ARCHITECTURE OF PERSONAL MOBILE NAVIGATION SYSTEM

Jae-Chul Kim, Ju-Wan Kim, and Jong-Hyun,Park

LBS & Telematics Fusion Research Team, Telematics Reasearch Division, ETRI
{kimjc, juwan, jhp}@etri.re.kr

ABSTRACT: The technique of the information communication are advanced recently and a performance enhance of a hand carried computing device was developed rapidly. Mobile Communication Carrier developed currently the phone navigation and are carrying out the service. But such service localizes at the vehicle movement. In This paper, we explain a system structure for the pedestrian navigation of the Wireless Internet Platform for Interoperability(WIPI) mobile phone which contains the MS-Based Global Positioning System(GPS) internally. And we verified the result to be developed by this method that proposes.

KEY WORDS: Navigation, GPS, LBS, Mobile sevice

1. INTRODUCTION

Recently, the performance improvement of the mobile computing device was rapidly developed with the technique development of information and communication. Presently, the mobile telecom company (SKT, KTF) develops the cellular phone base navigation system and which implements a service but in which this service confines to a vehicle and which is developed and are comprised of the form which is suitable for the car navigation. Moreover, the personal navigation is not comprised in the road in which a vehicle goes but it is comprised of the sidewalk in which a building stands close together. Therefore, the navigation system which the existing GPS uses causes the performance degradation due to the error of a direction and location. A result by the method proposed in this paper showed. Then, as it was the region where a building stands close together, the GPS error gradually increased and a difficulty was in a direction and the location information acquirement required for the personal navigation.

However, in this paper, we propose the new personal navigation method additionally using the kalman filter and directional correction method with GPS and electric compass as the method for overcoming the limit of error of GPS in a system to be proposed.

2. TITLE AND ABSTRACT BLOCK

2.1 Network Data

A road network data is constructed for the car navigation. And a redefine only need for the Data construction which is suitable for a walk. As shown in table 1, it is necessary to have the additional data type. And it is not necessary to have the information and rotation information to an intersection required in the road network.

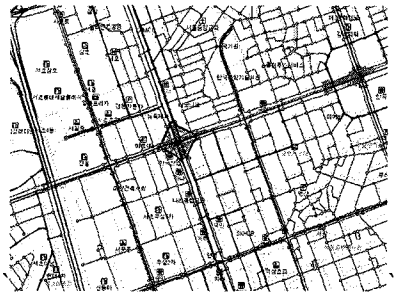
Table 1. Personal navigation network data attribute

Classification	LAYER	SHAPE
Bridge	*P_BDG*	*POLYGON*
Overpass	*P_OBG*	
Tunnel	*P_TNL*	
Crosswalk	*P_PCL*	
Crosswalk safty zone	*P_PCA*	
Subway walk enterance	*P_UGP*	*POINT*
Subway enterance	*P_SWP*	
Sidewalk node	*P_NODE*	
Sidewalk link	*P_LINK*	*POLYLINE*

The figure 1 indicates data of the personal navigation road network and car navigation road network. It compares to have the two-way link in which the car navigation road network has the direction and the personal navigation road network has sidewalk information without the direction. Moreover, in case of the personal navigation, the information of the bridge, the overpass, a tunnel, a crosswalk, a subway, a sidewalk, and etc is additionally needed and a granularity increases.

(a) car navigation road (b) personal navigation road

network nerwork



(c) overlay network

Figure 1. Network data compare

3. SYSTEM ARCHITECTURE

3.1 Gateway server

The gateway server produced the thread-pool (thread pool) based on the multi-thread server consisting of the parallel model processed the business logic. This can guarantee the constant response time while maintaining the load of the system of a server even if the traffic is increased to the minimum thread. According to the request type of WIPI client, the valid thread is brought with the size (Pool) and the SOAP request corresponding with a request is comprised and a request is delivered to the Geo-Mobility Server [1]. Thereafter, it processes to the form in which WIPI client can process the response delivered from the Geo-Mobility Server and delivers to WIPI.

