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(71) Applicant (*for all designated States except US*): **LG ELECTRONICS INC.** [KR/KR]; 20, Yoido-dong, Youngdungpo-gu, Seoul 150-875 (KR).

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **YI, Dong Hoon** [KR/KR]; 5/5, 5(o)-bunji, Dongseon-dong 5(o)-ga, Seong-buk-gu, Seoul 136-055 (KR). **JUNG, Mun Ho** [KR/KR]; 615-701, Woosung 6-danji Apt., Jeongdeunmaeul, Jeongja-dong, Bundang-gu, Seongnam-si, Gyeonggi-do 463-753 (KR).

(74) Agent: **CHUNG, Jong Ok**; 2nd Fl., KCEA Bldg., 1543-6, Secho-ku, Secho-dong, Seoul 137-872 (KR).

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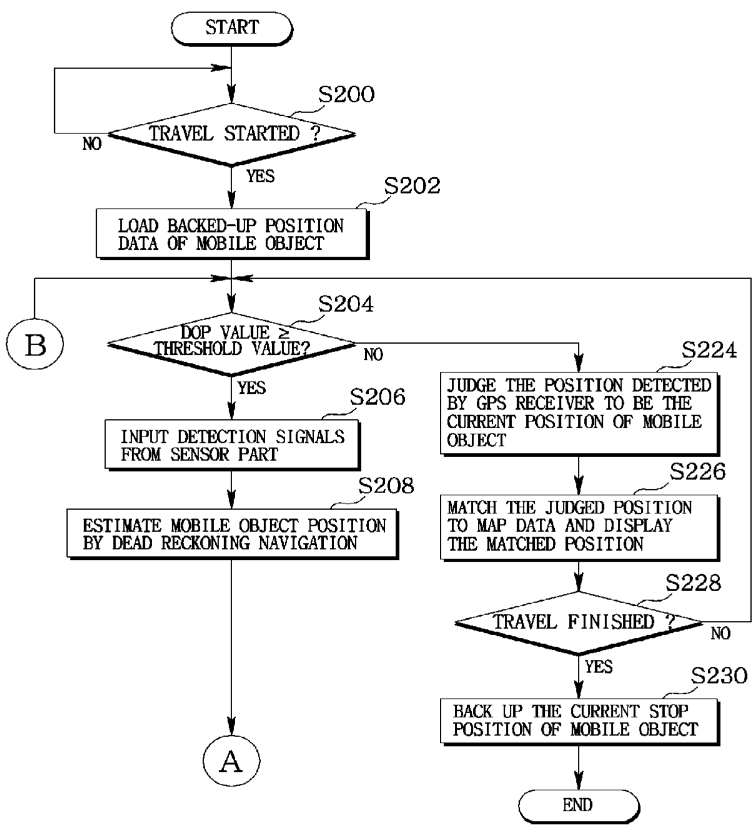
(54) Title: METHOD OF ESTIMATING POSITION OF A MOBILE OBJECT IN A NAVIGATION SYSTEM



(57) Abstract: A method of estimating position of a mobile object in a navigation system is provided that comprises the steps of loading a mobile object position data backed up during stoppage of the mobile object, at an initial stage of travel as the mobile object restarts traveling, estimating a current position of the mobile object from the loaded position data of the mobile object by virtue of dead reckoning navigation, causing the estimated current position of the mobile object to be matched to a map data, determining whether the mobile object has entered into a link, based on the mobile object position matched to the map data and detection signals indicative of the travel conditions of the mobile object generated from a sensor part, and if the mobile object is determined to have entered into the link, estimating the current position of the mobile object by way of establishing the azimuth angle of the link as an azimuth angle of the mobile object through the dead reckoning navigation.

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Description

METHOD OF ESTIMATING POSITION OF A MOBILE OBJECT IN A NAVIGATION SYSTEM

Technical Field

[1] The present invention is directed to a method of estimating position of a mobile object in a navigation system that can assure accurate estimation of the current position of a mobile object by way of establishing the azimuth angle of a link into which the mobile object has entered, as an azimuth angle of the mobile object itself, in a case that the current position of the mobile object has to be estimated in reliance upon dead reckoning navigation due to the failure of normal receipt of navigation messages.

Background Art

[2] Traffic congestion becomes aggravated in correspondence to the steady increase of mobile objects such as automotive vehicles and the like. This is particularly serious in that the social infrastructures, including roads, can hardly catch up with the expansion of the number of the mobile objects.

