{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, the so-called global positioning system (GPS) that measures the current position of a vehicle on the basis of a GPS signal received by an antenna in the vehicle from GPS satellites has become widely available. Moreover, a technology for charging a toll to a vehicle traveling in a toll area, which is an area where a toll is charged, on the basis of the position of the vehicle measured by the GPS has been developed.

PTL 1 discusses a charging device that compares the toll area with the current position of the vehicle measured by the GPS, issues a notification that the vehicle is approaching the toll area, and charges a toll according to the time of entry and the distance traveled by the vehicle within the toll area.

{Citation List}

{Patent Literature}

{0003}

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

{Summary of Invention}

{Technical Problem}

{0004}

However, the accuracy of GPS is sometimes significantly reduced in, for example, urban areas where the visibility of GPS satellites is low. For this reason, there is a possibility that a vehicle traveling within the toll area is determined as having traveled longer than the actual traveled distance. In that case, a correct toll fee according to the actual traveled distance is not charged to the vehicle.

{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 measure the distance traveled by a vehicle with higher accuracy.

{Solution to Problem}

{0006}

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

{0007}

An information processing device according to a first aspect of the present invention includes receiving means for receiving positional information from a plurality of vehicles, the positional information indicating the position of each vehicle; and calculating means for calculating a route and a distance traveled by a vehicle corresponding to the positional information received by the receiving means by performing an averaging process on the received positional information using the positional information of another vehicle.

{0008}

With the above configuration, the receiving means receives the positional information indicating the positions of the vehicles from the vehicles.

For example, the positional information of each vehicle is generated on the basis of a GPS signal received from GPS satellites and indicates the position of the vehicle based on the latitude and the longitude thereof. However, the positional information can sometimes include an error and does not always indicate an accurate position of the vehicle.

Thus, the calculating means calculates the route and the distance traveled by the vehicle corresponding to the positional information received by the receiving means by performing the averaging process on the received positional information using the positional information of the other

vehicle.

{0009}

Consequently, the present invention performs the averaging process on the positional information received by the receiving means using the positional information of the other vehicle so as to reduce an error in the positional information, thereby measuring the distance traveled by the vehicle with higher accuracy.

{0010}

In the first aspect, it is preferable that the information processing device further include storage means for storing the positional information received by the receiving means for each vehicle and each predetermined area that corresponds to the position indicated by the positional information. The calculating means preferably performs the averaging process on the positional information received by the receiving means by using the positional information of the other vehicle, stored in the storage means, in the area corresponding to the positional information.

{0011}

With the above configuration, the storage means stores the positional information received by the receiving means for each vehicle and each predetermined area corresponding to the position indicated by the positional information.

For example, each predetermined area is set so as to

surround, with a predetermined margin, a road on which the vehicles travel. Such an area may be set for each branching road, or multiple roads that are parallel to each other may be set as a single area.

The calculating means performs the averaging process on the positional information received by the receiving means by using the positional information of the other vehicle in the area corresponding to the positional information.

{0012}

Consequently, since the present invention does not need to perform a so-called map matching process for correcting the positional information of a vehicle on the basis of map data indicating the position, the width, and the length of a road, the distance traveled by the vehicle can be measured more simply with higher accuracy.

{0013}

In the first aspect, it is preferable that the positional information be generated on the basis of a global-positioning-system signal transmitted from a global-positioning-system satellite, and that the positional information of the other vehicle used for the averaging process by the calculating means include positional information generated within a predetermined time period in which an effect of an error occurring due to the state of the global-positioning-system signal transmitted from the global-positioning-system

satellite is minimized.

{0014}

With the above configuration, the positional information is generated on the basis of the GPS signal transmitted from the GPS satellite, and the positional information of the other vehicle used for the averaging process includes positional information generated within a predetermined time period in which the effect of a GPS error occurring due to the state of the GPS signal transmitted from the GPS satellite is reduced.

