Research about Route Guidance by Car Navigation with an Emphasis on Safety and Ease of Driving

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1. Background

With the development of technology in IT, more and more drivers use the car navigation system for setting the trip route, at the end of December 2013, there are 59.74 million car navigations systems in Japan[1].(Figure 1)

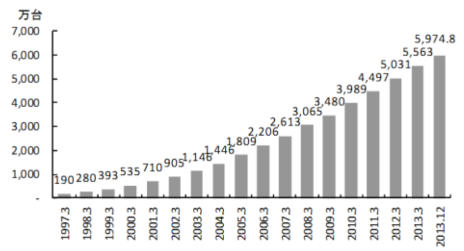

Figure 1. The data of using car navigation in Japan

Ootsuka[2] et al. analyzed in detailed 2310 samples in Japan to obtain that: With the popularity of car navigation systems, the different guidance which are provided by car navigation and road sign is still existed. It can imagine the driver will feel very confused when encounter such a situation.

Hence there is need to develop a car navigation system that is consistent with road sign system to reduce this confusion, anxiety situation.

2. Research Content

2.1 Car navigation

In order to search the shortest path, car navigation use different algorithms. The classical algorithm used in car navigation is Dijkstra algorithm. In this research we will use the Dijkstra algorithm. Dijkstra algorithm is a graph search that solves the single-source shortest path problem for a graph with non-negative edge path costs, producing a shortest path. The procedure of calculating shortest path is:

1) Network of city and the link attribute(such as length, time) as the input;
2) Driver set the original and destination;
3) The system calculate the shortest path through different algorithm;
4) The system renders the path on screen.

2.2 Road sign system database

Road signs are very useful facilities in city, the purpose of these facilities is to show some information for drivers, especially for unfamiliar drivers. Usually, it can reduce the anxiety and straying of drivers by showing the name and direction of address.

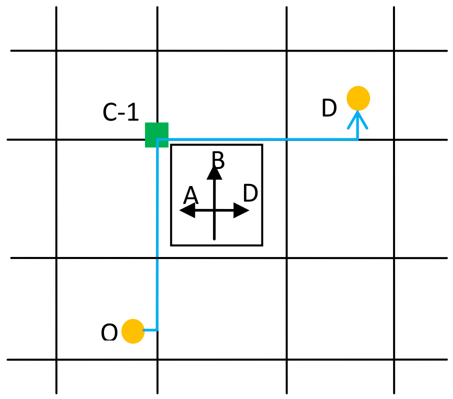

Figure 2. The network of road and road sign

To adjust the ordinary shortest path algorithm used in car navigation systems, we consider how to integrate road signs to calculate the shortest path in this research. In order to combine the car navigation and road sign, we develop a kind of road sign database, which can be identified by computer program. The database contains the content as follow:

Table 1. The structure of road sign database

<table>
<tr><td colspan="3">Sign ID</td><td>001</td></tr>
<tr><td colspan="3">Link ID</td><td>001</td></tr>
<tr><td colspan="3">From node ID</td><td>002</td></tr>
<tr><td colspan="3">To node ID</td><td>003</td></tr>
<tr><td colspan="3">Road ID</td><td>Name-a</td></tr>
<tr><td colspan="3">Crossing name</td><td>C-1</td></tr>
<tr><td colspan="3">Branch number</td><td>3</td></tr>
<tr><td rowspan="6">Branch1</td><td colspan="2">Branch ID</td><td>001-3-1</td></tr>
<tr><td rowspan="5">Name of destination</td><td>Major address</td><td></td></tr>
<tr><td>primary address</td><td></td></tr>
<tr><td>Common address</td><td>D</td></tr>
<tr><td>Famous address</td><td></td></tr>
<tr><td>Other address</td><td></td></tr>
<tr><td>…</td><td>….</td><td>….</td><td>….</td></tr>
</table>

1) Road Sign ID;
2) Link ID, the ID is according with roads database of city;
3) From Node ID;
4) To Node ID;
5) Road ID;
6) The name of crossing where the sign is installed;
7) The number of branch;
8) Detailed describes about a branch which include: Branch ID, name of address(major address, primary address, common address, famous address, other address).