[3] As one of the solutions to the traffic congestion, attention has been drawn to a navigation system that receives navigation messages periodically transmitted from earth-orbiting satellites for a global positioning system simply referred to as GPS herein below with the use of a GPS receiver and detects the travel conditions, e.g., speed and heading, of a mobile object by means of sensors mounted to the mobile object. The navigation system is also adapted to determine the current position of the mobile object based on the navigation messages received by the GPS receiver and the travel condition signals detected by the sensors, which in turn is matched to the map data and displayed on a display unit.

[4] Such a navigation system enables the user for the mobile object to ascertain the current position of the mobile object and the shortest route up to a target destination from the current position. Under the guidance of the navigation system, the user can search for, beforehand, the travel route along which the mobile object should run to reach the target destination and then drive the mobile object along the travel route so searched, which makes it possible for the user to efficiently utilize a given road network.

[5] At the initial stage of travel of the mobile object, viz., at the initial operation of the navigation system, there may occur such an instance that the navigation system fails to accurately receive the navigation messages transmitted from the GPS satellites for a period of 30 seconds minimum to 15 minutes maximum, depending on the weather condition, the building disposition around the mobile object, the solar spot and the ar-

rangement of the GPS satellites with respect to the current position of the mobile object. In the event that the navigation messages are not received accurately, the navigation system is designed to estimate the current position of the mobile object with resort to what is called dead reckoning navigation. In other words, the navigation system can estimate the current position of the mobile object by taking advantage of the detection signals issued from a gyroscope, a vehicle speed sensor and the like, all of which are built in the mobile object.

[6] In case of estimating the current position of the mobile object with the use of the dead reckoning navigation, it has been the conventional practice that the azimuth angle of the mobile object is approximately detected by integrating the detection signals of the gyroscope and then accumulating the integrated values. Estimating the azimuth angle of the mobile object in reliance upon the gyroscope detection signals in this manner, however, has a limitation in accurately detecting the azimuth angle of the mobile object, because a bit of error is generated each time of estimation and continues to accumulate as the mobile object travels.

[7] In particular, due to the errors in the azimuth angle of the mobile object that will be accumulated as the mobile object enters into and continues to travel along the link of a map, there poses a drawback in that the current position of the mobile object cannot be precisely matched to the link but, instead, tends to be matched to the location that falls outside the link.

Disclosure of Invention

Technical Problem

[8] Accordingly, it is an object of the present invention to provide a method of estimating position of a mobile object in a navigation system that can minimize errors in the azimuth angle of a mobile object and thereby assure accurate estimation of the current position of a mobile object by way of establishing the azimuth angle of a link into which the mobile object has entered, as an azimuth angle of the mobile object itself, in a case that the current position of the mobile object has to be estimated in reliance upon dead reckoning navigation.

Technical Solution

[9] In accordance with one aspect of the instant invention, there is provided a method of estimating position of a mobile object in a navigation system, comprising the steps of loading a mobile object position data backed up during stoppage of the mobile object, at an initial stage of travel as the mobile object restarts traveling, estimating a current position of the mobile object from the loaded position data of the mobile object by virtue of dead reckoning navigation, causing the estimated current position of the mobile object to be matched to a map data, determining whether the mobile object has

entered into a link, based on the mobile object position matched to the map data and detection signals indicative of the travel conditions of the mobile object generated from a sensor part, and if the mobile object is determined to have entered into the link, estimating the current position of the mobile object by way of establishing the azimuth angle of the link as an azimuth angle of the mobile object through the dead reckoning navigation.

[10] It is preferred according to the invention that the method of estimating position of a mobile object in a navigation system further comprises the steps of detecting the mobile object position through the use of navigation messages received by a global positioning system receiver, calculating the dilution of precision value for the position detected, and comparing the dilution of precision value with a predetermined threshold value in a control part, wherein the current position of the mobile object is estimated in reliance upon the dead reckoning navigation, if the dilution of precision value is equal to or greater than the threshold value.

[11] It is also preferred according to the invention that the method of estimating position of a mobile object in a navigation system further comprises the steps of, if the dilution of precision value is less than the threshold value, judging the position detected by the global positioning system receiver to be the current position of the mobile object, and causing the judged position of the mobile object to be matched to the map data.

[12] It is further preferred according to the invention that, at the determining step, determination is made that the mobile object has entered into the link, if the position of the mobile object is matched to the link of the map data and if it is confirmed from the detection signals of the sensor part that the mobile object has traveled forward for more than a predetermined distance.

[13] It is still further preferred according to the invention that, if the mobile object is determined not to have entered into the link as yet, the current position of the mobile object is estimated by virtue of the dead reckoning navigation while detecting the azimuth angle of the mobile object from the detection signals of the sensor part.

[14] It is yet still further preferred according to the invention that the azimuth angle of the mobile object is detected by way of integrating detection signals of a gyroscope in the sensor part and then accumulating the integrated values.

