

[DESCRIPTION]

[TITLE OF INVENTION]

BILLING PROCESSING SYSTEM, BILLING PROCESSING METHOD, BILLING
PROCESSING DEVICE, PROGRAM, AND RECORDING MEDIUM

5 [Technical Field]

[0001]

The present invention relates to a billing processing system, a billing processing
method, a billing processing device, a program, and a recording medium. Priority is
claimed on Japanese Patent Application No. 2012-243767, filed November 5, 2012, the
10 content of which is incorporated herein by reference.

[Background Art]

[0002]

As a system following a dedicated short-range communication (DSRC) type
electronic road pricing (ERP) system, a system using a global positioning system (GPS),
15 such as a billing system which is put to practical use for heavy vehicles such as trucks on
expressways in Germany, is believed to be promising. The system using GPS has been
standardized.

[0003]

When a position is measured using a general GPS receiver without an improved
20 functionality such as a differential GPS (DGPS), a positioning error is equal to or less
than about 10 m in a conspicuous place in which GPS satellites are arranged well and
four or more GPS satellites are distributed discretely in the sky.

[0004]

However, when positioning means using the GPS is applied to an urban area
25 which is an ERP target area and in which buildings are arranged, there are multipath

problems and the like in which GPS signals are blocked or GPS signals are randomly reflected by buildings and overhead structures. Accordingly, in an urban area having many structures, it is generally difficult to exhibit positioning performance specific to the GPS.

5 [0005]

When the GPS as positioning means for positioning a vehicle is applied to the ERP system, a countermeasure against the problems which are caused when the GPS is used in an urban area is indispensable. A high-sensitivity GPS receiver may be used to receive weak GPS signals in an urban area. However, a high-sensitivity GPS receiver is likely to be affected by a multipath signal and, the high-sensitivity becomes a new technical problem. Various techniques related to these circumstances are known (for example, see Patent Literature 1).

[0006]

For example, Patent Literature 1 discloses a device configured to transmit and receive information such as fee collection to a mobile object traveling in a billing zone and to perform a billing process on a user of the mobile object. More specifically, this device detects position information of a mobile object. The device determines a billing zone in predetermined map information, determines a buffer area at a boundary between the billing zone and a zone other than the billing zone, correlates the map information with the position information, and determines an entrance state indicating whether the mobile object has entered at least one of the billing zone and the buffer area. The device generates billing information for the mobile object based on the determination result. In this way, according to this device, it is possible to satisfactorily determine whether a vehicle is present in the billing zone even when a detection error is present when detecting a position of the vehicle, to generate billing information for the vehicle

depending on the entrance state without installing a road machine at all entrance and exit positions such as entrances, and to properly perform a billing process for a user of the vehicle with a simple configuration.

[Citation List]

5 [Patent Literature]

[0007]

[Patent Literature 1]

Japanese Patent No. 3352036

[Summary of Invention]

10 [Technical Problem]

[0008]

The technique disclosed in Patent Literature 1 is efficient as a technique for properly performing a billing process for a user of a vehicle which is traveling in the billing zone when a positioning error of the GPS in the billing zone is not known.

15 [0009]

On the other hand, a positioning result of the GPS at the same positioning position tends to have a constant positioning error based on an environment thereof when the environment such as arrangement of peripheral structures of the positioning position does not vary.

20 [0010]

Therefore, in order to properly cope with constant positioning errors at a plurality of positioning positions in the billing zone using the technique disclosed in Patent Literature 1, it is necessary to set a range of a buffer area depending on the constant positioning error at a predetermined positioning position among a plurality of positioning positions which can be candidates around a core area.

25

[0011]

However, when the range of the buffer area is set depending on a small positioning error, there may be an area which is included in the billing zone but is not included in the buffer area and thus a business operator of a toll road suffers a disadvantage.

[0012]

On the other hand, when the range of the buffer area is set depending on a large positioning error, there may be an area which is not included in the billing zone but is included in the buffer area and thus a user suffers a disadvantage.

[Solution to Problem]

[0013]

In order to solve the above-mentioned problems, according to a first aspect of the present invention, there is provided a billing processing system that performs a billing process for specific road usage, the billing processing system including: a positioning device installed in a vehicle and configured to measure a position using a signal transmitted from another device; and a billing processing device installed in the vehicle and configured to perform the billing process for the specific road usage, wherein the billing processing device includes; a position specifying unit configured to correct a positioning result measured by the positioning device using information on a positioning error generated due to a surrounding conditions and to specify a position of the vehicle; a road use determining unit configured to determine whether the vehicle is using the specific road based on information on the position specified by the position specifying unit; and a billing processing unit configured to perform the billing process for the specific road usage when the road use determining unit determines that the vehicle is using the specific road.

[0014]

The billing processing device may further include a billing amount calculating unit configured to calculate a billing amount for use of the road when the road use determining unit determines that the vehicle is using the specific road, and the billing processing unit may perform the billing process based on the billing amount calculated by the billing amount calculating unit.

[0015]

The billing processing device may further include a travel distance calculating unit configured to calculate a travel distance of the vehicle based on the information of the position specified by the position specifying unit when the road use determining unit determines that the vehicle is using the specific road, and the billing amount calculating unit may calculate the billing amount based on the travel distance calculated by the travel distance calculating unit.

[0016]

According to a second aspect of the present invention, there is provided a billing processing method of performing a billing process for specific road usage, the billing processing method including: a position specifying step of correcting a positioning result measured by a positioning device, which is installed in a vehicle to measure a position using a signal transmitted from another device, using information on a positioning error generated due to surrounding conditions and specifying a position of the vehicle; a road use determining step of determining whether the vehicle is using the specific road based on information on the position specified in the position specifying step; and a billing processing step of performing the billing process for the specific road usage when it is determined in the road use determining step that the vehicle is using the specific road.

