

Description

Title of Invention: ONBOARD UNIT, TOLL COLLECTION SYSTEM, TOLL
COLLECTION METHOD, AND PROGRAM

Technical Field

[0001]

The present disclosure relates to an onboard unit, a toll collection system, a toll collection method, and a program.

Background Art

[0002]

On a current toll road and an expressway, a toll fare is calculated using a toll charge table distributed from a center server to an exit tollgate server of an exit tollgate. The toll charge table defines a toll fare corresponding to a travel section (travel distance) from an entrance tollgate to an exit tollgate.

[0003]

There is a case where a toll fare is applied with a discount. For example, Patent Document 1 describes a technique of applying a time-of-day discount to a vehicle passed through an entrance tollgate in a specific time of day. There is a case where a different toll charge table is set depending on a travel route of a road.

[0004]

A toll charge table applied with a time-of-day discount, a (normal) toll charge table not applied with a time-of-day discount, and the like are distributed from the center server to each exit tollgate server at necessary timings such as start and end timings of the discount time of day, for example. The exit tollgate server calculates a toll fare of each vehicle by using the distributed toll charge table.

Citation List

Patent Literature

[0005]

Patent Document 1: JP 2009-199347 A

Summary of Invention

Technical Problem

[0006]

In recent years, it is required to flexibly change the toll fare of each vehicle depending on the situation of the road on which the vehicle has traveled. However, the known mechanism has difficulty in taking a flexible measure such as changing the toll fare applied to an individual vehicle depending on such a road situation.

[0007]

An object of the present disclosure is to provide an onboard unit, a toll collection system, a toll collection method, and a program that can calculate a toll fare according to a situation of a road on which an individual vehicle has traveled.

Solution to Problem

[0008]

According to one aspect of the present disclosure, an onboard unit includes: a toll information acquisition unit configured to acquire toll information for specifying a toll corresponding to a travel distance of a vehicle on a toll road; a toll change information acquisition unit configured to acquire toll change information applied to at least a part of a section where the vehicle has traveled; a calculation unit configured to calculate a toll fare of the vehicle by applying an integrated change toll based on the toll change information to a toll calculated using the toll information; and a notification unit configured to perform notification of the toll fare calculated to an exit tollgate server of an exit tollgate of the toll road.

[0009]

According to one aspect of the present disclosure, a toll collection system includes: the onboard unit described above; and an exit tollgate server provided at an exit tollgate of the toll road, in which the exit tollgate server includes a toll fare acquisition unit configured to acquire the toll fare of the vehicle provided as notification from the onboard unit, and a charge processing unit configured to perform charge processing of charging the toll fare acquired to the vehicle.

[0010]

According to one aspect of the present disclosure, a toll collection method includes: a step of acquiring, by an onboard unit mounted on a vehicle, toll information for specifying a toll corresponding to a travel distance of the vehicle on a toll road; a step of acquiring, by the onboard unit, toll change information applied to at least a part of a section where the vehicle has traveled; a step of calculating, by the onboard unit, a toll fare of the vehicle by

applying an integrated change toll based on the toll change information to a toll
calculated using the toll information; a step of performing, by the onboard unit,
notification of the toll fare calculated to an exit tollgate server of an exit
tollgate of the toll road; a step of acquiring, by the exit tollgate server, the toll
5 fare of the vehicle provided as notification from the onboard unit; and a step of
performing, by the exit tollgate server, charge processing of charging the toll
fare acquired to the vehicle.
[0011]

According to one aspect of the present disclosure, a program causes an
10 onboard unit to execute: a step of acquiring toll information for specifying a
toll corresponding to a travel distance of a vehicle on a toll road; a step of
acquiring toll change information applied to at least a part of a section where
the vehicle has traveled; a step of calculating a toll fare of the vehicle by
applying an integrated change toll based on the toll change information to a toll
15 calculated using the toll information; and a step of performing notification of
the toll fare calculated to an exit tollgate server of an exit tollgate of the toll
road.

Advantageous Effects of Invention

20 [0012]
According to the above aspect, it is possible to calculate the toll fare
depending on a route on which an individual vehicle has traveled and the
situation of a road.

25 Brief Description of Drawings

[0013]
FIG. 1 is a view illustrating an overall configuration of a toll collection
system according to a first embodiment.

FIG. 2 is a view illustrating a functional configuration of an onboard
30 unit according to the first embodiment.

FIG. 3 is a view illustrating a functional configuration of an entrance
tollgate server according to the first embodiment.

FIG. 4 is a view illustrating a functional configuration of an exit tollgate
server according to the first embodiment.

35 FIG. 5 is a view illustrating a functional configuration of a roadside
device according to the first embodiment.

FIG. 6 is a first sequence diagram illustrating an example of processing
of the toll collection system according to the first embodiment.

FIG. 7 is a view illustrating a transmission example of toll information and toll change information according to the first embodiment.

FIG. 8 is a second sequence diagram illustrating an example of processing of the toll collection system according to the first embodiment.

5 FIG. 9 is a third sequence diagram illustrating an example of processing of the toll collection system according to the first embodiment.

FIG. 10 is a fourth sequence diagram illustrating an example of processing of the toll collection system according to the first embodiment.

10 FIG. 11 is a schematic block diagram illustrating a configuration of a computer according to the first embodiment.

Description of Embodiments

[0014]

First Embodiment

15 Embodiments will be described in detail hereinafter with reference to the drawings.

[0015]

Overall Configuration

20 FIG. 1 is a view illustrating the overall configuration of the toll collection system according to the first embodiment. As illustrated in FIG. 1, a toll collection system 100 includes an onboard unit 10 mounted on a vehicle V, an entrance tollgate server 20, an exit tollgate server 30, a roadside device 40, and a center server 50.

[0016]

25 The onboard unit 10 corresponds to an automatic toll collection system (also called an "electronic toll collection system"). In Japan, processing of automatically paying a toll fare of a toll road of the vehicle V is performed by the electronic toll collection system (also called ETC system (trade name)). Note that the onboard unit 10 of the present embodiment calculates the toll fare
30 of the vehicle V by acquiring toll information for specifying a toll corresponding to a travel distance of the vehicle on the toll road. In the present embodiment, an example will be described in which the toll corresponding to the travel distance is, for example, a toll determined by a road business operator corresponding to a distance (section) from each entrance tollgate to
35 each exit tollgate. In other embodiments, the toll corresponding to the travel distance may be a toll corresponding to the travel distance (actual measurement distance) measured by a GNSS positioning function of the vehicle V or the

onboard unit 10, or may be a toll corresponding to a business distance determined by a road business operator.

