

DESCRIPTION

POSITION NOTIFICATION APPARATUS, VEHICLE POSITION NOTIFICATION
METHOD, ONBOARD UNIT, VEHICLE POSITION CALCULATION METHOD
5 AND PROGRAM, AND VEHICLE POSITION CALCULATION SYSTEM

TECHNICAL FIELD

[0001]

The present invention relates to a position notification apparatus and a vehicle
10 position notification method that notify an onboard unit mounted in a vehicle of a present
position of the corresponding vehicle, an onboard unit that is mounted in a vehicle and
calculates a position at which the vehicle is present based on information notified of by a
position notification apparatus, a vehicle position calculation method and program, and a
vehicle position calculation system that calculates a position at which a vehicle is
15 present.

Priority is claimed on Japanese Patent Application No. 2011-155574, filed July
14, 2011, the content of which is incorporated herein by reference.

BACKGROUND ART

20 [0002]

Conventionally, an onboard unit mounted in a vehicle performs positioning of
the vehicle. Vehicle positioning is used in road pricing and driving safety support
systems (DSSS) in addition to display of a vehicle position by a car navigation function.
A vehicle positioning method is exemplified by a Global Positioning System (GPS)/dead
25 reckoning (DR) scheme of positioning a vehicle mainly by the GPS and correcting the

vehicle position at any time based on output values of a speed sensor and a gyro sensor mounted in the vehicle by DR.

[0003]

However, when vehicle positioning is performed according to the GPS/DR
5 scheme alone, detection errors of the speed sensor and the gyro sensor are accumulated with the lapse of time, and thus there is a problem in that accuracy deteriorates under the condition of continuous use due to accumulation of the corresponding errors. To solve this problem, there is a method in which a beacon notifies an onboard unit of information representing an installation position of the corresponding beacon, and the onboard unit
10 corrects a position of a vehicle based on the corresponding notification according to the installation position of the beacon included in the notification (for example, see Patent Document 1).

[0004]

In addition, a method of correcting a position using an optical beacon is
15 disclosed in Patent Document 2.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0005]

20 [Patent Document 1] Japanese Unexamined Patent Application, First Publication No. H10-281781

[Patent Document 2] Japanese Unexamined Patent Application, First Publication No. 2009-026056

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006]

However, a communication range of a beacon is about 5 meters, and it is impossible to know at which point in the corresponding communication range communication is completed. For this reason, when a vehicle position calculation method employing a method disclosed in Patent Document 1 is used, there is a problem in that an error corresponding to a size of the communication range is included in a post-correction vehicle position.

An object of the present invention is to provide a position notification apparatus, a vehicle position notification method, an onboard unit, a vehicle position calculation method and program, and a vehicle position calculation system capable of reducing an error that occurs when a vehicle position is corrected.

MEANS FOR SOLVING THE PROBLEMS

15 [0007]

In order to achieve the aforementioned objects, a position notification apparatus of the present invention is a position notification apparatus that notifies an onboard unit mounted in a vehicle of a present position of the vehicle, and includes: a detection unit that detects the vehicle; and a notification unit that notifies the onboard unit of a detection time at which the detection unit has detected the vehicle and a correction reference position that is a position corrected as a position at which the vehicle has been present at the detection time by wireless communication.

[0008]

In the position notification apparatus of the present invention, the detection unit may detect a vehicle present behind a boundary of a communication range of wireless

communication by the notification unit in a vehicle travel direction.

[0009]

In the position notification apparatus of the present invention, the detection unit may detect a vehicle present near the boundary of the communication range of wireless communication by the notification unit.

[0010]

The position notification apparatus of the present invention may include: a recording unit that sequentially records detection times at which the detection unit has detected vehicles on a storage unit; and an erasure unit that erases the detection time notified of by the notification unit from the storage unit, and the notification unit may perform sequential communication with onboard units in order of entry into the communication range of wireless communication, and notify an onboard unit that is a communication target of a detection time representing the earliest time among the detection times stored on the storage unit.