[0017]

According to a third aspect of the present invention, there is provided a billing processing device that is installed in a vehicle to perform a billing process for specific road usage, the billing processing device including: a position specifying unit configured to correct a positioning result measured by a positioning device, which is installed in a vehicle to measure a position using a signal transmitted from another device, using information on a positioning error generated due to a surrounding conditions and to specify a position of the vehicle; a road use determining unit configured to determine whether the vehicle is using the specific road based on information on the position specified by the position specifying unit; and a billing processing unit configured to perform the billing process for the specific road usage when the road use determining unit determines that the vehicle is using the specific road.

[0018]

According to a fourth aspect of the present invention, there is provided a program causing a computer to serve as a billing processing device which is installed in a vehicle to perform a billing process for specific road usage, the program causing the computer to serve as: a position specifying unit configured to correct a positioning result measured by a positioning device, which is installed in a vehicle to measure a position using a signal transmitted from another device, using information on a positioning error generated due to a surrounding conditions and to specify a position of the vehicle; a road use determining unit configured to determine whether the vehicle is using the specific road based on information on the position specified by the position specifying unit; and a billing processing unit configured to perform the billing process for the specific road usage when the road use determining unit determines that the vehicle is using the specific road.

[0019]

According to a fifth aspect of the present invention, there is provided a recording medium having a program, which causes a computer to serve as a billing processing device installed in a vehicle to perform a billing process for specific road usage, recorded thereon, the program causing the computer to serve as: a position specifying unit
5 configured to correct a positioning result measured by a positioning device, which is installed in a vehicle to measure a position using a signal transmitted from another device, using information on a positioning error generated due to a surrounding conditions and to specify a position of the vehicle; a road use determining unit configured to determine whether the vehicle is using the specific road based on information on the position
10 specified by the position specifying unit; and a billing processing unit configured to perform the billing process for the specific road usage when the road use determining unit determines that the vehicle is using the specific road.

[0020]

The above-mentioned summary of the present invention does not disclose all
15 necessary features of the present invention. Sub-combinations of the feature groups may constitute the present invention.

[Advantageous Effects of Invention]

[0021]

As can be clearly understood from the above description, according to the
20 present invention, when a positioning error is present due to a surrounding conditions, it is possible to specify a position of a vehicle more accurately using signals of the GPS or the like and to perform a billing process based on the position information.

[Brief Description of Drawings]

[0022]

25 Fig. 1 is a diagram showing an example of a usage environment of a billing

processing system 100 according to a first embodiment.

Fig. 2 is a diagram showing an example of a block configuration of an onboard device 110.

Fig. 3 is a diagram showing an example of information stored in a positioning error information storage unit 119 in the form of a table.

Fig. 4 is a diagram showing an example of information stored in a billing zone information storage unit 120 in the form of a table.

Fig. 5 is a diagram showing an example of the concept of a multipath error.

Fig. 6 is a diagram showing an example of a flow of operations of the onboard device 110.

Fig. 7 is a diagram showing an example of a flow of operations of the onboard device 110.

Fig. 8 is a diagram showing an example of a usage environment of a billing processing system 200 according to a second embodiment.

Fig. 9 is a diagram showing an example of a block configuration of an onboard device 210.

Fig. 10 is a diagram showing an example of information stored in a billing point information storage unit 221 in the form of a table.

Fig. 11 is a diagram showing an example of a flow of operations of the onboard device 210.

Fig. 12 is a diagram showing an example of a hardware configuration of a computer 800 constituting the onboard device according to the embodiments.

[Description of Embodiments]

[0023]

Hereinafter, the present invention will be described in conjunction with

embodiments of the present invention, but the following embodiments do not limit the present invention based on the appended claims and not all combinations of features described in the embodiments are essential to the solution of the present invention.

[0024]

5 Fig. 1 is a diagram showing an example of a usage environment of a billing processing system 100 according to a first embodiment. The billing processing system 100 is a system configured to perform a billing process based on a travel distance of a vehicle in a billing zone. The performing of the billing process based on the travel distance of a vehicle in the billing zone may be an example of “performing of a billing process for specific road usage” in the present invention.

[0025]

The billing processing system 100 includes an onboard device 110, a GPS receiver 130, and a display 150. The onboard device 110 may be an example of the “billing processing device” in the present invention. The GPS receiver 130 may be an example of the “positioning device” in the present invention.

[0026]

The GPS receiver 130 is a device configured to measure a position using signals transmitted from GPS satellites. For example, the GPS receiver 130 is installed at a position at which an antenna of the GPS receiver 130 is not shielded, such as on a dashboard D of a vehicle. The GPS receiver 130 is electrically connected to the onboard device 110. The GPS receiver 130 calculates longitude and latitude of the GPS receiver 130 as a positioning result through simultaneous equations using GPS signals transmitted from three or four GPS satellites. Here, the longitude and latitude of the

GPS receiver 130 can be considered to be the longitude and latitude of the vehicle. The

GPS receiver 130 outputs data indicating the positioning result to the onboard device 110.

The GPS satellites may be an example of the “another device” in the present invention.

The GPS signals may be an example of the “signal” in the present invention.

[0027]

The onboard device 110 is a device configured to perform a billing process
5 depending on a travel distance of the vehicle in a billing zone. For example, the
onboard device 110 is installed at a position which does not interfere with driving and
which is reached by a vehicle driver's hand, such as a side surface of a center console C
of the vehicle. The onboard device 110 is electrically connected to the GPS receiver
130 and the display 150. An integrated circuit (IC) card is inserted into a card slot I of
10 the onboard device 110. Here, a nonvolatile memory storing information of a user of
the billing processing system 100, billing information such as usage history, or the like,
application data for realizing a security processing, and the like are mounted in the IC
card. When input the data from the GPS receiver 130, the onboard device 110 performs
a billing process depending on a travel distance of the vehicle in a billing zone. The
15 onboard device 110 outputs data, which is used to display the result of the billing process,
to the display 150.

