{DESCRIPTION}

{Title of Invention}

INFORMATION PROCESSING DEVICE, TOLL COLLECTION SYSTEM, AND TOLL COLLECTION METHOD

{Technical Field}

{0001}

The present invention relates to information processing devices, toll collection systems, and toll collection methods.

{Background Art}

{0002}

In the related art, an on-board device that receives radio waves from a satellite via a global-positioning-system (GPS) antenna of a vehicle and that uses a built-in GPS device to detect the position and the traveling direction of the vehicle has been developed. When the vehicle enters a toll area, the on-board device pays a toll with a credit card (for example, see PTL 1).

{Citation List}

{Patent Literature}

{0003}

{PTL 1} Japanese Unexamined Patent Application, Publication No. Hei 11-213192

{Summary of Invention}

{Technical Problem}

{0004}

However, the on-board device discussed in PTL 1 needs to store toll-area information that indicates a toll area where a toll is charged. In addition, if the toll-area is changed, it is necessary to download new toll-area information that corresponds to the changed toll area.

This new toll-area information needs to be downloaded simultaneously to on-board devices installed in vehicles from a predetermined central unit. This is because, when multiple vehicles enter the new toll area at the same time, an unfair situation may occur where the toll is not charged to vehicles that have not downloaded the new toll-area information but is charged to vehicles that have downloaded the new toll-area information.

For example, since there are several tens of thousands to several hundreds of thousands or more of vehicles that should download the new toll-area information, there is a possibility that the aforementioned problem may occur due to such a large number of vehicles not being able to simultaneously download the toll-area information from the central unit.

{0005}

In view of such circumstances, an object of the present invention is to provide an information processing device, a toll collection system, and a toll collection method that

can charge a toll to vehicles that have entered a toll area without the need for on-board devices installed in multiple vehicles to download toll-area information.

{Solution to Problem}

{0006}

In order to solve the aforementioned problem, an information processing device, a toll collection system, and a toll collection method of the present invention employ the following solutions.

An information processing device according to a first aspect of the present invention includes receiving means for receiving positional information indicating the position of a vehicle from the vehicle; first storage means for storing toll-area information indicating an area where a toll is charged to the vehicle; charging means for charging the toll to the vehicle on the basis of the positional information received by the receiving means and the toll-area information stored in the first storage means; and updating means for updating the toll-area information stored in the first storage means to new toll-area information when the new toll-area information is input.

{0007}

With the above configuration, the receiving means receives the positional information indicating the position of the vehicle from the vehicle, and the first storage means

stores the toll-area information indicating the area where a toll is charged to the vehicle. The charging means charges the toll to the vehicle on the basis of the positional information received by the receiving means and the toll-area information stored in the first storage means.

The positional information of the vehicle is generated, for example, on the basis of a GPS signal received from a GPS satellite. The toll-area information indicates, for example, the toll area based on the latitude and the longitude thereof.

If the toll area is changed due to road maintenance or a traffic jam of vehicles, new toll-area information is generated. Therefore, when the new toll-area information is input to the device, the updating means updates the toll-area information stored in the first storage means to the new input toll-area information.

Accordingly, in the present invention, the toll-area information is stored in the first storage means, the toll is charged to the vehicle on the basis of the toll-area information and the positional information transmitted from the vehicle, and the toll-area information stored in the first storage means is appropriately changed to new toll-area information, whereby the toll can be charged to vehicles that have entered the toll area without the need for on-board devices installed in multiple vehicles to

download the toll-area information.

{0008}

In the first aspect, it is preferable that the receiving means further receive, from the vehicle, identification information of a preset antenna received by the vehicle from the antenna, which is used for identifying the position of the vehicle. Moreover, it is preferable that the information processing device further include first correcting means for correcting the positional information received by the receiving means on the basis of the position of the vehicle estimated from the identification information of the antenna received by the receiving means if the position of the vehicle estimated on the basis of the identification information of the antenna received by the receiving means does not match the position of the vehicle estimated on the basis of the positional information received by the receiving means.

{0009}

With the above configuration, the receiving means further receives, from the vehicle, the identification information of the preset antenna, which is used for identifying the position of the vehicle, received by the vehicle from the antenna. The identification information of the antenna indicates, for example, the latitude and the longitude of the set position of the antenna.

If the position of the vehicle estimated on the basis of the identification information of the antenna received by the receiving means does not match the position of the vehicle estimated on the basis of the positional information of the vehicle received by the receiving means, the first correcting means corrects the positional information received by the receiving means on the basis of the position of the vehicle estimated from the identification information of the antenna received by the receiving means.