[15] It is yet still further preferred according to the invention that the method of estimating position of a mobile object in a navigation system further comprises the steps of determining whether the mobile object stops traveling and backing up the current position data of the mobile object if the mobile object is determined to have stopped.

Advantageous Effects

[16] As apparent from the foregoing, the instant purpose of the invention lies in that a position of a mobile object is estimated by way of dead reckoning navigation at an initial stage of travel under which the navigation messages are not received normally. If the estimated position is matched to a link and the mobile object is determined to have traveled forward for more than a predetermined distance, it is judged that the mobile object has entered the target road, an azimuth angle information thereof is established as an azimuth angle of the mobile object. This helps reduce an error in the azimuth angle of the mobile object which would otherwise occur in the dead reckoning navigation and assures that the current position of the mobile object can be estimated in a precise and accurate manner.

Brief Description of the Drawings

[17] The above and other objects, features and advantages of the present invention will become apparent from the following description of a preferred embodiment given in conjunction with the accompanying drawings, in which:

[18] Fig. 1 is a block diagram showing a navigation system to which the method of estimating position of a mobile object according to the present invention is applied; and

[19] Figs. 2a and 2b are flowcharts illustrating a preferred embodiment of the method of estimating position of a mobile object according to the present invention.

Best Mode for Carrying Out the Invention

[20] A preferred embodiment of the inventive method of estimating position of a mobile object in a navigation system will now be set forth in detail with reference to the drawings attached.

Mode for the Invention

[21] Referring to Fig. 1, there is shown a block diagram of a navigation system to which the method of estimating position of a mobile object according to the present invention is applied. In the Figure, reference numeral 100 designates a plurality of GPS satellites that orbit the earth and serve to periodically transmit navigation messages to a GPS receiver designated by reference numeral 102. The GPS receiver 102 is adapted to extract the current position of a mobile object by receiving at least four of the navigation messages transmitted from the plurality of GPS satellites 100. In addition, the GPS receiver 102 calculates the dilution of precision ,hereinafter reffered to as DOP, hereinbelow value on the basis of the position where it receives the navigation messages. Throughout this specification, it should be appreciated that the DOP value denotes a geometrical error stemming from the positional relationship of the GPS receiver with respect to those GPS satellites that transmit the navigation messages used in extracting the current position of the mobile object.

[22] Reference numeral 104 designates a command input part through which the user can input operation commands to be executed, whereas reference numeral 106 designates a sensor part 106 which is built in the mobile object to detect the travel conditions of the mobile object. The sensor part 106 includes, for instance, a gyroscope and a speed sensor mounted to the mobile object, both of which are used to detect the heading and the traveled distance of the mobile object.

[23] Reference numeral 108 designates a map data storage part at which the map data is stored. Designated by reference numeral 110 is a control part. The control part 110 is adapted to compare the DOP value calculated by the GPS receiver 102 with a predetermined threshold value. If the DOP value is less than the threshold value, the control part 102 will judge the position extracted by the GPS receiver 102 to be the current position of the mobile object. On the other hand, in the event that the DOP value is equal to or greater than the threshold value, the control part 102 will judge the current position of the mobile object based on the detection signals from the sensor part 106. Moreover, the control part 110 serves to match the current position of the mobile object to the map data stored at the map data storage part 108 and control the display thereof.

[24] Reference numeral 112 denotes a display drive part that plays a role in displaying the map and the current position of the mobile object on a display part 114 under the control of the control part 110.

[25] With the navigation system of such an arrangement as noted above, the GPS receiver 102 is adapted to receive at least four of the navigation messages transmitted from the GPS satellites 100, as the mobile object is caused to travel by the user. Based on the navigation messages received, the GPS receiver 102 detects the current position of the mobile object and calculates the DOP value, which in turn is sent to the control part 110.

[26] The sensor part 106 is adapted to detect the travel conditions of the mobile object and then generate detection signals indicative of the travel conditions. In other words, the sensor part 106 produces pulse signals or other type of signals indicating the azimuth angle variation and the travel distance of the mobile object.

[27] The control part 110 serves to compare the DOP value received from the GPS receiver 102 with a predetermined threshold value, wherein the DOP value remains small if the GPS satellites 100 are disposed uniformly with respect to the GPS receiver 102 but becomes greater if the disposition of the GPS satellites 100 is uneven. The DOP value is most preferably less than 2, preferably 2-3, and ordinarily 4-5. If the DOP value is equal to or greater than 6, it cannot be adopted because a great deal of error would occur in the process of detecting the position of the mobile object based on the navigation messages received. For the very reason, the control part 110 is designed

to store a numeral 4 or 5 as the predetermined threshold value, compare the DOP value with the predetermined threshold value, and judge the position detected by the GPS receiver 102 to be the current position of the mobile object only when the DOP value is less than the predetermined threshold value.