[0011]

In the position notification apparatus of the present invention, the detection unit may detect the onboard unit mounted in the vehicle present in a predetermined detection area based on reflected light of laser light emitted to the detection area by a laser sensor installed above a road surface, and the notification unit may notify the onboard unit of the detection time at which the detection unit has detected the onboard unit mounted in the vehicle by wireless communication.

[0012]

In order to achieve the aforementioned objects, an onboard unit of the present invention is an onboard unit that is mounted in a vehicle, calculates a position at which the vehicle is present based on information notified of by a position notification

apparatus, and includes: a calculation unit that calculates a position at which the vehicle is present each time based on a distance traveled by the vehicle and records the position on a storage unit as travel history information; a receiver unit that receives a detection time at which the vehicle has been detected by the position notification apparatus and a
5 correction reference position that is a position to be corrected as a position at which the vehicle has been present at the detection time from the position notification apparatus by wireless communication; and a correction unit that corrects the position at which the vehicle is present based on a travel history from the detection time to a current time stored on the storage unit and the correction reference position.

10 [0013]

In order to achieve the aforementioned objects, a vehicle position calculation system of the present invention is a vehicle position calculation system that calculates a position at which a vehicle is present, and includes: an onboard unit that calculates the position at which the vehicle having the onboard unit mounted therein is present; and a
15 position notification apparatus that notifies the onboard unit of a present position of the vehicle in which the onboard unit is mounted, the position notification apparatus includes: a detection unit that detects the vehicle; and a notification unit that notifies the onboard unit of a detection time at which the detection unit has detected the vehicle and a correction reference position that is a position corrected as a position at which the vehicle
20 has been present at the detection time by wireless communication, and the onboard unit includes: a calculation unit that calculates a position at which the vehicle having the onboard unit installed therein is present each time based on a distance traveled by the vehicle and records the position on a storage unit as travel history information; a receiver unit that receives the detection time at which the vehicle has been detected by the
25 position notification apparatus and the correction reference position that is a position to

be corrected as the position at which the vehicle has been present at the detection time from the position notification apparatus by wireless communication; and a correction unit that corrects the position at which the vehicle is present based on a travel history from the detection time to a current time stored on the storage unit and the correction reference position.

[0014]

In order to achieve the aforementioned objects, a vehicle position notification method of the present invention is a vehicle position notification method using a position notification apparatus that notifies an onboard unit mounted in a vehicle of a present position of the vehicle, a detection unit detects the vehicle, and a notification unit notifies the onboard unit of a detection time at which the detection unit has detected the vehicle and a correction reference position that is a position corrected as a position at which the vehicle has been present at the detection time by wireless communication.

[0015]

In order to achieve the aforementioned objects, a vehicle position calculation method of the present invention is a vehicle position calculation method using an onboard unit that is mounted in a vehicle and calculates a position at which the vehicle is present based on information notified of by a position notification apparatus, a calculation unit calculates a position at which the vehicle is present each time based on a distance traveled by the vehicle and records the position on a storage unit as travel history information, a receiver unit receives a detection time at which the vehicle has been detected by the position notification apparatus and a correction reference position that is a position to be corrected as a position at which the vehicle has been present at the detection time from the position notification apparatus by wireless communication, and a correction unit corrects the position at which the vehicle is present based on a travel

history from the detection time to a current time stored on the storage unit and the correction reference position.

[0016]

In order to achieve the aforementioned objects, a program of the present invention is a program for causing an onboard unit that is mounted in a vehicle and calculates a position at which the vehicle is present based on information notified of by a position notification apparatus to function as a calculation unit that calculates a position at which the vehicle is present each time based on a distance traveled by the vehicle and records the position on a storage unit as travel history information, a receiver unit that receives a detection time at which the vehicle has been detected by the position notification apparatus and a correction reference position that is a position to be corrected as a position at which the vehicle has been present at the detection time from the position notification apparatus by wireless communication, and a correction unit that corrects the position at which the vehicle is present based on a travel history from the detection time to a current time stored on the storage unit and the correction reference position.