Accordingly, in the present invention, since the position of the vehicle is corrected on the basis of the identification information of the preset antenna, the position of the vehicle can be corrected with high accuracy.

{0010}

In the first aspect, it is preferable that the information processing device further include second storage means for storing road information indicating the position of a road in the area; and second correcting means for correcting the positional information received by the receiving means on the basis of the road information stored in the second storage means. In this case, it is preferable that the updating means further update the road information stored in the second storage means to new road information when the new road information is input.

{0011}

With the above configuration, the second storage means stores the road information indicating the position of the road in the area, and the correcting means corrects the positional information of the vehicle received by the receiving means on the basis of the road information. When new road information is input to the device, the updating means updates the road information stored in the second storage means to the new road information.

Accordingly, in the present invention, since the position of the vehicle is corrected on the basis of the road information, and the stored road information is appropriately updated, the position of the vehicle can be corrected with high accuracy.

{0012}

In the first aspect, the positional information of the vehicle is preferably generated on the basis of a global-positioning-system signal received from a global-positioning-system satellite. Moreover, it is preferable that the information processing device further include third storage means for storing global-positioning-system base station information indicating a set position of a global-positioning-system base station that receives the global-positioning-system signal; and third correcting means for obtaining a difference on the basis of a signal transmitted from the global-positioning-system base station and the

global-positioning-system base station information stored in the third storage means so as to correct the positional information received by the receiving means on the basis of the difference. In this case, it is preferable that the updating means further update the global-positioning-system base station information stored in the third storage means to new global-positioning-system base station information when the new global-positioning-system base station information is input.

{0013}

With the above configuration, the positional information of the vehicle is generated on the basis of the global-positioning-system (GPS) signal received from the GPS satellite, the third storage means stores the GPS-base-station information indicating the set position of the GPS base station that receives the GPS signal, and the third correcting means obtains a difference on the basis of the signal transmitted from the GPS base station and the GPS-base-station information stored in the third storage means so as to correct the positional information of the vehicle received by the receiving means on the basis of the difference.

When new GPS-base-station information is input to the device, the updating means updates the GPS-base-station information stored in the third storage means to the new

GPS-base-station information.

Accordingly, in the present invention, since the position of the vehicle is corrected on the basis of the signal from the GPS base station, and the stored GPS-base-station information is appropriately updated, the position of the vehicle can be corrected with high accuracy.

{0014}

In the first aspect, it is preferable that the information processing device further include distance calculating means for calculating a distance from the vehicle to the area indicated by the toll-area information on the basis of the positional information received by the receiving means and the toll-area information stored in the first storage means; and transmitting means for transmitting information based on the distance calculated by the distance calculating means to an on-board device that is installed in the vehicle and that issues a notification of the distance.

{0015}

With the above configuration, the distance from the vehicle to the area indicated by the toll-area information is calculated on the basis of the positional information of the vehicle and the toll-area information, and the information based on the calculated distance is transmitted to the on-board device that is installed in the vehicle and that issues a notification of the distance.

Consequently, by issuing a notification based on the information received by the on-board device, an occupant of the vehicle can be notified of the distance from the vehicle to the area where the toll is charged to the vehicle.

{0016}

A toll collection system according to a second aspect of the present invention includes an on-board device that is installed in a vehicle and that generates and transmits positional information indicating the position of the vehicle; and the aforementioned information processing device.

{0017}

With the above configuration, since the toll collection system includes the on-board device that is installed in the vehicle and that generates and transmits the positional information indicating the position of the vehicle, and the aforementioned information processing device, a toll can be charged to vehicles that have entered the toll area without the need for on-board devices installed in multiple vehicles to download the toll-area information.

{0018}

A toll collection method according to a third aspect of the present invention is performed by an information processing device including storage means and receiving means for receiving predetermined information from a

vehicle. The method includes a first step of receiving positional information indicating the position of the vehicle from the vehicle via the receiving means; a second step of storing toll-area information, which indicates an area where a toll is charged to the vehicle, in the storage means and updating the toll-area information stored in the storage means to new toll-area information when the new toll-area information is input to the information processing device; and a third step of charging the toll to the vehicle on the basis of the positional information received by the receiving means and the toll-area information stored in the storage means.

{0019}

With the above configuration, the toll-area information is stored in the storage means, the toll is charged to the vehicle on the basis of the toll-area information and the positional information transmitted from the vehicle, and the toll-area information stored in the storage means is appropriately changed to new toll-area information. Therefore, the present invention can charge a toll to vehicles that have entered the toll area without the need for on-board devices installed in multiple vehicles to download the toll-area information.

