

Description

Title of Invention: MANAGEMENT SERVER, RETURN METHOD OF TOLL,
AND PROGRAM

Technical Field

[0001]

The present disclosure relates to a management server, a return method of a toll, and a program.

Background Art

[0002]

An automatic toll collection system (is also called an electronic toll collection system. In Japan, it is called an ETC (registered tradename) system) is used as a technology for collecting a toll of a toll road. The automatic toll collection system performs wireless communication with an on-board unit mounted on a vehicle at a tollgate of a toll road to automatically collect a toll corresponding to a travel distance (travel section) from an entrance tollgate to an exit tollgate where the vehicle has traveled.

[0003]

The toll corresponding to the travel distance from the entrance tollgate to the exit tollgate is defined in, for example, a toll table, and is distributed from a center server to a toll (e.g., the exit tollgate) that collects the toll. There is a case where the toll is applied with a discount. For example, Patent Document 1 describes a technique of applying a time-of-day discount to a vehicle that passed through an entrance tollgate in a specific time of day. A toll table applied with a time-of-day discount, a (normal) toll table not applied with a time-of-day discount, and the like are distributed from the center server to each tollgate at necessary timings such as start and end timings of the discount time of day, for example. Each tollgate calculates a toll of each vehicle by using the toll table having been distributed.

Citation List

Patent Literature

[0004]

35 Patent Document 1: JP 2009-199347 A

Summary of Invention

Technical Problem

[0005]

On a toll road, there is a case of an occurrence of a specific event that lowers the quality of a service provided to a vehicle, such as traffic jam and road closure due to construction or weather. However, in the known technique,
5 it is difficult to specify which section and when an individual vehicle traveled and what the situation of the section at that time was (presence/absence of traffic jam or the like). For this reason, when the specific event occurs, it is not possible to respond flexibly, such as changing (discounting) the toll of the vehicle impacted by this specific event.

10 [0006]

An object of the present disclosure is to provide a management server, a return method of a toll, and a program that can specify a vehicle impacted by a specific event and return a toll to the vehicle.

15 **Solution to Problem**

[0007]

According to one aspect of the present disclosure, a management server includes: a traveling vehicle information collection unit configured to collect traveling vehicle information including an entry time and an exit time of a
20 vehicle for each area of a toll road, and vehicle specification information configured to specify the vehicle; a specific event recording unit configured to record specific event information including an occurrence area and an occurrence period of a specific event that impacts use of the toll road; a target vehicle extraction unit configured to extract a target vehicle that exists in the
25 occurrence area and the occurrence period of the specific event based on the traveling vehicle information and the specific event information; and a return processing unit configured to return a toll for the specific event to the target vehicle extracted.

[0008]

30 According to one aspect of the present disclosure, a return method of a toll includes: collecting traveling vehicle information including an entry time and an exit time of a vehicle for each area of a toll road, and vehicle specification information configured to specify the vehicle; recording specific event information including an occurrence area and an occurrence period of a
35 specific event that impacts use of the toll road; extracting a target vehicle that exists in the occurrence area and the occurrence period of the specific event based on the traveling vehicle information and the specific event information; and returning a toll for the specific event to the target vehicle extracted.

[0009]

According to one aspect of the present disclosure, a program causes a management server to execute collecting traveling vehicle information including an entry time and an exit time of a vehicle for each area of a toll road, and vehicle specification information configured to specify the vehicle, recording specific event information including an occurrence area and an occurrence period of a specific event that impacts use of the toll road, extracting a target vehicle that exists in the occurrence area and the occurrence period of the specific event based on the traveling vehicle information and the specific event information, and returning a toll for the specific event to the target vehicle extracted.

Advantageous Effects of Invention

[0010]

According to the above aspect, it is possible to specify a vehicle impacted by a specific event and return a toll to the vehicle.

Brief Description of Drawings

[0011]

FIG. 1 is a schematic diagram illustrating an overall configuration of a management system according to a first embodiment.

FIG. 2 is a block diagram illustrating a functional configuration of a management server according to the first embodiment.

FIG. 3 is a sequence diagram illustrating a processing example of the management system according to the first embodiment.

FIG. 4 is a schematic diagram illustrating an overall configuration of a management system according to a second embodiment.

FIG. 5 is a block diagram illustrating a functional configuration of a management server according to the second embodiment.

FIG. 6 is a sequence diagram illustrating a processing example of an application system according to the second embodiment.

FIG. 7 is a schematic block diagram illustrating a configuration of a computer according to any of the embodiments.

Description of Embodiments

[0012]

First Embodiment

Hereinafter, the first embodiment will be described in detail with reference to FIGS. 1 to 3.