EFFECTS OF THE INVENTION

[0017]

According to the present invention, a notification unit does not notify of a position of the notification unit itself to cause a position of a vehicle to be corrected, but a detection unit that performs vehicle detection separately from a beacon is prepared, and notifies an onboard unit of a detection time at which the detection unit has detected the vehicle and a correction reference position, thereby causing the vehicle position to be corrected. Accordingly, it is possible to notify the onboard unit of the accurate vehicle position corresponding to the detection time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a constitution diagram of a vehicle position calculation system in
5 accordance with a first preferred embodiment of the present invention.

FIG. 2 is a schematic block diagram showing a constitution of an information
processing apparatus.

FIG. 3 is a sequence diagram illustrating an operation for the vehicle position
calculation system to notify an onboard unit of information.

10 FIG. 4 is a schematic block diagram showing a constitution of an onboard unit in
accordance with the first preferred embodiment.

FIG. 5 is a flowchart illustrating operation of the onboard unit in accordance
with the first preferred embodiment.

FIG. 6 is a schematic block diagram showing a constitution of an information
15 processing apparatus in accordance with a second preferred embodiment.

PREFERRED EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0019]

(First preferred embodiment)

20 Hereinafter, a first preferred embodiment of the present invention will be
described in detail with reference to drawings.

FIG. 1 is a constitution diagram of a vehicle position calculation system in
accordance with a first preferred embodiment of the present invention.

A vehicle position calculation system includes a laser sensor (detection unit) 1,
25 an information processing apparatus 2, a beacon (notification unit) 3, and onboard units

4.

[0020]

The laser sensor 1 is installed above a road surface, and emits laser light to a predetermined detection range on the road surface, thereby detecting the presence of a vehicle that passes over the road surface.

When the laser sensor 1 detects a vehicle, the information processing apparatus 2 specifies a detection time that is a time at which the corresponding vehicle has been detected.

In order of entry into a communication range B by the onboard units 4, the beacon 3 performs sequential communication with the corresponding onboard units 4 having made the entry. When an onboard unit 4 enters the communication range B of the beacon 3, the beacon 3 notifies the onboard unit 4 of a correction reference position used for correcting position information in the onboard unit 4 and the detection time specified by the information processing apparatus 2. Here, the correction reference position may be information representing a latitude and a longitude of the laser sensor 1, a combination of an ID of the beacon 3 and a distance between the corresponding beacon 3 and the laser sensor 1, or the like.

The onboard unit 4 is mounted in the vehicle, and sequentially calculates a position at which the corresponding vehicle is present. Also, the onboard unit 4 corrects the calculated position based on the information notified of by the beacon 3.

In addition, in the first preferred embodiment, the laser sensor 1 detects the presence of a vehicle that is present behind a boundary of the communication range B of the beacon 3 in a vehicle travel direction and near the boundary (for example, about 1 meter).

Although the communication range B of the beacon 3 is not necessarily consistent according to vehicles due to an installation position of the onboard unit 4, a

material of a windshield, a vehicle speed, and the like, a position that serves as an average boundary of a communication range is regarded as a vicinity of the communication range in the first preferred embodiment.

[0021]

5 FIG. 2 is a schematic block diagram showing a constitution of the information processing apparatus 2.

 The information processing apparatus 2 includes a detection information acquiring unit 21, a detection time specifying unit 22, a detection time recording unit (recording unit) 23, a detection time queue (storage unit) 24, and an output unit (erasure
10 unit) 25.

 The detection information acquiring unit 21 acquires detection information representing whether or not a vehicle has been detected from the laser sensor 1. When the detection information acquired by the detection information acquiring unit 21 represents that a vehicle is present, the detection time specifying unit 22 specifies the
15 corresponding time as a detection time.

 The detection time recording unit 23 records the detection time specified by the detection time specifying unit 22 in the detection time queue 24.

 The detection time queue 24 stores the detection time recorded by the detection time recording unit 23.

20 When the onboard unit 4 enters the communication range B of the beacon 3, the output unit 25 extracts the detection time from the detection time queue 24 and outputs the detection time to the beacon 3. In the first preferred embodiment, “extraction from a queue” represents a process of reading information initially recorded in the queue and erasing the corresponding information. In other words, the output unit 25 erases the
25 detection time notified of by the beacon 3 from the detection time queue 24. Also, the

beacon 3 notifies the onboard unit 4 that is a communication target of a detection time representing the earliest time among detection times stored in the detection time queue 24.