{Advantageous Effects of Invention}

{0020}

An advantage of the present invention is the ability to charge a toll to vehicles that have entered a toll area without the need for on-board devices installed in multiple vehicles to download toll-area information.

{Brief Description of Drawings}

{0021}

{Fig. 1} Fig. 1 illustrates the overall configuration of a toll collection system according to a first embodiment of the present invention.

{Fig. 2} Fig. 2 is a block diagram schematically illustrating the configuration of an on-board device according to the first embodiment of the present invention.

{Fig. 3} Fig. 3 is a block diagram schematically illustrating the configuration of a central unit according to the first embodiment of the present invention.

{Fig. 4} Fig. 4 is a flowchart illustrating the flow of an update program according to the first embodiment of the present invention.

{Fig. 5} Fig. 5 is a block diagram schematically illustrating the configuration of a central unit according to a second embodiment of the present invention.

{Fig. 6} Fig. 6 is a block diagram schematically illustrating the configuration of a central unit according to a third embodiment of the present invention.

{Fig. 7} Fig. 7 is a block diagram schematically

illustrating the configuration of a central unit according to a fourth embodiment of the present invention.

{Description of Embodiments}

{0022}

Embodiments of an information processing device, a toll collection system, and a toll collection method according to the present invention will be described below with reference to the drawings.

{0023}

First Embodiment

A first embodiment of the present invention will be described below.

Fig. 1 is an overall schematic view of a toll collection system 10 according to the first embodiment of the present invention.

As shown in Fig. 1, the toll collection system 10 includes a facility 16 having a central unit 14 serving as an information processing device. The central unit 14 charges a toll to a vehicle 12 traveling through a toll area A serving as an area where a toll is charged (road pricing). The facility 16 including the central unit 14 may be provided outside the toll area A.

Antennas 18 for identifying the position of the vehicle 12 are set in advance in the toll area A. The vehicle 12 traveling in the vicinity of one of the antennas 18 receives

identification information of the antenna 18 from the antenna 18. The identification information of the antenna 18 indicates the position of the antenna 18 and includes, for example, the latitude and the longitude of the set position of the antenna 18.

{0024}

Fig. 2 is a block diagram schematically illustrating the configuration of an on-board device 20 installed in the vehicle 12 according to the first embodiment.

As shown in Fig. 2, the on-board device 20 includes a power supply circuit 26 connected with a vehicle power source 22 and an internal battery 24, a wide-area communication unit 28 that transmits/receives various kinds of information to/from the central unit 14, a global-positioning-system (GPS) receiver 30 that receives a GPS signal transmitted from multiple GPS satellites, an on-board storage section 32 that stores various kinds of information, a controller 34, a communication section 36 that performs communication with the antennas 18, a display section 38, a notification section 40 such as a buzzer or a light-emitting diode (LED), an IC-card insertion section 42 in which an integrated-circuit (IC) card is inserted, an IC-card interface 44 (shown as "IC-card I/F" in Fig. 2) provided in the IC-card insertion section 42, and a communication port 46.

{0025}

In Fig. 2, various components, such as the GPS receiver 30, do not necessarily need to be contained in the on-board device 20. For example, such various components may be configured in any form so long as they are capable of transmitting/receiving information. As one possible configuration example, a portable terminal having a GPS function may be connected to the on-board device 20 via an external connector, and the GPS function of this portable terminal may be used as the GPS receiver 30.

Based on the GPS signal received from the multiple GPS satellites, the controller 34 generates positional information indicating the current position of the vehicle 12. Specifically, the positional information indicates the position of the vehicle 12 based on the latitude and the longitude thereof.

{0026}

The wide-area communication unit 28 performs wireless communication with an external device and can communicate with, for example, the central unit 14.

{0027}

The power supply circuit 26 mainly adjusts a voltage supplied from the vehicle power source 22 to a voltage suitable for the on-board device 20, and supplies the voltage to each component in the on-board device 20. The

internal battery 24 is provided so as to ensure enough power for performing communication even when the power supply from the vehicle power source 22 is disconnected.

{0028}

The on-board storage section 32 stores various kinds of information, such as vehicle information including owner information, vehicle-type information, and a vehicle ID of the vehicle 12; positional information of the vehicle 12; identification information of the on-board device; balance information and card information read from the IC card; and identification information of one of the antennas 18 received therefrom via the communication section 36 when the vehicle 12 travels in the vicinity of the antenna 18.