[0028]

The display 150 is a device configured to display characters or figures. For
example, the display 150 is installed at a position which can be visually recognized by
20 the vehicle driver, such as the center console C of the vehicle. The display 150 is
electrically connected to the onboard device 110. When input the data from the onboard
device 110, the display 150 displays the results of the billing process indicated by the
data.

[0029]

25 In this embodiment, in order to prevent description from being complicated, a

configuration in which the billing processing system 100 includes one GPS receiver 130 and one display 150 will be described. However, the billing processing system 100 may include a plurality of GPS receivers 130 and a plurality of displays 150.

[0030]

5 Fig. 2 shows an example of a block configuration of the onboard device 110.

The onboard device 110 includes a positioning data input receiving unit 111, a position specifying unit 112, a road use determining unit 113, a travel distance calculating unit 114, a billing amount calculating unit 115, a billing processing unit 116, a data output unit 117, a digital map storage unit 118, a positioning error information storage unit 119,
10 and a billing zone information storage unit 120. Functions and operations of the constituent units will be described in detail below.

[0031]

The positioning data input receiving unit 111 receives data indicating a positioning result, which is output from the GPS receiver 130.

15 [0032]

The position specifying unit 112 corrects the positioning result measured by the GPS receiver 130 using information on a positioning error generated due to a surrounding conditions and specifies a position of the vehicle.

[0033]

20 The road use determining unit 113 determines whether the vehicle has entered the billing zone based on the position information specified by the position specifying unit 112. The road use determining unit 113 determines whether the vehicle has entered the billing zone based on the position information specified by the position specifying unit 112. The determining of whether the vehicle has entered the billing zone and the
25 determining of whether the vehicle has entered the billing zone may be an example of

“whether the vehicle is using a specific road” in the present invention.

[0034]

The travel distance calculating unit 114 calculates the travel distance of the vehicle based on the position information specified by the position specifying unit 112 until the road use determining unit 113 determines that the vehicle has exited the billing zone after the road use determining unit 113 determines that the vehicle has entered the billing zone.

[0035]

The billing amount calculating unit 115 calculates a billing amount for use of the road until the road use determining unit 113 determines that the vehicle has exited the billing zone after the road use determining unit 113 determines that the vehicle has entered the billing zone. For example, the billing amount calculating unit 115 calculates the billing amount based on the travel distance calculated by the travel distance calculating unit 114.

[0036]

The billing processing unit 116 performs a billing process for use of the road until the road use determining unit 113 determines that the vehicle has exited the billing zone after the road use determining unit 113 determines that the vehicle has entered the billing zone. For example, the billing processing unit 116 performs the billing process of the billing amount calculated by the billing amount calculating unit 115.

[0037]

The data output unit 117 outputs data, which is used to display the billing amount calculated by the billing amount calculating unit 115, to the display 150. When the billing processing unit 116 performs the billing process, the data output unit 117 outputs data indicating a notification of this.

[0038]

The digital map storage unit 118 stores digital map data. Here, the digital map is a digitalized map which can be processed by a computer. For example, the digital map is prepared using a preparation method such as a method of reading a paper map with a scanner and digitalizing the paper map.

[0039]

The positioning error information storage unit 119 stores information on positioning errors.

[0040]

The billing zone information storage unit 120 stores information on billing zones.

[0041]

Fig. 3 shows an example of information stored in the positioning error information storage unit 119 in the form of a table. The positioning error information storage unit 119 stores information of positioning positions (longitude and latitude) and information of the positioning result (longitude and latitude) in correlation with each other. The information stored in the positioning error information storage unit 119 may be an example of the “information on the positioning error generated due to a surrounding conditions” in the present invention.

[0042]

The information of positioning positions (longitude and latitude) is information indicating longitude and latitude on the digital map stored in the digital map storage unit 118. For example, a target positioning position of the information of positioning positions (longitude and latitude) is a position at which the positioning error of the GPS is generated due to the environment in the billing zone or peripheries thereof. In the

following description, the longitude and latitude (E, N) displayed by the information of positioning positions (longitude and latitude) is referred to as a positioning position (E, N).

[0043]

5 The information of a positioning result (longitude and latitude) is information indicating the longitude and latitude as the positioning result using signals received by the GPS receiver 130 at the position of the longitude and latitude indicated by the information of the positioning position (longitude and latitude). In the following description, the longitude and latitude (E, N) indicated by the information of the positioning result (longitude, latitude) is referred to as a positioning result (E, N). In this example, when a position is measured using the signals received by the GPS receiver 130 at a positioning position (Ea, Na), it indicates that the positioning result is a positioning result (Eb, Nb).

[0044]

15 Fig. 4 shows an example of information stored in the billing zone information storage unit 120 in the form of a table. The billing zone information storage unit 120 stores information of road identifiers (IDs) and information of billing amounts (yen/km) in correlation with each other.

[0045]

20 The information of a road ID is an identifier which identifies a road corresponding to a billing zone. The information of a road ID corresponds to identification information of a road which is attached to a road on the digital map stored in the digital map storage unit 118. In the following description, a road identified by road ID “R*****” is referred to as a road “R*****”.

25 [0046]

The information of a billing amount (yen/km) is information indicating a billing amount when a road identified by a road ID is used. In this example, the billing amount when a road “R0048” is used is “250 (yen/km)”.

[0047]

5 Fig. 5 shows an example of the concept of a multipath error. Principal error factors in GPS positioning are errors of atomic clocks of GPS satellites, an error due to deviation of a GPS satellite from its orbit, an error due to arrangement of GPS satellites, an ionosphere delay error, a multipath error, and an error due to noise generated in the GPS receiver.

10 [0048]

Among these error factors, the multipath error which has a large influence on the positioning will be described herein.

