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[0008]

[0009]

According to one aspect of the present disclosure, a travel route guidance method includes: notifying a vehicle of guidance information

indicating which of a plurality of roads to travel on at a notification point before a divergence point at which a road diverges into the plurality of roads; receiving, from the vehicle, travel history information that can specify a road on which the vehicle has traveled and notification history information that can specify whether the vehicle has been notified of guidance information corresponding to the road on which the vehicle has traveled; and calculating a variable amount of a toll fare of the vehicle based on the travel history information and the notification history information.

Advantageous Effects of Invention

According to the above aspect, it is possible to guide a vehicle to an arbitrary route depending on the situation of the road.

Brief Description of Drawings

FIG. 1 is a schematic view illustrating an overall configuration of a travel route guidance system according to a first embodiment.

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

FIG. 3 is a block diagram illustrating a functional configuration of an exit tollgate server according to the first embodiment.

FIG. 4 is a block diagram illustrating a functional configuration of a roadside device according to the first embodiment.

FIG. 5 is a sequence diagram illustrating an example of processing of the travel route guidance system according to the first embodiment.

FIG. 6 is a sequence diagram illustrating an example of processing of a travel route guidance system according to a second embodiment.

FIG. 7 is a schematic view illustrating an overall configuration of a travel route guidance system according to a third embodiment.

FIG. 8 is a sequence diagram illustrating an example of processing of the travel route guidance system according to the third embodiment.

FIG. 9 is a schematic block diagram illustrating a configuration of a computer according to each of the embodiments.

Description of Embodiments

[0012]

First Embodiment

Hereinafter, the first embodiment will be described in detail with reference to FIGS. 1 to 5.

[0013]

Overall Configuration

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

10 [0014]

The onboard unit 10 performs processing of automatically paying a toll fare of a toll road of the vehicle V by an automatic toll collection system (also called an "electronic toll collection system". In Japan, it is also called an electronic toll collection (ETC) (registered trademark) system).

15 [0015]

One exit tollgate server 30 is provided at a tollgate office of each tollgate of a toll road, for example. In the example of FIG. 1, exit tollgate servers 30B, 30C, ... are provided at respective tollgate offices of a B tollgate, a C tollgate, The exit tollgate server 30 performs wireless 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 of collecting a toll fare of the vehicle V.

[0016]

25 The roadside device 40 is provided at a notification point of a toll road. The notification point is set before (upstream) a divergence point at which a road diverges into the plurality of roads. The roadside device 40 notifies the vehicle V passing through the notification point of guidance information via a roadside antenna 41 installed at the notification point. The roadside antenna 41 performs wireless communication (e.g., DSRC communication) with the onboard unit 10 of the vehicle V passing through the notification point. In the present embodiment, the travel route guidance system 100 includes the roadside antenna 41 as a guidance information notification unit.

[0017]

35 The center server 50 is a server that manages the plurality of exit tollgate servers 30 and the roadside device 40. In the present embodiment, the center server 50 distributes guidance information to the roadside device 40 at the notification point.

[0018]

Example of Guidance Information

The guidance information is information for a user to determine which of a plurality of roads diverged at a divergence point to travel on. The present embodiment includes information (variable toll information) indicating a variation (discount or extra) of a toll fare of at least one road of these roads. The guidance information may include a guidance reason in place of or in addition to the variable toll information. For example, when a specific event described later occurs on a certain road, the guidance reason includes information that prompts the vehicle V to avoid the road where this specific event has occurred to head for another road.

[0019]

When a specific event occurs at a road or a facility, the center server 50 generates guidance information including variable toll information regarding the road affected by the specific event and/or the guidance reason, in accordance with information input by an operator (road business operator). The specific event includes various events such as a traffic jam, a sudden event (wrong-way driving car, animal entry, falling object, and the like), and facility unavailability (the parking lot is full and the like). Based on information on a specific event obtained from a monitoring system, a monitoring camera installed on a road, a notification, or the like, the operator determines and inputs, to the center server 50, whether to vary the toll fare of the road affected by the specific event, and that variable amount. Note that the center server 50 has the variable amount of the toll fare corresponding to the specific event registered in advance, and may automatically generate guidance information including variable toll information regarding the road affected by the specific event and/or the guidance reason, in accordance with information on the specific event acquired from an external system or the like. In the present embodiment, an example in which the center server 50 generates guidance information in accordance with an operator's input will be described.