{0029}

The IC card inserted in the IC-card insertion section 42 is, for example, a contact-type IC card and has a built-in IC chip equipped with a flash memory or a microprocessor unit (MPU). In addition to card information such as a card ID number, the IC card stores the balance, the usage history, and the like. The information stored in the IC card can be read and rewritten by the controller 34 via the IC-card interface 44.

{0030}

In such an on-board device 20, when the IC card is inserted into the IC-card insertion section 42, the

controller 34 reads the IC card information and the balance stored in the IC card and writes the information in the on-board storage section 32 via the IC-card interface 44, and also displays the balance on the display section 38 for a certain period of time (e.g., about 10 seconds). Furthermore, when the controller 34 is able to properly read the information from the IC card, the controller 34 activates the notification section 40 so as to notify the user of normal operation. Consequently, for example, the notification section 40 notifies the user of the normal operation by setting off a buzzer sound if the notification section 40 is a buzzer or by turning on an LED if the notification section 40 is an LED.

On the other hand, if the controller 34 is not able to read the information from the IC card, the controller 34 displays an error message on the display section 38, activates the notification section 40 so as to notify the user of the error, and prompts the user to reinsert the IC card. The notification mode of the notification section 40 differs between normal operation and abnormal operation.

{0031}

When the controller 34 acquires a request signal from the central unit 14 via the wide-area communication unit 28, the controller 34 reads information, such as the identification information of the on-board device 20, the

positional information of the vehicle 12, and the card information, stored in the on-board storage section 32, and outputs the read information to the central unit 14 as a response signal to the request signal.

{0032}

The communication port 46 is an interface for performing communication with an external device and is, for example, connectable with a wireless or wired communication medium.

{0033}

Fig. 3 is a block diagram schematically illustrating the configuration of the central unit 14 according to the first embodiment.

The central unit 14 includes a wide-area communication unit 50 that performs wireless communication with the on-board device 20 installed in the vehicle 12, a central processing unit (CPU) 52 that controls the entire central unit 14, an antenna corrector 54 that corrects the positional information of the vehicle 12 using the identification information of the corresponding antenna 18, a toll-area-information storage section 56 that stores toll-area information indicating the location of the toll area A based on the latitude and the longitude thereof, a toll-fee determining section 58 that determines a toll fee for the vehicle 12 traveling in the toll area A, a toll-table

storage section 60 that stores the toll fee for the vehicle 12 as table information, a communication section 62 that transmitting/receiving information to/from other information processing devices, and an information input section 64 to which new toll-area information is input.

{0034}

The CPU 52 causes the wide-area communication unit 50 to transmit a request signal to the vehicle 12, receives a response signal from the on-board device 20 via the wide-area communication unit 50, and outputs the response signal to the antenna corrector 54.

{0035}

If the position of the vehicle 12 estimated on the basis of the identification information of the antenna 18 included in the input response signal does not match the position of the vehicle 12 estimated on the basis of the positional information of the vehicle 12 included in the input response signal, the antenna corrector 54 corrects the positional information of the vehicle 12 on the basis of the position of the vehicle 12 estimated from the identification information of the antenna 18. The corrected positional information of the vehicle 12 is output to the CPU 52.

{0036}

Based on the positional information of the vehicle 12 included in the response signal received by the wide-area

communication unit 50 and the toll-area information stored in the toll-area-information storage section 56, the CPU 52 detects whether the vehicle 12 has entered or exited the toll area A. Then, the detected information regarding whether the vehicle 12 has entered or exited the toll area A is output as entry/exit information from the CPU 52 to the toll-fee determining section 58. The entry/exit information includes the response signal of the vehicle 12, the traveled distance within the toll area A, the times of entry and exit, and the like.

{0037}

The toll-fee determining section 58 determines a toll fee for the vehicle 12 on the basis of the input entry/exit information of the vehicle 12 and the table information stored in the toll-table storage section 60. The table information includes a toll fee to be charged to the vehicle 12 when entering the toll area A and a toll fee according to the traveled distance of the vehicle 12 within the toll area A. The toll-fee determining section 58 outputs the response signal and toll-fee information indicating the determined toll fee to the wide-area communication unit 50 and the communication section 62.

The wide-area communication unit 50 transmits the toll-fee information to the on-board device 20 identified on the basis of the identification information of the on-board

device 20 included in the response signal. When the on-board device 20 receives the toll-fee information, the on-board device 20 issues a notification of the toll fee indicated by the toll-fee information.

The communication section 62 transmits information indicating the toll fee and an account number of a financial institution designated by the card information included in the response signal to another information processing device (i.e., an information processing device of the financial institution) so that the toll fee indicated by the toll-fee information is debited from the account corresponding to the account number.