A GPS error occurs due to the state of a GPS signal. The state of a GPS signal changes depending on the number of GPS satellites that can be observed from a vehicle, the set positions of the GPS satellites, and the condition of the ionosphere. Although the number of GPS satellites that can be observed from a vehicle and the set positions of the GPS satellites change with time, they substantially match at the same location and the same time, even on different days.

{0015}

Consequently, the present invention performs the averaging process using the positional information of other vehicles equivalent to one full day (i.e., the last 24 hours from the current time) so that the effect of an error occurring due to the state of a GPS signal transmitted from the GPS satellites can be reduced. In other words, the error can be reduced.

{0016}

In the first aspect, it is preferable that the positional information be generated on the basis of a global-positioning-system signal transmitted from a global-positioning-system satellite. Moreover, it is preferable that the information processing device further include second 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 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 second storage means so as to correct the positional information received by the receiving means on the basis of the difference. The calculating means preferably calculates the route and the distance traveled by the vehicle corresponding to the received positional information by performing the averaging process on the corrected positional information using the positional information of the other vehicle.

{0017}

According to the present invention, since the positional information of the vehicle is corrected on the basis of the signal from the GPS base station, the distance traveled by the vehicle can be measured with higher accuracy.

{0018}

In the first aspect, the global-positioning-system base station preferably includes a plurality of global-positioning-system base stations respectively provided in a plurality of predetermined correction areas, and the correcting means preferably corrects positional information included in each correction area using the difference based on the signal transmitted from the global-positioning-system base station provided in the correction area.

{0019}

With the above configuration, since the positional information of the vehicle is corrected using the difference based on the signal from the GPS base station provided in each of the predetermined correction areas, the distance traveled by the vehicle can be measured with higher accuracy.

{0020}

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.

{0021}

Since the above configuration includes the on-board device that is installed in a vehicle and that transmits positional information indicating the running position

thereof, and the aforementioned information processing device, the distance traveled by the vehicle can be measured with higher accuracy.

{0022}

A toll collection method according to a third aspect of the present invention is implemented by an information processing device including storage means for storing toll-area information indicating an area where a toll is charged to vehicles, and receiving means for receiving positional information from a plurality of vehicles, the positional information indicating the position of each vehicle. The method includes a first step of calculating a route and a distance traveled by a vehicle corresponding to the positional information received by the receiving means by performing an averaging process on the received positional information using the positional information of another vehicle; and a second step of charging the toll to the vehicle on the basis of the traveled distance calculated in the first step and the toll-area information stored in the storage means.

{0023}

With the above configuration, since the averaging process is performed on the positional information received by the receiving means using the positional information of the other vehicle, an error in the positional information can be reduced, thereby measuring the distance traveled by the

vehicle with higher accuracy. Therefore, the present invention can accurately charge a toll to a vehicle traveling in a toll area.

{Advantageous Effects of Invention}

{0024}

The present invention has a notable advantage in that it is possible to measure the distance traveled by a vehicle with higher accuracy.

{Brief Description of Drawings}

{0025}

{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 schematic view illustrating averaging areas according to the first embodiment of the present invention.

{Fig. 5A} Fig. 5A is a schematic view illustrating vehicle-position-history information stored in a vehicle-position-history storage section according to the first embodiment of

the present invention.

{Fig. 5B} Fig. 5B is a schematic view illustrating vehicle-position-history information stored in a vehicle-position-history storage section according to the first embodiment of the present invention.

{Fig. 6} Fig. 6 is a flowchart illustrating the flow of an averaging program according to the first embodiment of the present invention.

{Fig. 7} Fig. 7 is a schematic view for explaining the averaging program according to the first embodiment of the present invention.

{Fig. 8} Fig. 8 illustrates the overall configuration of a toll collection system according to a second embodiment of the present invention.

{Fig. 9} Fig. 9 is a block diagram schematically illustrating the configuration of a central unit according to the second embodiment of the present invention.

{Fig. 10} Fig. 10 illustrates the overall configuration of a toll collection system according to a third embodiment of the present invention.