[0022]

5 Next, an operation for the vehicle position calculation system to notify the onboard unit 4 of information in accordance with the first preferred embodiment will be described.

FIG. 3 is a sequence diagram illustrating an operation for the vehicle position calculation system to notify the onboard unit 4 of information.

10 First, the laser sensor 1 detects whether or not a vehicle is present in a detection range L to which laser light is emitted (step S1). Here, the laser sensor 1 calculates a distance from an emission position of the laser light to a reflection point of the laser light based on a time from when the laser light is emitted to when the reflected light is received, and determines whether or not a vehicle is present according to whether or not
15 the corresponding distance has reached a predetermined threshold value or less. The laser sensor 1 outputs detection information representing whether or not a vehicle is present to the information processing apparatus 2 (step S2). Also, the laser sensor 1 sequentially outputs detection information to the information processing apparatus 2 at predetermined sensing intervals.

20 [0023]

When the laser sensor 1 outputs the detection information, the detection information acquiring unit 21 of the information processing apparatus 2 acquires the detection information from the laser sensor 1 (step S3). Next, the detection time specifying unit 22 determines whether or not the detection information acquired by the
25 detection information acquiring unit 21 represents that a vehicle is present (step S4).

When the detection information represents that a vehicle is not present (step S4: NO), the process returns to step S3 and waits for acquisition of next detection information.

[0024]

On the other hand, when the detection information represents that a vehicle is present (step S4: YES), the detection time specifying unit 22 specifies the current time as a detection time (step S5). Next, the detection time recording unit 23 records the detection time specified by the detection time specifying unit 22 in the detection time queue 24 (step S6).

[0025]

10 The vehicle passes through the detection range L of the laser sensor 1, and then enters the communication range B of the beacon 3.

The beacon 3 sequentially sends signals for checking the presence of the onboard unit 4 that is a communication target, and determines whether or not a communicable onboard unit 4 is present based on whether or not there is a response to the corresponding signal (step S7). When it is determined that no communicable onboard unit 4 is present (step S7: NO), the process returns to step S7, and the beacon 3 repeats a determination of whether or not a communicable onboard unit 4 is present.

On the other hand, when it is determined that a communicable onboard unit 4 is present (step S7: YES), the beacon 3 outputs a request for a detection time to the information processing apparatus 2 (step S8).

[0026]

When the beacon 3 outputs the request for a detection time, the output unit 25 of the information processing apparatus 2 acquires the request for a detection time from the beacon 3 (step S9). Next, the output unit 25 extracts the detection time from the detection time queue 24 (step S10). Next, the output unit 25 outputs the extracted

detection time to the beacon 3 (step S11).

[0027]

When the information processing apparatus 2 outputs the detection time, the beacon 3 acquires the corresponding detection time (step S12). Then, the beacon 3
5 notifies the onboard unit 4 of the acquired detection time and a previously determined correction reference position (step S13).

Through the process described above, the beacon 3 can notify the onboard unit 4 of the detection time of the vehicle by the laser sensor 1 and the correction reference position.

10 The output unit 25 of the information processing apparatus 2 outputs detection time to the beacon 3 in order of recording in the detection time queue 24. Also, the beacon 3 performs communication with the onboard units 4 in order of entry into the communication range B. Accordingly, even when a plurality of vehicles enter the communication range B of the beacon 3 at different times, it is possible to notify the
15 onboard units 4 of correct detection times. Particularly in the first preferred embodiment, the laser sensor 1 detects a vehicle that is present near the boundary of the communication range B of the beacon 3. Accordingly, there is a low probability of a vehicle passing between detection and notification, and a high probability of a detection order being identical to a notification order. Furthermore, in the first preferred
20 embodiment, the laser sensor 1 detects a vehicle present behind the boundary of the communication range B of the beacon 3 in the vehicle travel direction. Accordingly, a vehicle is detected by the laser sensor 1, and then enters the communication range B of the beacon 3. For this reason, the beacon 3 can immediately notify an onboard unit 4 having entered the communication range B of a detection time without waiting for the
25 laser sensor 1 to end detection.

