Urban Real-Time Traffic Monitoring Method

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Abstract. In urban real-time traffic monitoring, due to the difficult of delay time acquisition at intersection, complicated calculation model, lead to inaccurate traffic discriminant. Aiming at this problem, it proposed a real-time traffic discriminant method based on the simplified network model. In traffic data collection various types of intersections are abstracted as a node in this method, and the delay time at intersection are included in the pasting time of connected roads, then conduct backstepping calculated according to different types of nodes at monitoring, obtained the traffic conditions of regular road, rotary road and intersection, thus realize real-time monitoring. Finally, to verify the validity of the method through simulation of urban real-time traffic monitoring results.

Keywords: Traffic monitoring; Simplified road network model; Rotary road, Overpass

1 Introduction

Urban road traffic status information (traffic information) has been the key information of intelligent transportation systems (ITS), it is accurate, real-time acquisition and processing is the foundation of the induced traffic, traffic control and other applications. Real-time traffic monitoring service provide the received traffic information to travelers in the form of radio, SMS, roadside signage, help them to select the traffic routes so as to avoid congestion, and arrive at the destination more quickly, and for the traffic police to find the blocked section of the road and help to arrange person for traffic relief. Real-time traffic monitoring service not only requires the accuracy of data collection, but also how to represent the current situation of the urban traffic according to the collected data, including the current congestion area, traffic jam, congestion degree.

2. Simplified Road Network Model and Its Advantages

In simplified road network model, all the regular intersection, traffic light intersection, overpass and rotary road are abstracted as nodes, the one-way road
between two nodes is abstracted as a directed arc, two-way road between two nodes is abstracted as two directed arc. Each directed arc weighted at least one time spend weight $w'_{pij}$, where $w'_{pij}$ represents the actual passing time of the vehicle traveling from direction $p$ at the starting point $i$ to destination $j$ of the section, that is the sum total of the passing time from start point $i$ and passing section $<v_i, v_j>$.

Fig. 1. Adjacent intersections travel time relations in simplified road network model

Fig.1 shows the traffic connection condition of adjacent intersection A and B in urban road network, the weights of AB section are $w'_{NAB}, w'_{WAB}, w'_{SAB}$, they represent the time of vehicle at direction N,W and S at t time frame through turn left, go straight and turn right bypass intersection A, and travel to intersection B, respectively. that is the sum total of the travelling time of bypassing the current intersection from different direction and travelling on the section. The number of weights of the road section depends on the number of forerunner directly to the starting point of this section.

Simplified road network model adopts a simple data collection method, to distinguish the turning delay time at intersection traveling from different direction to the downstream section and the turning time of rotary road, which considering the actual traffic condition of the time of different upstream section to bypass the intersection, rotary road and the travel time of traveling to downstream is different. The simplified road network model implicitly considered the impact of traffic waiting time and road congestion time on road traffic conditions but difficult to be measured, so it considered the above delay time at the same time simply abstracted road network model, for ITS follow-up work, such as: the real-time road traffic monitoring, vehicle real-time path planning, etc., laid a good foundation.

3 Road Condition Discriminated Method Based on Simplified Road Network Model

In this paper, the urban road is divided into three types, the regular road, road located in the rotary road and overpass road. The rotary road refers to the one-way road in the
traffic network, used for traffic diversion, reducing congestion. And overpass refers to modern land bridge that establishes upper and lower layers at the important traffic intersection in the city, for multi-direction traveling without inter-affect, according to with or without connection ramp between intersecting roads, ramp type and the organization form of traffic flow, can be divided into separate overpass, fully interoperable overpass, partial interoperable overpass and circular intersection, etc. [14].

Due to the intensive distribution rotary road, shorter distance between nodes of road nodes of rotary road, overpass, made the intersection positioning more difficult at the data collection and acquisition delay lead the error effect more apparent, easy to be offset or misalignment. Simplified road network model made up for the defects exactly, the whole rotary road and the whole overpass are abstracted as a node, no need to collect the actual passing time of each segment of rotary road and overpass, only need to record the hour of entering and leaving the rotary road and overpass, actual transit time can be obtained through a simple back calculation algorithm. Then compared the actual time with ideal passing time, you can get the traffic information of each segment of rotary road and overpass.

According to the traffic congestion level, the traffic condition can be divided into blocked, tiny blocked, slow down and unblocked state, and set three critical value \( a_1, a_2 \) and \( a_3 \) used in road condition representation, where, \( a_1 < a_2 < a_3 \), the value can be adjusted according to different urban condition. Ideal passing time of the section is \( T_0 \), \( T_0 = \frac{L}{v_0} \), where, \( L \) is the length, \( v_0 \) is the limit speed of the section(related with the road level). Discrimination criteria: when the actual passing time \( < a_1 * T_0 \) means unblocked state, \( a_1 * T_0 < \text{actual passing time} \leq a_2 * T_0 \) means slow down, \( a_2 * T_0 < \text{actual passing time} \leq a_3 * T_0 \) means tiny blocked, actual passing time \( > a_3 * T_0 \) means blocked state. As shown in following table:

<table>
<thead>
<tr>
<th>( T ) actual passing time</th>
<th>state</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T &lt; a_1 * T_0 )</td>
<td>unblocked</td>
</tr>
<tr>
<td>( a_1 * T_0 &lt; T \leq a_2 * T_0 )</td>
<td>slow down</td>
</tr>
<tr>
<td>( a_2 * T_0 &lt; T \leq a_3 * T_0 )</td>
<td>tiny blocked</td>
</tr>
<tr>
<td>( T &gt; a_3 * T_0 )</td>
<td>blocked</td>
</tr>
</tbody>
</table>

### 4 Experimental Result

Based on the proposed simplified network model of the real-time traffic calculation method, the simulation experiment was carried out. Experiment using Mapinfo format map of a certain area in Chongqing, the development environment and tools include:
1) the Windows 7 operating system, 2) visual studio 2008, 3) Mapx plugin. Real-time traffic data using simulated data from the literature. There are total 573 road nodes and 1090 sections in experimental map road net, of which 2 rotary roads, 5 overpasses. After simplifying, the number of road section in the network structure are 969, reduced by 11%, while minimizing the amount of data collection, at the same time also reduced the network storage space.

To distinguish the traffic information through different colors on the map, the green represents unblocked; Yellow means slow; Blue stands for tiny blocked; Red stands for blocked.

5 Conclusion

This paper proposed a simplified network model oriented traffic monitoring method, the purpose of reappearance of the current traffic conditions on the electronic map can be realized only through the comparison of the travel time from different precursor into the road. And the required data can be easy collection, any on-board equipment with a GPS positioning function or the driver's personal phone can provide data source for the information center, road network simplification also greatly reduced the required data collection, this provides a new train of thought for the urban traffic information collection and processing. Through the experiment, verified the feasibility and effectiveness of the method. However due to the collected GPS data coverage is limited, this paper adopted simulated data, after the acquisition technology based on GPS terminal and simplified network model [12] matured in study group, it will further verify the method, adjust the algorithm according to the actual situation, make traffic calculation more accurate.

References