[0013]

Overall Configuration

5 FIG. 1 is a schematic diagram illustrating the overall configuration of the management system according to the first embodiment. A management system 100 is a system for returning at least a part of the toll to the vehicle impacted by a specific event when this specific event is detected on the toll road. The specific event is, for example, an event that lowers the quality of a
10 travel service of a toll road, such as a traffic jam, an accident, construction, weather, a failure, a lane restriction or a road closure due to a fallen object or the like, or closure of a tollgate. The specific event may include a case where a facility such as a rest area or a parking area is unavailable (parking lot is full, facility is unavailable due to breakage, and the like). The toll is a toll of a toll
15 road or a toll of a facility. Note that the management system 100 may be configured as one function of an automatic toll collection system that collects a toll of a vehicle. As illustrated in FIG. 1, the management system 100 includes a management server 10, an on-board unit 20 mounted on a vehicle V, a monitoring device 40, and a payment server 50.

20 [0014]

 When a specific event is detected on a toll road, the management server 10 specifies a vehicle impacted by this specific event to request the payment server 50 to return the toll. The management server 10 specifies a vehicle using each area and a time thereof from a roadside device provided at an
25 entrance/exit of each area of a toll road. Note that in the present embodiment, the area of the toll road includes a road section between nodes such as divergence and convergence, and facilities such as a rest area or a parking area.

[0015]

 In the present embodiment, the management system 100 includes
30 automatic number plate recognition (ANPR) cameras 31 and 32 as roadside devices. The ANPR cameras 31 and 32 are license plate recognition devices that read license plate information on a passing vehicle from an image of the vehicle. The ANPR camera 31 is installed at an entrance of each area (section or facility), and transmits, to the management server 10, traveling vehicle
35 information in which license plate information on a vehicle having entered each area and an entry time (read time) are recorded. The ANPR camera 32 is installed at an exit of each area, and transmits, to the management server 10, traveling vehicle information in which license plate information (hereinafter,

also described as NP information) on a vehicle having exited from each section and an exit time (read time) thereof are recorded. Note that the ANPR cameras 31 and 32 may be installed only in some sections such as a divergence of the toll road (a B section and a C section in FIG. 1). Note that for consecutive areas (sections), the ANPR camera 31 provided at the entrance of the next section can also serve as an exit (exit detection) camera for a previous section, and thus the ANPR camera 32 at the exit of the previous section may be omitted. In this case, the read time of the NP information by the ANPR camera 31 at the entrance of the next section serves as both the exit time from the previous section and the entry time to the next section.

[0016]

The on-board unit 20 is an on-board unit used in a known automatic toll collection system, performs wireless communication (e.g., DSRC communication) with a roadside antenna provided at a tollgate, and automatically performs billing of a toll of the toll road.

[0017]

The monitoring device 40 is a device used for monitoring of the toll road in a monitoring center or the like, for example, and detects, and notifies the management server 10 of, occurrence and resolution of a specific event in the present embodiment.

[0018]

The payment server 50 performs return processing of the toll to the vehicle impacted by the specific event in accordance with a request from the management server 10.

[0019]

Functional Configuration of Management Server

FIG. 2 is a block diagram illustrating the functional configuration of the management server according to the first embodiment. As illustrated in FIG. 2, the management server 10 includes a traveling vehicle information collection unit 101, a specific event recording unit 102, a target vehicle extraction unit 103, an impact degree calculation unit 104, and a return processing unit 105.

[0020]

The traveling vehicle information collection unit 101 collects, from a roadside device, traveling vehicle information including an entry time and an exit time of the vehicle for each area of a toll road, and vehicle specification information that can specify the vehicle. In the present embodiment, the roadside device is the ANPR cameras 31 and 32, and the traveling vehicle

information includes NP information (vehicle specification information) of the vehicle and an entry time or an exit time.

[0021]

5 The specific event recording unit 102 records an occurrence area and an occurrence period of a specific event that impacts the use of the toll road. In the present embodiment, the specific event recording unit 102 receives and records specific event information indicating occurrence and resolution of a specific event from the monitoring device 40. For example, a monitor of the toll road detects and inputs, to the monitoring device 40, occurrence and
10 resolution of a specific event based on a video or a report obtained from a monitoring means 41 (a traffic counter, a monitoring camera, a patrol vehicle, and the like). The monitoring device 40 generates, and notifies the management server 10 of, specific event information (information including the type, the occurrence area, and the occurrence period of a specific event) in accordance
15 with the input from the monitor. The monitoring device 40 may automatically generate, and notify the management server 10 of, specific event information based on information provided from an external system (such as a traffic jam information provision system). Note that the monitoring means 41 in FIG. 2 is an example, and information regarding the specific event may be obtained from
20 other monitoring means (e.g., report from a user, weather information, and the like).