[0017]

One entrance tollgate server 20 is provided at a tollgate office of each tollgate on a toll road, for example. While FIG. 1 only illustrates an entrance tollgate server 20A provided at a tollgate office of an A tollgate, the entrance tollgate server 20 is also provided in each tollgate office of a B tollgate, a C tollgate, and the like. The entrance tollgate server 20 performs communication (e.g., DSRC communication) with the onboard unit 10 of the vehicle V via a roadside antenna 21 provided at the entrance tollgate, and performs processing regarding collection of the toll fare. In the present embodiment, the entrance tollgate server 20 performs transmission of toll information and the like to the onboard unit 10 as processing regarding collection of the toll fare.

[0018]

One exit tollgate server 30 is provided at a tollgate office of each tollgate on a toll road, for example. In the example of FIG. 1, the tollgate offices of the A tollgate, the B tollgate, the C tollgate, and the like are provided with exit tollgate servers 30A, 30B, 30C, and the like, respectively. The exit tollgate server 30 performs communication (e.g., DSRC communication) with the onboard unit 10 of the vehicle V via a roadside antenna 31 provided at the exit tollgate, and performs processing regarding collection of the toll fare. In the present embodiment, as the processing regarding collection of the toll fare, the exit tollgate server 30 acquires the toll fare of the vehicle V calculated by the onboard unit 10 and performs collection processing of the toll fare.

[0019]

The roadside device 40 is provided at a notification point of a toll road. The notification point includes, for example, an ITS spot provided at a branching point of a toll road or the like, a free flow charging point, and a connection point of a toll road having a different toll system. The roadside device 40 performs communication (e.g., DSRC communication) with the onboard unit 10 of the vehicle V passing through the notification point via a roadside antenna 41 installed at the notification point, and transmits toll information or toll change information. The toll change information includes information regarding changes of the toll, such as a discount or an extra applied to at least a part of a section where the vehicle V travels.

[0020]

The center server 50 distributes toll information to the entrance tollgate server 20 of each tollgate and the roadside device 40 of each notification point.

In the present embodiment, an example will be described in which toll information includes a toll charge table defining a toll fare corresponding to a travel distance (travel section) from an entrance tollgate to an exit tollgate. The entrance tollgate server 20 and the roadside device 40 transmit toll information including a toll charge table to the onboard unit 10.

[0021]

The center server 50 may directly transmit the toll charge table to the onboard unit 10 by cellular communication. In this case, the onboard unit 10 acquires the toll charge table from the center server 50 using a cellular communication function mounted on the onboard unit 10 or using a cellular communication function of a terminal device 11 connectable to the onboard unit 10. The terminal device 11 is a smartphone, a tablet, or the like, and is communicably connected to the onboard unit 10 in a wired or wireless manner (e.g., Bluetooth (registered trademark)).

[0022]

Functional Configuration of Onboard Unit

FIG. 2 is a view illustrating the functional configuration of the onboard unit according to the first embodiment. As illustrated in FIG. 2, the onboard unit 10 includes a toll information acquisition unit 101, a toll change information acquisition unit 102, a calculation unit 103, a notification unit 104, and a toll information recording unit 105.

[0023]

The toll information acquisition unit 101 acquires toll information for specifying a toll corresponding to a travel distance of the vehicle V on the toll road. The toll information includes a toll charge table defining a toll fare from an entrance tollgate to an exit tollgate of a toll road.

[0024]

The toll change information acquisition unit 102 acquires the toll change information applied to at least a part of a section where the vehicle V travels. The toll change information includes amounts of a discount and an extra for a certain section.

[0025]

The calculation unit 103 calculates the toll fare of the vehicle V by applying an integrated change toll based on the toll change information to the toll calculated using the toll information.

[0026]

The notification unit 104 notifies an exit tollgate server of an exit tollgate of a toll road of a toll fare having been calculated.

[0027]

The toll information recording unit 105 records acquired toll information and toll change information.

[0028]

5 Functional Configuration of Entrance Tollgate Server

FIG. 3 is a view illustrating the functional configuration of the entrance tollgate server according to the first embodiment. As illustrated in FIG. 3, the entrance tollgate server 20 includes a first toll information reception unit 201, a first toll information transmission unit 202, and an entrance information
10 transmission unit 203.

[0029]

The first toll information reception unit 201 receives toll information from the center server 50. The toll information includes a toll charge table defining a toll fare corresponding to a travel distance (travel section) from an entrance tollgate provided with the entrance tollgate server 20 to at least some of the exit tollgates at a downstream side thereof. The at least some of the exit tollgates mean, for example, exit tollgates that exist between an entrance tollgate and the next notification point.

[0030]

20 The first toll information transmission unit 202 transmits toll information including the toll charge table to the onboard unit 10 of the vehicle V arriving at an entrance tollgate via the roadside antenna 21 of an entrance tollgate.

[0031]

25 The entrance information transmission unit 203 transmits entrance information to the onboard unit 10 of the vehicle V arriving at the entrance tollgate via the roadside antenna 21 of the entrance tollgate. The entrance information includes identification information on the entrance tollgate where the vehicle V has entered, and date and time when the vehicle V arrived at the entrance tollgate (processing execution date and time).
30

[0032]

Functional Configuration of Exit Tollgate Server

FIG. 4 is a view illustrating the functional configuration of the exit tollgate server according to the first embodiment. As illustrated in FIG. 4, the exit tollgate server 30 includes an exit information transmission unit 301, a toll fare acquisition unit 302, and a charge processing unit 303.

[0033]

The exit information transmission unit 301 transmits exit information to the onboard unit 10 of the vehicle V arriving at an exit tollgate via the roadside antenna 31 of an exit tollgate. The exit information includes identification information on the exit tollgate where the vehicle V has entered.

5 [0034]

The toll fare acquisition unit 302 acquires the toll fare of the vehicle V calculated by the onboard unit 10.

[0035]

10 The charge processing unit 303 performs charge processing of charging the toll fare acquired from the onboard unit 10 to the vehicle V.

[0036]

Functional Configuration of Roadside Device

15 FIG. 5 is a view illustrating the functional configuration of the roadside device according to the first embodiment. As illustrated in FIG. 5, the roadside device 40 includes a second toll information reception unit 401, a second toll information transmission unit 402, a change information reception unit 403, and a change information transmission unit 404.

[0037]

20 The second toll information reception unit 401 receives toll information from the center server 50. The toll information includes a toll charge table defining the toll fare to at least some of the exit tollgates at a downstream side of the notification point provided with the roadside device 40. The at least some of the exit tollgates mean, for example, exit tollgates that exist before reaching the next notification point.

25 [0038]

The second toll information transmission unit 402 transmits toll information including the toll charge table received by the second toll information reception unit 401 to the onboard unit 10 of the vehicle V arriving at the notification point provided with the roadside device 40.

