속도 정보를 기반으로 한 차량 경로 제공 시스템에 대한 연구

김태민 김진호 이종수
홍익대학교 전기정보제어공학과

Service Path Guidance System is based on speed information

Taemin Kim Jinho Kim Jongsu Lee
Hongik University electrical information & control engineering

Abstract - This paper presents the Traffic information system that based on an embedded WinCE board which has GPS and HSDPA. This system is able to overcome the limit of area using the Internet service which other systems can't provide. When the embedded board receives data about the geometric and vehicle speed information, it transmits to the server via HSDPA/the Internet. The server receives and processes it for the path services. And also we present the path guidance algorithm which is based on the speed information. These algorithm responses to the dynamical traffic condition through updating traffic information. Especially, we suggest a Traffic Status Variable in each branch which represents each road's traffic status. This Traffic Status Variable contains speed, road grade; we separate the road three groups as speed limitation; and past speed data - for example, week day rush hour of each road. In addition, the data of cross about left-turn or right-turn can update. Those elements is consisted Traffic Status Variable.

1. Introduction

Traffic information service system which is used of the present time has lots of problems and limit. The existing traffic information is gathered by manpower, which means currently system does not serve real time. This one is hard to grasps traffic density analysis and time series analysis in the downtown, and thenit has limitation that authenticity secure of suitable road capacity analyzes, as a result it can't provide traffic jam control information. These reasons make hard to apply to establish the policy of road. In this paper we suggest the system which is able to dynamically response via GPS, HSDPA, and Traffic Status Variable for traffic status.

2. System structure

2.1 GPS, HSDPA, and Embedded board (WinCE)

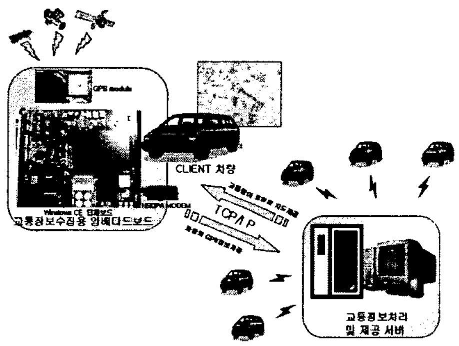
This paper uses GPS, HSDPA, and Embedded Board (WinCE) for communicating between embedded board and web server. HSDPA is five times faster than 1xEV-DO (2.54Mbps), thus we can serve the map which has specific geographical data, and even the car navigation doesn't have the map user can download a map through high speed HSDPA. This paper uses one of GPS data format NMEA 0183, specifically 'GPRMC (Global Positioning Recommended Minimum Specific GPS/TRANSIT data)'. An abbreviation shows the hint; this data provides speed and date. So, we take GPRMC data in NMEA 0183 sentences and transmit the server through HSDPA network.

2.2 Web Server

[Table1] displays traffic information system structure. It shows resource of embedded board and property of the server. The part of server uses MySQL for handling received the GPS data from embedded board and providing necessary information for end-user. [Figure1] shows the composition of the entire system.

<Table 1> Traffic information System Environment

Index	Server	Embedded board
Machine	Pentium 4	PXA255 (Intel Xscale core)
OS	Window XP	Windows CE
Protocol	TCP/IP	TCP/IP
Feature	MySQL APACHE server	TFT LCD GPS/HSDPA module



<Figure 1> System Architecture

3. Algorithm

3.1 Dijkstra Algorithm

Dijkstra's algorithm, named after its discoverer, Dutch computer scientist Edsger Dijkstra, is a greedy algorithm that solves the single-source shortest path problem for a directed graph with non negative edge weights.

```
function Dijkstra(Graph, source):
  for each vertex v in Graph:              // Initializations
        dist[v] := infinity                // Unknown distance function from s to v
        previous[v] := undefined
     dist[source] := 0                     // Distance from s to s
     Q := copy(Graph)                      // Set of all unvisited vertices
     while Q is not empty:                 // The main loop
        u := extract_min(Q)                // Remove best vertex from priority queue;
        for each neighbor v of u:          //returns source on first iteration
             alt = dist[u] + length(u, v)
             if alt < dist[v]              // Relax (u,v)
                  dist[v] := alt
                  previous[v] := u
```

<Figure 2> Dijkstra Algorithm Pseudocode

In this paper, we use this algorithm for finding the shortest route, and also adapting Traffic Status Variable.

3.2 Traffic Status Variable

This variable is based on speed data of each branch. This speed data is not just composed recent speed data, but also past speed data record. This past data record can give more guarantees the path guidance, as like Monday morning rush h our is harder than the other days. Road's speed limitation is also important in this variable. Even the speed data recorded high in the server if the speed limitation is lower than speed data, we can't get an assurance this path. Therefore we sepa rate three grades; over 90km/h, 89~60km/h, under 59km/h. T hese also represent express way, main road and branch road. So, we combine these elements

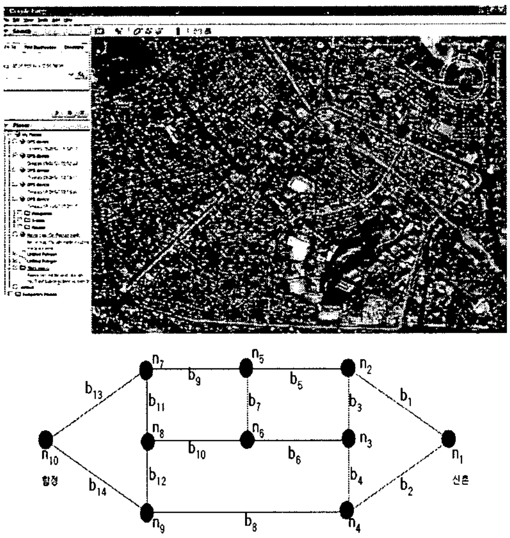
$$T_n = t_n + C_1 t_{old\_n} + C_2 R_n$$