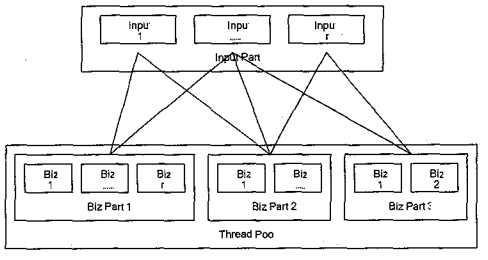


Figure 2. Gateway business logic

3.1.1 XML Processing: Presently, in the WIPI version, a server has to provide the processing for the SOAP [3] protocol and XML for the Geo-Mobility server and the coupling which provides a function to the web service since not supporting the XML [2]. The XML processing takes shape the parsing structure which uses the SAX parser the XML decoding which obtains from the SOAP response while it is comprised the structure of changing the attribute value by using the SAX [3] and DOM [3] parser but the part for comprising the SOAP request using DOM and every time reduces the burden which produces to DOM in the memory.

3.1.2 Data transmission:

A protocol could divide into the part for the processing according to the action code and error handling. And data used the Ping-Pong mode which divided Data into the Block unit due to the memory resource limitation nature of WIPI and instability of the mobile network and which it transmits.

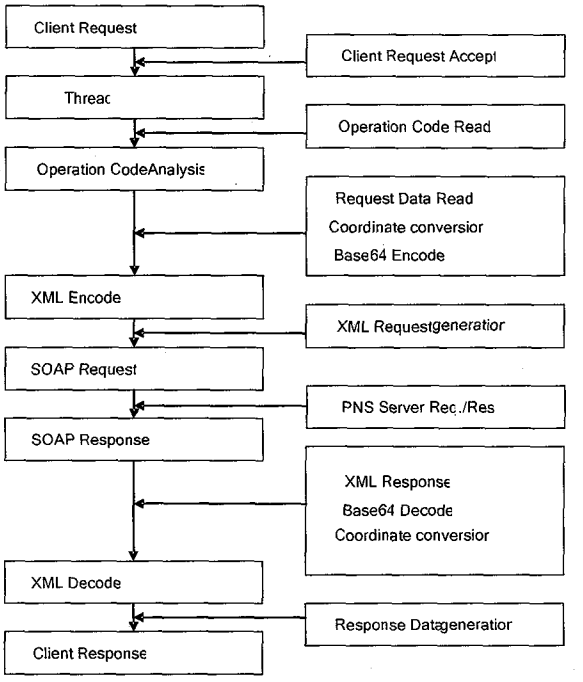


Figure 3. Gateway server data flow

3.2 Personal Navigation Server

It operates with with the Gateway server while providing the service for the PNS navigating to the web service structure identically with the Geo-Mobility Server link web service path data are delivered to WIPI client.

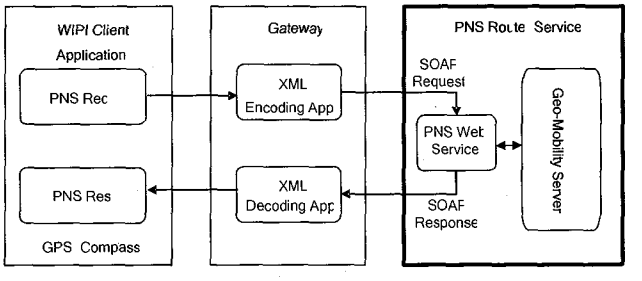


Figure 4. Personal Navigation Server

3.2.1 Routing for personal navigation : First, after the XML document being received and doing the SAX Parsing, the Start point and End point are found. The Start location and the Link in which a distance is most short adjacent to the End location are found. The method for finding Link is. And the method for finding Link is not positioned between twoes of a link and one the case and the other one kind positioned between link twoes are the case getting isloated from.

After finding the equation of two nodes on Link, it maps with the minimum distance on Link to one point and after finding the minimum distance with two nodes connecting a link on Link from virtual position (start and End), a node in the minimum distance is found. The first source and destination location

become the node. The Dijkstra algorithm [4] is operated in order to obtain the minimum distance and the nodes of the minimum distance are found. Real, in the virtual node, each first node and end node were set up but because it has the case of becoming the opposite side node, existence and nonexistence are again determined about this point and it is the minimum distance a node is calculated and is comprised. Finally, because of being connected to the level of a different, it again inquires the coordinate of the points about this different line and Link comprises a coordinate between a node and a node about each node set up. The coordinates between the nodes and that node are mapped in the routing node and the Response XML document is made and is answered.