30 [0039]

35 For example, at the A tollgate in FIG. 1, the entrance tollgate server 20A transmits, to the onboard unit 10, toll information including a toll charge table from the A tollgate to the B tollgate. At an ITS spot E (notification point), the roadside device 40 transmits, to the onboard unit 10, toll information including a toll charge table up to the C tollgate. For example, the center server 50 distributes, to the roadside device 40 of the ITS spot E, a toll charge table from the A tollgate to the C tollgate upstream relative to the ITS spot E, and a toll charge table from the B tollgate to the C tollgate. At this time, the roadside

device 40 acquires information (e.g., entrance information recorded in an IC card (also called an ETC card in Japan) inserted in the onboard unit 10 and used in the automatic toll collection system) indicating the entrance tollgate through which the vehicle V passed held by the onboard unit 10, and transmits
 5 a toll charge table originating from the entrance tollgate to the onboard unit 10. For example, upon acquiring information indicative of having passed through the A tollgate from the onboard unit 10, the roadside device 40 of the ITS spot E transmits a toll charge table from the A tollgate to the C tollgate to this onboard unit 10.

10 [0040]

Note that in other embodiments, the entrance tollgate server 20A may transmit, at the entrance tollgate, the toll charge table from the A tollgate to the next notification point to the onboard unit 10, and the roadside device 40 may transmit, at the notification point, the toll charge table to the next notification
 15 point or the exit tollgate to the onboard unit 10. In this case, every time the vehicle V passes through the entrance tollgate and the notification point, the toll charge table of each section is accumulated in the onboard unit 10. When passing through the exit tollgate, the onboard unit 10 integrates the tolls defined in the toll charge tables having been accumulated to calculate the toll
 20 corresponding to the section where the vehicle V has traveled.

[0041]

In a case where the toll road includes a large number of tollgates, the capacity of the toll charge table covering the toll fares to all the exit tollgates increases. Then, there is a possibility that the onboard unit 10 cannot receive
 25 (fails to receive) this toll charge table before the vehicle V passes through the entrance tollgate. Therefore, by transmitting the toll charge table divided into small parts to the onboard unit 10 in stages at the entrance tollgate and the notification point as described above, it is possible to suppress reception failure of the toll charge table at the onboard unit 10.

30 [0042]

On a toll road where the toll changes depending on the travel route of the vehicle V, the onboard unit 10 may be able to receive a different toll charge table depending on which road the vehicle V has traveled on. In the example of FIG. 1, when the vehicle V passes through an ITS spot D, the roadside device
 35 40 of the ITS spot D transmits, to the onboard unit 10, a toll charge table in a case of not traveling on a detour. On the other hand, when the vehicle V passes through an ITS spot F, the roadside device 40 of the ITS spot F transmits a toll charge table in a case of travelling on the detour. This enables the roadside

device 40 to transmit, to the onboard unit 10, the toll charge table corresponding to the travel route of the individual vehicle V.

[0043]

5 The change information reception unit 403 receives the toll change information from the center server 50.

[0044]

10 The change information transmission unit 404 transmits the toll change information received by the change information reception unit 403 to the onboard unit 10 of the vehicle V arriving at the notification point provided with the roadside device 40.

[0045]

15 The toll change information is information indicating a change (discount or extra) in the toll for at least a part of a section (a section including the notification point) of the toll road. For example, the toll change information includes information indicating a discount amount or an extra amount of the toll corresponding to the road situation. The road situations include, for example, a traffic jam, a sudden event (an accident, a fire, a natural disaster, and the like), lane reduction due to construction, a fallen object, a wrong-way driving vehicle, and speed regulation due to a weather condition. The
20 information indicating the change of the toll includes, for example, a price to be discounted or added (xxx JPY discount or extra). For example, as illustrated in FIG. 1, it is assumed that due to an occurrence of a traffic jam in a part of the detour, the road business operator has given a discount of the toll to the vehicle V traveling on this detour. In this case, at the ITS spot F, the toll change
25 information indicating the discount of the toll is transmitted to the onboard unit 10 of the vehicle V traveling on the detour.

[0046]

30 When receiving an instruction to cancel the toll change information (end the discount or extra) from the center server 50, the change information reception unit 403 deletes the toll change information. Then, the change information transmission unit 404 does not transmit the toll change information.

[0047]

Processing Example 1 of Toll Collection System

35 FIG. 6 is the first sequence diagram illustrating an example of the processing of the toll collection system according to the first embodiment. FIG. 7 is a view illustrating a transmission example of the toll information and the toll change information according to the first embodiment. FIG. 8 is the second

sequence diagram illustrating an example of the processing of the toll collection system according to the first embodiment. Here, the flow of processing of the toll collection system 100 at the entrance tollgate and the notification point (ITS spot) will be described with reference to FIGS. 6 to 8. It is assumed that the toll charge table has been distributed from the center server 50 to the entrance tollgate server 20 of each tollgate and the roadside device 40 of each ITS spot.

[0048]

For example, at the time of activation of the onboard unit 10, the toll information acquisition unit 101 of the onboard unit 10 requests the toll charge table from the center server 50 via the terminal device 11 (step S101). At this time, the center server 50 is notified of position information (the position of the vehicle V) of the terminal device 11. The center server 50 transmits, to the onboard unit 10 via the terminal device 11, the toll charge table originating from the entrance tollgate included in a predetermined distance from the terminal device 11 (step S102). The toll charge table received from the center server 50 is recorded in the toll information recording unit 105 of the onboard unit 10 (step S103).

[0049]

When the vehicle V arrives at the entrance tollgate of the toll road, the entrance information transmission unit 203 of the entrance tollgate server 20 transmits the entrance information to the onboard unit 10 via the roadside antenna 21 (step S111). Note that when the onboard unit 10 acquires the toll charge table and supports a new sequence of calculating the toll fare by itself, the entrance information transmission unit 203 of the entrance tollgate server 20 transmits, to the onboard unit 10, the entrance information added with an identifier indicating that the toll information can be provided. For example, as illustrated in FIG. 7, it is assumed that the vehicle V enters the toll road from the A tollgate. In this case, the entrance information transmission unit 203 of the entrance tollgate server 20A transmits, to the onboard unit 10, the identification information on the A tollgate and the entrance information including the date and time when the vehicle V arrived at the A tollgate, with the identifier added.

[0050]

The toll information acquisition unit 101 of the onboard unit 10 records, in an IC card (ETC card) not illustrated, the entrance information received from the entrance tollgate server 20A (step S112). When the entrance information is added with the identifier, the toll information acquisition unit 101 of the

onboard unit 10 requests the toll information from the entrance tollgate server 20A (step S113).

[0051]

Next, the first toll information transmission unit 202 of the entrance tollgate server 20A transmits, to the onboard unit 10, the toll information including the latest toll charge table distributed from the center server 50 (step S114).