T_n : *Traffic Status Variable*
t_n : *branch passing time* $(b_n / v_{n\,(passing\ velocity\ of\ each\ branch)})$
$t_{old\ n}$: *recorded branch passing time*
R_n : *road grade*
C_1, C_2 : *proportional factor*

4. Experiment

4.1 Sample Map

We set up a sample map from Shin-chon rotary to Hap-jeo ng rotary for test this system. At first we get the log of GPS by car. Below figure3 shows the whole sample map and simpl ification map graph.



<Figure 3> Sample Map and Graph

And we make a label each node and branch. Below tables 2 d isplays each node and branch data.

<Table 2> Branches and Traffic status variable data

	Length (m)
b_1	461
b_2	392
b_3	278
b_4	354
b_5	1083
b_6	567
b_7	354
b_8	1326
b_9	416
b_{10}	272
b_{11}	516
b_{12}	320
b_{13}	570
b_{14}	850

$$T_n = t_n + C_1 t_{old\_n} + C_2 R_n$$

	T.S.V.
T_1	8.2
T_2	6.8
T_3	7.3
T_4	9.5
T_5	130.2
T_6	11.7
T_7	10.0
T_8	79.7
T_9	7.3
T_{10}	6.5
T_{11}	10.7
T_{12}	7.6
T_{13}	10.0
T_{14}	17.3

4.2 Algorithm Simulation

Through sample graph and branches data, we get an adjacency matrix. This matrix used for Dijkstra algorithm.

<Table 3> Adjacency Matrix

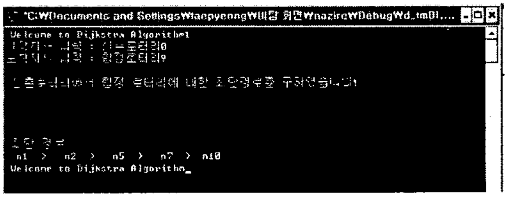
	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10
n1	0	b1	∞	b2	∞	∞	∞	∞	∞	∞
n2	b1	0	b3	∞	b5	∞	∞	∞	∞	∞
n3	∞	b3	0	b4	∞	b6	∞	∞	∞	∞
n4	b2	∞	b4	0	∞	∞	∞	∞	b8	∞
n5	∞	b5	∞	∞	0	b7	b9	∞	∞	∞
n6	∞	∞	b6	∞	b7	0	∞	b10	∞	∞
n7	∞	∞	∞	∞	b9	∞	0	b11	∞	b13
n8	∞	∞	∞	∞	∞	b10	b11	0	b12	∞
n9	∞	∞	∞	b8	∞	∞	∞	b12	0	b14
n10	∞	∞	∞	∞	∞	∞	b13	∞	b14	0

(a)

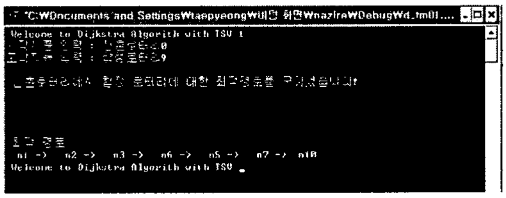
	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10
n1	0	T1	∞	T2	∞	∞	∞	∞	∞	∞
n2	T1	0	T3	∞	T5	∞	∞	∞	∞	∞
n3	∞	T3	0	T4	∞	T6	∞	∞	∞	∞
n4	T2	∞	T4	0	∞	∞	∞	∞	T8	∞
n5	∞	T5	∞	∞	0	T7	T9	∞	∞	∞
n6	∞	∞	T6	∞	T7	0	∞	T10	∞	∞
n7	∞	∞	∞	∞	T9	∞	0	T11	∞	T13
n8	∞	∞	∞	∞	∞	T10	T11	0	T12	∞
n9	∞	∞	∞	T8	∞	∞	∞	T12	0	T14
n10	∞	∞	∞	∞	∞	∞	T13	∞	T14	0

(b)

In this case, b_5, b_8 has traffic jam. That reason Traffic Status Variable value is much changed. Below Figure shows the route guidance when before using Traffic Status Variable and after adapting Traffic Status Variable.



<Figure 4> Simulation Result by Adjacency Matrix (a)



<Figure 5> Simulation Result by Adjacency Matrix (b)

5. Conclusion

In this paper, we shows the system that response dynamically traffic status. Embedded Board, GPS and HSDPA are consisting of remote path guidance system. Web server record speed data and calculate each road's Traffic Status Variable. Therefore, we verify this system and algorithm are able to dynamically react.

[Reference]

[1] Yonghu-Jang, "Develop dynamic road flow information is based on GPS", 2006. 5

[2] Jaebeom-Bae, "Using GPS and CDMA communication, Traffic information record system for ATIS", 2004. 2

[3] Taemin Kim, "Traffic Information and Path Guidance System is based on Windows CE Board using GPS and HSDPA", , 2007. 4

This work was supported by 2007 Hongik UNiversity Research Fund