[0020]

In the example of FIG. 1, a toll road diverges from a road 1 to roads 2A and 2B at a divergence point N1 and merges at a merging point N2 to connect to a road 3. Note that the roads 2A and 2B that diverge may be direct routes and detour routes of the same route, or may be different routes (different toll roads). It is assumed that a traffic jam has occurred on the road 2B on this toll road. In a case where the traffic jam on the road 2B is a natural traffic jam, there is a possibility that the traffic jam increases when the toll fare of the road 2B is discounted. Therefore, the operator does not discount the toll fare of the

road 2B. Note that the operator may discount the toll fare of the road 2A in order to solve the natural traffic jam of the road 2B (reduce the traffic volume of the road 2B). The operator may add an extra in the toll fare of the road 2B in place of or in addition to a discount of the toll fare of the road 2A.

5 [0021]

When the operator inputs the variable tolls of the road 2A and the road 2B, the center server 50 generates and transmits, to the roadside device 40 at a notification point 1, guidance information based on the input content. For example, the center server generates and transmits, to the roadside device 40 at the notification point 1, guidance information indicating "road 2A: 100 yen discount" and "road 2B: no discount" based on the information input by the operator. Note that the center server 50 may omit information on the road 2B on which the toll fare does not vary (not include it into guidance information). The roadside device 40 at the notification point 1 notifies each vehicle V (the onboard unit 10) arriving at the notification point 1 of guidance information. The driver of the vehicle V determines which of the road 2A and the road 2B to travel on based on the guidance information. As in the above example, when the toll fare of the road 2A is discounted, the driver of the vehicle V is more likely to select the road 2A than the road 2B. In this manner, by notifying each vehicle V of the guidance information, it is possible to guide the travel route of the vehicle V as desired by the road business operator.

[0022]

When the cause of the traffic jam on the road 2B is due to a problem in road equipment (damage to a road or a tunnel, closing of a tollgate, and the like), the convenience of the road business operator such as road construction, or due to a natural disaster, a sudden event, or the like, the operator may discount the toll fare of the road 2B. The operator may further discount the toll fare of the road 2A in order to reduce the traffic volume of the road 2B.

[0023]

Note that the center server 50 has the content (presence/absence of a discount or an extra, and the amount thereof) of the variable toll corresponding to a combination of the content, the cause, the scale (degree of a traffic jam and the like) of the specific event set in advance, and when the operator inputs a combination of these pieces of information, the center server 50 may automatically generate the guidance information including the variable toll.

[0024]

When it is known from statistical information or the like that the traffic volume of the road 2B decreases (or the traffic volume of the road 2A

increases) in a specific period (season, day of the week, time of day, and the like), for example, the operator may set the toll fare of the road 2B to be discounted in this specific period, for example. In this case, the center server 50 automatically generates guidance information to discount the toll fare of the road 2B in the specific period based on information set in advance by the operator. In this case, the center server 50 sets, in the guidance information, a notification period (notification start time and notification end time) corresponding to this specific period. The roadside device 40 at the notification point 1 notifies the vehicle V of this guidance information only during the notification period having been set. In this manner, regarding the road where a variation of the toll fare repeatedly occurs, the vehicle V may be automatically notified of the guidance information without the operator performing input each time.

[0025]

Furthermore, guidance information indicating a discount of only the road 2A and guidance information indicating a discount of only the road 2B may be set such that, for example, every n vehicles passing through the notification point 1 is notified alternately of them. Doing this can also perform fine control so that the traffic volumes of the roads 2A and 2B are substantially equal.

[0026]

The operator may input only the guidance reason without varying the toll fares of the roads 2A and 2B. For example, the operator inputs a specific event (traffic jam) occurring on the road 2B, a degree thereof (○ km traffic jam), or the like as a guidance reason. Then, the center server 50 generates guidance information including this guidance reason. Doing this can guide the vehicle V to avoid the road 2B and head for the road 2A without varying the toll fare.