[0022]

The target vehicle extraction unit 103 extracts the target vehicle that existed in the occurrence area and the occurrence period of the specific event
25 based on the traveling vehicle information and the specific event information.

[0023]

The impact degree calculation unit 104 calculates the impact degree of the specific event for each target vehicle based on the entry time and the exit time of the target vehicle in the occurrence area of the specific event.

30 [0024]

The return processing unit 105 returns the toll corresponding to the specific event to the target vehicle having been extracted. In the present embodiment, an example in which the return processing unit 105 performs a return by granting a point corresponding to at least a part of the toll to an IC
35 card 21 (e.g., an ETC card used in the ETC system in Japan) to be used in the on-board unit 20 will be described. In another embodiment, the return may be performed by a partial refund or a discount on the toll. The return processing unit 105 may vary the return amount (the value of the point to be returned) for

each target vehicle based on the impact degree on each target vehicle calculated by the impact degree calculation unit 104.

[0025]

Processing Example of Management System

5 FIG. 3 is a sequence diagram illustrating a processing example of the management system according to the first embodiment. Hereinafter, a flow of processing of the management system 100 of the present embodiment will be described with reference to FIG. 3. Note that here, a case where a traffic jam, which is a specific event, occurs in the C section in FIG. 1 will be described as
10 an example. In the examples of FIGS. 1 and 3, the management system 100 performs processing on one vehicle V, but actually performs similar processing on a plurality of vehicles in parallel.

[0026]

 First, it is assumed that the vehicle V enters an A section. Then, an
15 ANPR camera 31A provided at the entrance of the A section acquires NP information on the vehicle V (step S101). The ANPR camera 31A generates and transmits, to the management server 10, traveling vehicle information including the NP information on the vehicle V having been acquired and the entry time of the vehicle V into the A section (step S102). The entry time of the vehicle V
20 into the A section is the time when the ANPR camera 31A reads the NP information on the vehicle V.

[0027]

 The traveling vehicle information collection unit 101 of the management server 10 records the traveling vehicle information on the vehicle V received
25 from the ANPR camera 31A (step S103).

[0028]

 When the vehicle V exits the A section, the ANPR camera 32A provided at the exit of the A section acquires NP information on the vehicle V (step S104), and generates and transmits, to the management server 10, traveling
30 vehicle information including the NP information on the vehicle V having been acquired and the exit time of the vehicle V from the A section (step S105). The exit time of the vehicle V from the A section is the time when the ANPR camera 32A reads the NP information on the vehicle V. The traveling vehicle information collection unit 101 of the management server 10 records the
35 traveling vehicle information on the vehicle V received from the ANPR camera 32A (step S106).

[0029]

Thereafter, a series of processing of steps S101 to S106 is executed each time the vehicle V enters each section and exits from each section. For example, as illustrated in FIG. 3, when the vehicle V enters the C section after the A section, an ANPR camera 31C at the entrance of the C section acquires the NP information on the vehicle V and transmits the traveling vehicle information to the management server 10, and the entry of the vehicle V into the C section is recorded in the management server 10 (steps S101 to S103). When the vehicle V exits the C section, an ANPR camera 32C at the exit of the C section acquires the NP information on the vehicle V and transmits the traveling vehicle information to the management server 10, and the exit of the vehicle V from the C section is recorded in the management server 10 (steps S104 to S106).

[0030]

It is assumed that, for example, a traffic jam occurs as a specific event in the C section while the vehicle V is traveling in the C section. It is assumed that the traffic jam in this C section is detected by the monitoring device 40 after the vehicle V exits the C section. Upon detecting the traffic jam in the C section, the monitoring device 40 transmits the specific event information to, and notifies of, the management server 10 (step S107). The specific event information includes the type (traffic jam), the occurrence area (C section), and the occurrence period (occurrence time to resolution time) of the specific event. When the traffic jam in the C section has not been resolved (the traffic jam is still ongoing), the occurrence period needs not include the resolution time.

[0031]

The specific event recording unit 102 of the management server 10 records the specific event information received from the monitoring device 40 (step S108). Note that when newly receiving specific event information indicating that the traffic jam in the C section has been resolved from the monitoring device 40, the specific event recording unit 102 records (overwrites) in step S108 the specific event information regarding the traffic jam in the C section added with the resolution time of the traffic jam. This can specify, from the specific event information, the period in which the specific event occurred.