[0052]

The toll information acquisition unit 101 of the onboard unit 10 records, in the toll information recording unit 105, the toll information received from the entrance tollgate server 20A (step S115).

[0053]

For example, it is assumed that a traffic jam occurs on the detour (FIG. 1) provided with the ITS spot F, and the road business operator gives a discount of subtracting, by a certain amount (e.g., 100 JPY), the toll fare of the vehicle having traveled on this detour. At this time, as illustrated in FIG. 6, the center server 50 transmits toll change information indicating a discount amount (-100 JPY) to a roadside device 40F of the ITS spot F (step S121). The change information reception unit 403 of the roadside device 40F records the toll change information received from the center server 50 (step S122).

[0054]

Thereafter, as illustrated in FIG. 7, it is assumed that the vehicle V arrives at the ITS spot F. At this time, at the ITS spot F, the change information transmission unit 404 of the roadside device 40F transmits the toll change information to the onboard unit 10 of the vehicle V via a roadside antenna 41F (step S123). Then, the toll change information acquisition unit 102 of the onboard unit 10 records, in the toll information recording unit 105, the toll change information received from the roadside device 40F (step S124).

[0055]

It is assumed that, for example, there is a traffic jam in a section at and after the ITS spot E, and the road business operator gives a discount for subtracting a price corresponding to a travel distance (travel section) to the vehicle V traveling in this section. Also in this case, the processing in steps S121 to S124 in FIG. 6 is executed. That is, the center server 50 transmits the toll change information indicating the discount amount (e.g., -50 JPY up to the C tollgate, -100 JPY at and after the C tollgate) corresponding to the travel distance to the roadside device 40E of the ITS spot E (step S121). The change information reception unit 403 of the roadside device 40E records the toll

change information received from the center server 50 (step S122). When the vehicle V arrives at the ITS spot E, the change information transmission unit 404 of the roadside device 40E transmits this toll change information to the onboard unit 10 (step S123), and the toll change information acquisition unit 102 of the onboard unit 10 records, in the toll information recording unit 105, the received toll change information (step S124).

[0056]

Note that the center server 50 gives an instruction to the roadside devices 40E and 40F to cancel the toll change information indicating the discount due to the traffic jam at the timing when the traffic jam is resolved. Then, the change information reception unit 403 of each of the roadside devices 40E and 40F deletes the toll change information indicating the discount due to the traffic jam, and thereafter, the change information transmission unit 404 of each of the roadside devices 40E and 40F does not transmit this toll change information. By this, the toll change information indicating the discount due to the traffic jam is recorded only in the onboard unit 10 of the vehicle V having actually traveled in the target section during the occurrence of the traffic jam. That is, it is possible to flexibly apply a change (a discount or an extra) to the toll fare depending on the situation of the road on which an individual vehicle V has actually traveled.

[0057]

As another example, the road business operator may give a time-of-day discount to the vehicle V traveling on the toll road in a specific time of day. In this case, the center server 50 transmits the toll change information indicating the time-of-day discount to each ITS spot at the start time of the discount (step S121). The change information reception unit 403 of the roadside device 40 records the toll change information received from the center server 50 (step S122). When the vehicle V arrives at the ITS spot, the change information transmission unit 404 of the roadside device 40 transmits this toll change information to the onboard unit 10 (step S123), and the toll change information acquisition unit 102 of the onboard unit 10 records, in the toll information recording unit 105, the received toll change information (step S124). Note that the center server 50 gives an instruction to cancel the toll change information indicating the time-of-day discount at the end time of the discount. Then, the change information reception unit 403 of each roadside device 40 deletes the toll change information indicating the time-of-day discount, and thereafter, the change information transmission unit 404 of each roadside device 40 does not transmit the toll change information indicating the time-of-day discount. In this

way, whether the vehicle V traveled in any section at the time when the time-of-day discount is applied can be recorded in the toll change information.

[0058]

There is a case where some entrance tollgates of the toll road are provided with a known entrance tollgate server not supporting the new sequence. FIG. 8 illustrates a processing example in a case where the vehicle V arrives at the entrance tollgate not supporting the new sequence in this manner.

[0059]

First, the known entrance tollgate server transmits the entrance information to the onboard unit 10 (step S111). This entrance information is not added with an identifier indicating that the toll information can be provided to the entrance information.

[0060]

The toll information acquisition unit 101 of the onboard unit 10 records, in the IC card (ETC card) not illustrated, the entrance information received from the known entrance tollgate server (step S112). Since the entrance information is not added with the identifier, the toll information acquisition unit 101 ends the processing without requesting the toll information (step S116).

[0061]

Note that when the distance between the position at which the onboard unit 10 is activated and the entrance tollgate through which the vehicle V passes is close, the toll charge table originating from this entrance tollgate is acquired in the processing at the time of activation (steps S101 to S103 in FIG. 6). Therefore, when the toll charge table cannot be acquired at the entrance tollgate, the toll charge table acquired at the time of activation may be used in calculation (step S202 in FIG. 9) of the toll fare described later. In a case where the position at the time of activation is away from the entrance tollgate and the toll charge table cannot be acquired, steps S101 to S103 may be executed after step S116 to acquire the toll charge table originating from the entrance tollgate through which the vehicle V has passed from the center server 50. At this time, in step S101, the toll information acquisition unit 101 of the onboard unit 10 notifies the center server 50 of entrance information in place of the position information on the terminal device 11. In step S102, the center server 50 identifies the entrance tollgate through which the vehicle V has passed from the entrance information, and transmits the toll charge table originating from this entrance tollgate.

[0062]

As illustrated in FIG. 8, the toll charge table may be transmitted to the onboard unit 10 at the ITS spot. The second toll information transmission unit 402 of the roadside device 40 transmits the toll information including the toll charge table to the onboard unit 10 of the vehicle V passing through the ITS spot (step S131). The toll information acquisition unit 101 of the onboard unit 10 records, in the toll information recording unit 105, the toll information received from the roadside device 40 (step S132).

[0063]

For example, the roadside device 40 of the ITS spot D may transmit, to the onboard unit 10, the toll charge table originating from the entrance tollgate through which the vehicle V has passed. In this case, the second toll information transmission unit 402 of the roadside device 40 first requests the onboard unit 10 to transmit the entrance information in step S131. The toll information acquisition unit 101 of the onboard unit 10 transmits the entrance information recorded in the ETC card to the roadside device 40. Then, the second toll information transmission unit 402 of the roadside device 40 transmits, to the onboard unit 10, the toll charge table originating from the entrance tollgate (e.g., the A tollgate) indicated by the entrance information among the toll charge tables distributed to the roadside device 40. In this case, the toll charge table of the toll information recording unit 105 is updated as the onboard unit 10 travels on the toll road. The onboard unit 10 calculates the toll corresponding to the travel distance (travel section) of the vehicle V using the updated toll charge table.