[0027]

Functional Configuration of Onboard Unit

FIG. 2 is a block diagram illustrating a functional configuration of the onboard unit according to the first embodiment. As illustrated in FIG. 2, the onboard unit 10 includes a travel history recording unit 101, a notification history recording unit 102, and a history information transmission unit 103.

[0028]

The travel history recording unit 101 records a travel history of the vehicle V. The travel history of the vehicle V includes at least information that can specify a road on which the vehicle V has traveled after a divergence point.

[0029]

For example, the travel history recording unit 101 acquires and records positioning information indicating the travel position of the vehicle V at regular intervals from a positioning device 20. The positioning device 20 is a GNSS receiver included in the onboard unit 10 or an external device (e.g., a device
5 incorporating a GNSS receiver such as a car navigation system or a smartphone) connected to the onboard unit 10. In this case, the time series of the positioning information recorded in the period from passage of the vehicle V through an entrance tollgate to arrival at an exit tollgate is travel history
10 information of the vehicle V.

[0030]

Note that when the positioning device 20 is an external device such as a car navigation system or a smartphone, the positioning device 20 may specify which road the vehicle V has traveled on among roads (sections) divided by
15 nodes (interchange, divergence point, merging point, and the like) of a toll road based on positioning information and map data. In this case, the travel history recording unit 101 may acquire a road on which the vehicle V has entered and an entry time thereof in place of the positioning information from the
positioning device 20. In this case, a list of the roads on which the vehicle V
20 has traveled is the travel history information of the vehicle V. Doing this can reduce the data amount of the travel history information as compared with a case where the positioning information is recorded as a travel history.

[0031]

There is a case where at least one of the roads 2A and 2B that diverge is
25 provided with a roadside communication device as in the example of FIG. 1, for example, on the toll road. In the roadside communication device, a roadside antenna 61 that performs wireless communication (e.g., DSRC communication) with the onboard unit 10 of the vehicle V that is passing is installed. The roadside antenna 61 transmits position information of the roadside
30 communication device to the onboard unit 10 of the vehicle V. In this case, in place of positioning device 20, the travel history recording unit 101 may record, as travel history, the position information acquired from the roadside antenna 61 of the roadside communication device and the transmission time thereof. In this case, a list of the position information received from the
35 roadside communication device by the vehicle V is the travel history information of the vehicle V. In the example of FIG. 1, if the position information (information indicating the road 2B) of the roadside communication device is recorded in the travel history information after

communication with the roadside antenna 41 at the notification point 1 is performed, it is known that the vehicle V has traveled on the road 2B, and if the position information of the roadside communication device is not recorded, it is known that the vehicle V has traveled on the road 2A. Doing this can eliminate
 5 the need for the positioning device 20 and simplify the configuration of the onboard unit 10.

[0032]

The notification history recording unit 102 records a notification history that can specify the guidance information that the vehicle V is notified of at the
 10 notification point. In the present embodiment, the notification history recording unit 102 receives and records, as a notification history, guidance information from the roadside antenna 41 at the notification point.

[0033]

The notification history recording unit 102 notifies the driver of the
 15 vehicle V of the received guidance information via an output device 21. The output device 21 is a speaker included in the onboard unit 10, and notifies the driver of the content of the guidance information by voice. The output device 21 may be a speaker or a display of an external device (e.g., a car navigation system, a smartphone, or the like) connected to the onboard unit 10, and
 20 notifies the driver of the content of the guidance information by voice, text, or the like. With reference to the guidance information, the driver determines a road (travel route) after a divergence point to travel on.

[0034]

When the vehicle V arrives at the exit tollgate, the history information
 25 transmission unit 103 transmits the travel history information and the notification history information of the vehicle V to the exit tollgate server 30 via the roadside antenna 31.

[0035]

Functional Configuration of Exit Tollgate Server

FIG. 3 is a block diagram illustrating a functional configuration of the
 30 exit tollgate server according to the first embodiment. As illustrated in FIG. 3, the exit tollgate server 30 includes a history information reception unit 301, a variable toll calculation unit 302, and a billing processing unit 303.