[0032]

Next, the target vehicle extraction unit 103 of the management server 10 extracts the target vehicle impacted by the specific event based on the specific event information and the traveling vehicle information (step S109). For example, the target vehicle extraction unit 103 specifies a specific event

occurrence area (C section) and an occurrence period from the specific event information. The target vehicle extraction unit 103 extracts, as a target vehicle, from the traveling vehicle information, a vehicle existing in the occurrence area (C section) during the occurrence period of this specific event. In the example
 5 of FIG. 3, the target vehicle extraction unit 103 extracts the vehicle V as a target vehicle.

[0033]

The impact degree calculation unit 104 of the management server 10 calculates the impact degree of the specific event on the target vehicle based on
 10 the traveling vehicle information on the target vehicle (vehicle V) having been extracted (step S110). Specifically, the impact degree calculation unit 104 reads, from the traveling vehicle information, the entry time of the target vehicle (vehicle V) into the C section and the exit time from the C section to calculate the time required for the target vehicle to travel in the C section. A
 15 reference time required for traveling when no specific event is present for each section is set in advance, and the impact degree calculation unit 104 calculates the impact degree such that the value of the impact degree increases as the time actually required for the target vehicle to travel in the C section is longer than the reference time. Note that the value of the impact degree according to the
 20 difference from the reference time may be calculated using a predefined function, table, or the like. For example, since the time required to pass through the C section is longer for a vehicle that entered the C section after a traffic jam occurred than for a vehicle having entered the C section before the traffic jam occurred and impacted by the traffic jam from the middle, the former vehicle is
 25 determined to have had a larger impact by the traffic jam. That is, the actual impact of the specific event on the individual target vehicle can be quantified for evaluation.

[0034]

The return processing unit 105 of the management server 10 calculates a
 30 return amount to the target vehicle based on the impact degree (step S111). The return processing unit 105 calculates the return amount to the target vehicle based on, for example, a table in which the return amount is defined in advance according to the specific event and the impact degree. The return processing unit 105 may calculate the return amount to the target vehicle by multiplying
 35 the return amount defined in advance according to the specific event by a coefficient according to the impact degree. The coefficient is set by a function, a table, or the like such that, for example, the more the impact degree increases, the more the return amount increases.

[0035]

Next, the return processing unit 105 of the management server 10 transmits the calculated return amount and the vehicle specification information (NP information) of the target vehicle to the payment server 50 to request a
5 return of the toll to the target vehicle (vehicle V) (step S112). The payment server 50 performs return processing of the toll to the target vehicle in accordance with the request from the management server 10 (step S113). In the present embodiment, the payment server 50 grants a point corresponding to the return amount according to the type and the impact degree of the specific event
10 to the IC card 21 to be used in the on-board unit 20 of the target vehicle, thereby returning the toll.

[0036]

The on-board unit 20 of the target vehicle (vehicle V) records the point granted to the IC card 21 (step S114). This enables the target vehicle to receive
15 a point return for the delay (deterioration in service) due to the impact of the traffic jam.

[0037]

Note that the traveling vehicle information includes NP information on the target vehicle but does not include IC card information that can specify the
20 IC card 21. Therefore, in step S112, the return processing unit 105 returns the toll by the following methods, for example.

[0038]

Method 1

When the target vehicle has exited the toll road, processing of collecting
25 the toll is performed at the exit tollgate. At this time, the tollgate server (not illustrated) of the exit tollgate transmits, to the payment server 50 of higher order, NP information on the vehicle, on-board unit information (identification information on the on-board unit 20), IC card information on the IC card 21 to be used in the on-board unit 20, detailed information including the toll of the
30 vehicle, and the payment server 50 performs the final payment processing. The return processing unit 105 of the management server 10 transmits the return amount calculated in step S111 and the NP information on the target vehicle to the payment server 50 to request the return processing (step S112). The payment server 50 extracts the detailed information on the target vehicle based
35 on the NP information, and performs the return processing (point granting) on the target vehicle based on the IC card information included in the detailed information (step S113).

[0039]

Method 2

When the target vehicle has not exited the toll road, the return processing unit 105 of the management server 10 transmits the NP information on the target vehicle and the return amount calculated in step S111 to the payment server 50 to request the return processing, similarly to method 1 (step S112). At this time point, the payment server 50 has not recorded the detailed information on the target vehicle created by the tollgate server of the exit tollgate. Upon receiving the detailed information from the exit tollgate, the payment server 50 collates it with the NP information on the target vehicle, and when the matching detailed information exists, performs return processing (point granting) on the target vehicle based on the IC card information included in this detailed information (step S113).

[0040]

Note that in the above example, the management server 10 calculates the impact degree based on the time required for the target vehicle to travel the C section in step S110, but no such limitation is intended. In another embodiment, the same point may be uniformly granted to the target vehicle traveling in a traffic-jammed section. In this case, step S110 is omitted, and in steps S111 to S113, return processing of granting a fixed return amount (point) according to the type of specific event is performed.