[28] If the DOP value is equal to or greater than the predetermined threshold value, the control part 110 will estimate the current position of the mobile object based on the detection signals indicative of the travel conditions of the mobile object received from the sensor part 106, at which time the finally known position of the mobile object that was already determined when the DOP value remains less than the threshold value is used as a reference position. In this estimating process of the instant invention, the control part 110 determines whether the mobile object has entered into the link and, if the mobile object is determined to be on the link, establishes the azimuth angle of the link into which the mobile object has entered, as the azimuth angle of the mobile object, through a dead reckoning navigation, thereby reducing the error in the azimuth angle of the mobile object and assuring precise estimation of the current position of the mobile object.

[29] Once the current position of the mobile object is determined in this fashion, the control part 110 reads out the map data stored in the map data storage part 108 in order to match the current position of the mobile object to the map data, after which the matched map data is fed to the display drive part 112 so that the map and the current position of the mobile object can be displayed on the display part 114 in combination.

[30] Turning now to Figs. 2a and 2b, there are shown flowcharts illustrating the method of estimating position of a mobile object according to the present invention. As illustrated in these figures, the control part 110 determines at the step of S200 whether the mobile object begins to travel or not by use of the detection signals received from the sensor part 106. More specifically, in the event that the mobile object begins to move, the gyroscope of the sensor part 106 generates azimuth angle detection signals indicative of the heading of the mobile object, while the speed sensor of the sensor part 106 issues pulse signals indicative of the speed of the mobile object. Responsive to the azimuth angle detection signals and the pulse signals sent from the sensor part 106, the control part 110 makes decision as to whether the mobile object begins to travel or not.

[31] If it is determined that the mobile object starts traveling, at the step of S202, the control part 110 loads, at the initial stage of travel, the mobile object position data that was backed up during stoppage of the mobile object as set forth infra and establishes the loaded position data as the current position of the mobile object.

[32] At the step of S204, the control part 110 compares the DOP value received from the GPS receiver 102 with the predetermined threshold value. In a case that the DOP value is equal to or greater than the predetermined threshold value, it becomes impossible to

accurately detect the current position of the mobile object in reliance upon the navigation messages that the GPS receiver 102 receives. On that account, at the step of S206, the control part 110 receives the detection signals indicative of the mobile object travel conditions from the sensor part 106 and, at the step of S208, estimates the current position of the mobile object by virtue of dead reckoning navigation. In other words, by taking the mobile object position data loaded at the preceding step as a reference position, the control part 110 estimates the current position of the mobile object through the use of the detection signals indicative of the mobile object travel conditions issued from the sensor part 106.

[33] Once the current position of the mobile object is estimated in this manner, at the step of S210, the control part 110 matches the estimated current position of the mobile object to the map data stored in the map data storage part 108 and causes the matched current position of the mobile object to be displayed on the display part 114 through the display drive part 112, thus enabling the user to ascertain the current position of the mobile object.

[34] At the step of S212, the control part 110 determines whether the current position of the mobile object is matched to the link of the map data and, at the step of S214, makes determination as to whether the mobile object has moved forward for more than a predetermined distance, by use of the detection signals indicative of the mobile object travel conditions fed from the sensor part 106, through which process the control part 110 decides exact entry of the mobile object into the link. In the case of estimating the current position of the mobile object through the dead reckoning navigation with the use of the detection signals from the sensor part 106, a great deal of errors may be generated in the azimuth angle of the mobile object which is detected by accumulating the detection signals of the gyroscope of the sensor part 106. As a result, there may take place such an event that the mobile object is erroneously matched to the link even though the mobile object lies in fact out of the link. Taking this account, in accordance with the present invention, entry of the mobile object into the link is determined by confirming whether, as a result of the current position of the mobile object being matched to the map data, the mobile object is matched to the link and whether the mobile object has traveled forward for more than, e.g., 100m, in that link.

[35] If such determination shows that the current position of the mobile object is matched to the link and further that the mobile object has moved for more than the predetermined distance, the control part 110 then concludes that the mobile object has entered into the link and, at the step of S216, establishes the azimuth angle of the link to which the current position of the mobile object is matched as the current azimuth angle of the mobile object.

[36] To the contrary, if it is determined either that the current position of the mobile

object is not matched to the link or that, even though the matching is successfully accomplished, the mobile object failed to move forward for more than a predetermined distance, the control part 110 concludes that the mobile object has not entered into the link. At the step of S218, in the same manner as the prior art, the control part 110 integrates the detection signals received from the gyroscope of the sensor part 106 and establishes the cumulative value of integration as the azimuth angle of the mobile object.