[0028]

Next, an onboard unit 4 in accordance with the first preferred embodiment will be described.

FIG. 4 is a schematic block diagram showing a constitution of an onboard unit 4 in accordance with the first preferred embodiment.

The onboard unit 4 includes a position acquiring unit 41, a sensor information acquiring unit 42, a map information storage unit 43, a position calculation unit (calculation unit) 44, a position storage unit 45, a display unit 46, a receiver unit 47, and a position correction unit (correction unit) 48.

10 [0029]

The position acquiring unit 41 acquires a current position of a vehicle by a GPS function.

The sensor information acquiring unit 42 acquires output values of a speed sensor and a gyro sensor mounted in the vehicle.

15 The map information storage unit 43 stores map information including a road pattern.

The position calculation unit 44 performs calculation of a current position at predetermined time intervals by the GPS/DR scheme based on the position information acquired by the position acquiring unit 41 or the output values of the sensors acquired by the sensor information acquiring unit 42, and records the calculated position information in the position storage unit 45. At this time, the position calculation unit 44 performs map matching based on the map information stored in the map information storage unit 43.

20 The position storage unit 45 stores the position information calculated by the position calculation unit 44 in association with time in time order.

The display unit 46 combines the latest position information stored in the position storage unit 45 with the map information stored in the map information storage unit 43, and displays the combined information on a display of the onboard unit 4.

[0030]

- 5 The receiver unit 47 receives the detection time and the correction reference position notified of by the beacon 3.

The position correction unit 48 performs correction of the position information stored in the position storage unit 45 based on the detection time and the correction reference position received by the receiver unit 47. At this time, the position correction
10 unit 48 performs a map matching process based on the map information stored in the map information storage unit 43.

[0031]

Next, operation for the onboard unit 4 to calculate position information in accordance with the first preferred embodiment will be described.

- 15 FIG. 5 is a flowchart illustrating operation of the onboard unit 4 in accordance with the first preferred embodiment.

When the onboard unit 4 starts a position information calculation operation, first, the position acquiring unit 41 acquires a current position of a vehicle by a GPS function (step S21). Next, the position calculation unit 44 performs a map matching
20 process based on the position information acquired by the position acquiring unit 41 and map information stored in the map information storage unit 43, thereby estimating a current vehicle position. Then, the position calculation unit 44 records position information representing the estimated position in the position storage unit 45 in association with the current time (step S22), and waits for a next position calculation
25 timing.

[0032]

Next, the position calculation unit 44 determines whether or not the current time is a position calculation timing (for example, 10 seconds after the previous position calculation time) (step S23). When it is determined that the current time is a position calculation timing (step S23: YES), the position acquiring unit 41 acquires a current position of the vehicle by the GPS function (step S24). Also, the sensor information acquiring unit 42 acquires output values of the speed sensor and the gyro sensor between the time at which the position calculation unit 44 has calculated the previous position information and the current time. Next, the position calculation unit 44 reads the previously calculated position information from the position storage unit 45, and estimates a current position by autonomous navigation based on the output values acquired by the sensor information acquiring unit 42 (step S25). Next, the position calculation unit 44 performs a map matching process based on the position acquired by the position acquiring unit 41, the position estimated by autonomous navigation, and the map information stored in the map information storage unit 43, thereby estimating a current vehicle position. Then, the position calculation unit 44 records position information representing the estimated position in the position storage unit 45 in association with the current time (step S26).

[0033]

When the position calculation unit 44 records the position information in the position storage unit 45 in step S26, or determines that the current time is not a position calculation timing in step S23 (step S23: NO), it is determined whether or not the receiver unit 47 has received a detection time and a correction reference position from the beacon 3 (step S27). When the receiver unit 47 has received a detection time and a correction reference position from the beacon 3 (step S27: YES), the position correction

unit 48 reads position information associated with the detection time received by the receiver unit 47 from the position storage unit 45 (step S28). Next, the position correction unit 48 calculates a distance and a direction between a position represented by the read position information and the correction reference position received by the receiver unit 47 (step S29). Next, the position correction unit 48 performs a map matching process based on the latest position information stored in the position storage unit 45, the distance and the direction calculated in step S29, and the map information stored in the map information storage unit 43, thereby correcting the latest position information (step S30).

