EXTRACTION MAIN MAP DATA FROM KIWI FORMAT OF NAVIGATION ELECTRONIC MAP DATA

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ABSTRACT
Map display is basic function and spatial reference for vehicle navigation system. Based on object-oriented programming (OOP) and C++ computer language, the paper provides and practices an approach of parsing main map data of Kiwi format and translating them into MapInfo’s MIF format, which is open and used widely for spatial data sharing. Finally, by a case study, it extracts necessary road attributes in MapInfo’s MIF format. The paper not only improves comprehension of Kiwi but also facilitates research on software development in field of navigational digital map.

1. INTRODUCTION

Navigation, which has gotten much concern from GPS, GIS and IT fields, is one of hot topics at present. There has been a heated discussion on whether Navigation electronic map data should be standardized urgently. To meet the need, some factual standards appear. For example, Japan Kiwi-W Consortium puts forward Kiwi, which is one of popular navigation electronic map data formats (1). Given a case study, the paper provides and practices an approach of parsing main map data of Kiwi format and translating them into MapInfo’s MIF format basing on object-oriented programming (OOP) and C++ computer language.

2. PARSING MAIN MAP DATA

Parsing main map data automatically and expresses data simply, which is data processing at low level just as translating
a kind of language into another.

Nested classes of OOP simulate layer-by-layer nested structure of main map data conformably, and the nested classes’ structure of main map data is shown as following figure 1. It is of great efficiency to using nested class for better hiding class name and reducing global identifier, emphasizing on master-slave relation between nested class and peripheral class [2]. Main map data classes are similar basically including one parse () corresponding to one output () member function. There into, assigning a value for member variant, that is data translation, is implemented in parse () function. While output () function mainly outputs debug information. Each nested class that describes each relevant data table, is regarded as a kind of data type. Member variants of each nested class correspond to data items of each data table. In order to manage a series of the same structure table data items effectively, it adopts vector data type of C++ standard template library (STL) to store them.

![Figure 1: Nested classes to parse main map data](image)

### 3. EXTRACTION MAIN MAP DATA

Extraction main map data is a procedure of information screening. That is, to extract correlative coordinates or attribute fields in terms of certain application. First of all, it designs special class or structure to format extracted information contents. Secondly, according to different storage structures of different geographical element, it implements formatively parsing and extracting in-step through devising member function and calling corresponding parse () function in read class. Such as road appellation, toll standard, type code and so on, are common attributes of one multilink. But factual length, direction indicator, lane, function rank, and sort code of isolation belt etc. vary from link to link. Therefore, before extracting link attributes, common road attributes should be firstly gotten in parse () function of multilink.

Take lane extraction for example: firstly, judging lane direction occupying two bits in physical storage, which indicate four statuses including zero for unknown, one for forward, two for backward, three for including forward and backward. Then, searching lane number stored by forward and backward each occupying three bits, which denotes eight conditions as follows: zero means one lane in one way, one means two lanes in one way, two means two lanes in two ways, three means three lanes in two ways, four means three lanes in one way, five means four lanes in two ways, six means lane
number greater than four in one or two ways, seven means reserved. The following figure 2 shows lane number extraction on the condition of three and four.

![Diagram](image)

**Figure 2:** diagrammatic sketch of lane number extraction

When bit value of direction is zero, do nothing. But if it is one or two, bit value of lane number equaling to four shows three lanes in one way just as figure 2 (b) illustrating. While bit value of direction is three, bit value of lane number equaling to three expresses three lanes in two ways such as figure 2 (a) showing. Other fields can be also obtained only by corresponding processing.

4. CONVERSION MAIN MAP DATA

Transforming formatted information obtained by extraction into plain code exchange format of other application systems is called conversion main map data. It is high-quality information processing just as paginal information translation. There are mainly composed of normalized coordinate calculation and transformation, format conversion. Based on key element road network, the followings will explain conversion of main map data.

4.1 Normalized coordinate calculation and transformation

Kiwi adopts normalized coordinates system and utilizes record value of actual coordinates’ range, which maps to actual coordinates system. Normalized coordinates system effectively compressed storage space through encoding coordinates increment. For example, x-axis and y-axis of a road parcel are both divided into 4096. Its coordinates range from zero to 4095. If normalized coordinates of start node is given, adding corresponding offset in terms of parcel type represents a series of coordinates of middle shape points. So the whole multilink shape is obtained. Computing background data coordinates which is stored by three basic graphic elements such as point, line and surfaces is similar to road data.