[0036]

The history information reception unit 301 receives, from the vehicle V
 35 (the onboard unit 10), travel history information that can specify a road on which the vehicle V has traveled, and notification history information

indicating whether the vehicle V has been notified of guidance information corresponding to the road on which the vehicle V has traveled.

[0037]

5 The variable toll calculation unit 302 calculates a variable toll to be applied to the vehicle V based on the travel history information and the notification history information acquired from the onboard unit 10 of the vehicle V.

[0038]

10 The billing processing unit 303 calculates a distance (section) from an entrance tollgate to an exit tollgate where the vehicle V has traveled and a toll fare corresponding to the vehicle type of the vehicle V. A calculation method of the toll fare corresponding to the distance and the vehicle type is the same as that in a known technique. The billing processing unit 303 applies the calculated toll fare to the variable toll calculated by the variable toll calculation
15 unit 302 to calculate a final toll fare (actual billing amount) and performs billing processing for the vehicle V.

[0039]

Functional Configuration of Roadside Device

20 FIG. 4 is a block diagram illustrating a functional configuration of the roadside device according to the first embodiment. As illustrated in FIG. 4, the roadside device 40 includes a notification processing unit 401.

[0040]

The notification processing unit 401 records the guidance information received from the center server 50. The notification processing unit 401 notifies
25 the onboard unit 10 of each vehicle V passing through the notification point of the recorded guidance information via the roadside antenna 41. Note that as described above, the guidance information may have a notification period set, and in this case, the notification processing unit 401 notifies the onboard unit 10 of each vehicle V of the guidance information only during the notification
30 period having been set.

[0041]

Processing Example of Travel Route Guidance System

35 FIG. 5 is a sequence diagram illustrating an example of processing of the travel route guidance system according to the first embodiment. The flow of processing of the travel route guidance system 100 of the present embodiment will be described with reference to FIG. 5.

[0042]

When the vehicle V enters the toll road, the travel history recording unit 101 of the onboard unit 10 records a travel history of the vehicle V (step S101). Note that when acquiring the travel history (positioning information or information on a road on which the vehicle has traveled) from the positioning device 20, the travel history recording unit 101 of the onboard unit 10 executes the processing of step S101 every time the travel history is acquired. When recording the position information of the roadside communication device as a travel history, the travel history recording unit 101 of the onboard unit 10 executes the processing of step S101 every time the position information is received from the roadside antenna 61 of the roadside communication device. [0043]

The center server 50 generates guidance information based on the information input by the operator and transmits it to the roadside device 40 at a notification point corresponding to the guidance information (step S102). Here, as illustrated in FIG. 1, a case where a traffic jam has occurred on the road 2B of the road 2A and the road 2B downstream of the notification point 1 will be described as an example. In accordance with the operator's input, the center server 50 generates and transmits, to the roadside device 40 at the notification point 1, guidance information indicating "road 2A: 100 yen discount" and "road 2B: no discount (no variation)". [0044]

The notification processing unit 401 of the roadside device 40 at the notification point 1 records the guidance information received from the center server 50 (step S103). The notification processing unit 401 of the roadside device 40 notifies the vehicle V (the onboard unit 10) passing through the notification point 1 of the guidance information via the roadside antenna 41 (step S104). Note that when the notification period of the guidance information is designated, the notification processing unit 401 of the roadside device 40 executes notification of the guidance information (step S104) only when the current time is within the notification period. [0045]

When the vehicle V arrives at the notification point 1, the notification history recording unit 102 of the onboard unit 10 receives and records, as a notification history, the guidance information from the roadside device 40 (the roadside antenna 41) (step S105). The notification history recording unit 102 notifies the driver of the vehicle V of the received guidance information via the output device 21 (step S106). With reference to the guidance information, the

driver determines a road (the road 2A or the road 2B) on which the vehicle will travel after passing through the notification point 1.