[0049]

The multipath error is generated when radio waves from a GPS satellite are reflected by hills, buildings, trees, ground surfaces, and the like and are received by the antenna of the GPS receiver. As shown in Fig. 5, at a position P1 such as a road between a high-rise building B1 and a high-rise building B2, a direct radio wave W1 from a GPS satellite S may be blocked by the high-rise building B1 and may not reach the position and only a radio wave W2 reflected by the opposite high-rise building B2 may reach the position. The radio wave W2 travels a longer way by the reflection than the direct radio wave W1. Accordingly, the GPS receiver calculates that the distance to the GPS satellite S is greater than the actual distance, which causes a positioning error.

[0050]

The multipath wave which is reflected by the high-rise building B2 in an urban area and is then received has a great influence on high-sensitivity GPS. For example,

25

the positioning result may be a position P2 on the opposite side of the high-rise building B2 like a mirror image.

[0051]

Fig. 6 shows an example of a flow of operations of the onboard device 110. In
5 description of this flow of operations, processes which specify the position of a vehicle will be described in detail. This flow of operations will be described with reference to Figs. 1 to 5.

[0052]

(The GPS receiver 130 repeatedly calculates the longitude and latitude of the
10 GPS receiver 130 over time as a positioning result with simultaneous equations using GPS signals transmitted from three or four GPS satellites. The GPS receiver 130 outputs data indicating the positioning result to the onboard device 110 whenever the positioning result is calculated.

[0053]

15 The positioning data input receiving unit 111 of the onboard device 110 sends the data to the position specifying unit 112 whenever input the data from the GPS receiver 130 (S101).

([0054]

The position specifying unit 112 of the onboard device 110 corrects the
20 positioning result indicated by the data using information stored in the positioning error information storage unit 119 whenever the data sent from the positioning data input receiving unit 111 is received, and specifies the position of the vehicle (S102). For example, when a variation from a value of longitude and latitude based on the previous positioning result to a value of longitude and latitude based on the current positioning
25 result is less than a threshold value, the position specifying unit 112 specifies the value of

longitude and latitude based on the current positioning result as the position of the vehicle. On the other hand, when a variation from a value of longitude and latitude based on the previous positioning result to a value of longitude and latitude based on the current positioning result is equal to or greater than the threshold value, the position specifying unit 112 corrects the value of longitude and latitude based on the current positioning result using the information stored in the positioning error information storage unit 119. For example, when the value of longitude and latitude based on the current positioning result is (Eb, Nb), the position specifying unit 112 reads information “(Ea, Na)” of the positioning position (latitude, longitude) stored in correlation with the information “(Eb, Nb)” of the positioning result (latitude, longitude) among the information stored in the positioning error information storage unit 119. Then, the position specifying unit 112 specifies the value of longitude and latitude (Ea, Na) as the position of the vehicle.

[0055]

Fig. 7 shows an example of a flow of operations of the onboard device 110. In description of this flow of operations, processes when a vehicle has entered a billing zone will be described in detail. This flow of operations will be described with reference to Figs. 1 to 6.

[0056]

The onboard device 110 performs the processes of steps S101 to S102 which are shown in Fig. 6 and repeatedly specifies the position of the vehicle over time. The position specifying unit 112 of the onboard device 110 sends data indicating the specified value of longitude and latitude as data indicating the position information of the vehicle to the road use determining unit 113 and the travel distance calculating unit 114 whenever the position of the vehicle is specified.

[0057]

When the vehicle is not present in any billing zone, the road use determining unit 113 of the onboard device 110 determines whether the vehicle has entered a billing zone (S201) based on the position information indicated by the data, the digital map stored in the digital map storage unit 118, and the information stored in the billing zone information storage unit 120 whenever the data sent from the position specifying unit 112 is received. For example, the road use determining unit 113 performs map matching using the value of longitude and latitude which is the position information indicated by the data received from the position specifying unit 112 and the digital map stored in the digital map storage unit 118. Then, the road use determining unit 113 specifies a road ID on the digital map in which the vehicle is present as the map matching result. When information of the same road ID as the road ID is not stored in the billing zone information storage unit 120, the road use determining unit 113 determines that the vehicle does not enter a billing zone (NO in S201). On the other hand, when the information of the same road ID as the road ID on the digital map is stored in the billing zone information storage unit 120, the road use determining unit 113 determines that the vehicle has entered a billing zone (YES in S201). When it is determined that the vehicle has entered the billing zone, the road use determining unit 113 sends data indicating that effect to the travel distance calculating unit 114.

[0058]

When the data sent from the road use determining unit 113 is received, the travel distance calculating unit 114 calculates the travel distance of the vehicle in the billing zone whenever the data sent from the position specifying unit 112 is received (S202). For example, the travel distance calculating unit 114 calculates the travel distance of the vehicle based on the movement distance of the vehicle on the digital map and the scale of

the digital map. Then, the travel distance calculating unit 114 sends the road ID of the road on which the vehicle travels and data indicating the travel distance on the road indicated by the road ID to the billing amount calculating unit 115 whenever the travel distance of the vehicle is calculated.

5 [0059]

When the data sent from the travel distance calculating unit 114 is received, the billing amount calculating unit 115 of the onboard device 110 calculates a billing amount based on the information indicated by the data and the information stored in the billing zone information storage unit 120. In this example, the billing amount calculating unit
10 115 calculates the billing amount whenever the travel distance increases by “1 (km)”. The billing amount calculating unit 115 sends data indicating the calculated billing amount to the data output unit 117.

[0060]

When the data sent from the billing amount calculating unit 115 is received, the
15 data output unit 117 of the onboard device 110 outputs data for displaying the billing amount indicated by the data to the display 150. In this way, the billing amount in the billing zone is displayed on the display 150 in real time.

