



Examined Patent Publication(B1)

Bibliographic Data

Int.Cl.	H04W 64/00 H04W 88/18
Published Date	20190919
Registration No.	1020230300000
Registration Date	20190911
Application No.	1020180011045
Application Date	20180130
Unexamined Publication No.	1020190091901
Unexamined Publication Date	20190807
Requested Date of Examination	20180130
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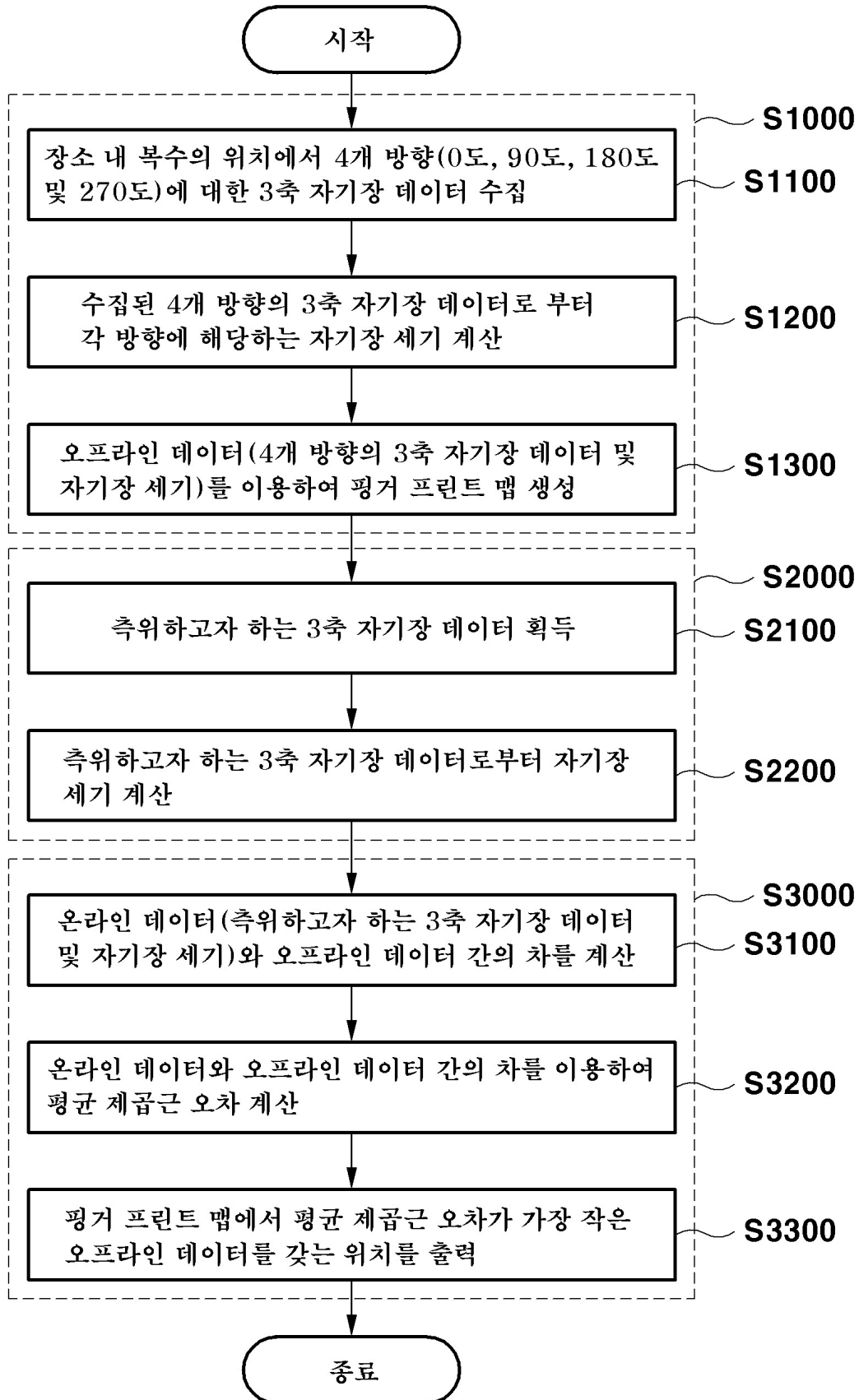
Title of Invention

Magnetic field based indoor positioning method using smart device and system having the method

Abstract

The invention relates to indoor determination method and system of the magnetic field base using the smart instrument, more specifically, to indoor determination method and system of the magnetic field base using the smart instrument in which determination is possible of the indoor based on the magnetic field information of the magnetic field sensor equipped in the smart instrument of the user through the fingerprint mode.