[0041]

There is a possibility that the time spent by the target vehicle and the impact degree are not proportional to each other, such as a case where the specific event is facility unavailability (such as facility failure in a rest area). Also in this case, the impact degree needs not be calculated (step S110 is omitted), and the return amount (point) according to the type of specific event may be returned to the user in steps S111 to S113.

[0042]

In still another embodiment, a table in which the impact degree is preset for each type of specific event may be prepared, and the impact degree may be calculated based on this table in step S110. For example, in a case where the parking lot of the rest area is full and unavailable for use (parking) and a case where the facility in the rest area is unavailable due to a failure (parking is available), different impact degrees may be calculated.

[0043]

Operational Effects

As described above, the management server 10 according to the present embodiment includes:

the traveling vehicle information collection unit 101 that collects traveling vehicle information including an entry time and an exit time of a vehicle for each area of a toll road, and vehicle specification information configured to specify the vehicle; the specific event recording unit 102 that
 5 records specific event information including an occurrence area and an occurrence period of a specific event that impacts use of the toll road; the target vehicle extraction unit 103 that extracts a target vehicle that existed in an occurrence area and an occurrence period of the specific event based on the traveling vehicle information and the specific event information; and the return
 10 processing unit 105 that returns a toll for the specific event to the target vehicle having been extracted.
 [0044]

By doing this, when detecting a specific event on a toll road, the management server 10 can specify the vehicle impacted by this specific event
 15 and return the toll. Therefore, the user who has not received a sufficient service (suffered a disadvantage) due to the specific event can be compensated by the return of the toll.
 [0045]

The management server 10 further includes the impact degree
 20 calculation unit 104 that calculates an impact degree of the specific event on a target vehicle based on the specific event information, in which the return processing unit 105 performs a return to the target vehicle according to an impact degree of the specific event.
 [0046]

For example, there is a case where the impact degree on the target
 25 vehicle (disadvantage to be suffered by the user) is different according to the type of specific event. Therefore, the management server 10 can perform an appropriate return according to the impact degree by the specific event by changing the return amount (the value of the point to be granted) according to
 30 each specific event from the information included in the specific event information in this manner.
 [0047]

The impact degree calculation unit 104 calculates the time required for the target vehicle to use the occurrence area from the entry time and the exit
 35 time of the target vehicle in the occurrence area of the specific event, and calculates the impact degree such that the impact degree becomes larger as the time required for use of the occurrence area is longer than a preset reference time.

[0048]

For example, the impact degree (delay time) of the traffic jam on the target vehicle varies depending on the timing of entering the section where the traffic jam occurs. Therefore, the management server 10 can appropriately
 5 return the toll according to the disadvantage suffered by each target vehicle by calculating the magnitude of the impact degree of the specific event on the individual target vehicle as described above.

[0049]

From the ANPR cameras 31 and 32 (license plate recognition devices)
 10 that are provided at respective entrances and exits of a plurality of areas of the toll road and read NP information on a vehicle entering the area and a vehicle exiting the area, the traveling vehicle information collection unit 101 acquires the traveling vehicle information including NP read time, which is an entry time and an exit time at the area of the vehicle, and NP information, which is
 15 vehicle specification information on the vehicle.

[0050]

By doing this, by the ANPR cameras 31 and 32 detecting entry and exit of the vehicle at the entrance/exit of each area, the management system 100 can easily specify the target vehicle that existed in the time when and the area
 20 where the specific event occurred. Therefore, the toll can be appropriately returned only to the specified target vehicle.

[0051]

Second Embodiment

Hereinafter, the second embodiment will be described in detail with
 25 reference to FIGS. 4 to 6. Components common to those of the above-described embodiment are denoted by identical reference signs, and detailed description will be omitted.

[0052]

FIG. 4 is a schematic diagram illustrating the overall configuration of
 30 the management system according to the second embodiment. FIG. 5 is a block diagram illustrating the functional configuration of the management server according to the second embodiment. As illustrated in FIGS. 4 and 5, the management system 100 of the present embodiment includes roadside antennas 33 and 34 as roadside devices installed at an entrance/exit of each area.