2.3 Comfortable car navigation

For solving the question that guidance by car navigation systems and road signs are different, we consider how to integrate the database and car navigation.

In order to combine the two systems, we use parameters α and β and assume the value of α and β to adjust the method of calculating the link attribute, in the table 2, the value of β represents the direction of turning, the value of α represents whether the name of destination is in the road sign or not. And the formula is Formula 1 and the adjust algorithm is showed in Figure 3 and Figure 4:

$$L`` = L（1+\alpha*\beta）/（2-\alpha） \qquad (1)$$

L``: after adjusted L

L: original attribute of link

Table 2. The value of α, β and L``

Destination in road sign	Straight（β=0）	Left（β=1）	Right（β=2）
Yes（α=0）	1/2L	1/2L	1/2L
No（α=1）	1L	2L	3L

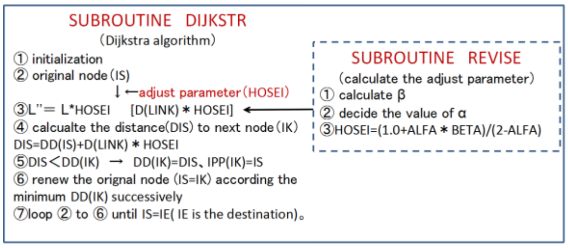

Figure 3.The algorithm of adjust Dijkstra

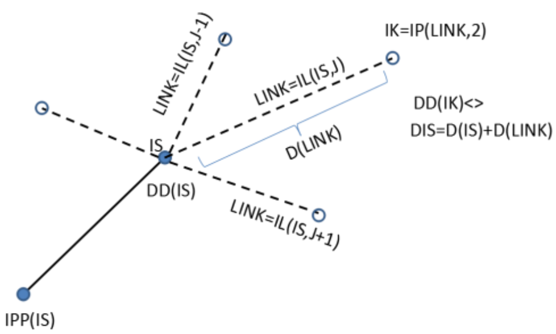

Figure 4. The explain of one node

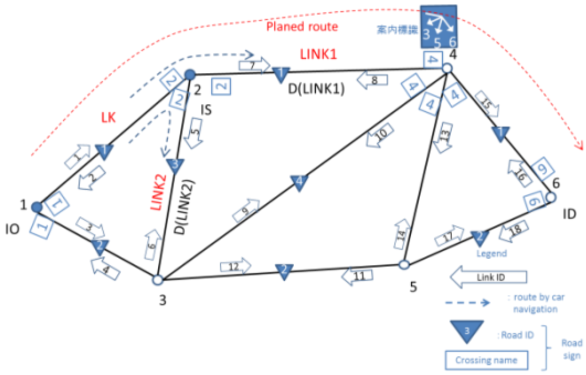

Figure 5. A example of adjust Dijkstra algorithm

For explaining the procedure，we assume one driver is on the Link1 and close to the node2.And the node2 is the original node, when the driver arrive the node2, he begins to think to select one route form link5 and link7, after calculating the distance to node4 and node3.（Figure 5）

Then the program simulate the procedure as below, firstly it begins to decide the value of β to node4 and node3 and calculate the value of α too, after getting the value of β and α, the program adjust the value of link7 and link5, then compare the values of two links, and select the link with minor value and renew the original node. And the program will do this loop until original node equates node6. After the loop, the result of route includes: node2, node4, node6.

3 Conclusion

Compared with the traditional shortest path only using Dijkstra algorithm, the improved algorithm with considering road sign database and turn will effectively solve the issue of the different guidance gave by road sign and the car navigation.

[References]

1) Ministry of Land, Infrastructure and Transport and Touism HP; data about car navigation by total Electronics and Information Technology Industries Association (JEITA) 2014.2.17
2) Suehisa MASAKE，Satoshi TOI，Kohji OOTSUA，Kajita YOSHITAK：The Investigation of Actual Condition about the Using of Road Sign and Car Navigation，24th traffic engineering research recital paper reported Collection，pp.117-120，2004