[0061]

On the other hand, when the vehicle is in a billing zone, the road use
20 determining unit 113 determines whether the vehicle has exited the billing zone (S205) based on the position information indicated by the data, the digital map stored in the digital map storage unit 118, and the information stored in the billing zone information storage unit 120 whenever the data sent from the position specifying unit 112 is received. This process is the same process as the process of determining whether the vehicle has
25 entered the billing zone and thus detailed description thereof will not be repeated.

When the road use determining unit 113 determines that the vehicle does not exit the billing zone (NO in S205), the onboard device 110 repeatedly performs the processes of steps S202 to S205. On the other hand, when it is determined that the vehicle has exited the billing zone (YES in S205), the road use determining unit 113 sends data indicating
5 that effect to the billing amount calculating unit 115.

[0062]

When the data sent from the road use determining unit 113 is received, the billing amount calculating unit 115 sends data indicating the billing amount up to that time to the billing processing unit 116.

10 [0063]

When the data sent from the billing amount calculating unit 115 is received, the billing processing unit 116 of the onboard device 110 performs a billing process by subtracting the same amount of electronic money as the billing amount indicated by the data from the IC card inserted into the card slot I (S206). The billing processing unit
15 116 sends data indicating the billing process result to the data output unit 117.

[0064]

When the data sent from the billing processing unit 116 is received, the data output unit 117 of the onboard device 110 outputs data for displaying the billing process result indicated by the data to the display 150 (S207). In this way, the billing process
20 result is displayed on the display 150.

[0065]

Fig. 8 shows an example of a usage environment of a billing processing system 200 according to a second embodiment. The billing processing system 200 is a system configured to perform a billing process when a vehicle has passed through a billing point.
25 The performing of a billing process when a vehicle has passed through a billing point

may be an example of “performing a billing process for specific road usage” in the present invention.

[0066]

The billing processing system 200 includes an onboard device 210, a GPS receiver 130, and a display 150. The onboard device 210 may be an example of the “billing processing device” in the present invention. Out of elements of the billing processing system 200, the elements having the same names and reference signs as the elements of the billing processing system 100 according to the first embodiment have the same functions and operations as those in the billing processing system 100.

10 [0067]

The onboard device 210 is a device configured to perform a billing process when a vehicle has passed through a billing point. For example, the onboard device 210 is installed at a position which does not interfere with driving and which can be reached by a vehicle driver’s hand, such as a side surface of a center console C of the vehicle.

15 The onboard device 210 is electrically connected to the GPS receiver 130 and the display 150. An integrated circuit (IC) card is inserted into a card slot I of the onboard device 210. When data output from the GPS receiver 130 is received, the onboard device 210 performs a billing process when the vehicle has passed through a billing point. The onboard device 210 outputs data, which is used to display the result of the billing process,
20 to the display 150.

[0068]

In this embodiment, in order to prevent description from being complicated, a configuration in which the billing processing system 200 includes one GPS receiver 130 and one display 150 will be described. However, the billing processing system 200 may
25 include a plurality of GPS receivers 130 and a plurality of displays 150.

[0069]

Fig. 9 shows an example of a block configuration of the onboard device 210.

The onboard device 210 includes a positioning data input receiving unit 111, a position specifying unit 112, a road use determining unit 213, a billing amount calculating unit

5 215, a billing processing unit 216, a data output unit 117, a positioning error information storage unit 119, and a billing point information storage unit 221. Functions and operations of the constituent units will be described in detail below.

[0070]

Out of elements of the onboard device 210, the elements having the same names
10 and reference signs as the elements of the onboard device 110 according to the first embodiment have the same functions and operations as those in the onboard device 110.

[0071]

The road use determining unit 213 determines whether the vehicle has passed a billing point based on the position information specified by the position specifying unit
15 112. The determining of whether the vehicle has passed a billing point may be an example of “determining whether the vehicle is using a specific road” in the present invention.

[0072]

When the road use determining unit 213 determines that the vehicle has passed
20 through a billing point, the billing amount calculating unit 215 calculates a billing amount for use of the road.

[0073]

When the road use determining unit 213 determines that the vehicle has passed through a billing point, the billing processing unit 216 performs a billing process for use
25 of the road. For example, the billing processing unit 216 performs the billing process

based on the billing amount calculated by the billing amount calculating unit 215.

[0074]

The billing point information storage unit 221 stores information on billing points.

5 [0075]

Fig. 10 shows an example of the information stored in the billing point information storage unit 221 in the form of a table. The billing point information storage unit 221 stores billing point IDs, information of positions (longitude, latitude), and information of billing amounts (yen) in correlation with one another.

10 [0076]

The information of a billing point ID is an identifier which uniquely identifies a billing point. In the following description, a billing point indicated by information of billing point ID “P*****” is referred to as a billing point “P*****”.

[0077]

15 The information of a billing position (longitude, latitude) is information indicating a position of a billing point at which a billing process should be performed when the vehicle has passed through the billing point. In this example, the position (longitude, latitude) of the billing point “P0001” is “(Eg, Ng)”.

[0078]

20 The information of a billing amount (yen) is information indicating a billing amount to be billed when the vehicle has passed through the position indicated by the information of the billing position (longitude, latitude). In this example, “200 (yen)” is billed when the vehicle has passed through the billing point “P0001”.

[0079]

25 Fig. 11 shows an example of a flow of operations of the onboard device 210.

In description of this flow of operations, processes when the vehicle has passed through a billing point will be described in detail. This flow of operations will be described with reference to Figs. 1 to 10.

[0080]

5 Out of process steps of the flow of operations of the onboard device 210, the process steps having the same names and reference signs as the process steps of the flow of operations of the onboard device 110 according to the first embodiment have the same functions and operations as those of the flow of operations of the onboard device 110.

[0081]

10 The onboard device 210 performs the same processes as the processes of steps S101 to S102 shown in Fig. 6 and repeatedly specifies the position of the vehicle over time. The position specifying unit 112 of the onboard device 210 sends data indicating the specified value of longitude and latitude as data indicating the position information of the vehicle to the road use determining unit 213 whenever the position of the vehicle is
15 specified.