{0038}

If the toll area A is changed due to road maintenance or a traffic jam of vehicles 12, new toll-area information is generated. In this case, the new toll-area information is input to the central unit 14 according to the first embodiment via the information input section 64, and an update process for updating the toll-area information is performed.

The information input section 64 may be of any type so long as it can input information to the central unit 14, and may be, for example, a reading device that reads information stored in a portable storage medium, such as a universal serial bus (USB) connector that reads information stored in

a USB memory, a compact disc read-only memory (CD-ROM) drive that reads information stored in a CD-ROM, and a digital versatile disk (DVD) drive that reads information stored in a digital versatile disk read-only memory (DVD-ROM), or a communication device that reads information via a communication line, such as a local area network (LAN).

{0039}

Fig. 4 is a flowchart illustrating the flow of an update program executed by the CPU 52 when the update process is to be performed. The update program is preliminarily stored in a predetermined region of a read-only memory (ROM) (not shown) or the like.

{0040}

First, in step 100, it is determined whether or not information input via the information input section 64 is toll-area information. In the case of yes, the process proceeds to step 102, whereas, in the case of no, the process proceeds to step 104.

{0041}

In step 102, the toll-area information stored in the toll-area-information storage section 56 is updated to new toll-area information input via the information input section 64, and the program ends.

In addition to the new input toll-area information, for example, update-timing information indicating the time and

date for updating the toll-area information may be input to the central unit 14. If such update-timing information is input, the CPU 52 temporarily stores the new input toll-area information in a region of the toll-area-information storage section 56 that is different from that for the pre-updated toll-area information (i.e., currently used toll-area information) until the time and date indicated by the update-timing information is reached.

When the time and date indicated by the update-timing information is reached, the CPU 52 updates the toll-area information stored in the toll-area-information storage section 56 to the new toll-area information.

{0042}

In step 104, predetermined processing is performed on the input information (e.g., the input information is stored in another storage medium (not shown) or deleted without being stored), and the program ends.

{0043}

As described above, the central unit 14 according to the first embodiment receives positional information indicating the position of a vehicle 12 from the vehicle 12 via the wide-area communication unit 50, and the toll-area-information storage section 56 stores toll-area information indicating a toll area A where a toll is charged to the vehicle 12. Based on the positional information received

via the wide-area communication unit 50 and the toll-area information stored in the toll-area-information storage section 56, the toll-fee determining section 58 charges a toll to the vehicle 12. Furthermore, when new toll-area information is input to the central unit 14, the CPU 52 updates the toll-area information stored in the toll-area-information storage section 56 to the new input toll-area information.

Therefore, the central unit 14 according to the first embodiment can charge a toll to vehicles 12 that have entered the toll area A without the need for the on-board devices installed in multiple vehicles 12 to download the corresponding toll-area information.

{0044}

Furthermore, in the central unit 14 according to the first embodiment, if the position of a vehicle 12 estimated on the basis of the identification information of the corresponding antenna 18 received by the wide-area communication unit 50 does not match the position of the vehicle 12 estimated on the basis of the positional information of the vehicle 12 received by the wide-area communication unit 50, the antenna corrector 54 corrects the positional information received by the wide-area communication unit 50 on the basis of the position of the vehicle 12 estimated from the identification information of

the antenna 18 received by the wide-area communication unit 50.

Accordingly, since the central unit 14 according to the first embodiment corrects the position of the vehicle 12 on the basis of the identification information of the corresponding preset antenna 18, the position of the vehicle 12 can be corrected with high accuracy.

{0045}

Second Embodiment

A second embodiment of the present invention will be described below.

Because the configuration of an on-board device 20 according to the second embodiment is similar to the configuration of the on-board device 20 according to the first embodiment shown in Fig. 1, a description thereof will be omitted.

Fig. 5 illustrates the configuration of a central unit 14 according to the second embodiment. Components in Fig. 5 that are the same as those in Fig. 3 are given the same reference numerals as in Fig. 3, and descriptions thereof will be omitted.

{0046}

The central unit 14 according to the second embodiment includes a map-information storage section 70 that stores road information indicating the positions of roads in the

toll area A, and a map matching processor 72 that corrects positional information of a vehicle 12 on the basis of the road information. In addition to the positions of the roads within the toll area A, the road information also includes the positions of roads in the vicinity of the toll area A.