[37] The azimuth angle of the mobile object established in this manner is utilized in estimating the current position of the mobile object when the estimation is to be conducted by way of the dead reckoning navigation at the step of S208. Establishing the azimuth angle of the link into which the mobile object has entered as the current azimuth angle of the mobile object as described above helps remove errors which would otherwise take place in the dead reckoning navigation, thus making sure that the current position of the mobile object can be estimated accurately and precisely.

[38] At the step of S220, determination is made as to whether the mobile object finishes traveling and stops, viz, whether the engine of the mobile object is turned off. If it is determined that the mobile object does not stop and continues to travel, the control part 110 will be returned back to the step of S204 and repeatedly perform the operation of comparing the DOP value with the predetermined threshold value.

[39] In the event that the DOP value is determined to be less than the predetermined threshold value at the step of S204, the control part 110 concludes that the position detected by the GPS receiver 102 is trustworthy and, at the step of S224, judges the position detected by the GPS receiver 102 to be the current position of the mobile object. At the step of S226, the control part 110 matches the judged current position of the mobile object to the map data and causes the matched current position of the mobile object to be displayed on the display part 114 through the display drive part 112, thus enabling the user to ascertain the current position of the mobile object.

[40] At the step of S228, determination is made as to whether the mobile object finishes traveling and stops. If it is determined that the mobile object does not stop and continues to travel, the control part 110 will be returned back to the step of S204 and repeatedly perform the operation of comparing the DOP value with the predetermined threshold value.

[41] If the determination made at the steps of S220 and S228 reveals that the mobile object ceases to travel with its engine turned off, the current stop position of the mobile object is stored as a backup data at the steps of S222 and S230, which position data is used when the mobile object restarts traveling at a later time.

[42] Although a preferred embodiment of the present invention has been described for the purpose of illustration, it should be understood that the invention is not limited to

the particular embodiment disclosed herein. It will be apparent to those skilled in the art that various changes or modifications may be made thereto within the scope of the invention defined by the appended claims.

Industrial Applicability

[43] Accordingly, the present invention helps reduce an error in an azimuth angle of a mobile object which would otherwise occur in the dead reckoning navigation and assures that a current position of the mobile object can be extimated in a precise and accurate manner.

Claims

[1] A method of estimating position of a mobile object in a navigation system, comprising the steps of:
loading a mobile object position data backed up during stoppage of the mobile object, at an initial stage of travel as the mobile object restarts traveling;
estimating a current position of the mobile object from the loaded position data of the mobile object by virtue of dead reckoning navigation;
causing the estimated current position of the mobile object to be matched to a map data;
determining whether the mobile object has entered into a link, based on the mobile object position matched to the map data and detection signals indicative of the travel conditions of the mobile object generated from a sensor part; and
if the mobile object is determined to have entered into the link, estimating the current position of the mobile object by way of establishing the azimuth angle of the link as an azimuth angle of the mobile object through the dead reckoning navigation.

[2] The method of estimating position of a mobile object in a navigation system as recited in claim 1, further comprising the steps of:
detecting the mobile object position through the use of navigation messages received by a global positioning system receiver;
calculating the dilution of precision value for the position detected; and
comparing the dilution of precision value with a predetermined threshold value in a control part;
wherein the current position of the mobile object is estimated in reliance upon the dead reckoning navigation, if the dilution of precision value is equal to or greater than the threshold value.

[3] The method of estimating position of a mobile object in a navigation system as recited in claim 2, further comprising the steps of:
if the dilution of precision value is less than the threshold value, judging the position detected by the global positioning system receiver to be the current position of the mobile object; and
causing the judged position of the mobile object to be matched to the map data.

[4] The method of estimating position of a mobile object in a navigation system as recited in claim 1, wherein, at the determining step, determination is made that the mobile object has entered into the link, if the position of the mobile object is matched to the link of the map data and if it is confirmed from the detection signals of the sensor part that the mobile object has traveled straight for more

than a predetermined distance.

