchers have tried to integrate GIS software and traffic demand forecasting software, so that the GIS software screen could display the traffic demand forecasting results. However, there is the limitation that it only shows the traditional traffic assignment results instead of using the geographical data provided by GIS. Although such integration on the software level might be useful for the traffic planning businesses, since only a few software developers could change the environment of the software and use the database directly, there will still exist the barrier for the further research and development of traffic models on the micro simulation level.

2.3 Aim of this Paper

In order to alleviate the investigative workload and to forecast the transport demand on a more accurate scale, it is very imperative to develop micro simulation models using the
geographical information database. This paper will endeavour to build a base system that integrates geographical database to micro simulation without depending on the existing GIS software. This paper produces the method of showing the geographical data, making road network data for traffic simulation, and aggregating the information of land use beside each road in order to promote a base system for micro traffic simulation.

3 STRUCTURE OF BASE SYSTEM USING GIS DATA

3.1 System Overview

This system was developed as an application of the Windows operating system by using Visual C++ and Open GL graphics libraries. All the methods of creating network data can be exercised just through the operation of GUI (Graphical User Interface) using a mouse. In order to simulate traffic flow on a detailed level, this study uses the 1/2500 scale digital map data of Zenrin Co., Ltd, which provides a GIS database of almost all the densely populated cities in Japan. Among the 128 layers provided by the digital map data, this study uses two of them, the street block data and the building data, which are considered to be important to traffic simulations.

To carry out traffic simulation, we first need to build the traffic network as well as its data including node number, link number, start node number and end node number of each link, link attributes like width, length, etc. Usually, this work is done by manpower and requires a great deal of time. This paper develops a tool that could create these data on system GUI.

3.2 GUI: viewing the study area

Using the digital map database, the system is firstly designed to draw the study area. In the present phase, we only use two dimensional building and street block data in our system. In the digital map database, street block data includes the apex number and apex coordinate and by using this data each street block can be connected through a line. Building data includes apex number, coordinate of each apex, which indicates the shape of building on the land. The number of building floors is also included as an example of the land use information. A total floor space, for example, which might have a deep relationship with the traffic demand, can be acquired by using its two-dimensional apex coordinates and number of stories. Each building’s data is read and drawn as a polygon with coordinates, so it is stored in the program individually and can be identified if necessary. According to the coordinates, it is also possible to search the building data within a certain street block.

Diagram 1 is a screen example of the system using the data of Oita City, Japan. By pressing the X key, Z key or arrow keys on the keyboard, the user can adjust the zoom and position of viewing scale, so he can see the study area easily through this GUI.
3.3 Creating Traffic Network Data

Usually, creating traffic network data for simulation is done by manpower and requires arduous work. This paper develops a tool that could create these data on screen interactively with mouse or dialog boxes. See Diagram 2. Users can draw the network with a mouse, and each node and link is automatically given a number. Users can also delete links or nodes at any time and all of the existing nodes or links will be re-numbered simultaneously.

Data recorded in the traffic network can be classified into node data, link data and link attribute data. Recording the coordinate value of each node (x,y) and giving an identification number is realized by using the following data structure. Besides the node coordinate values, it also includes the pointer of the next node, making the network nodes a data chain, so that you can easily delete any node from the chain.

```c
typedef struct Node{
    float x,y;  // coordinate of each point
    struct Node * next;  // next node
};
```

For links, a similar structure is used in the program as follows.

```c
typedef struct singleLink{
    int nStartPoint,nEndPoint;
    int nDirFlag;    // one way link or two way link
    float LinkWidth,LinkLength;
    int lCityBlockIndex,rCityBlockIndex; // index of street blocks at both sides
    BUILDINGINFO lInfo,rInfo; // information of buildings at both sides
    char Discription[MAX_TXTNUM]; // for storing users’ input
    struct singleLink * next;  // next link
};
```

The structure contains not only the basic photographic data of a link, such as the start point (node) and end point, but also other attributes of the link including its width, length, the index of street blocks at both sides, and information on buildings at both sides. It also makes it possible for storing users’ input and deleting any existing link at the data chain.
3.4 Creating Link Attributes

There are two kinds of link attributes; one is specified from the GIS database, and the another is added by the user.

1. Specified from the GIS database
   - Link length: Since every link has its coordinates of start node and end node, it is very easy to calculate its length.
   - Link Width: It can be calculated as the average distance between the edges of street blocks on both sides of the link.
   - Other information: Attributes can be retrieved from the individual building data in the street block on both sides.

2. By the user

Sometimes the users need to manually input the information to the link on the basis of the results of field investigation or other sources. In this system, if a user wants to add some information to a certain link, he just needs to click the link and then the dialog box will be ready to accept the inputs. See Diagram 3. The dialog box also shows the other information that relate to the link. Of course, all the data can be saved to a text file.

4 CONCLUSIONS

It is imperative to use GIS data to explore the methods of simulating constantly changing traffic flow. However, there might be limitations to the development and research on traffic simulation by using existing GIS software. This paper has shown the following: (1) that a base system can be built up by using GIS data without depending on the GIS software; (2) The process of creating Traffic Network Data, which usually needs arduous work, can now be simplified by using the system.

Since this system integrates geographical information database and traffic network data, it could be the base system on which various traffic simulations research can be carried out. It also makes it possible to display the result of simulations.

REFERENCES