{Description of Embodiments}

{0026}

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.

{0027}

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.

{0028}

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 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.

{0029}

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, these 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.

With the so-called GPS that measures the current position on the basis of 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, and additionally includes the time and date

when the positional information was generated.

{0030}

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.

{0031}

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

{0032}

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; and balance information and card information read from the IC card.

{0033}

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.

{0034}

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.

{0035}

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.

{0036}

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.

{0037}

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, a traveled-distance calculator 54 that calculates the route and the distance traveled by the vehicle 12, a vehicle-position-history storage section 55 that successively stores the

positional information of the vehicle 12 received by the wide-area communication unit 50, 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 toll-table information, and a communication section 62 that transmits/receives information to/from other information processing devices.

{0038}

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 positional information of the vehicle 12 included in the response signal to the traveled-distance calculator 54.

{0039}

The traveled-distance calculator 54 calculates the route and the distance traveled by the vehicle 12 on the basis of the positional information of the vehicle 12 input from the CPU 52 and the positional information stored in the vehicle-position-history storage section 55.

{0040}

The vehicle-position-history storage section 55 stores

the received positional information as information in the form of, for example, a table (referred to as "vehicle-position-history information" hereinafter) for each vehicle 12 and each predetermined averaging area that corresponds to the position indicated by the positional information.

The averaging areas are obtained by segmenting the toll area A into multiple segments on the basis of roads on which vehicles 12 travel. An average distance traveled by vehicles 12 in the same averaging area is calculated from the latitude and the longitude indicated by the positional information of each vehicle 12.

{0041}

Fig. 4 is a schematic view of the averaging areas. Each averaging area is set so as to surround, with a predetermined margin (e.g., 2 m), the corresponding road (i.e., a region surrounded by solid lines) on which vehicles 12 travel. Moreover, each averaging area may be set for each branching road, or multiple roads that are parallel to each other may be set as a single averaging area.

{0042}

Fig. 5A and Fig. 5B is a schematic view illustrating the vehicle-position-history information stored in the vehicle-position-history storage section 55. As shown in Fig. 5A and Fig. 5B, each averaging area is defined by the latitude and the longitude thereof, and the positional information of each

vehicle 12 is stored in a time-series fashion when the vehicle 12 travels through the averaging area.

Positional information of a vehicle 12 that has deviated from the averaging area (i.e., some of the positions indicated by a triangle (Δ) in Fig. 4) is not stored as vehicle-position-history information.

{0043}

Then, the CPU 52 detects whether a vehicle 12 has entered or exited the toll area A on the basis of the position of the vehicle 12 based on the traveled route calculated by the traveled-distance calculator 54 and the toll-area information stored in the toll-area-information storage section 56. Subsequently, information indicating the distance traveled by the vehicle 12 detected as having entered or exited the toll area A and the times of entry and exit into and from the toll area A is output as entry/exit information from the CPU 52 to the toll-fee determining section 58.

{0044}

The toll-area information stored in the toll-area-information storage section 56 is appropriately updated when the toll area A is changed due to road maintenance or a traffic jam of vehicles 12.

{0045}

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 toll-table information stored in the toll-table storage section 60. The toll-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 distance traveled by 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.

{0046}

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.

{0047}

With GPS, the accuracy thereof is sometimes significantly reduced in, for example, urban areas where the visibility of GPS satellites is low. Therefore, the traveled-distance calculator 54 according to the first embodiment performs an averaging process on the positional information included in the response signal received by the wide-area communication unit 50 using the positional information of other vehicles 12 so as to calculate the route and the distance traveled by the vehicle 12 corresponding to the received positional information, thereby reducing an error in the positional information.

{0048}

Fig. 6 is a flowchart illustrating the flow of an averaging program executed by the traveled-distance calculator 54 when the central unit 14 performs the averaging process. The averaging program is stored in advance in a predetermined region of a read-only memory (ROM) (not shown). The averaging program commences when the central unit 14 starts to operate and ends when the central unit 14 stops operating.