대표도면(Representative drawing)



Scope of Claims

Claim 1:

The step it includes the step of position-measuring the reference location in which difference of offline data and on-line data in 3 shaft magnetic field data outputted in the arbitrary position within 3 shaft magnetic field data which is measured figure 0 , figure 90 , and figure 180 and 270 stare at the direction and the step :

place which builds the fingerprint map it collects the Oersted (it the hereinafter says to be this with 39) in the smart instrument and the step :

of obtaining the Oersted and fingerprint map are most small in the multiple positions (it the hereinafter says to be this with 39) of the place for determination to the position of the smart instrument ; and of position-measuring: the indoor ephemeris method of the magnetic field base which includes the step :

of saving the root mean square error from the difference counted with the step :

calculates the difference between on-line data and offline data of being increased and the step of outputting the reference location having offline data in which the root mean square error is most small at the fingerprint map to the position of the smart instrument ; and uses the smart instrument in which

root mean square error is calculated by the following equation 1.

[Equation 1]

Here, D_j means the total number of the direction in which the difference between the Oersted of the Oersted of offline data of the k number direction and on-line data , and

N in which the root mean square error between offline data of the j number reference location and on-line data, the difference between the x-axis magnetic field of the x-axis magnetic field of offline data of the k number direction and on-line data, the difference between the y-axis magnetic field of the y-axis magnetic field of offline data of the k number direction and on-line data, the difference between the z shaft magnetic field of offline data of the k number direction and on-line data , and

in which

corresponds to the j number reference location correspond to the j number reference location

corresponds to the j number reference location

corresponds to the j number reference location are measured.

Claim 2:

As for claim 1, the indoor ephemeris method of the magnetic field base using the smart instrument in which the location information of reference locations is stored in

fingerprint map.

Claim 3:

The computer program stored in the recording medium performing the indoor ephemeris method of the magnetic field base using the smart instrument of any one claim among claim 1 to claim 2.

Claim 4:

The smart instrument in which the computer program of claim 3 is stored.

Claim 5:

The indoor positioning system of the magnetic field base which includes the smart instrument in which the server :

, that the computer program of claim 3 is stored the server and transmission and/or reception of 3 shaft magnetic field data are possible ; 3 shaft magnetic field data

server is received to on a real time basis from the smart instrument ; and uses the smart instrument calculating the difference between offline data and on-line data and outputs the position of the smart instrument.

Claim 6:

The indoor positioning system of the magnetic field base which includes the server in which the smart instrument :

and offline data of claim 4 are stored ; and uses the smart instrument in which

smart instrument communicates with the server and which receives offline data and calculating the difference between on-line data and offline data and outputting the position of the smart instrument.

Claim 7:

Deletion.

Claim 7:

Deletion.

Claim 8:

Deletion.

Claim 8:

Deletion.

Claim 9:

Deletion.

Claim 9:

Deletion.

Technical Field

The invention relates to indoor determination method and system of the magnetic field base using the smart instrument, more specifically, to indoor determination method and system of the magnetic field base using the smart instrument in which determination is possible of the indoor based on the magnetic field information of the magnetic field sensor equipped in the smart instrument of the user through the fingerprint mode.

Background Art

It is to do the location confirm of the specific target and generally the GPS (Global Positioning System) of the U.S. is used and the signal is received from the satellite in which this GPS is positioned about the earth and the position of the specific target is position-measured.

Because of being the global navigation satellite system (Global Positioning System) it is called technologies position-measuring the position of the specific target using the satellite like the upper part and the upper part has GLONASS of the Russia, the Galileo of the Europe and BeiDou of the China etc. besides GPS of the U.S.

The global navigation satellite system was very much used for the military use and aircraft, the vessel etc. but aircraft, are very much used in the private section and the position is used in order to mainly confi

from the position of the specific target at the outdoor environment.

In the meantime, in the global navigation satellite system is the outdoor environment, because the multipath fading problem the signal degrade occurs with the building that the signal receives the signal in which the building becomes wrong since it becomes the obstacle of the signal and the signal size is changed in case the reason for being mainly used uses in the inner climate occurs the use is curbed in the indoor.

In order to position-measure the specific target with the presented method in the indoor, the wireless access point (AP), and the determination technologies of the infra base such as the Bluetooth and RFID are used.