[0064]

In other embodiments, the onboard unit 10 may acquire a toll charge table divided for each section at the entrance tollgate and each ITS spot. For example, it is assumed that only the toll charge table up to the B tollgate is transmitted to the onboard unit 10 at the A tollgate. In this case, the roadside device 40 of the ITS spots E and F at a downstream side of the B tollgate may transmit, to the onboard unit 10, the toll charge table from the B tollgate to the C tollgate. The toll information acquisition unit 101 of the onboard unit 10 records the received toll charge table in the toll information recording unit 105. By this, as the vehicle V travels on the toll road, the toll charge table including the toll fare to the next exit tollgate is accumulated in the toll information recording unit 105. The onboard unit 10 integrates the tolls defined in the plurality of accumulated toll charge tables, and calculates the toll corresponding to the travel distance (travel section) of the vehicle V.

[0065]

Note that in a case where all the entrance tollgates of the toll road have been supporting the new sequence, that is, in a case where the onboard unit 10 can acquire all the toll charge tables necessary on the toll road, the processing of steps S101 to S103 may be skipped at the time of activation of the onboard unit 10.

[0066]

When failing in acquisition (steps S114 to S115 in FIG. 6 and steps S131 to S132 in FIG. 8) of the toll charge table at the entrance tollgate and the ITS spot, the onboard unit 10 may execute steps S101 to S103 to acquire the toll charge table.

[0067]

Processing Example 2 of Toll Collection System

FIG. 9 is the third sequence diagram illustrating an example of the processing of the toll collection system according to the first embodiment. FIG. 10 is the fourth sequence diagram illustrating an example of the processing of the toll collection system according to the first embodiment. Here, the flow of processing of the toll collection system 100 at the exit tollgate will be described with reference to FIGS. 9 to 10 and 7.

[0068]

First, the flow of processing in a case where the vehicle V arrives at the exit tollgate supporting the new sequence in which the onboard unit 10 acquires the toll charge table and calculates the toll fare by itself will be described with reference to FIGS. 7 and 9. When the vehicle V arrives at the exit tollgate of the toll road, the exit information transmission unit 301 of the exit tollgate server 30 transmits the exit information to the onboard unit 10 via the roadside antenna 31 (step S201). For example, as illustrated in FIG. 7, it is assumed that the vehicle V enters the toll road from the A tollgate and exits the toll road at the C tollgate. In this case, the exit information transmission unit 301 of the exit tollgate server 30C transmits, to the onboard unit 10, the exit information including the identification information on the C tollgate.

[0069]

The calculation unit 103 of the onboard unit 10 calculates the toll fare of the vehicle V based on the toll information and the toll change information recorded in the toll information recording unit 105 and the exit information received from the exit tollgate server 30C (step S202).

[0070]

For example, in the example of FIG. 7, the toll charge table corresponding to the travel distance (travel section) from the A tollgate to the C

tollgate is recorded in the toll information recording unit 105. The calculation unit 103 calculates the toll from the A tollgate to the C tollgate based on this toll charge table and the exit information (information indicating the C tollgate). When the toll charge table for each vehicle type is recorded, the calculation unit 103 calculates the toll from the A tollgate to the C tollgate based on the toll charge table corresponding to the vehicle type recorded in the onboard unit 10. Note that as described above, the toll charge table illustrated in FIG. 7 may be the toll charge table recorded in the toll information recording unit 105 updated based on the toll charge table acquired by the onboard unit 10 at each ITS spot. In other embodiments, the plurality of toll charge tables (e.g., the toll charge table from the A tollgate to the B tollgate and the toll charge table from the B tollgate to the C tollgate) divided for each section acquired by the onboard unit 10 at the entrance tollgate and each ITS spot are recorded in the toll information recording unit 105, and the calculation unit 103 of the onboard unit 10 may calculate the toll corresponding to the travel section (section from the A tollgate to the C tollgate) of the vehicle V by integrating the tolls for respective sections defined in these toll charge tables.

[0071]

Toll change information F and E received by at the ITS spots F and E are each recorded in the toll information recording unit 105. The toll change information F includes information indicating the discount amount (e.g., -100 JPY) for the vehicle V having passed through the detour, and the toll change information E includes information indicating the discount amount (e.g., -50 JPY up to the C tollgate, and -100 JPY at and after the C tollgate) corresponding to the travel distance. The calculation unit 103 calculates the toll fare of the vehicle V by adding, to the toll from the A tollgate to the C tollgate, a value obtained by integrating the discount amounts of the toll change information F and E. In the above example, the discount amount of the vehicle V is -150 JPY obtained by integrating -100 JPY of the toll change information F and -50 JPY of the toll change information E (up to the C tollgate). Assuming that the toll from the A tollgate to the C tollgate is 500 JPY, the toll fare of the vehicle V is 350 JPY.

[0072]

Note that in the above example, the discount amount is expressed by a negative price, but may be expressed by a positive price in other embodiments. In this case, when the toll change information indicates a discount, the calculation unit 103 may calculate the toll fare of the vehicle V by subtracting the discount amount (an integrated value of the toll change information) from

the toll from the A tollgate to the C tollgate. When the toll change information indicates an extra fair, the calculation unit 103 calculates the toll fare of the vehicle V by adding the extra amount (an integrated value of the toll change information) to the toll from the A tollgate to the C tollgate.

5 [0073]

The notification unit 104 of the onboard unit 10 notifies the exit tollgate server 30C of the toll fare calculated by the calculation unit 103 (step S203). At this time, the calculation unit 103 may notify the exit tollgate server 30C of the entrance information recorded on the IC card together with the toll fare as evidence of the toll fare.

10

[0074]

Next, as illustrated in FIG. 9, the charge processing unit 303 of the exit tollgate server 30 performs charge processing of charging the toll fare provided as notification from the onboard unit 10 (step S204) to the vehicle V. The content of the charge processing is similar to the charge processing in the known automatic toll collection system. When the charge processing is completed, the charge processing unit 303 of the exit tollgate server 30 transmits charge information to the center server 50 (step S205), and ends the processing. The charge information includes, for example, identification information on the onboard unit 10 and the toll fare.

15

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[0075]

The flow of processing in a case where the vehicle V arrives at an exit tollgate not supporting the new sequence will be described with reference to FIG. 10. When the vehicle V arrives at the exit tollgate, the known exit tollgate server not supporting the new sequence performs processing (normal automatic toll collection processing) in the known automatic toll collection system. For example, the exit tollgate server requests the onboard unit 10 to transmit the entrance information (step S211). Note that on the toll road on which different toll fares are charged depending on the vehicle type, the exit tollgate server requests the onboard unit 10 to also transmit the vehicle type.