{0049}

First, in step 100, the program is on standby until new positional information is input from the CPU 52. The program proceeds to step 102 when the new positional information is input.

{0050}

In step 102, the positional information of the other vehicles 12 included in the averaging area that corresponds to the position of the vehicle 12 indicated by the input positional information is read from the vehicle-position-history storage section 55.

{0051}

In step 104, an averaging process is performed on the received positional information by using the positional information of the other vehicles 12 read in step 102.

More specifically, in step 104, based on the positional information of the vehicle 12 input in step 100, the route traveled by the vehicle 12 in the averaging area (e.g., a vehicle 12 denoted by a hollow circle (○) in Fig. 7) and the routes traveled by other vehicles 12 in the same averaging area in the same direction as the aforementioned vehicle 12 (e.g., vehicles 12 denoted by a solid circle (●) and a triangle (Δ) in Fig. 7) are calculated. The traveling direction of the vehicles 12 can be determined on the basis of time/date information additionally included in the positional information.

Then, in step 104, the route traveled by the vehicle 12 input in step 100 and the routes traveled by the other vehicles 12 are averaged out (an averaged traveled route is denoted by a solid line in Fig. 7). The averaged traveled

route is set as the route traveled by the vehicle 12 input in step 100, and the distance traveled by the vehicle 12 is calculated from the averaged traveled route.

{0052}

Since positional information of a vehicle 12 that has deviated from the averaging area (i.e., some of the positions indicated by a triangle (Δ) in Fig. 7) is not stored as vehicle-position-history information, such positional information is not used for the averaging process. Therefore, positional information with a large GPS error is not used for the averaging process, thereby improving the averaging accuracy. Specifically, each averaging area is set so as to surround the corresponding road with a predetermined margin, and the margin indicates an acceptable error range for an error in positional information.

{0053}

Furthermore, the positional information of the other vehicles 12 used for the averaging process in step 104 is positional information generated within a predetermined time period in which the effect of an error occurring due to the state of a GPS signal transmitted from the GPS satellites can be minimized.

{0054}

A GPS error occurs due to the state of a GPS signal. The state of a GPS signal changes depending on the number of GPS

satellites that can be observed from a vehicle 12, the set positions of the GPS satellites, and the condition of the ionosphere. Although the number of GPS satellites that can be observed from a vehicle 12 and the set positions of the GPS satellites change with time, they substantially match at the same location and the same time, even on different days. Specifically, the averaging process according to the first embodiment is performed using positional information of other vehicles 12 equivalent to one full day (i.e., the last 24 hours from the current time) so that the effect of an error occurring due to the state of a GPS signal transmitted from the GPS satellites can be minimized. In other words, the error can be reduced.

If the number of other vehicles 12 that have traveled in the averaging area within one full day is smaller than or equal to a predetermined number of vehicles (e.g., 50 vehicles), the averaging process may be performed using positional information of other vehicles 12 equivalent to multiple days, the number of which satisfies the predetermined number of vehicles.

{0055}

In step 106, the positional information input in step 100 is included in the vehicle-position-history information so as to be stored in the vehicle-position-history storage section 55. In addition, the distance traveled by the vehicle 12

calculated in step 104 is output to the CPU 52. Then, the program returns to step 100 and repeats step 100 to step 106 until the central unit 14 stops operating.

{0056}

As described above, the central unit 14 according to the first embodiment is an information processing device that charges a toll to vehicles that have entered or exited a toll area. In the central unit 14, the wide-area communication unit 50 receives, from a vehicle 12, positional information indicating the position of the vehicle 12 based on the latitude and the longitude thereof. The traveled-distance calculator 54 calculates the route and the distance traveled by the vehicle corresponding to the positional information received by the wide-area communication unit 50 by performing an averaging process on the received positional information using the positional information of other vehicles 12.

{0057}

Therefore, the central unit 14 according to the first embodiment can measure the distance traveled by the vehicle 12 with higher accuracy.