{0047}

A response signal received by the wide-area communication unit 50 is input to the map matching processor 72 via the CPU 52. Then, the map matching processor 72 corrects the positional information of the vehicle 12 on the basis of the road information stored in the map-information storage section 70 and the positional information of the vehicle 12 included in the input response signal. In detail, for example, if the position of the vehicle 12 estimated from the positional information of the vehicle 12 does not match the position of a road indicated by the road information, the map matching processor 72 corrects the positional information of the vehicle 12 so that the position of the vehicle 12 is located on the nearest road. Then, the corrected positional information of the vehicle 12 is output to the antenna corrector 54.

{0048}

If road maintenance, such as construction of a new road within the toll area A or in the vicinity thereof, is performed, new road information reflecting this state is

generated.

Therefore, when the new road information is input to the central unit 14 according to the second embodiment via the information input section 64, a process similar to the update process shown in Fig. 4 is performed, thereby updating the road information stored in the map-information storage section 70 to the new road information.

{0049}

As described above, in the central unit 14 according to the second embodiment, the map-information storage section 70 stores the road information indicating the positions of roads in the toll area A, and the map matching processor 72 corrects the positional information of a vehicle 12, received by the wide-area communication unit 50, on the basis of the road information. Then, when new road information is input to the central unit 14, the CPU 52 updates the road information stored in the map-information storage section 70 to the new road information.

Accordingly, since the central unit 14 according to the second embodiment corrects the position of the vehicle 12 on the basis of the road information and appropriately updates the stored road information, the position of the vehicle 12 can be corrected with high accuracy.

{0050}

Third Embodiment

A third embodiment of the present invention will be described below.

Because the configuration of an on-board device 20 according to the third embodiment is similar to the configuration of the on-board device 20 according to the first embodiment shown in Fig. 1, a description thereof will be omitted.

Fig. 6 illustrates the configuration of a central unit 14 according to the third embodiment. Components in Fig. 6 that are the same as those in Fig. 5 are given the same reference numerals as in Fig. 5, and descriptions thereof will be omitted.

{0051}

In the toll area A according to the third embodiment, a GPS base station is set. The GPS base station transmits, to the central unit 14, a signal (referred to as "reception information" hereinafter) indicating the latitude and the longitude based on a GPS signal received from the GPS satellites.

The central unit 14 according to the third embodiment includes a GPS-base-station-information storage section 80 that stores GPS-base-station information, and a GPS corrector 82 that corrects the positional information of a vehicle 12 on the basis of the GPS-base-station information. The GPS-base-station information indicates the set position

of the GPS base station. The GPS-base-station information sets the reception information transmitted from the GPS base station and the set position of the GPS base station in correspondence with each other and is used for obtaining the difference therebetween.

The on-board device 20 installed in the vehicle 12 transmits the positional information indicating the current position of the vehicle 12 to the central unit 14 via the wide-area communication unit 28.

{0052}

The positional information of the vehicle 12 received by the wide-area communication unit 50 and the reception information of the GPS base station are input to the GPS corrector 82 via the CPU 52. Then, the GPS corrector 82 corrects the positional information of the vehicle 12 received by the wide-area communication unit 50 on the basis of the reception information transmitted from the GPS base station and the GPS-base-station information stored in the GPS-base-station-information storage section 80. In detail, the GPS corrector 82 compares the latitude and the longitude of the set position indicated by the GPS-base-station information stored in the GPS-base-station-information storage section 80 with the latitude and the longitude indicated by the reception information transmitted from the GPS base station so as to obtain the difference

therebetween. Then, the GPS corrector 82 corrects the positional information of the vehicle 12 on the basis of the obtained difference.

{0053}

If a new GPS base station is set or if the currently set GPS base station is removed or moved, new GPS-base-station information reflecting this state is generated.

Therefore, when the new GPS-base-station information is input to the central unit 14 according to the third embodiment via the information input section 64, a process similar to the update process shown in Fig. 4 is performed, thereby updating the GPS-base-station information stored in the GPS-base-station-information storage section 80 to the new GPS-base-station information.

{0054}

As described above, in the central unit 14 according to the third embodiment, the GPS-base-station-information storage section 80 stores the GPS-base-station information used for correcting a GPS signal, and the GPS corrector 82 obtains a difference on the basis of the signal transmitted from the GPS base station and the GPS-base-station information stored in the GPS-base-station-information storage section 80 so as to correct the positional information of the vehicle 12 received by the wide-area communication unit 50. When new GPS-base-station

information is input to the central unit 14, the CPU 52 updates the GPS-base-station information stored in the GPS-base-station-information storage section 80 to the new GPS-base-station information.

Accordingly, since the central unit 14 according to the third embodiment corrects the position of the vehicle 12 on the basis of the signal from the GPS base station and appropriately updates the stored GPS-base-station information, the position of the vehicle 12 can be corrected with high accuracy.