[0046]

Next, when the vehicle V arrives at the exit tollgate, the exit tollgate
 5 server 30 performs wireless communication with the onboard unit 10 of the vehicle V via the roadside antenna 31, and performs processing of calculating the toll fare of the vehicle V (step S107). The processing of calculating the toll fare is the same as the processing executed in a known automatic toll collection system. For example, in the ETC system in Japan, an IC card (an ETC card)
 10 inserted into the onboard unit 10 and communicating with a roadside antenna (not illustrated) when passing through an entrance tollgate records entrance information that can specify when and which entrance tollgate the vehicle has passed through. The onboard unit 10 has the vehicle type of the vehicle V recorded in advance. The exit tollgate server 30 acquires the entrance
 15 information and the vehicle type from the onboard unit 10 to calculate a distance (section) from the entrance tollgate to the exit tollgate where the vehicle V has traveled, and the toll fare corresponding to the vehicle type. At this time, the exit tollgate server 30 may calculate the toll fare of the vehicle V using a toll table in which a toll fare corresponding to the distance and the
 20 vehicle type is defined.

[0047]

The history information reception unit 301 of the exit tollgate server 30 requests the history information from the onboard unit 10 (step S108). Then, the history information transmission unit 103 of the onboard unit 10 transmits,
 25 to the exit tollgate server 30, history information including the travel history information and the notification history information of the vehicle V (step S109).

[0048]

The variable toll calculation unit 302 of the exit tollgate server 30
 30 calculates the variable amount of the toll fare of the vehicle V based on the received history information (step S110). Specifically, when the road on which the vehicle V has been notified of the variation in the toll fare by the guidance information, and the road on which the vehicle V has traveled that is specified from the travel history information, match each other, the variable toll
 35 calculation unit 302 calculates the variable amount in the toll fare of the vehicle V based on the information (presence/absence of a discount or an extra, and the amount thereof) included in the guidance information. For example, the variable toll calculation unit 302 specifies, from the travel history information

(the time series of positioning information or the list of roads), which of the roads 2A and 2B corresponding to the guidance information at the notification point 1 the vehicle V has traveled on. In the above example, the variable amount when the vehicle V travels on the road 2A is "-100 yen (100 yen discount)", and the variable amount when the vehicle V travels on the road 2B is "±0 yen (no discount)". Note that when the vehicle V has been notified of a plurality of pieces of guidance information, the variable toll calculation unit 302 determines a discount amount (or an extra amount) to be applied to the vehicle V for each piece of guidance information to calculate a variable amount in which these discount amounts (or extra amounts) are integrated.

[0049]

Next, the variable toll calculation unit 302 of the exit tollgate server 30 applies the toll fare calculated in step S107 to the variable toll calculated in step S110 to calculate a final toll fare (actual billing amount) of the vehicle V (step S111).

[0050]

The billing processing unit 303 of the exit tollgate server 30 performs billing processing of billing the vehicle V for the toll fare calculated in step S111 (step S112). This billing processing is the same as the processing of the known automatic toll collection system. The billing processing unit 303 generates and transmits, to the center server 50, billing data including the toll fare calculated in step S111 and identification information of the onboard unit 10 (step S113).

[0051]

Doing this enables the driver of the vehicle V to select a travel route with a lower toll fare with reference to the guidance information. The travel route guidance system 100 can guide the travel route of the vehicle V as desired by the road business operator by the guidance information.

[0052]

Note that although an example in which the travel history recording unit 101 of the onboard unit 10 records all the travel histories of the vehicle V during traveling on the toll road has been described, the present invention is not limited to this. When the vehicle V has been notified of the guidance information, the travel history recording unit 101 may record, as a travel history, only information indicating which of the roads corresponding to this guidance information the vehicle has traveled on. In the example of FIG. 1, the guidance information that the vehicle V is notified of at the notification point 1 corresponds to the roads 2A and 2B downstream thereof. Therefore, when

receiving the notification of the guidance information at the notification point 1, the travel history recording unit 101 records, as a travel history, information indicating which of the roads 2A and 2B the vehicle V has traveled on, and thereafter, even if the vehicle V has continuously traveled on the road 3, the travel history recording unit 101 does not record, in the travel history, information indicating that the vehicle V has traveled on this road 3. Then, it is possible to greatly reduce the data amount of the travel history information, and shorten the communication time between the onboard unit 10 and the exit tollgate server 30. Since the variable toll calculation unit 302 of the exit tollgate server 30 does not need to specify the road on which the vehicle V has traveled, the processing time can be shortened.