{0058}

Furthermore, the central unit 14 according to the first embodiment stores the positional information received by the wide-area communication unit 50 in the vehicle-position-history storage section 55 for each vehicle 12 and each

averaging area corresponding to the position indicated by the positional information. Then, the traveled-distance calculator 54 performs an averaging process on the positional information received by the wide-area communication unit 50 using the positional information of other vehicles 12 in the averaging area corresponding to the positional information.

{0059}

Consequently, since the central unit 14 according to the first embodiment does not need to perform a so-called map matching process for correcting the positional information of a vehicle on the basis of map data indicating the position, the width, and the length of a road, the distance traveled by the vehicle can be measured more simply with higher accuracy.

{0060}

Furthermore, in the central unit 14 according to the first embodiment, since the positional information of other vehicles 12 used for the averaging process is positional information generated within a predetermined time period in which the effect of an error occurring due to the state of a GPS signal transmitted from the GPS satellites can be minimized, an error occurring due to the state of a GPS signal transmitted from the GPS satellites can be reduced.

{0061}

Although a configuration in which the current position of a vehicle 12 is detected by using radio waves from GPS

satellites is described in the first embodiment, the present invention is not limited to this configuration. Alternatively, the current position of a vehicle 12 may be detected by using radio waves transmitted from wireless local-area-network (LAN) access points that are established mainly for internet connection and that use a wireless LAN called wireless fidelity (Wi-Fi).

{0062}

Second Embodiment

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

{0063}

Fig. 8 illustrates the configuration of a toll collection system 10 according to the second embodiment. Components in Fig. 8 that are the same as those in Fig. 1 are given the same reference numerals as in Fig. 1, and descriptions thereof will be omitted.

In the toll area A according to the second embodiment, a GPS base station 70 is set. The GPS base station 70 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. Although the GPS base station 70 according to the second embodiment is provided in the facility 16 that has the central unit 14, the GPS base station 70 may alternatively be

provided at another location in the toll area A.

{0064}

Fig. 9 illustrates the configuration of the central unit 14 according to the second embodiment. Components in Fig. 9 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.

The central unit 14 according to the second 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.

{0065}

The positional information of the vehicle 12 received by the wide-area communication unit 50 and the reception information of the GPS base station 70 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 70

and the GPS-base-station information stored in the GPS-base-station-information storage section 80.

{0066}

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 70 so as to obtain the difference therebetween. Then, the GPS corrector 82 corrects (by subtraction) the positional information of the vehicle 12 using the obtained difference, and outputs the corrected positional information to the traveled-distance calculator 54.

{0067}

The traveled-distance calculator 54 calculates the route and the distance traveled by the vehicle corresponding to the received positional information by performing an averaging process on the corrected positional information using the positional information of other vehicles 12.

{0068}

Consequently, since the toll collection system 10 according to the second embodiment corrects the positional information of the vehicle 12 on the basis of the signal from the GPS base station 70, the distance traveled by the vehicle 12 can be measured with higher accuracy.

{0069}

Third Embodiment

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

{0070}

Fig. 10 illustrates the configuration of a toll collection system 10 according to the third embodiment. Components in Fig. 10 that are the same as those in Fig. 8 are given the same reference numerals as in Fig. 8, and descriptions thereof will be omitted.

{0071}

As shown in Fig. 10, the toll collection system 10 according to the third embodiment is provided with a plurality of GPS base stations 70 in respective correction areas B within the toll area A.

The correction areas B are predetermined areas set within the toll area A in accordance with geographical conditions therein, such as the density and the height of buildings and the locations of mountains. Specifically, the areas set as the correction areas B are where a GPS error caused by geographical conditions may be large.

{0072}

The GPS-base-station information stored in the GPS-base-station-information storage section 80 indicates the latitude and the longitude of the set position of each GPS base station

70, as well as the range of the correction area B corresponding to the GPS base station 70.

{0073}

The GPS corrector 82 corrects the positional information included in each correction area B by using a difference based on the reception information transmitted from the GPS base station 70 provided in the correction area B.