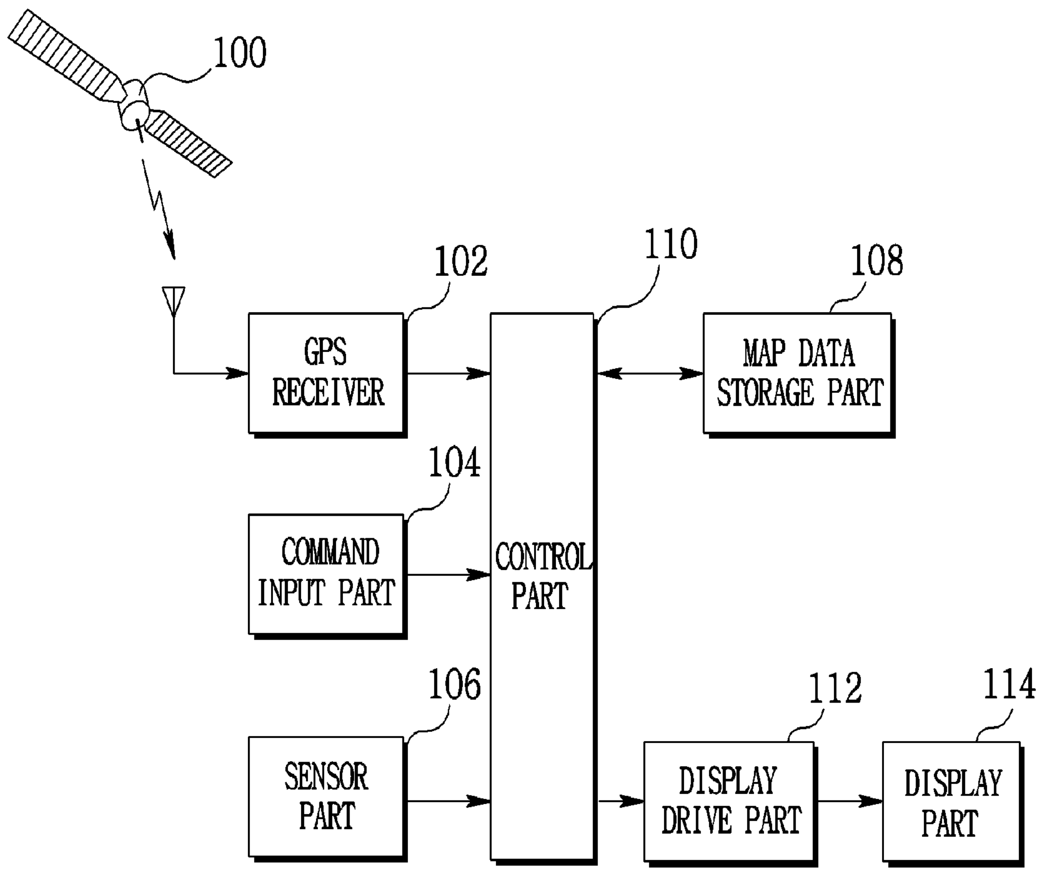
[5] The method of estimating position of a mobile object in a navigation system as recited in claim 1, wherein, if the mobile object is determined not to have entered into the link as yet, the current position of the mobile object is estimated by virtue of the dead reckoning navigation while detecting the azimuth angle of the mobile object from the detection signals of the sensor part.

[6] The method of estimating position of a mobile object in a navigation system as recited in claim 5, wherein the azimuth angle of the mobile object is detected by way of integrating detection signals of a gyroscope in the sensor part and then accumulating the integrated values.