For instance, before computing all shape points of one multilink, judging whether the parcel within start node locating is integrated which is divided into basic parcels with disaccord attribute at most eight multiplying eight, or divided parcel which consist of basic parcels with the same attribute at most eight multiplying eight, or else. The way of parcels division is similar to quad-tree. Study a case by figure 3: The upper-left gray grid indicates integrated parcel. The upper-right gray grid denotes basic parcel. Divided parcel is shown by intermediate gray grid, which is divided into minimum parcel.

![Diagram](image)

**Figure 3:** divided and integrated parcel
The relative location \((x_{lon}, y_{lat})\), which indicate line and column in integrated parcel of basic parcel that start node lies in, and its normalization coordinates \(p(x, y)\) are both known. Then normalized coordinates-\((x_1, y_1)\) of start node in integrated parcel are formulated as following:

\[
\begin{align*}
x_1 &= x + x_{lon} \times 4096 \\
y_1 &= y + y_{lat} \times 4096
\end{align*}
\]

In divided parcel or others, normalized coordinates of start node are calculated by:

\[
\begin{align*}
x_1 &= x \\
y_1 &= y
\end{align*}
\]

Main map data has hierarchical structure; therefore, it is stored from levels to block sets to blocks to parcels. If one level is divided into block sets by \(a \times b\), one block set is divided into blocks by \(c \times d\), while one block is divided into parcels by \(e \times f\), at last the level is divided into \(a \times c \times e\) lines and \(b \times d \times f\) columns. Simultaneously, if longitude and latitude difference of the whole level-\((D_{lon}, D_{lat})\) is given, the longitude and latitude difference of each parcel-\((D_{lon}, D_{lat})\) can be obtained by following formulation:

\[
\begin{align*}
D_{lon} &= D_{lon} \div (a \times c \times e) \div 4096 \\
D_{lat} &= D_{lat} \div (b \times d \times f) \div 4096
\end{align*}
\]

Given lower-left geographical coordinates of parcel-\((x_2, y_2)\) and normalized coordinates of start node-\((x_1, y_1)\), geographical coordinates of start node-\((x_3, y_3)\) is formulated as following:

\[
\begin{align*}
x_3 &= (x_1 \times D_{lon} + x_2) \times 1000 \\
y_3 &= (y_1 \times D_{lat} + y_2) \times 1000
\end{align*}
\]

Geographical coordinates of start node-\((x_3, y_3)\) can be integrated into other geographical information system (GIS).

4.2 Format conversion

MapInfo’s plain code format-MIF describes graph and attribute of spatial entity and is extensively used in data exchange and sharing of GIS. Geographical coordinates extracted from main map data can be conveniently converted into MIF format through programming.

5. A CASE STUDY

Based on OOP thought, this paper practices the approach to extract main map data, especially road network from Shenzhen kiwi data, and then converting into MapInfo’s MIF format. In this case, road network coordinates and attributes are extracted completely from main map data of kiwi. All shape points coordinates of each multilink are normalized and converted into geographical coordinates.
Simultaneously, extracting name and background data is verified successfully and matching precisely. In addition, MapInfo’s MIF data is obtained. Road network data in MapInfo’s MIF format is shown in following figure 4.

![Road network of MapInfo obtained from main map data of kiwi](image)

Figure 4: road network of MapInfo obtained from main map data of kiwi

From the above case study, we can easily see that the advantage of the method is very clear. It is feasible to transfer from kiwi to MIF format. Furthermore, relief map obtained has characteristics of good visualization and complete information. But it only implements attributes of MIF format extracted from kiwi; how to extract and manage other fields needs further research. In addition to, converting other major data formats of GIS into kiwi also needs to solve urgently.

6. CONCLUSIONS

Real time, high activity vehicle navigation system using kiwi format mainly depend on physical storage module and hardware. As one of electronic map formats, kiwi has high expansibility but no commonality. It is much concerned with hardware and application of vehicle navigation system. Kiwi format aims to compress and encapsulation volume of the data but not adopts the thought of spatial information integration. Information abstraction is not an easy case and has strict demands in algorithm and data organization. The paper not only improves data source sharing between navigation systems but also facilitates research on software development in the field of navigational digital map. At the same time, borrowing ideas from Kiwi model, it has practical meanings to develop electronic map standard with our Chinese automatic knowledge property right.

7. REFERENCES

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Research Interests
Design and Application of Geographic Information System, Route-planning algorithm, Vehicle navigation system