{0074}

In detail, based on the received positional information and the GPS-base-station information stored in the GPS-base-station-information storage section 80, the GPS corrector 82 detects the correction area B where the vehicle 12 that has transmitted the positional information is located. Then, the GPS corrector 82 reads, from the GPS-base-station-information storage section 80, the latitude and the longitude of the set position of the GPS base station 70 corresponding to the detected correction area B, and compares the latitude and the longitude of the read set position with the latitude and the longitude indicated by the reception information transmitted from the GPS base station 70 so as to obtain the difference therebetween.

Subsequently, the GPS corrector 82 corrects the positional information of the vehicle 12 included in the correction area B using the aforementioned difference (by subtraction), and outputs the corrected positional information

to the traveled-distance calculator 54.

If there is no correction area B that corresponds to the input positional information of the vehicle 12, the GPS corrector 82 outputs the input positional information to the traveled-distance calculator 54 without correcting the positional information. Alternatively, the GPS corrector 82 corrects the input positional information using reception information transmitted from the GPS base station 70 provided at a representative location (i.e., the facility 16), and outputs the corrected positional information to the traveled-distance calculator 54.

{0075}

Consequently, since the toll collection system 10 according to the third embodiment corrects the positional information of the vehicle 12 on the basis of a signal from the GPS base station 70 provided in each of the correction areas B, the distance traveled by the vehicle 12 can be measured with higher accuracy.

{0076}

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.

{Reference Signs List}

10 toll collection system

12 vehicle

14 central unit

20 on-board device

50 CPU

54 traveled-distance calculator

55 vehicle-position-history storage section

70 GPS base station

80 GPS-base-station-information storage section

82 GPS corrector

{CLAIMS}

{Claim 1}

An information processing device comprising:

receiving means for receiving positional information from a plurality of vehicles, the positional information indicating the position of each vehicle; and

calculating means for calculating a route and a distance traveled by a vehicle corresponding to the positional information received by the receiving means by performing an averaging process on the received positional information using the positional information of another vehicle.

{Claim 2}

The information processing device according to Claim 1, further comprising storage means for storing the positional information received by the receiving means for each vehicle and each predetermined area that corresponds to the position indicated by the positional information,

wherein the calculating means performs the averaging process on the positional information received by the receiving means by using the positional information of the other vehicle, stored in the storage means, in the area corresponding to the positional information.

{Claim 3}

The information processing device according to Claim 1 or 2, wherein the positional information is generated on the

basis of a global-positioning-system signal transmitted from a global-positioning-system satellite, and

wherein the positional information of the other vehicle used for the averaging process by the calculating means includes positional information generated within a predetermined time period in which an effect of an error occurring due to the state of the global-positioning-system signal transmitted from the global-positioning-system satellite is minimized.

{Claim 4}

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

wherein the information processing device further comprises:

second 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

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 second storage means so as to correct the positional information received by the receiving

means on the basis of the difference, and

wherein the calculating means calculates the route and the distance traveled by the vehicle corresponding to the received positional information by performing the averaging process on the corrected positional information using the positional information of the other vehicle.

{Claim 5}

The information processing device according to Claim 4, wherein the global-positioning-system base station includes a plurality of global-positioning-system base stations respectively provided in a plurality of predetermined correction areas, and

wherein the correcting means corrects positional information included in each correction area using the difference based on the signal transmitted from the global-positioning-system base station provided in the correction area.

{Claim 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.

{Claim 7}

A toll collection method of an information processing device including storage means for storing toll-area information indicating an area where a toll is charged to vehicles, and receiving means for receiving positional information from a plurality of vehicles, the positional information indicating the position of each vehicle, the method comprising:

a first step of calculating a route and a distance traveled by a vehicle corresponding to the positional information received by the receiving means by performing an averaging process on the received positional information using the positional information of another vehicle; and

a second step of charging the toll to the vehicle on the basis of the traveled distance calculated in the first step and the toll-area information stored in the storage means.