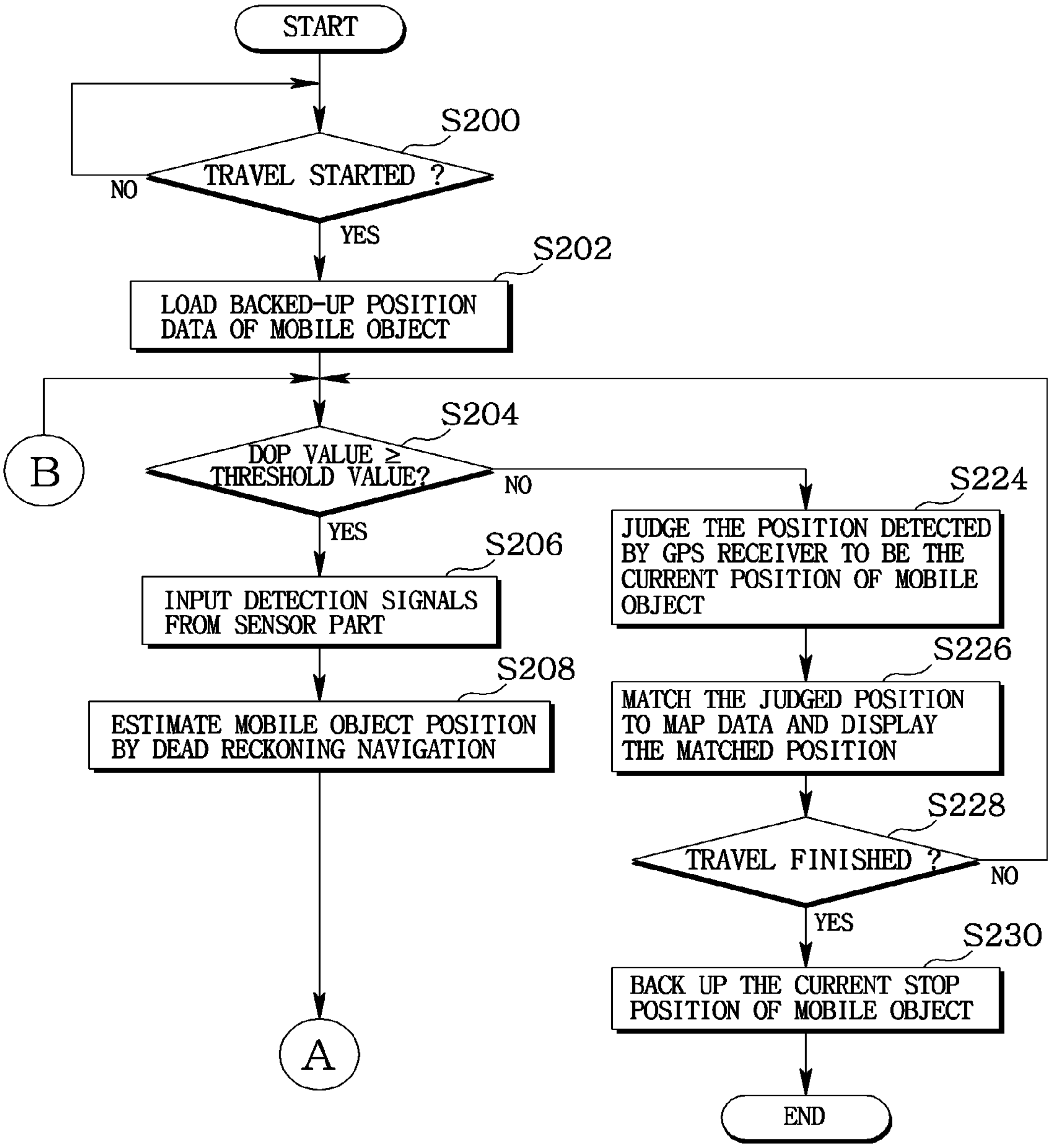
[7] The method of estimating position of a mobile object in a navigation system as recited in claim 1, further comprising the steps of: determining whether the mobile object stops traveling; and backing up the current position data of the mobile object if the mobile object is determined to have stopped.

[8] The method of estimating position of a mobile object in a navigation system as recited in claim 7, wherein, at the stoppage determining step, determination is made that the mobile object has stopped traveling, if an engine of the mobile object is turned off.

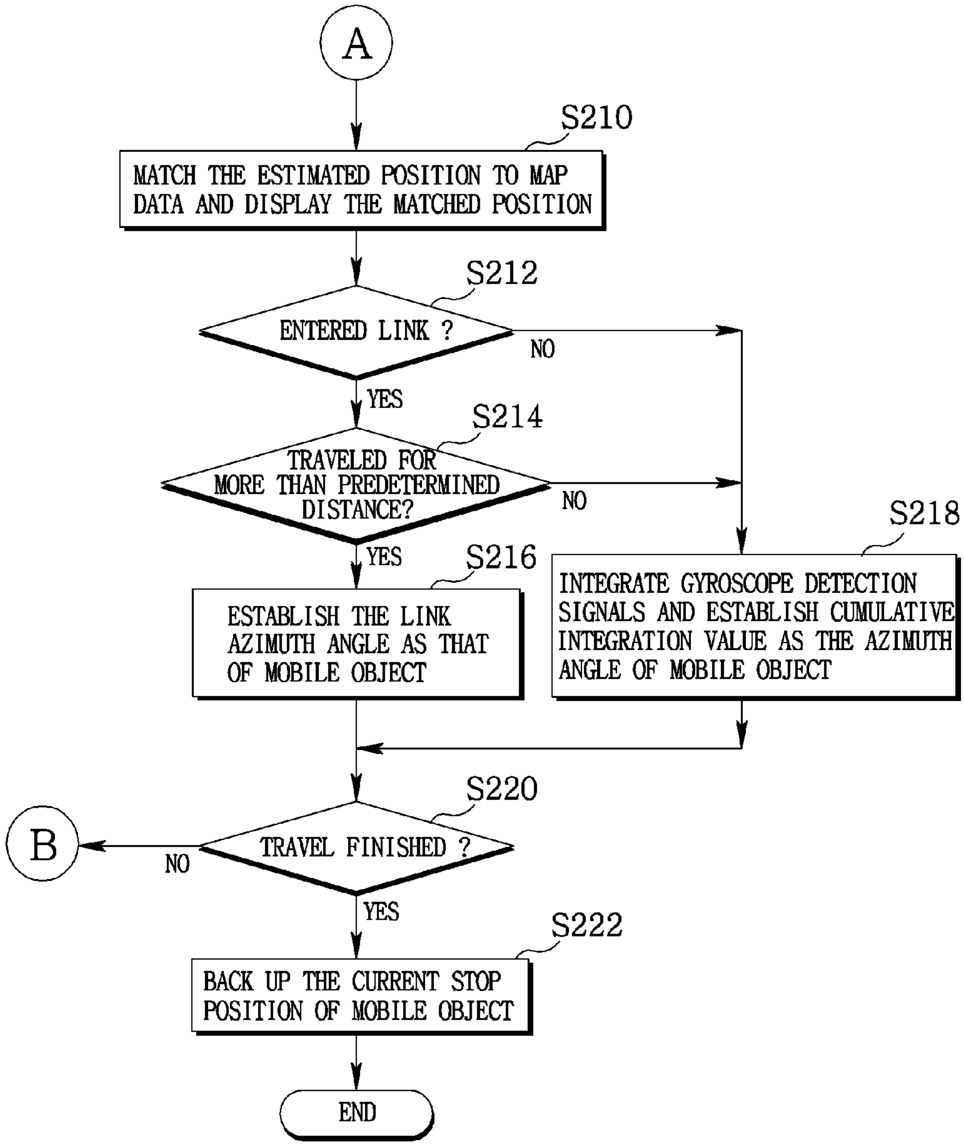
[Fig. 1]