The apparatus for transmitting the wireless access point (AP), and data such as the Bluetooth and RFID so that the determination technology of the infra bases estimate the position in the building room is installed and the position is estimated from the apparatus using the received signal information.

Moreover, the arrival angle of the received signal is measured to be the method for estimating the position and the intensity of the received signal at the position arbitrarily set up with the triangulation method for deciding the position in the given space is stored in advance and this is compared with the measured value and the fingerprinting method for estimating the position is mainly applied.

But it has the problem that the cost efficiency is not poor since the determination technology of the infra bases have to set up the wireless access point, and the equipment such as the Bluetooth and RFID and because apparatuses which are developed so that the determination technology of the infra bases transmit data are used the positioning error is large.

Summary of Invention

Problem to be solved

The invention is provided to solve the above-described problem. And indoor determination method and system of the magnetic field base using the smart instrument which can position-measure the interior location even though it does not install the apparatus in which the object of the present invention is generated the wireless access point (AP), and the separate signal such as the Bluetooth and RFID at the building inside are to be provided.

Means to solve the problem

To solve the above-described purpose. And the present invention is to provide the indoor ephemeris method of the magnetic field base using the smart instrument which comprises the step of position-measuring the reference location in which difference of offline data and on-line data in the step the step: smart instrument of collecting 3 shaft magnetic field data (it the hereinafter says to be the 'offline data') and building the fingerprint map is positioned at the arbitrary position within the place and of obtaining 3 shaft magnetic field data (it the hereinafter says to be the 'on-line data') outputted in the smart instrument. And fingerprint map are most small in the multiple position (it the hereinafter says to be the 'reference location') within the place for determination with the position of the smart instrument.

In a preferred embodiment, in the fingerprint map, the location information of reference locations is stored.

In a preferred embodiment, in 3 shaft magnetic field data of offline data is each reference location, Figure 0, figure 90, and figure 180 and 270 are obtained by each 3 shaft magnetic field data about the direction.

In a preferred embodiment, in offline data, the Oersted calculated from 3 shaft magnetic field data of offline data is more included and the Oersted calculated from 3 shaft magnetic field data of on-line data is more included in on-line data.

In a preferred embodiment, the above-mentioned step of position-measuring: the step of calculating the difference between increased on-line data and offline data, the step of saving the root mean square error from the calculated difference, and the step of outputting the location information of the reference location having offline data are included. As to the step of, the root mean square error is most small at the fingerprint map.

Moreover, the computer program stored in the recording medium performing the indoor ephemeris method of the magnetic field base in which the invention uses the smart instrument is more provided.

Moreover, the invention more provides the smart instrument in which the computer program is stored.

Moreover, the invention includes the server, and the smart instrument and 3 shaft magnetic field data the server is received to on a real time basis from the smart instrument and the indoor positioning system of the magnetic field base using the smart instrument calculating the difference between offline data and on-line data and can output the position of the smart instrument is more provided. As to the server, the computer program is stored. As to the smart instrument, the transmission and/or reception is the server and 3 shaft magnetic field data possible.

Moreover, the invention includes the smart instrument, and the server and the indoor positioning system of the magnetic field base using the smart instrument in which the smart instrument communicates with the server and which can receive offline data and which calculates the difference between on-line data and offline data and outputting the position of the smart instrument is more provided. As to the smart instrument, the computer program is stored. As to the server, offline data are stored.

Effects of the Invention

According to indoor determination method and system of the magnetic field base using the smart instrument of the present invention., the position can be estimated by using only the magnetic field sensor equipped in the smart instrument. Therefore the position has the advantage that it installs the indoor at apparatuses generated the signal for the positional system and it does not need to form the infra.

Moreover, 3 shaft magnetic field data and the difference in which figure 0 , figure 90 , and figure 180 and 270 obtain 3 shaft magnetic field data about the direction and the invention is outputted 3 shaft magnetic field data of offline data from the smart instrument are compared and the position is position-measured. In that way although 3 shaft magnetic field data differently measured according to the direction is used the positioning error can be minimized.

Description of Embodiments

In the present invention, the current general term which is widely used in which the used term was possible was chosen. But the meaning should be grasped in consideration of the meaning of having the term which the applicant arbitrarily selects but the specific in that case being written in the detailed description of the invention part which is not name of the term which is in this case simple or being used.

Hereinafter, specifically the technical composition of the invention is illustrated with reference to preferred embodiments shown in the attached drawing.