10 [0034]

When the position information is corrected in step S30, or the receiver unit 47 has not received a detection time and a correction reference position from the beacon 3 in step S27 (step S27: NO), the onboard unit 4 determines whether or not an end request for the process has been input from the outside by manipulation, interrupt processing, or the like by a user or the like (step S31). When it is determined that the end request has not been input from the outside (step S31: NO), the process returns to step S3, and the onboard unit 4 continues calculation of position information. On the other hand, when it is determined that the end request has been input from the outside (step S31: YES), the onboard unit 4 ends the process.

20 [0035]

As described above, in accordance with the first preferred embodiment, the beacon 3 notifies the onboard unit 4 of a detection time at which the laser sensor 1 has detected a vehicle and a position reference position that is a position corrected as a position at which the corresponding vehicle has been present at the detection time by wireless communication. Accordingly, the beacon 3 can notify the onboard unit 4 of an

accurate vehicle position at a certain detection time, and it is possible to reduce an error that occurs when a vehicle position is corrected by the onboard unit 4.

[0036]

Also, according to the first preferred embodiment, the laser sensor 1 detects a vehicle that is present behind the boundary of the communication range B of the beacon 3 in a vehicle travel direction. Accordingly, the vehicle is detected by the laser sensor 1, and then enters the communication range B of the beacon 3. For this reason, the beacon 3 can immediately notify an onboard unit 4 having entered the communication range B of a detection time without waiting for the laser sensor 1 to end detection.

10 [0037]

Also, according to the first preferred embodiment, the laser sensor 1 detects a vehicle that is present near the boundary of the communication range B of the beacon 3. Accordingly, a probability of the vehicle passing between detection and notification becomes low. For this reason, a probability of an order of detection by the laser sensor 1 being identical to an order of notification by the beacon 3 is high.

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[0038]

Also, according to the first preferred embodiment, the output unit 25 of the information processing apparatus 2 outputs detection times to the beacon 3 in order of recording in the detection time queue 24. Also, the beacon 3 performs communication with the onboard units 4 in order of entry into the communication range B.

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Accordingly, even when a plurality of vehicles enter the communication range B of the beacon 3 at different times, it is possible to notify the onboard units 4 of correct detection times.

[0039]

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Also, according to the first preferred embodiment, the position calculation unit

44 of an onboard unit 4 records a position at which a vehicle is present as travel history information in the position storage unit 45, and the position correction unit 48 corrects the position at which the vehicle is present based on the travel history stored in the position storage unit 45 and a detection time and a correction reference position received from the beacon 3. Accordingly, the onboard unit 4 can reduce an error that occurs upon correction of the vehicle position.

[0040]

(Second preferred embodiment)

Hereinafter, a second preferred embodiment of the present invention will be described in detail with reference to a drawing.

Between the second preferred embodiment and the first preferred embodiment, there is a difference in the constitution of the information processing apparatus 2.

FIG. 6 is a schematic block diagram showing a constitution of the information processing apparatus 2 in accordance with the second preferred embodiment.

The information processing apparatus 2 of the second preferred embodiment further includes an onboard unit position estimating unit 26 in addition to the information processing apparatus 2 of the first preferred embodiment.

[0041]

A detection information acquiring unit 21 acquires an arrival time of reflected laser light and intensity of the reflected light from the laser sensor 1 as detection information representing whether or not there is a vehicle.

The onboard unit position estimating unit 26 estimates a position of an onboard unit 4 based on the detection information acquired by the detection information acquiring unit 21. For example, when the intensity of the reflected light is less than a predetermined threshold value, the onboard unit position estimating unit 26 can

determine that the laser has been emitted to a windshield, and estimate that the onboard unit 4 is present at the corresponding position. This is because onboard units 4 are mostly installed near windshields of vehicles. Also, when a distance calculated based on the arrival time of the reflected light is a predetermined threshold value corresponding to a height of a windshield of a vehicle or more, the onboard unit position estimating unit 26 can determine that the laser has been emitted to the windshield, and estimate that the onboard unit 4 is present at the corresponding position.