{0055}

Fourth Embodiment

A fourth embodiment of the present invention will be described below.

Because the configuration of an on-board device 20 according to the fourth embodiment is similar to the configuration of the on-board device 20 according to the first embodiment shown in Fig. 1, a description thereof will be omitted.

Fig. 7 illustrates the configuration of a central unit 14 according to the fourth embodiment. Components in Fig. 7 that are the same as those in Fig. 3 are given the same reference numerals as in Fig. 3, and descriptions thereof will be omitted.

{0056}

The central unit 14 according to the fourth embodiment includes a distance calculator 90 that calculates a distance (referred to as "toll-area arrival distance" hereinafter) from a vehicle 12 to the toll area A, indicated by the toll-area information stored in the toll-area-information storage section 56, on the basis of positional information of the vehicle 12 included in a response signal received by the wide-area communication unit 50 and the toll-area information.

The distance calculator 90 calculates the toll-area arrival distance at predetermined time intervals (e.g., every 30 seconds) on the basis of the latitude and the longitude indicated by the positional information and the latitude and the longitude of the toll area A. More specifically, the toll-area arrival distance is, for example, the shortest linear distance from the vehicle 12 to the toll area A or the distance of the shortest route from the vehicle 12 to the toll area A.

If the vehicle 12 is already located within the toll area A or if the vehicle 12 is traveling away from the toll area A, the distance calculator 90 does not calculate the toll-area arrival distance.

{0057}

The toll-area arrival distance calculated by the distance calculator 90 is input to the CPU 52. If the toll-

area arrival distance satisfies a predetermined condition, the CPU 52 outputs, to the wide-area communication unit 50, distance information indicating the toll-area arrival distance and identification information for identifying the on-board device 20 installed in the vehicle 12 corresponding to the toll-area arrival distance.

The predetermined condition is a preset distance including, for example, 500 m, 400 m, 300 m, 200 m, and 100 m. Specifically, the distance information is output from the CPU 52 to the wide-area communication unit 50 every time the toll-area arrival distance becomes smaller than or equal to the aforementioned distance.

{0058}

When the wide-area communication unit 50 receives the distance information from the CPU 52, the wide-area communication unit 50 transmits the distance information to the on-board device 20 identified on the basis of the identification information received together with the distance information. The on-board device 20 having received the distance information issues a notification of the toll-area arrival distance indicated by the distance information by using, for example, sound or an image.

{0059}

As described above, the central unit 14 according to the fourth embodiment calculates the toll-area arrival

distance on the basis of the positional information of the vehicle 12 and the toll-area information, and transmits the distance information based on the calculated toll-area arrival distance to the on-board device 20. Therefore, by issuing a notification based on the distance information received by the on-board device 20, a vehicle occupant of the vehicle 12 can be notified of the distance from the vehicle 12 to the toll area A.

{0060}

The CPU 52 may be equipped with the function of the distance calculator 90.

Furthermore, the central unit 14 according to the fourth embodiment may be combined with the central unit 14 according to the second embodiment or the third embodiment.

{0061}

Furthermore, the CPU 52 may calculate the time (referred to as "toll-area arrival time") that it takes the vehicle 12 to arrive in the toll area A on the basis of the toll-area arrival distance and the speed of the vehicle 12, and may input information indicating the toll-area arrival time to the wide-area communication unit 50 together with or in place of the distance information. When the on-board device 20 receives the information indicating the toll-area arrival time via the wide-area communication unit 50, the on-board device 20 issues a notification of the toll-area

arrival time by using, for example, sound or an image.

{0062}

Although the present invention has been described above with reference to the above embodiments, the technical scope of the invention is not limited to the scope discussed in the embodiments. Various modifications and alterations to the above embodiments are permissible so long as they do not depart from the spirit of the invention, and embodiments in which such modifications and alterations are additionally made are also encompassed within the technical scope of the invention.

{0063}

For example, although the on-board device 20 is configured to receive a GPS signal from the GPS satellites so as to generate positional information of the vehicle 12 in the above embodiments, the present invention is not limited to this configuration. Alternatively, the on-board device 20 may be configured to receive signals transmitted from wireless LAN access points set in the toll area A and the vicinity thereof so as to generate positional information of the vehicle 12 using these signals, or may be configured to generate positional information of the vehicle 12 with a combined use of the GPS signal and the signals transmitted from the wireless LAN access points.

{0064}

Furthermore, although a single central unit 14 is set in the toll area A in the above embodiments, the present invention is not limited to this configuration. For example, multiple central units 14 may be set in the toll area A.