[0082]

 Whenever the data sent from the position specifying unit 112 is received, the road use determining unit 213 of the onboard device 210 determines whether the vehicle has passed through a billing point based on the position information indicated by the data
20 and the information stored in the billing point information storage unit 221 (S301). For example, when a difference between the value of longitude and latitude which is the position information indicated by the data received from the position specifying unit 112 and the value of longitude and latitude indicated by information of a billing position (longitude, latitude) stored in the billing point information storage unit 221 is equal to or
25 greater than a threshold value, the road use determining unit 213 determines that the

vehicle does not pass through a billing point (NO in S301). In this case, the road use determining unit 213 does not perform any process. On the other hand, for example, when the difference between the value of longitude and latitude which is the position information indicated by the data received from the position specifying unit 112 and the value of longitude and latitude indicated by information of a billing position (longitude, latitude) stored in the billing point information storage unit 221 is less than the threshold value, the road use determining unit 213 determines that the vehicle has passed through a billing point (YES in S301). Then, the road use determining unit 213 sends data indicating the information of the billing point ID of the billing point which the vehicle is determined to pass through to the billing amount calculating unit 215.

[0083]

When the data sent from the road use determining unit 213 is received, the billing amount calculating unit 215 of the onboard device 210 reads information of a billing amount (yen) stored in correlation with the billing point ID indicated by the data received from the road use determining unit 213 from the information stored in the billing point information storage unit 221. The billing amount calculating unit 215 calculates the billing amount indicated by the read information as a billing amount for passage of the vehicle through the billing point (S302). Then, the billing amount calculating unit 215 sends data indicating the calculated billing amount to the billing processing unit 216.

[0084]

Then, the onboard device 210 performs the same processes as the processes of steps S206 to S207 shown in Fig. 7 and outputs data for displaying the billing process result to the display 150. In this way, the billing process result is displayed on the display 150.

[0085]

The billing processing system may include a speaker instead of the display or in addition to the display. In this case, the data output unit of the onboard device outputs data for outputting the billing amount information that calculated by the billing amount
5 calculating unit to the speaker. When the billing processing unit performs a billing process, the data output unit outputs data for outputting an audible notification of billing processing unit performed a billing process to the speaker.

[0086]

As described above, the billing processing system includes the GPS receiver
10 installed in the vehicle and configured to measure a position using signals transmitted from GPS satellites. The billing processing system includes the onboard device installed in the vehicle and configured to perform a billing process for specific road usage. The onboard device corrects the positioning result measured by the GPS
15 receiver using the information on the positioning error generated due to a surrounding conditions and specifies the position of the vehicle. The onboard device determines whether the vehicle is using the specific road based on the specified position information. The onboard device performs the billing process for use of the road when it is determined that the vehicle is using the specific road.

[0087]

20 In this way, according to the billing processing system, it is possible to specify a position of a vehicle more accurately using GPS signals and to perform a billing process based on the position information, when a positioning error due to a surrounding conditions is present.

[0088]

25 As described above, when it is determined that the vehicle is using the specific

road, the onboard device calculates a billing amount for use of the road. The onboard device performs the billing process based on the calculated billing amount.

[0089]

In this way, according to the billing processing system, it is possible to perform
5 a billing process for specific road usage when the specific road is used, without depending on an external device such as a server.

[0090]

As described above, the onboard device calculates the travel distance of the vehicle based on the specified position information when it is determined that the vehicle
10 is using a specific road. The onboard device calculates a billing amount based on the calculated travel distance.

[0091]

In this way, the billing processing system can be applied to a toll road which employs distance billing.

15 [0092]

Fig. 12 shows an example of a hardware configuration of a computer 800 which constitutes the onboard device according to an embodiment. The computer 800 according to this embodiment includes a CPU peripheral unit including a central processing unit (CPU) 802, a random access memory (RAM) 803, a graphic controller 804, and a display 805 which are connected to each other by a host controller 801, an input and output unit including a communication interface 807, a hard disk drive 808, and a compact disk read only memory (CD-ROM) drive 809 which are connected to each other by an input and output controller 806, and a legacy input and output unit including a read only memory (ROM) 810, a flexible disk drive 811, and an input and output chip
25 812 which are connected to the input and output controller 806.

[0093]

The host controller 801 connects the RAM 803 to the CPU 802 accessing the RAM 803 at a high transmission rate and the graphic controller 804. The CPU 802 operates based on programs stored in the ROM 810 and the RAM 803 and controls the constituent units. The graphic controller 804 acquires image data which is generated on a frame buffer installed in the RAM 803 by the CPU 802 and the like and displays the acquired image data on the display 805. Instead, the graphic controller 804 may include a frame buffer configured to store image data generated by the CPU 802 and the like therein.

10 [0094]

The input and output controller 806 connects the host controller 801 to the communication interface 807, the hard disk drive 808, and the CD-ROM drive 809 which are relatively high-speed input and output devices. The hard disk drive 808 stores programs and data used by the CPU 802 of the computer 800. The CD-ROM drive 809 reads a program or data from a CD-ROM 892 and supplies the program or data to the hard disk drive 808 via the RAM 803.

[0095]

The ROM 810 and relatively low-speed input and output devices such as the flexible disk drive 811 and the input and output chip 812 are connected to the input and output controller 806. The ROM 810 stores a booting program which is executed when the computer 800 starts and/or programs depending on hardware of the computer 800, and the like. The flexible disk drive 811 reads a program or data from a flexible disk 893 and supplies the program or data to the hard disk drive 808 via the RAM 803. The input and output chip 812 connects the flexible disk drive 811 to the input and output controller 806 and connects various input and output devices to the input and output

25

controller 806, for example, via a parallel port, a serial port, a keyboard port, and a mouse port.