3.2.2 GPS information correction using the Kalman Filter: Since the distribution of the GPS information error obtained for PNS being irregular and noted coinciding with with the traveling direction of the terminal, the kalman filter [5] in which it was necessary to have data correction and the real time processing is possible was used. The kalman filter is the recursive algorithm of the minimum error variance which it respects to optimally do about the ignotusLat state variable of the dynamic system from data in which the noise which the operation interval is measured is printed with estimation. In the industry field, it had been being very much used for the navigation of the artificial satellite, the locus estimation of a missile, a radar, and etc. and as to the kalman filter, the value for use is more and more enhanced to the fresh high-speed high performance micro processor system in the very complicated real time processing system to the development of a processor. As follows, it can show the Kalman algorithm if any kind of system can be expressed as the system equation as follows and observational equation.

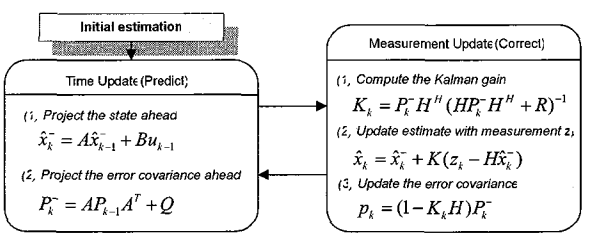


Figure 5. Kalman Filter Algorithm

$$x_k = Ax_{k-1} + Bu_k + w_{k-1} \quad (1)$$

$$z_k = Hx_k + v_k \quad (2)$$

In the system equation, a x means the state variable for optimizing and A expresses the conversion factor an one-stage connecting the state variable of the next step. B and u are the additional input value having no concern in a system. A w is the system error value of the state variable x in the k step. A w is used in the kalman filter as the standard deviation about the real value which it already knows which while individually finding a value or designating as the variable Q. In the observational equation, a z is the observed value and this is expressed in the state variable x and conversion factor H and a v is the observation error (measurement error). A v cannot know each value like a w and is used as the variable R which is the dispersion about the observation true value in the kalman filter. The GPS information received according to the time cannot show in terms of the linear equation. In " system error w and observation error v distribute regularly about each true value and the average is the zero and the dispersion is Q and R. It does not fit for the assumption of the kalman filter. Therefore, according to the average distribution of the received GPS information, the result of producing the some correction value cannot help being expected. The system conversion coefficient A and observation conversion factor H were assumed to 1. The system error w and observation error v took the mode which substituted a value and obtains the inappropriate a result.

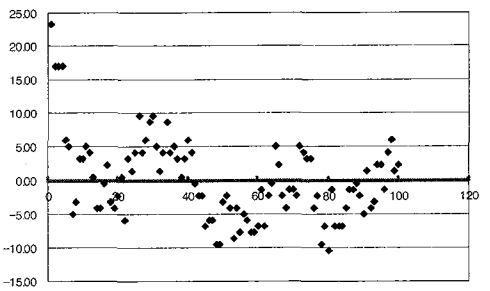


Figure 6. Longitude Error(WGS84)

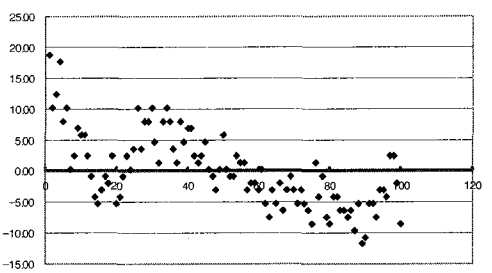


Figure 7. Latitude Error(WGS84)