But it can not be restricted to the embodiment in which here the invention is explained and it be embodied into the dissimilar form. The same reference number shows the same components element through the specification whole.

It is the method for position-measuring the position of the smart instrument in the indoor using the magnetic field information in which the indoor ephemeris method of the magnetic field base using the smart instrument according to a preferred embodiment of the present invention is outputted in the smart instrument from the equipped magnetic field sensor.

Moreover, the indoor ephemeris method of the magnetic field base using the smart instrument for a preferred embodiment of the present invention is performed by the computer and the computer program performing the indoor ephemeris method of the magnetic field base functioning the computer in the computer and uses the smart instrument is stored.

Moreover, the computer means the computing device of the broad sense including the smart instrument like the smartphone not only the general personal computer, or the tablet PC.

Moreover, the computer program may be the things in which it is stored in the separate recording medium and it can be provided and it is specially designed for the invention rather than and the recording medium is formed. And in the computer software field, it is known to a person skilled in the art and it is usable.

For example, it can be the magnetic-optical recording medium, ROM, RAM, the singleness including the flash memory etc in which the recording medium can serve both the hard disk, the magnetic media like the floppy disk and magnetic tape, CD, the optical recording media like DVD, and magnetism and optical recording or the hardware device which is formed in order to store the program instruction by the combination and perform.

Moreover, the computer program can be the computer program consisting of program instruction, local data file, and the singleness or the combination including the local data structure etc and it can be the computer program organized as the high level language code which can be performed by the computer using the interpreter etc. not only the machine code. It is made with the compiler.

Moreover, the computer program can be stored in the server transmitting the computer program through the communication network.

It is composed of the server (120) in which the indoor location determination system (100) of the magnetic field base referring to Figure 1, using the smart instrument of the invention is connected to drawing in which fig. 1 shows the indoor location determination system of the magnetic field base using the smart instrument according to a preferred embodiment of the present invention through the smart instrument (110), the smart instrument (110) and communication network.

Here, the computer program is stored in the smart instrument (110) or it can be stored in the server (120).

In case the computer program is stored in the smart instrument (110) offline data illustrated in the lower part are stored in the server (120) and offline data is received to the smart instrument (110) from the server (120) and the position of the smart instrument (110) can be position-measured.

But offline data can be stored in the smart instrument (110) and in this case, the server (120) can position-measure the position with the smart instrument (110) without the need.

Moreover, in case the computer program is stored in the server (120) the server (120) is transmitted 3 shaft magnetic field data from the smart instrument (110) and the position of the smart instrument (110) can be position-measured and the positioning result can be transmitted in the smart instrument (110).

Hereinafter, the indoor position measurement method of the magnetic field base using the smart instrument according to a preferred embodiment of the present invention with reference to fig. 2 is particularly illustrated.

Referring to Figure 2, the magnetic field base indoor ephemeris method using the smart instrument according to a preferred embodiment of the present invention includes the step (S1000) building the fingerprint map, and 3 shaft magnetic field data acquisition step (S2000) outputted in the smart instrument and the step (S3000) position-measuring the position of the smart instrument.

The step (S1000) building the fingerprint map collects 3 shaft magnetic field data at the multiple position (it the hereinafter says to be the 'reference location') of the place for determination using the smart instrument in advance (S1100).

Moreover, according to the direction measured as to the position in which 3 shaft magnetic field data is the same, because the value is changed 3 shaft magnetic field data is acquired in Figure 0, Figure 90, Figure 180, Figure 270 which is the direction of 4 at each reference location.

Next obtained 3 shaft magnetic field data the Oersted are found for the sake using the following equation (S1200).

Here, M_A the Oersted, and the m_x x-axis magnetic field data, and the m_y the y-axis magnetic field data m_z shows z shaft magnetic field data.

So that the Oersted improve the positioning accuracy, the Oersted is not calculated as the additionally calculated value and determination is possible with 3 shaft magnetic field data.

But it is the be desirable for the positioning accuracy improvement to use the Oersted.

The fingerprint map is produced using next 3 shaft magnetic field data and magnetic field data (it the hereinafter says to be the 'offline data') (S1300).

Here, in the present invention, the fingerprint means offline data to the operation making the location information in which the indoor paper divided to the fixed size produces the map and the fingerprint map is collected with the fingerprint which collects into a database.

Moreover, the indoor paper the location information for expressing is reference locations in which the fingerprint map collects offline data stored in the map.

Therefore, it as shown in table 1 can be stored in a database in order to build the fingerprint map.