[0096]

5 Programs supplied to the hard disk drive 808 via the RAM 803 are stored on a recording medium such as the flexible disk 893, the CD-ROM 892, or an integrated circuit (IC) card and are supplied by a user. The programs are read from the recording medium, are installed in the hard disk drive 808 of the computer 800 via the RAM 803, and are executed by the CPU 802.

[0097]

10 A program which is installed in the computer 800 to cause the computer 800 to serve as an onboard device causes the computer 800 to serve as the position specifying unit configured to correct a positioning result measured by the GPS receiver using information on a positioning error generated due to a surrounding conditions and to specify the position of a vehicle in step S102, the road use determining unit configured to
15 determine whether the vehicle is using a specific road in steps S201, S205, and S301 on the basis of the position information specified by the position specifying unit, and the billing processing unit configured to perform a billing process for use of the road in step S206 when the road use determining unit determines that the vehicle is using the specific road.

20 [0098]

The program may cause the computer 800 to serve as the billing amount calculating unit configured to calculate a billing amount for use of the road in steps S203 and S302 when the road use determining unit determines that the vehicle is using the specific road and the billing processing unit configured to perform a billing process
25 based on the billing amount calculated by the billing amount calculating unit in step

S206.

[0099]

The program may cause the computer 800 to serve as the travel distance calculating unit configured to calculate a travel distance of the vehicle in step S202 based on the position information specified by the position specifying unit when the road use determining unit determines that the vehicle is using the specific road and the billing amount calculating unit configured to calculate a billing amount in step S203 based on the travel distance calculated by the travel distance calculating unit.

[0100]

Information processing described in the programs serve as the positioning data input receiving unit, the position specifying unit, the road use determining unit, the travel distance calculating unit, the billing amount calculating unit, the billing processing unit, the data output unit, the digital map storage unit, the positioning error information storage unit, the billing zone information storage unit, and the billing point information storage unit which are specific means as combinations of software and the above-mentioned hardware resources by causing the computer 800 to read the programs. A specific onboard device corresponding to usage is constructed by realizing calculation or processing of information corresponding to the usage of the computer 800 according to this embodiment using the specific means.

[0101]

For example, when the computer 800 communicates with an external device or the like, the CPU 802 executes a communication program loaded onto the RAM 803 and instructs the communication interface 807 to perform a communication process based on processing details described in the communication program. The communication

interface 807 reads transmission data stored in a transmission buffer area installed in a

storage device such as the RAM 803, the hard disk drive 808, the flexible disk 893, or the CD-ROM 892 and transmits the read transmission data to a network, or writes reception data received from the network in a reception buffer area installed in the storage device, under the control of the CPU 802. In this way, the communication interface 807 may
5 transmit transmission and reception data to the storage device in a direct memory access manner. Instead, the transmission and reception data may be transmitted by causing the CPU 802 to read data from the storage device as a transmission source or the communication interface 807 and to write data to the communication interface 807 or the storage device.

10 [0102]

The CPU 802 reads all or a necessary part onto the RAM 803 in a direct memory access manner from a file or a database stored in an external storage device such as the hard disk drive 808, the CD-ROM 892, or the flexible disk 893, and performs various processes on the data in the RAM 803. The CPU 802 writes back the processed
15 data to the external storage device in a direct memory access manner or the like.

[0103]

In these processes, the RAM 803 can be considered to temporarily hold details of the external storage device and thus the RAM 803, the external storage device, and the like are generically referred to as a memory unit or a storage device in this embodiment.

20 A variety of information such as various programs, data tables, and databases in this embodiment, is stored in the storage device and is subjected to information processing. The CPU 802 may have a part of the RAM 803 in a cache memory and may perform reading and writing on the cache memory. In this aspect, the cache memory serves as a part of the RAM 803. Accordingly, in this embodiment, the cache memory is included
25 in the RAM 803, the memory unit, and/or the storage device unless they are distinctly

described.

[0104]

The CPU 802 performs various processes such as various calculations, information processing, condition determination, information search, and substitution described in this embodiment, which are designated by a sequence of commands of a program, on data read from the RAM 803, and writes back the result to the RAM 803. For example, when the condition determination is performed, the CPU 802 determines whether conditions that various parameters described in this embodiment be greater than, less than, equal to or greater than, equal to or less than, or equal to other parameters or constants are satisfied, and branches the sequence of commands into different sequences of commands or calls a sub routine depending on whether the conditions are satisfied or unsatisfied.

[0105]

The CPU 802 can retrieve information stored in files or databases in the storage device. For example, when a plurality of entries in which an attribute value of a first attribute is correlated with an attribute value of a second attribute are stored in the storage device, the CPU 802 can obtain the attribute value of the second attribute correlated with the first attribute satisfying a predetermined condition by searching for an entry in which the attribute value of the first attribute corresponds to a designated condition out of the plurality of entries stored in the storage device and reading the attribute value of the second attribute stored in the entry.

[0106]

The above-mentioned programs or modules may be stored in an external storage medium. Examples of the storage medium include optical recording media such as a digital versatile disk (DVD) or a compact disk (CD), magneto-optical recording media

such as a magneto-optical disk (MO), tape media, and semiconductor memories such as an IC card, in addition to the flexible disk 893 and the CD-ROM 892. A program may be supplied to the computer 800 via a network using a storage medium such as a hard disk or a RAM installed in a server system connected to a dedicated communication
5 network or the Internet as a recording medium.

[0107]

While the present invention has been described in conjunction with the embodiments, the technical scope of the present invention is not limited to the scope described in the embodiments. It is apparent to those skilled in the art that the
10 embodiments may be modified or improved in various ways. It will be apparent from the description of the appended claims that the modifications or improvements can be included in the technical scope of the present invention.