100
102
110
108
GPS RECEIVER
MAP DATA STORAGE PART
104
COMMAND INPUT PART
CONTROL PART
106
112
114
SENSOR PART
DISPLAY DRIVE PART
DISPLAY PART

[Fig. 2]


START
S200
TRAVEL STARTED ?
NO
YES
S202
LOAD BACKED-UP POSITION DATA OF MOBILE OBJECT
B
S204
DOP VALUE ≥ THRESHOLD VALUE?
NO
YES
S224
JUDGE THE POSITION DETECTED BY GPS RECEIVER TO BE THE CURRENT POSITION OF MOBILE OBJECT
S206
INPUT DETECTION SIGNALS FROM SENSOR PART
S208
ESTIMATE MOBILE OBJECT POSITION BY DEAD RECKONING NAVIGATION
S226
MATCH THE JUDGED POSITION TO MAP DATA AND DISPLAY THE MATCHED POSITION
S228
TRAVEL FINISHED ?
NO
YES
S230
BACK UP THE CURRENT STOP POSITION OF MOBILE OBJECT
A
END

[Fig. 3]


A
S210
MATCH THE ESTIMATED POSITION TO MAP DATA AND DISPLAY THE MATCHED POSITION
S212
ENTERED LINK ?
NO
YES
S214
TRAVELED FOR MORE THAN PREDETERMINED DISTANCE?
NO
YES
S216
ESTABLISH THE LINK AZIMUTH ANGLE AS THAT OF MOBILE OBJECT
S218
INTEGRATE GYROSCOPE DETECTION SIGNALS AND ESTABLISH CUMULATIVE INTEGRATION VALUE AS THE AZIMUTH ANGLE OF MOBILE OBJECT
S220
B
TRAVEL FINISHED ?
NO
YES
S222
BACK UP THE CURRENT STOP POSITION OF MOBILE OBJECT
END

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference PE5026/PCT	**FOR FURTHER ACTION** see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. **PCT/KR2005/002673**	International filing date *(day/month/year)* **16 AUGUST 2005 (16.08.2005)**	(Earliest) Priority Date *(day/month/year)* 17 AUGUST 2004 (17.08.2004)
Applicant **LG ELECTRONICS INC. et al**		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
      ☐ The international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 2
      ☒ as suggested by the applicant.
      ☐ because the applicant failed to suggest a figure.
      ☐ because this figure better characterizes the invention.

   b. ☐ none of the figure is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2005/002673

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 G01S 5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC7 G01C G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
KOREAN PATENTS AND APPLICATIONS FOR INVENTIONS SINCE 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)
WPI "GPS""DOP"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 4-364491A (MAZD MOTOR CO) 16 DECEMBER 1992 see the whole document	1
A	JP 63-26530A (JAPAN RADIO CO) 04 FEBRUARY 1988 see the whole document	1
A	KR 2003-0072521A (FINE DIGITAL CO) 15 SEPTEMBER 2003 see the whole document	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
31 OCTOBER 2005 (31.10.2005)	**31 OCTOBER 2005 (31.10.2005)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer
SEO, Hawthorne
Telephone No. 82-42-481-5670