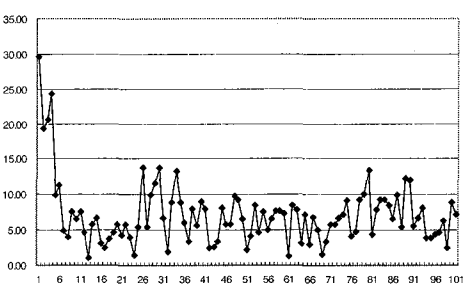


Figure 8. Center Point Error

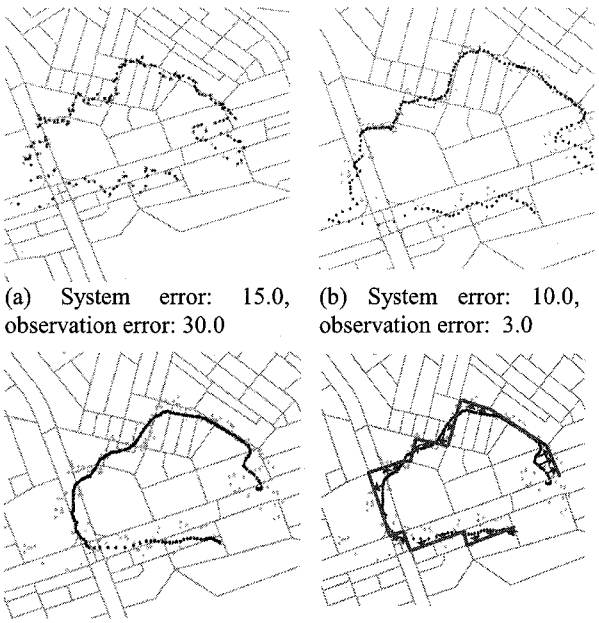
The GPS information which is dispersed as it gave the observation error was trusted and the correction value was back outward dispersed. In case the terminal changed a direction and moved, if the so small value was decreased the incorrect correction value was outputed. The number

of the GPS information which is received even if the GPS information moves the street thing same since being received to the irregular time interval is wrong. Therefore the different coordinate is distributed in the region thing same. The case of atrophying when actually fitting with the transfer position and has been amend occurs. (For example, 10 GPS information were received when moving 10m. 20 GPS information were received when moving the next 10m. It moved to the speed thing in fact same, it does, it glacially goes on the coordinate corrected in the second opinion 10m section for the first time.) Therefore, the GPS information except the constant time interval threw away. Therefore, the GPS information except the constant time interval periodically applied the GPS information to the kalman filter and fitted the correction information with the index grade of the terminal. Moreover, the GPS information received and the GPS information which it previously cultivates morals were compared. (the distance which absolutely cannot move within the time) did not use in case a distance so very much fell down. Because it does not trust in the kalman filter in case the case of being received in this values is less, it does not have the cause of a problem. However, before applying an affect to the kalman filter due to a cycle, it need to except in it is corrected in case of many times cultivating morals and outputted values.

3.2.3 Grid Azimuth Correction: The direction walking to the GPS signal which is received unlike the vehicle going by boat with the pedestrian silver walks although it amends the location information received from GPS to the kalman filter since the progressive direction is not fixed cannot be gotten a grip on. Therefore, by using data of the directional sensor, the walking direction of a pedestrian is grasped and the omission information is provided concerning the routing route of the destination location in the personal navigation.

4. EXPERIMENT AND RESULT

It extracts only that it is necessary to have among the received GPS information and applies to the kalman filter. Then, the GPS value is appropriately trusted according to the value of the observation error and the system error substituted and it is corrected. The GPS value showing the instantaneously big error does not trust. It has been amending according to many times distributed GPS values. It is seen that it is not corrected as it therefore actually back upward moves that a difference between the received GPS information and the route in which the real terminal moves are big. However the return value which is satisfied as the GPS value is evenly distributed like final two examples comes.



(a) System error: 15.0, observation error: 30.0

(b) System error: 10.0, observation error: 3.0

(c) System error 10.0, observation error: 1.2

(d) Map matching result

Figure 9. Error analysis and map matching result

Reference

[1] Kim, J. C., Heo, T. W., Kim, J. W., Park, J. H., 2005. Ubiquitous Location Based Service. International IEEE Conference on Intelligente Transportsystems, TC1.3, Vienna Austria, pp.841-845.

[2] David Hunter, Kurt Cagle, Chris Dix, Beginning XML. Wrox Press Inc., ISBN: 0764543946.

[3]Technical Report: SOAP Version 1.2 Working Draft. Available:http://www.w3.org/TR/soap12

[4] Dijkstra, E. W, 1959. A Note on Two Problems in Connection with Graphs. Numerische, pp.269-271

[5] Brown, R. G. and P. Y. C. Hwang, 1992. Introduction to Random Signals and Applied Kalman Filtering, Second Edition, John Wiley & Sons, Inc.