[0108]

It should be noted that the operations, procedures, steps, and stages in the system,
15 method, device, program, and recording medium described in the claims, description, and drawings can be performed in an arbitrary order unless “previously,” “before,” and the like, are particularly mentioned or a previous process output is used in a subsequent process. Even when the flows of operations in the claims, description, and drawings are explained using “preferentially,” “then,” and the like, it does not mean that performing
20 the flow of operations in this order is essential.

[Industrial Applicability]

[0109]

Particularly, the present invention can be applied to a billing processing system and a billing processing method in which a billing process for specific road usage is
25 performed, a billing processing device that is installed in a vehicle to perform a billing

process for specific road usage, a program causing a computer to serve as the billing processing device, and a recording medium having the program recorded thereon.

[Reference Signs List]

[0110]

- | | |
|----|--|
| 5 | 100 Billing processing system |
| | 110 Onboard device |
| | 111 Positioning data input receiving unit |
| | 112 Position specifying unit |
| | 113 Road use determining unit |
| 10 | 114 Travel distance calculating unit |
| | 115 Billing amount calculating unit |
| | 116 Billing processing unit |
| | 117 Data output unit |
| | 118 Digital map storage unit |
| 15 | 119 Positioning error information storage unit |
| | 120 Billing zone information storage unit |
| | 130 GPS receiver |
| | 150 Display |
| | 200 Billing processing system |
| 20 | 210 Onboard device |
| | 213 Road use determining unit |
| | 215 Billing amount calculating unit |
| | 216 Billing processing unit |
| | 221 Billing point information storage unit |
| 25 | 800 Computer |

	801 Host controller
	802 CPU
	803 RAM
	804 Graphic controller
5	805 Display
	806 Input and output controller
	807 Communication interface
	808 Hard disk drive
	809 CD-ROM drive
10	810 ROM
	811 Flexible disk drive
	812 Input and output chip
	892 CD-ROM
	893 Flexible disk
15	B1 High-rise building
	B2 High-rise building
	C Center console
	D Dashboard
	I Card slot
20	P1 Position
	P2 Position
	S GPS satellite
	W1 Radio wave
	W2 Radio wave

[CLAIMS]

[Claim 1]

A billing processing system that performs a billing process for specific road usage, the billing processing system comprising:

5 a positioning device installed in a vehicle and configured to measure a position using a signal transmitted from another device; and

 a billing processing device installed in the vehicle and configured to perform the billing process for the specific road usage,

 wherein the billing processing device includes:

10 a position specifying unit configured to correct a positioning result measured by the positioning device using information on a positioning error generated due to a surrounding conditions and to specify a position of the vehicle;

 a road use determining unit configured to determine whether the vehicle is using the specific road based on information on the position specified by the position

15 specifying unit; and

 a billing processing unit configured to perform the billing process for the specific road usage when the road use determining unit determines that the vehicle is using the specific road.

[Claim 2]

20 The billing processing system according to claim 1, wherein the billing processing device further includes a billing amount calculating unit configured to calculate a billing amount for use of the road when the road use determining unit determines that the vehicle is using the specific road, and

 wherein the billing processing unit performs the billing process based on the
25 billing amount calculated by the billing amount calculating unit.

[Claim 3]

The billing processing system according to claim 2, wherein the billing processing device further includes a travel distance calculating unit configured to calculate a travel distance of the vehicle based on the information of the position specified by the position specifying unit when the road use determining unit determines that the vehicle is using the specific road, and

wherein the billing amount calculating unit calculates the billing amount based on the travel distance calculated by the travel distance calculating unit.

[Claim 4]

A billing processing method of performing a billing process for specific road usage, the billing processing method comprising:

a position specifying step of correcting a positioning result measured by a positioning device, which is installed in a vehicle to measure a position using a signal transmitted from another device, using information on a positioning error generated due to a surrounding conditions and specifying a position of the vehicle;

a road use determining step of determining whether the vehicle is using the specific road based on information on the position specified in the position specifying step; and

a billing processing step of performing the billing process for the specific road usage when it is determined in the road use determining step that the vehicle is using the specific road.

[Claim 5]

A billing processing device that is installed in a vehicle to perform a billing process for specific road usage, the billing processing device comprising:

a position specifying unit configured to correct a positioning result measured by

a positioning device, which is installed in a vehicle to measure a position using a signal transmitted from another device, using information on a positioning error generated due to a surrounding conditions and to specify a position of the vehicle;

5 a road use determining unit configured to determine whether the vehicle is using the specific road based on information on the position specified by the position specifying unit; and

a billing processing unit configured to perform the billing process for the specific road usage when the road use determining unit determines that the vehicle is using the specific road.

10 [Claim 6]

A program causing a computer to serve as a billing processing device which is installed in a vehicle to perform a billing process for specific road usage, the program causing the computer to serve as:

15 a position specifying unit configured to correct a positioning result measured by a positioning device, which is installed in a vehicle to measure a position using a signal transmitted from another device, using information on a positioning error generated due to a surrounding conditions and to specify a position of the vehicle;

(a road use determining unit configured to determine whether the vehicle is using the specific road based on information on the position specified by the position specifying unit; and
20

a billing processing unit configured to perform the billing process for the specific road usage when the road use determining unit determines that the vehicle is using the specific road.

[Claim 7]

25 A recording medium having a program, which causes a computer to serve as a

billing processing device installed in a vehicle to perform a billing process for specific road usage, recorded thereon, the program causing the computer to serve as:

5 a position specifying unit configured to correct a positioning result measured by a positioning device, which is installed in a vehicle to measure a position using a signal transmitted from another device, using information on a positioning error generated due to a surrounding conditions and to specify a position of the vehicle;

a road use determining unit configured to determine whether the vehicle is using the specific road based on information on the position specified by the position specifying unit; and

10 a billing processing unit configured to perform the billing process for the specific road usage when the road use determining unit determines that the vehicle is using the specific road.