25

30

[0076]

Then, the notification unit 104 of the onboard unit 10 transmits the entrance information to the exit tollgate server (step S212). When the vehicle type is requested, the notification unit 104 also transmits the vehicle type together with the entrance information.

35

[0077]

Next, the exit tollgate server calculates the toll fare of the vehicle V based on the entrance information received from the onboard unit 10 and the

toll charge table defining the toll fare from each entrance tollgate distributed from the center server 50 (step S213). When the toll fare varies depending on the vehicle type, the exit tollgate server calculates the toll fare based on the entrance information and the vehicle type received from the onboard unit 10 and the toll charge table for each vehicle type. The exit tollgate server performs the charge processing of charging the calculated toll fare (step S214) to the vehicle V. These processing are the same as the processing in the known automatic toll collection system. When the charge processing is completed, the exit tollgate server transmits the charge information to the center server 50 (step S215), and ends the processing.

[0078]

Note that as in the example of FIG. 10, in a case of exiting the toll road from the exit tollgate not supporting the new sequence, the toll fare of the vehicle V is not applied with the toll change information (discount). In this case, by operating the terminal device 11, for example, the passenger of the vehicle V reports, to the center server 50, the change of the toll fare based on the toll change information. At this time, the terminal device 11 acquires the toll change information recorded in the onboard unit 10 and transmits it to the center server 50 as evidence. The center server 50 performs post-processing by point return or the like corresponding to the toll change information.

[0079]

As another example of the post-processing in a case where the toll change information (discount) is not applied at the exit tollgate, the following processing may be performed. For example, the roadside device 40 may record a communication log with the onboard unit 10 of each vehicle V. The communication log includes identification information on the onboard unit 10 having performed communication with the roadside device 40 and toll change information transmitted to the onboard unit 10. When receiving charge information on a certain onboard unit 10 from an exit tollgate not supporting the new sequence, the center server 50 acquires a communication log with the onboard unit 10 from each roadside device 40 based on the identification information. The center server 50 performs post-processing by point return or the like corresponding to the toll change information included in the acquired communication log.

[0080]

In this way, even in a case where the vehicle V has not received the discount because it has passed through the exit tollgate not supporting the new

sequence, the center server 50 can cope with point return or the like corresponding to the discount.

[0081]

Computer Configuration

5 FIG. 11 is a schematic block diagram illustrating the configuration of the computer according to the first embodiment. A computer 900 includes a processor 901, a main storage device 902, an auxiliary storage device 903, and an interface 904. The onboard unit 10, the entrance tollgate server 20, the exit tollgate server 30, and the roadside device 40 described above are mounted in
10 respective different computers 900. Then, the operation of each processing unit described above is stored in the auxiliary storage device 903 in the form of a program. The processor 901 reads the program from the auxiliary storage device 903, deploys it in the main storage device 902, and executes the above processing in accordance with the program. The processor 901 secures a
15 storage area used in the above processing in the main storage device 902 in accordance with the program.

[0082]

 The program may be for implementing some of the functions to be exerted by the computer 900. For example, the program may exert the function
20 by a combination with another program already stored in the auxiliary storage device 903 or a combination with another program mounted on another device. Note that in other embodiments, the computer may include a custom large scale integrated circuit (LSI) such as a programmable logic device (PLD) in addition to or in place of the above configuration. Examples of the PLD include a
25 programmable array logic (PAL), a generic array logic (GAL), a complex programmable logic device (CPLD), and a field programmable gate array (FPGA). In this case, some or all of the functions implemented by the processor may be implemented by the integrated circuit.

[0083]

30 Examples of the auxiliary storage device 903 include a hard disk drive (HDD), a solid state drive (SSD), a magnetic disk, a magneto-optical disk, a compact disc read only memory (CD-ROM), a digital versatile disc read only memory (DVD-ROM), and a semiconductor memory. The auxiliary storage device 903 may be an internal medium directly connected to a bus of the
35 computer 900 or may be an external medium (an external storage device 910) connected to the computer 900 via the interface 904 or a communication line. In a case where this program is distributed to the computer 900 via the communication line, the computer 900 having received the distribution may

deploy the program in the main storage device 902 and execute the above processing. In at least one embodiment, the auxiliary storage device 903 is a non-transitory tangible storage medium.

[0084]

5 Operational Effects

As described above, an onboard unit 10 according to the present embodiment includes: a toll information acquisition unit 101 configured to acquire toll information for specifying a toll corresponding to a travel distance of the vehicle V on a toll road; a toll change information acquisition unit 102
10 configured to acquire toll change information applied to at least a part of a section where the vehicle V has traveled; a calculation unit 103 configured to calculate a toll fare of the vehicle V by applying an integrated change toll based on the toll change information to a toll calculated using the toll information; and a notification unit 104 configured to notify the exit tollgate server 30 of an
15 exit tollgate of the toll road of the toll fare calculated.

[0085]

In the known technique, the exit tollgate server calculates the toll fare based on a toll charge table, and therefore it is not possible to grasp the time when the vehicle traveled in each section of the toll road and the road situation
20 of each section at that time. For this reason, it is difficult to flexibly change the toll fare depending on the road situation of the section where an individual vehicle traveled. On the other hand, in the present embodiment, as described above, the onboard unit 10 calculates the toll fare based on the toll information and the toll change information, whereby it is possible to calculate the toll fare
25 depending on the section where the vehicle V has actually traveled and the road situation thereof.

[0086]

The toll information acquisition unit 101 acquires, at an entrance tollgate of the toll road, toll information indicating a toll corresponding to a
30 travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the entrance tollgate.

[0087]

In this way, the onboard unit 10 can reduce the communication amount of the toll information at the entrance tollgate, and therefore it is possible to
35 suppress failure of communication such as failure in receiving the toll information while passing through the entrance tollgate.

[0088]

The toll information acquisition unit 101 acquires, at a predetermined notification point of the toll road, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the notification point, and the calculation unit 103 calculates the toll fare by applying the integrated change toll to a toll calculated by using a combination of the toll information acquired at the entrance tollgate and the toll information acquired at the notification point.

[0089]

In this way, as the vehicle V travels on the toll road, the onboard unit 10 can sequentially acquire and update the toll charge table including the toll to the next exit tollgate. This enables the onboard unit 10 to acquire different toll information for each travel route of the vehicle V to calculate the toll fare corresponding to the travel route of the vehicle V.

[0090]

The toll change information acquisition unit 102 acquires, at a predetermined notification point of the toll road, the toll change information applied to a section including at least the notification point.

[0091]

In this way, when the vehicle V passes through the notification point, the onboard unit 10 can acquire the toll change information depending on the situation of the section where the vehicle V has actually traveled and reflect it to the toll fare.