35 [0053]

The roadside antennas 33 and 34 perform wireless communication (e.g., DSRC communication) with the on-board unit 20 of a passing vehicle, and receive on-board unit information from the on-board unit 20. The on-board unit

information includes an on-board unit ID used as vehicle specification information. The roadside antenna 33 is installed at an entrance of each area (section or facility), and transmits, to the management server 10, traveling vehicle information in which on-board unit information (vehicle specification information) of a vehicle having entered each area and an entry time (communication time with the on-board unit 20) are recorded. The roadside antenna 34 is installed at an exit of each area, and transmits, to the management server 10, traveling vehicle information in which vehicle specification information (on-board unit information) on a vehicle having exited from each area and an exit time (communication time with the on-board unit 20) are recorded. Note that the roadside antennas 33 and 34 may be installed only in some sections such as a divergence of the toll road (the B section and the C section in FIG. 1). Note that for consecutive areas (sections), the roadside antenna 33 provided at the entrance of the next section can also serve as a roadside antenna for the exit (exit detection) of a previous section, and thus the roadside antenna 34 at the exit of the previous section may be omitted. In this case, the communication time of the roadside antenna 33 at the entrance of the next section serves as both the exit time from the previous section and the entry time to the next section.

[0054]

FIG. 6 is a sequence diagram illustrating a processing example of the application system according to the second embodiment. Hereinafter, a flow of processing of the management system 100 of the present embodiment will be described with reference to FIG. 6. Note that here, a case where a traffic jam, which is a specific event, occurs in the C section in FIG. 4 will be described as an example. In the examples of FIGS. 4 and 6, the management system 100 performs processing on one vehicle V, but actually performs similar processing on a plurality of vehicles in parallel.

[0055]

First, it is assumed that the vehicle V enters the A section. Then, a roadside antenna 33A provided at the entrance of the A section receives on-board unit information from the on-board unit 20 of the vehicle V (step S201). The roadside antenna 33A generates and transmits, to the management server 10, traveling vehicle information including the received on-board unit information and the entry time of the vehicle V into the A section (step S202). The entry time of the vehicle V into the A section is the time when the roadside antenna 33A communicates with the on-board unit 20 of the vehicle V.

[0056]

The traveling vehicle information collection unit 101 of the management server 10 records the traveling vehicle information on the vehicle V received from the roadside antenna 33A (step S203).

[0057]

5 When the vehicle V exits the A section, a roadside antenna 34A provided at the exit of the A section receives on-board unit information from the on-board unit 20 of the vehicle V (step S204). The roadside antenna 34A generates and transmits, to the management server 10, traveling vehicle information including the received on-board unit information and the exit time of the
10 vehicle V from the A section (step S205). The exit time of the vehicle V from the A section is the time when the roadside antenna 34A communicates with the on-board unit 20 of the vehicle V. The traveling vehicle information collection unit 101 of the management server 10 records the traveling vehicle information on the vehicle V received from the roadside antenna 34A (step S206).

15 [0058]

 Thereafter, a series of processing of steps S201 to S206 is executed each time the vehicle V enters each section and exits from each section. For example, as illustrated in FIG. 6, when the vehicle V enters the C section after the A section, a roadside antenna 33C at the entrance of the C section receives
20 the on-board unit information from the on-board unit 20 of the vehicle V and transmits the traveling vehicle information to the management server 10, and the entry of the vehicle V into the C section is recorded in the management server 10 (steps S201 to S203). When the vehicle V exits the C section, a roadside antenna 34C at the exit of the C section receives the on-board unit
25 information from the on-board unit 20 of the vehicle V and transmits the traveling vehicle information to the management server 10, and the exit of the vehicle V from the C section is recorded in the management server 10 (steps S204 to S206).

[0059]

30 Subsequent processing (steps S207 to S214) is the same as that in the first embodiment (steps S107 to S114 in FIG. 3).

[0060]

 Note that when the IC card information is included in the on-board unit information received in steps S201 and S204, the return processing unit 105 of
35 the management server 10 may request the return processing by transmitting, in step S212, to the payment server 50, the calculated return amount, the vehicle specification information (on-board unit ID) of the target vehicle, and the IC card information included in the on-board unit information. In step S213, the

payment server 50 performs the return processing based on the IC card information received from the management server 10. In terms of security, when the IC card information is not included in the on-board unit information received from the on-board unit 20 by the roadside antenna 34C, the payment server 50 performs the return processing by method 1 or method 2 of the first embodiment. That is, in step S213, the payment server 50 extracts the detailed information on the target vehicle based on the on-board unit ID received from the management server 10, and performs the return processing on the target vehicle based on the IC card information included in the detailed information.

[0061]

As described above, in the management server 10 according to the present embodiment, the traveling vehicle information collection unit 101 acquires, from the roadside antennas 33 and 34, the on-board unit information including the vehicle specification information and the traveling vehicle information including the entry time and the exit time of each area (section or facility) of the vehicle.

[0062]

By doing this, by the roadside antennas 33 and 34 detecting entry and exit of the vehicle at the entrance/exit of each area, the management system 100 can easily specify the target vehicle that existed in the time when and the area where the specific event occurred. Therefore, the toll can be appropriately returned only to the specified target vehicle.