When the onboard unit position estimating unit 26 estimates that an onboard unit 4 is present, a detection time specifying unit 22 specifies the time as a detection time.

10 [0042]

As described above, according to the second preferred embodiment, the information processing apparatus 2 detects an onboard unit 4 mounted in a vehicle present in a predetermined detection area based on reflected light of laser light emitted to the detection area by the laser sensor 1 installed above a road surface, and the beacon 3 notifies the onboard unit 4 of a detection time at which the onboard unit 4 has been detected by wireless communication. Accordingly, the information processing apparatus 2 can further reduce a detection error that occurs due to a length of a hood. Specifically, when vehicle detection is performed by the laser sensor 1, there is a probability of an error corresponding to a length of a hood occurring between a detection position of a vehicle and a mounting position of an onboard unit 4. However, according to the second preferred embodiment, the corresponding error can be erased, and it is possible to calculate a more accurate vehicle position.

[0043]

Although an preferred embodiment of this invention has been described in detail above with reference to drawings, a detailed constitution is not limited to that described

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above, and various design changes or the like can be made within a range that does not depart from the spirit of this invention.

For example, in the first preferred embodiment, a case in which the laser sensor 1 is used as a detection unit that performs vehicle detection has been described, but this invention is not limited to this case. For example, it is possible to use another sensor such as a line sensor or the like. Also, even when the laser sensor 1 is used, the type of sensing method used, such as a scan type, a multi-optical axis type, and the like, is of little import.

[0044]

The information processing apparatus 2 and the onboard unit 4 have computer systems therein.

Operations of the respective processing units described above are stored in a computer-readable recording medium in the form of a program, and a computer reads and runs the program, so that the process is performed. Here, the computer-readable recording medium is a magnetic disk, a magneto-optical disc, a CD-ROM, a DVD-ROM, a semiconductor memory, or the like. Also, the computer program may be delivered to a computer through a communication line, and the computer that has taken the delivery may be caused to run the corresponding program.

[0045]

The program may be a program for implementing some of the functions described above.

Also, the program may be a program that can implement the functions described above in combination with a program already recorded in a computer system, a so-called differential file (differential program).

INDUSTRIAL APPLICABILITY

[0046]

The present invention relates to a position notification apparatus and a vehicle position notification method that notify an onboard unit mounted in a vehicle of a present position of the corresponding vehicle. According to the present invention, it is possible to notify an onboard unit of an accurate position of a vehicle corresponding to a time at which the vehicle has been detected.

DESCRIPTION OF THE REFERENCE SYMBOLS

10 [0047]

- | | | |
|----|----|---------------------------------------|
| | 1 | Laser sensor |
| | 2 | Information processing apparatus |
| | 3 | Beacon |
| | 4 | Onboard unit |
| 15 | 21 | Detection information acquiring unit |
| | 22 | Detection time specifying unit |
| | 23 | Detection time recording unit |
| | 24 | Detection time queue |
| | 25 | Output unit |
| 20 | 26 | Onboard unit position estimating unit |
| | 41 | Position acquiring unit |
| | 42 | Sensor information acquiring unit |
| | 43 | Map information storage unit |
| | 44 | Position calculation unit |
| 25 | 45 | Position storage unit |

- 46 Display unit
- 47 Receiver unit
- 48 Position correction unit

What is claimed is:

1. A position notification apparatus that notifies an onboard unit mounted in a vehicle of a present position of the vehicle, comprising:

5 a detection unit that detects the vehicle; and

a notification unit that notifies the onboard unit of a detection time at which the detection unit has detected the vehicle and a correction reference position that is a position corrected as a position at which the vehicle has been present at the detection time by wireless communication.

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2. The position notification apparatus according to claim 1,

wherein the detection unit detects a vehicle present behind a boundary of a communication range of wireless communication by the notification unit in a vehicle travel direction.

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3. The position notification apparatus according to claim 1 or 2,

wherein the detection unit detects a vehicle present near the boundary of the communication range of wireless communication by the notification unit.