[0092]

A toll collection system 100 according to the present embodiment includes the onboard unit 10 described above and an exit tollgate server 30 provided at an exit tollgate of the toll road. The exit tollgate server 30 includes a toll fare acquisition unit 302 configured to acquire the toll fare of the vehicle V provided as notification from the onboard unit 10, and a charge processing unit 303 configured to perform charge processing of charging the toll fare acquired to an ETC card (or a credit card or the like associated with the ETC card) inserted into the onboard unit 10.

[0093]

In this way, the toll collection system 100 can charge, at the exit tollgate, a toll fare flexibly applied with a change (a discount or an addition) in the toll fare depending on the situation of the road on which the vehicle V has actually traveled.

[0094]

The toll collection system 100 further includes an entrance tollgate server 20 provided at an entrance tollgate of the toll road. The entrance tollgate server 20 includes a first toll information transmission unit 202 configured to transmit, to the onboard unit 10 of the vehicle V arriving at the entrance tollgate, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the entrance tollgate.

[0095]

In this way, the toll collection system 100 can reduce the communication amount of the toll information at the entrance tollgate, making it possible to suppress failure of communication such as failure in receiving the toll information while the onboard unit 10 passes through the entrance tollgate.

[0096]

The toll collection system 100 further includes a roadside device 40 provided at a predetermined notification point of the toll road. The roadside device 40 includes a second toll information transmission unit 402 configured to transmit, to the onboard unit 10 of the vehicle V arriving at the notification point, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the notification point.

[0097]

In this way, the toll collection system 100 can update the toll information recorded in the onboard unit 10 of the vehicle V as the vehicle V travels on the toll road. This enables the toll collection system 100 to charge the toll fare corresponding to the travel route of the vehicle V based on the toll information different for each travel route of the vehicle V.

[0098]

The roadside device 40 further includes a change information transmission unit 404 configured to transmit, to the onboard unit 10 of the vehicle V arriving at the notification point, toll change information applied to a section including the notification point.

[0099]

In this way, the toll collection system 100 can flexibly change the toll fare depending on the road situation of the section where each vehicle V travels.

[0100]

Other Embodiments

While one embodiment has been described in detail with reference to the drawings, the specific configuration is not limited to that described above, and various design changes and the like can be made. That is, in other embodiments, the order of the above-described processing may be appropriately changed. Parts of processing may be executed in parallel.

[0101]

Supplementary Notes

The above-described embodiments are understood as follows, for example.

[0102]

(1) According to a first aspect, an onboard unit 10 includes: a toll information acquisition unit 101 configured to acquire toll information for specifying a toll corresponding to a travel distance of a vehicle V on a toll road; a toll change information acquisition unit 102 configured to acquire toll change information applied to at least a part of a section where the vehicle V has traveled; a calculation unit 103 configured to calculate a toll fare of the vehicle V by applying an integrated change toll based on the toll change information to a toll calculated using the toll information; and a notification unit 104 configured to notify the exit tollgate server 30 of an exit tollgate of the toll road of the toll fare calculated.

[0103]

In the known technique, the exit tollgate server calculates the toll fare based on a toll charge table, and therefore it is not possible to grasp the time when the vehicle traveled in each section of the toll road and the road situation of each section at that time. For this reason, it is difficult to flexibly change the toll fare depending on the road situation of the section where an individual vehicle traveled. On the other hand, in the present embodiment, as described above, the onboard unit 10 calculates the toll fare based on the toll information and the toll change information, whereby it is possible to calculate the toll fare depending on the section where the vehicle V has actually traveled and the road situation thereof.

[0104]

(2) According to a second aspect, in the onboard unit 10 according to the first aspect, the toll information acquisition unit 101 acquires, at an entrance tollgate of the toll road, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the entrance tollgate.

[0105]

In this way, the onboard unit 10 can reduce the communication amount of the toll information at the entrance tollgate, making it possible to suppress failure of communication such as failure in receiving the toll information while passing through the entrance tollgate.

5 [0106]

(3) According to a third aspect, in the onboard unit 10 according to the second aspect, the toll information acquisition unit 101 acquires, at a predetermined notification point of the toll road, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some
10 of exit tollgates at a downstream side of the notification point, and the calculation unit 103 calculates the toll fare by applying the integrated change toll to a toll calculated by using a combination of the toll information acquired at the entrance tollgate and the toll information acquired at the notification point.

15 [0107]

In this way, as the vehicle V travels on the toll road, the onboard unit 10 can sequentially acquire and update the toll information including the toll to the next exit tollgate. This enables the onboard unit 10 to acquire different toll information for each travel route of the vehicle V to calculate the toll fare
20 corresponding to the travel route of the vehicle V.

[0108]

(4) According to a fourth aspect, in the onboard unit 10 according to any one of the first to third aspects, the toll change information acquisition unit 102 acquires, at a predetermined notification point of the toll road, the toll change
25 information applied to a section including at least the notification point.

[0109]

In this way, when the vehicle V passes through the notification point, the onboard unit 10 can acquire the toll change information depending on the situation of the section where the vehicle V has actually traveled and reflect it
30 to the toll fare.

[0110]

(5) According to a fifth aspect, a toll collection system 100 includes: the onboard unit 10 according to any one of the first to fourth aspects; and an exit tollgate server 30 provided at an exit tollgate of the toll road, in which the exit
35 tollgate server 30 includes a toll fare acquisition unit 302 configured to acquire the toll fare of the vehicle V provided as notification from the onboard unit 10, and a charge processing unit 303 configured to perform charge processing of charging the toll fare acquired to the vehicle V.

[0111]

In this way, the toll collection system 100 can charge, to the vehicle V, a toll fare flexibly applied with a change (a discount or an addition) in the toll fare depending on the situation of the road on which the vehicle V has actually traveled at the exit tollgate.

[0112]

(6) According to a sixth aspect, the toll collection system 100 according to the fifth aspect further includes an entrance tollgate server 20 provided at an entrance tollgate of the toll road, in which the entrance tollgate server 20 includes a first toll information transmission unit 202 configured to transmit, to the onboard unit 10 of the vehicle V arriving at the entrance tollgate, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the entrance tollgate.

[0113]

In this way, the toll collection system 100 can reduce the communication amount of the toll information at the entrance tollgate, making it possible to suppress failure of communication such as failure in receiving the toll information while the onboard unit 10 passes through the entrance tollgate.

[0114]

(7) According to a seventh aspect, the toll collection system 100 according to the sixth aspect further includes a roadside device 40 provided at a predetermined notification point of the toll road, in which the roadside device 40 includes a second toll information transmission unit 402 configured to transmit, to the onboard unit 10 of the vehicle V arriving at the notification point, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the notification point.