[0063]

Computer Configuration

FIG. 7 is a schematic block diagram illustrating the configuration of the computer according to any of the embodiments. A computer 900 includes a processor 901, a main storage device 902, an auxiliary storage device 903, and an interface 904. The above-described management server 10 is mounted in the computer 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, in the main storage device 902, a storage area used in the above processing in accordance with the program.

[0064]

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

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 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.

[0065]

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 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.

[0066]

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.

[0067]

Supplementary Notes

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

[0068]

(1) According to the first aspect, the management server 10 includes: the traveling vehicle information collection unit 101 configured to collect traveling vehicle information including an entry time and an exit time of a vehicle for each area of a toll road, and vehicle specification information

configured to specify the vehicle; the specific event recording unit 102 configured to record specific event information including an occurrence area and an occurrence period of a specific event that impacts use of the toll road; the target vehicle extraction unit 103 configured to extract a target vehicle that
 5 exists in the occurrence area and the occurrence period of the specific event based on the traveling vehicle information and the specific event information; and the return processing unit 105 configured to return a toll for the specific event to the target vehicle extracted.

[0069]

10 By doing this, when detecting a specific event on a toll road, the management server 10 can specify the vehicle impacted by this specific event and return the toll. Therefore, the user who has not received a sufficient service (suffered a disadvantage) due to the specific event can be compensated by the return of the toll.

15 [0070]

(2) According to the second aspect, the management server 10 according to the first aspect further includes the impact degree calculation unit 104 configured to calculate an impact degree of the specific event on the target vehicle based on the specific event information, in which the return processing
 20 unit 105 performs a return to the target vehicle according to the impact degree of the specific event.

[0071]

For example, there is a case where the impact degree on the target vehicle (disadvantage to be suffered by the user) is different according to the
 25 type of specific event. Therefore, the management server 10 can perform an appropriate return according to the impact degree by the specific event by changing the return amount according to each specific event from the information included in the specific event information in this manner.

[0072]

30 (3) According to the third aspect, in the management server 10 according to the second aspect, the impact degree calculation unit 104 calculates the time required for the target vehicle to use the occurrence area from the entry time and the exit time of the target vehicle in the occurrence area of the specific event, and calculates the impact degree such that the value of the impact degree
 35 becomes larger as the time required for use of the occurrence area is longer than a preset reference time.

[0073]

For example, the impact degree (delay time) of the traffic jam on the target vehicle varies depending on the timing of entering the section where the specific event (traffic jam) occurs. Therefore, the management server 10 can appropriately return the toll according to the disadvantage suffered by each target vehicle by calculating the magnitude of the impact degree of the specific event on the individual target vehicle as described above.

[0074]

(4) According to the fourth aspect, in the management server 10 according to the second aspect, the impact degree calculation unit 104 calculates the impact degree of the specific event based on a table in which an impact degree is set for each type of specific event.

[0075]

By doing this, it is possible to set an appropriate impact according to the content of the specific event, regarding events (e.g., the parking lot of the rest area being full, failure of the rest area facility, and the like) having different impact degrees on the user although there is no common evaluation criterion such as a delay time due to a traffic jam.

[0076]

(5) According to the fifth aspect, in the management server 10 according to any one of the first to fourth aspects, from the license plate recognition devices 31 and 32 that are provided at respective entrances and exits of a plurality of areas of the toll road and read license plate information on the vehicle entering the area and the vehicle exiting the area, the traveling vehicle information collection unit 101 acquires the traveling vehicle information including a license plate read time, which is the entry time and the exit time at the area of the vehicle, and license plate information, which is vehicle specification information on the vehicle.

[0077]

By doing this, by the license plate recognition devices 31 and 32 detecting entry and exit of the vehicle at the entrance/exit of each area, the management system 100 can easily specify the target vehicle that existed in the time when and the area where the specific event occurred. Therefore, the toll can be appropriately returned only to the specified target vehicle.

[0078]

(6) According to the sixth aspect, in the management server 10 according to any one of the first to fourth aspects, from the roadside antennas 33 and 34 that are provided at respective entrances and exits of a plurality of the areas of the toll road and, perform wireless communication with the on-

board units 20 of the vehicle entering the area and the vehicle exiting the area, and receive on-board unit information recorded in the on-board unit 20, the traveling vehicle information collection unit 101 acquires the traveling vehicle information including a communication time, which is the entry time and the exit time at the area of the vehicle and on-board unit information including vehicle specification information on the vehicle.

[0079]

By doing this, by the roadside antennas 33 and 34 detecting entry and exit of the vehicle at the entrance/exit of each area, the management system 100 can easily specify the target vehicle that existed in the time when and the area where the specific event occurred. Therefore, the toll can be appropriately returned only to the specified target vehicle.