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4. The position notification apparatus according to any one of claims 1 to 3, further comprising:

a recording unit that sequentially records detection times at which the detection unit has detected vehicles on a storage unit; and

25 an erasure unit that erases the detection time notified of by the notification unit from the storage unit,

wherein the notification unit performs sequential communication with onboard units in order of entry into the communication range of wireless communication, and notifies an onboard unit that is a communication target of a detection time representing an earliest time among the detection times stored on the storage unit.

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5. The position notification apparatus according to any one of claims 1 to 4, wherein the detection unit detects the onboard unit mounted in the vehicle present in a predetermined detection area based on reflected light of laser light emitted to the detection area by a laser sensor installed above a road surface, and

10 the notification unit notifies the onboard unit of the detection time at which the detection unit has detected the onboard unit mounted in the vehicle by wireless communication.

6. An onboard unit that is mounted in a vehicle and calculates a position at which the vehicle is present based on information notified of by a position notification apparatus, comprising:

a calculation unit that calculates a position at which the vehicle is present each time based on a distance traveled by the vehicle, and records the position on a storage unit as travel history information;

20 a receiver unit that receives a detection time at which the vehicle has been detected by the position notification apparatus and a correction reference position that is a position to be corrected as a position at which the vehicle has been present at the detection time from the position notification apparatus by wireless communication; and

a correction unit that corrects the position at which the vehicle is present based on a travel history from the detection time to a current time stored on the storage unit and

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the correction reference position.

7. A vehicle position calculation system that calculates a position at which a vehicle is present, comprising:

- 5 an onboard unit that calculates the position at which the vehicle having the onboard unit mounted therein is present; and
 - a position notification apparatus that notifies the onboard unit of a present position of the vehicle in which the onboard unit is mounted,
 - wherein the position notification apparatus includes:
 - 10 a detection unit that detects the vehicle; and
 - a notification unit that notifies the onboard unit of a detection time at which the detection unit has detected the vehicle and a correction reference position that is a position corrected as a position at which the vehicle has been present at the detection time by wireless communication, and
- 15 the onboard unit includes:
 - a calculation unit that calculates a position at which the vehicle having the onboard unit mounted therein is present each time based on a distance traveled by the vehicle and records the position on a storage unit as travel history information;
 - a receiver unit that receives the detection time at which the vehicle has been
 - 20 detected by the position notification apparatus and the correction reference position that is a position to be corrected as the position at which the vehicle has been present at the detection time from the position notification apparatus by wireless communication; and
 - a correction unit that corrects the position at which the vehicle is present based on a travel history from the detection time to a current time stored on the storage unit and
- 25 the correction reference position.

8. A vehicle position notification method using a position notification apparatus that notifies an onboard unit mounted in a vehicle of a present position of the vehicle, wherein a detection unit detects the vehicle, and

5 a notification unit notifies the onboard unit of a detection time at which the detection unit has detected the vehicle and a correction reference position that is a position corrected as a position at which the vehicle has been present at the detection time by wireless communication.

10 9. A vehicle position calculation method using an onboard unit that is mounted in a vehicle and calculates a position at which the vehicle is present based on information notified of by a position notification apparatus,

wherein a calculation unit calculates a position at which the vehicle is present each time based on a distance traveled by the vehicle, and records the position on a
15 storage unit as travel history information,

a receiver unit receives a detection time at which the vehicle has been detected by the position notification apparatus and a correction reference position that is a position to be corrected as a position at which the vehicle has been present at the detection time from the position notification apparatus by wireless communication, and

20 a correction unit corrects the position at which the vehicle is present based on a travel history from the detection time to a current time stored on the storage unit and the correction reference position.

10. A program for causing an onboard unit that is mounted in a vehicle and
25 calculates a position at which the vehicle is present based on information notified of by a

position notification apparatus to function as:

a calculation unit that calculates a position at which the vehicle is present each time based on a distance traveled by the vehicle, and records the position on a storage unit as travel history information;

5 a receiver unit that receives a detection time at which the vehicle has been detected by the position notification apparatus and a correction reference position that is a position to be corrected as a position at which the vehicle has been present at the detection time from the position notification apparatus by wireless communication; and

 a correction unit that corrects the position at which the vehicle is present based
10 on a travel history from the detection time to a current time stored on the storage unit and the correction reference position.