[0115]

In this way, the toll collection system 100 can update the toll information recorded in the onboard unit 10 of the vehicle V as the vehicle V travels on the toll road. This enables the toll collection system 100 to charge the toll fare corresponding to the travel route of the vehicle V based on the toll information different for each travel route of the vehicle V.

[0116]

(8) According to an eighth aspect, the toll collection system 100 according to the fifth or sixth aspect further includes a roadside device 40 provided at a predetermined notification point of the toll road, in which the

roadside device 40 includes a change information transmission unit 404 configured to transmit, to the onboard unit 10 of the vehicle V arriving at the notification point, toll change information applied to a section including the notification point.

5 [0117]

In this way, the toll collection system 100 can flexibly change the toll fare depending on the road situation of the section where each vehicle V travels.

[0118]

10 (9) According to a ninth aspect, a toll collection method includes: a step of acquiring, by an onboard unit 10 mounted on the vehicle V, toll information for specifying a toll corresponding to a travel distance of the vehicle V on a toll road; a step of acquiring, by the onboard unit 10, toll change information applied to at least a part of a section where the vehicle V has traveled; a step of
15 calculating, by the onboard unit 10, a toll fare of the vehicle V by applying an integrated change toll based on the toll change information to a toll calculated using the toll information; a step of notifying, by the onboard unit 10, an exit tollgate server 30 of an exit tollgate of the toll road of the toll fare calculated; a step of acquiring, by the exit tollgate server 30, the toll fare of the vehicle V
20 provided as notification from the onboard unit 10; and a step of performing, by the exit tollgate server 30, charge processing of charging the toll fare acquired to the vehicle V.

[0119]

(10) According to a tenth aspect, a program causes the onboard unit 10
25 to execute: a step of acquiring toll information for specifying a toll corresponding to a travel distance of the vehicle V on a toll road; a step of acquiring toll change information applied to at least a part of a section where the vehicle V has traveled; a step of calculating a toll fare of the vehicle V by applying an integrated change toll based on the toll change information to a toll
30 calculated using the toll information; and a step of providing, as notification, the toll fare calculated to an exit tollgate server 30 of an exit tollgate of the toll road.

Reference Signs List

35 [0120]

100 Toll collection system

10 Onboard unit

101 Toll information acquisition unit

- 102 Toll change information acquisition unit
- 103 Calculation unit
- 104 Notification unit
- 105 Toll information recording unit
- 5 11 Terminal device
- 20 Entrance tollgate server
- 201 First toll information reception unit
- 202 First toll information transmission unit
- 203 Entrance information transmission unit
- 10 21 Roadside antenna
- 30 Exit tollgate server
- 301 Exit information transmission unit
- 302 Toll fare acquisition unit
- 303 Charge processing unit
- 15 31 Roadside antenna
- 40 Roadside device
- 41 Roadside antenna
- 401 Second toll information reception unit
- 402 Second toll information transmission unit
- 20 403 Change information reception unit
- 404 Change information transmission unit
- 50 Center server
- V Vehicle

Claims

[Claim 1]

An onboard unit comprising:

a toll information acquisition unit configured to acquire toll information for specifying a toll corresponding to a travel distance of a vehicle on a toll road;

a toll change information acquisition unit configured to acquire toll change information applied to at least a part of a section where the vehicle has traveled;

a calculation unit configured to calculate a toll fare of the vehicle by applying an integrated change toll based on the toll change information to a toll calculated using the toll information; and

a notification unit configured to perform notification of the toll fare calculated to an exit tollgate server of an exit tollgate of the toll road.

[Claim 2]

The onboard unit according to claim 1, wherein

the toll information acquisition unit acquires, at an entrance tollgate of the toll road, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the entrance tollgate.

[Claim 3]

The onboard unit according to claim 2, wherein

the toll information acquisition unit acquires, at a predetermined notification point of the toll road, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the notification point, and

the calculation unit calculates the toll fare by applying the integrated change toll to a toll calculated by using a combination of the toll information acquired at the entrance tollgate and the toll information acquired at the notification point.

[Claim 4]

The onboard unit according to any one of claims 1 to 3, wherein

the toll change information acquisition unit acquires, at a predetermined notification point of the toll road, the toll change information applied to a section including at least the notification point.

[Claim 5]

A toll collection system comprising:
the onboard unit according to any one of claims 1 to 3; and
an exit tollgate server provided at an exit tollgate of the toll road,
wherein
the exit tollgate server includes
a toll fare acquisition unit configured to acquire the toll fare of the vehicle provided as notification from the onboard unit, and
a charge processing unit configured to perform charge processing of charging the toll fare acquired to the vehicle.

[Claim 6]

The toll collection system according to claim 5 further comprising:
an entrance tollgate server provided at an entrance tollgate of the toll road, wherein
the entrance tollgate server includes a first toll information transmission unit configured to transmit, to the onboard unit of the vehicle arriving at the entrance tollgate, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the entrance tollgate.

[Claim 7]

The toll collection system according to claim 6 further comprising:
a roadside device provided at a predetermined notification point of the toll road, wherein
the roadside device includes a second toll information transmission unit configured to transmit, to the onboard unit of the vehicle arriving at the notification point, toll information indicating a toll corresponding to a travel distance to an exit tollgate with respect to some of exit tollgates at a downstream side of the notification point.

[Claim 8]

The toll collection system according to claim 5 further comprising:

a roadside device provided at a predetermined notification point of the toll road, wherein

the roadside device includes a change information transmission unit configured to transmit, to the onboard unit of the vehicle arriving at the notification point, toll change information applied to a section including the notification point.

[Claim 9]

A toll collection method comprising:

a step of acquiring, by an onboard unit mounted on a vehicle, toll information for specifying a toll corresponding to a travel distance of the vehicle on a toll road;

a step of acquiring, by the onboard unit, toll change information applied to at least a part of a section where the vehicle has traveled;

a step of calculating, by the onboard unit, a toll fare of the vehicle by applying an integrated change toll based on the toll change information to a toll calculated using the toll information;

a step of performing, by the onboard unit, notification of the toll fare calculated to an exit tollgate server of an exit tollgate of the toll road;

a step of acquiring, by the exit tollgate server, the toll fare of the vehicle provided as notification from the onboard unit; and

a step of performing, by the exit tollgate server, charge processing of charging the toll fare acquired to the vehicle.

[Claim 10]

A program that causes an onboard unit to execute:

a step of acquiring toll information for specifying a toll corresponding to a travel distance of a vehicle on a toll road;

a step of acquiring toll change information applied to at least a part of a section where the vehicle has traveled;

a step of calculating a toll fare of the vehicle by applying an integrated change toll based on the toll change information to a toll calculated using the toll information; and

a step of performing notification of the toll fare calculated to an exit tollgate server of an exit tollgate of the toll road.