Number	Reference location	Direction	X-axis magnetic field(m_x)	Y-axis magnetic field(m_y)	Z shaft magnetic field(m_z)	Magnetic field Intensity(M_A)
1	$x1, y1$	0	30	100	-10	105
90	-20	140	13	142		
180	-20	-110	50	122		
270	110	90	60	154		
2	$x2, y2$	0	-50	110	42	127
90	-80	12	77	112		
180	36	-123	89	156		
270	41	-45	68	91		

That is, the reference location which is the position of offline data in which the indoor paper in which the fingerprint map is divided to the fixed size is collected at the indoor paper can be outputted.

In the construction the fingerprint map, the step (S2000) acquiring 3 shaft magnetic field data outputted in the smart instrument which is in the arbitrary position within the place is performed.

In advance, 3 shaft magnetic field data outputted in the smart instrument is obtained (S2100).

Next 3 shaft magnetic field data the Oersted are calculated after the captured using the equation 1 (S2200).

The Oersted is not calculated from 3 shaft magnetic field data outputted in the smart instrument in which the Oersted is not included in offline data.

The reference location in which difference of on-line data and offline data 3 shaft magnetic field data outputted in the smart instrument which is in the arbitrary position and Oersted (it the hereinafter says to be the 'on-line data') in the fingerprint map in the acquisition within the next place are most small the step of position-measuring is performed to the position of the smart instrument (S3000).

The step (S3000) position-measured with the position of the smart instrument calculates the difference between offline data and on-line data in advance (S3100).

The root mean square error (Root Mean Square Error, RMSE) is saved from the next calculated difference using the following equation (S3200).

The total number of the direction in which the difference between the Oersted of the Oersted of offline data of the k number direction and on-line data, and N corresponding to the increased j number reference location are measured is meant.

The root mean square error calculation is possible.

It is the be desirable to include and calculate.

In the next fingerprint map, the position of the reference location in which the root mean square error is most small is outputted (S3300).

The indoor paper divided to the size in which the referring to Figure 3 the fingerprint map is constant multiple reference location ($a_{1/sub}$, $a_{n/sub}$) exist in the map (s) as the diagram in which fig. 3 illustrates the operation of the fingerprint map according to a preferred embodiment of the present invention and offline data of 4 the direction (figure 0, Figure 90, Figure 180, Figure 270) is measured and each reference location is mapped.

If on-line data are acquired in the position (b) in which it has the smart instrument, the reference location in which the calculated root mean square error is most low between offline data and on-line data which is in the fingerprint map (s) is searched in the fingerprint map (s) and it outputs.

Fig. 4 showed the performance comparison result of the ephemeris method of the indoor ephemeris method of the magnetic field base using the smart instrument according to a preferred embodiment of the present invention and conventional infra base. The positioning error range was compared using the cumulative distribution function.

Referring to Figure 4, in the indoor corridor and laboratory, the experiment was progressed and if the positioning error between the indoor ephemeris method of the magnetic field base using the determination technology and smart instrument of the invention of the conventional infra base is compared, even when being simple it can confirm without the complexity which is greater than the determination technology of the infra base that the effective determination is possible.

Therefore, the indoor ephemeris method of the magnetic field base using the smart instrument of the invention has the advantage that the position can be position-measured by using only the smart instrument even though the separate signal generating apparatus is set up in the indoor for determination and the infra is not formed.

Moreover, although 3 shaft magnetic field data in which the measured value is changed according to the direction is used because the indoor ephemeris method of the magnetic field base using the smart instrument of the invention obtains 3 shaft magnetic field data and Oersted about 4 the direction in the offline data captured and it compares with offline data and the position is position-measured the positioning error can be minimized.

As shown in the above, the invention gave the preferred embodiment and it showed and it illustrated. But it is not restricted in the above-described embodiment and the spirit of this invention is experienced in the range that it does not deviate and the change and the various correction will be available in the technical Field of the Invention with a person skilled in the art.

Brief explanation of the drawing

Figure 1 is drawing, and

showing the system according to a preferred embodiment of the present invention Figure 2 is a flowchart, and

for illustrating the indoor ephemeris method of the magnetic field base using the smart instrument according to a preferred embodiment of the present invention Figure 3 is a diagram for the fingerprint map description of motion, and

according to a preferred embodiment of the present invention Figure 4 is graph showing the performance comparison result of the ephemeris method of the indoor ephemeris method of the magnetic field base using the smart instrument according to a preferred embodiment of the present invention and conventional infra base.

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