[0080]

(7) According to the seventh aspect, a return method of a toll includes: a step of collecting traveling vehicle information including an entry time and an exit time of a vehicle for each area of a toll road, and vehicle specification information configured to specify the vehicle; a step of recording specific event information including an occurrence area and an occurrence period of a specific event that impacts use of the toll road; a step of extracting a target vehicle that exists in the occurrence area and the occurrence period of the specific event based on the traveling vehicle information and the specific event information; and a step of returning a toll for the specific event to the target vehicle extracted.

[0081]

(8) According to the eighth aspect, a program causes the management server 10 to execute a step of collecting traveling vehicle information including an entry time and an exit time of a vehicle for each area of a toll road, and vehicle specification information configured to specify the vehicle, a step of recording specific event information including an occurrence area and an occurrence period of a specific event that impacts use of the toll road, a step of extracting a target vehicle that exists in the occurrence area and the occurrence period of the specific event based on the traveling vehicle information and the specific event information, and a step of returning a toll for the specific event to the target vehicle extracted.

Reference Signs List

[0082]

100 Management system

- 10 Management server
- 101 Traveling vehicle information collection unit
- 102 Specific event recording unit
- 103 Target vehicle extraction unit
- 5 104 Impact degree calculation unit
- 105 Return processing unit
- 20 On-board unit
- 21 IC card
- 31, 32 ANPR camera (license plate recognition device)
- 10 33, 34 Roadside antenna
- 40 Monitoring device
- 41 Monitoring means

Claims

[Claim 1]

A management server comprising:

a traveling vehicle information collection unit configured to collect traveling vehicle information including an entry time and an exit time of a vehicle for each area of a toll road, and vehicle specification information configured to specify the vehicle;

a specific event recording unit configured to record specific event information including an occurrence area and an occurrence period of a specific event that impacts use of the toll road;

a target vehicle extraction unit configured to extract a target vehicle that exists in the occurrence area and the occurrence period of the specific event based on the traveling vehicle information and the specific event information; and

a return processing unit configured to return a toll for the specific event to the target vehicle extracted.

[Claim 2]

The management server according to claim 1, further comprising:

an impact degree calculation unit configured to calculate an impact degree of the specific event on the target vehicle based on the specific event information, wherein

the return processing unit performs a return to the target vehicle according to the impact degree of the specific event.

[Claim 3]

The management server according to claim 2, wherein

the impact degree calculation unit

calculates a time required for the target vehicle to use the occurrence area from the entry time and the exit time of the target vehicle in the occurrence area of the specific event, and

calculates the impact degree such that a value of the impact degree increases as the time required to use the occurrence area is longer than a preset reference time.

[Claim 4]

The management server according to claim 2, wherein

the impact degree calculation unit calculates the impact degree of the specific event based on a table in which the impact degree is set for each type of the specific event.

[Claim 5]

The management server according to any one of claims 1 to 4, wherein from a license plate recognition device that is provided at an entrance and an exit of each of a plurality of areas of the toll road and reads license plate information on the vehicle entering the area and the vehicle exiting the area, the traveling vehicle information collection unit acquires the traveling vehicle information including a license plate read time, which is the entry time and the exit time at the area of the vehicle, and license plate information, which is vehicle specification information on the vehicle.

[Claim 6]

The management server according to any one of claims 1 to 4, wherein from a roadside antenna that is provided at an entrance and an exit of each of a plurality of the areas of the toll road, performs wireless communication with an on-board unit of the vehicle entering the area and the vehicle exiting the area, and receives on-board unit information recorded in the on-board unit, the traveling vehicle information collection unit acquires the traveling vehicle information including a communication time, which is the entry time and the exit time at the area of the vehicle and on-board unit information including vehicle specification information on the vehicle.

[Claim 7]

A return method of a toll comprising:
 collecting traveling vehicle information including an entry time and an exit time of a vehicle for each area of a toll road, and vehicle specification information configured to specify the vehicle;
 recording specific event information including an occurrence area and an occurrence period of a specific event that impacts use of the toll road;
 extracting a target vehicle that exists in the occurrence area and the occurrence period of the specific event based on the traveling vehicle information and the specific event information; and
 returning a toll for the specific event to the target vehicle extracted.

[Claim 8]

A program that causes a management server to execute:

- collecting traveling vehicle information including an entry time and an exit time of a vehicle for each area of a toll road, and vehicle specification information configured to specify the vehicle;

- recording specific event information including an occurrence area and an occurrence period of a specific event that impacts use of the toll road;

- extracting a target vehicle that exists in the occurrence area and the occurrence period of the specific event based on the traveling vehicle information and the specific event information; and

- returning a toll for the specific event to the target vehicle extracted.