In the case of this configuration, for example, the toll area A is segmented into multiple areas, and each segmented area is provided with a corresponding central unit 14, such that the central unit 14 is configured to charge a toll to each vehicle 12 within the segmented area.

{0065}

Furthermore, although a configuration in which the identification information of each antenna 18 indicates the latitude and the longitude of the set position of the antenna 18 is described in the above embodiments, the present invention is not limited to this configuration. An alternative configuration in which the identification information of each antenna 18 is an identification number used for identifying the antenna 18 is also permissible.

In the case of this configuration, the central unit 14 stores map information including the identification numbers of the antennas 18 and the set positions of the antennas 18 that are set in correspondence with each other, and the antenna corrector 54 obtains the latitude and the longitude of the set position of the corresponding antenna 18 by using

the map information so as to correct the positional information of the corresponding vehicle 12.

Furthermore, if a new antenna 18 is set or if a currently set antenna 18 is removed or moved, new map information reflecting this state is generated.

Therefore, when the new map information is input to the central unit 14 according to this configuration via the information input section 64, a process similar to the update process shown in Fig. 4 is performed, thereby updating the stored map information to the new map information.

{Reference Signs List}

10 toll collection system

12 vehicle

14 central unit

20 on-board device

50 wide-area communication unit

52 CPU

54 antenna corrector

56 toll-area-information storage section

58 toll-fee determining section

70 map-information storage section

72 map matching processor

80 GPS-base-station-information storage section

82 GPS corrector

90 distance calculator

CLAIMS

1. An information processing device comprising:

receiving means for receiving positional information indicating the position of a vehicle from the vehicle;

first storage means for storing toll-area information indicating an area where a toll is charged to the vehicle;

charging means for charging the toll to the vehicle on the basis of the positional information received by the receiving means and the toll-area information stored in the first storage means; and

updating means for updating the toll-area information stored in the first storage means to new toll-area information when the new toll-area information is input.

2. The information processing device according to Claim 1, wherein the receiving means further receives, from the vehicle, identification information of a preset antenna received by the vehicle from the antenna, the antenna being used for identifying the position of the vehicle, and

wherein the information processing device further comprises first correcting means for correcting the positional information received by the receiving means on the basis of the position of the vehicle estimated from the identification information of the antenna received by the receiving means if the position of the vehicle estimated on

the basis of the identification information of the antenna received by the receiving means does not match the position of the vehicle estimated on the basis of the positional information received by the receiving means.

3. The information processing device according to Claim 1 or 2, further comprising:

second storage means for storing road information indicating the position of a road in the area; and

second correcting means for correcting the positional information received by the receiving means on the basis of the road information stored in the second storage means,

wherein the updating means further updates the road information stored in the second storage means to new road information when the new road information is input.

4. The information processing device according to any one of Claims 1 to 3, wherein the positional information of the vehicle is generated on the basis of a global-positioning-system signal received from a global-positioning-system satellite,

wherein the information processing device further comprises:

third storage means for storing global-positioning-system base station information indicating a set position of a global-positioning-system base station that receives the global-positioning-system signal; and

third correcting means for obtaining a difference on the basis of a signal transmitted from the global-positioning-system base station and the global-positioning-system base station information stored in the third storage means so as to correct the positional information received by the receiving means on the basis of the difference, and

wherein the updating means further updates the global-positioning-system base station information stored in the third storage means to new global-positioning-system base station information when the new global-positioning-system base station information is input.

5. The information processing device according to any one of Claims 1 to 4, further comprising:

distance calculating means for calculating a distance from the vehicle to the area indicated by the toll-area information on the basis of the positional information received by the receiving means and the toll-area information stored in the first storage means; and

transmitting means for transmitting information based on the distance calculated by the distance calculating means to an on-board device that is installed in the vehicle and that issues a notification of the distance.

6. A toll collection system comprising:

an on-board device that is installed in a vehicle and that generates and transmits positional information

indicating the position of the vehicle; and

the information processing device according to any one of Claims 1 to 5.

7. A toll collection method of an information processing device including storage means and receiving means for receiving predetermined information from a vehicle, the method comprising:

a first step of receiving positional information indicating the position of the vehicle from the vehicle via the receiving means;

a second step of storing toll-area information, which indicates an area where a toll is charged to the vehicle, in the storage means and updating the toll-area information stored in the storage means to new toll-area information when the new toll-area information is input to the information processing device; and

a third step of charging the toll to the vehicle on the basis of the positional information received by the receiving means and the toll-area information stored in the storage means.