[0053]

Actions and Effects

As described above, the travel route guidance system 100 according to the present embodiment includes: the guidance information notification unit (the roadside antenna 41) that notifies the vehicle V of guidance information indicating a variation in a toll fare of at least one road of a plurality of roads at a notification point before a divergence point at which the vehicle V diverges into the plurality of roads; the history information reception unit 301 that receives, from the vehicle V, travel history information that can specify a road on which the vehicle V has traveled and notification history information that can specify whether the vehicle V has been notified of guidance information corresponding to the road on which the vehicle V has traveled; and the variable toll calculation unit 302 that calculates a variable toll to be applied to the vehicle V based on the travel history information and the notification history information.

[0054]

Doing this enables the travel route guidance system 100 to guide the vehicle V to another road with no traffic jam by notifying the vehicle V of the guidance information before a divergence point, for example, when one of a plurality of roads that diverge has a traffic jam. That is, the travel route guidance system 100 can guide the vehicle V to a road (route) desired by a business operator of a toll road depending on a road situation or the like. Since the driver of the vehicle V can know in advance which road the vehicle V should travel on by the guidance information, the vehicle V can travel by selecting a travel route advantageous for the driver by selecting a road on which no traffic jam has occurred.

[0055]

The guidance information includes variable toll information indicating a variation in the toll fare of at least one road of the plurality of roads, and the variable toll calculation unit 302 calculates the variable amount of the toll fare corresponding to travel of the vehicle V on the road when the road on which the vehicle V has been notified of the variation in the toll fare by the guidance information and the road on which the vehicle V has traveled that is specified from the travel history information match each other.

[0056]

Doing this enables the travel route guidance system 100 to apply the vehicle V to the variable toll only when the vehicle V has actually been notified of the guidance information and the vehicle V has traveled on the road where the vehicle V has been notified of the variation in the toll fare by this guidance information. For example, when the vehicle V is notified of guidance information for adding an extra to the toll fare of the road 2B due to an occurrence of a traffic jam, it is possible not to apply the extra toll to the vehicle V that has entered the road 2B before the vehicle V is notified of this guidance information. Therefore, it is possible not to cause a disadvantage (an extra in the toll fare) from occurring to the vehicle V that has traveled on the road 2B before starting guidance of the travel route by the guidance information. When the vehicle V is notified of the guidance information for discount of the toll fare of the road 2A in order to alleviate a traffic jam of the road 2B, it is possible to provide an advantage (a discount in the toll fare) only to the vehicle V that has traveled on the route (the road 2A) desired by the road business operator in accordance with the guidance information.

[0057]

The travel history information includes a time series of positioning information recorded by the onboard unit 10 of the vehicle V, or a road on which the vehicle V has traveled that is specified from the time series of the positioning information.

[0058]

Doing this enables the travel route guidance system 100 to accurately specify which road the vehicle V has traveled on based on the positioning information collected by the onboard unit 10 of the vehicle V or the list of the roads on which the vehicle V has traveled.

[0059]

The travel history information includes position information of a roadside communication device received by the onboard unit 10 of the vehicle

V from the roadside antenna 61 of the roadside communication device provided on the road.

[0060]

Doing this enables the travel route guidance system 100 to accurately
 5 specify which road the vehicle V has traveled on based on the position
 information recorded each time the onboard unit of the vehicle V passes
 through the roadside communication device.

[0061]

The guidance information notification unit is the roadside antenna 41
 10 that transmits the guidance information to the onboard unit 10 of the vehicle V,
 and the notification history information includes guidance information received
 by the onboard unit 10 from the roadside antenna 41.

[0062]

Doing this enables the travel route guidance system 100 to more reliably
 15 notify the driver of the vehicle V of the guidance information via the onboard
 unit 10.

[0063]

Second Embodiment

Hereinafter, the second embodiment will be described in detail with
 20 reference to FIG. 6. Components common to those of the above-described
 embodiment are denoted by identical reference signs, and detailed description
 will be omitted. In the first embodiment, an example in which the exit tollgate
 server 30 receives history information from the onboard unit 10 of the vehicle
 V that has arrived at an exit tollgate to calculate a variable toll has been
 25 described. In the second embodiment, an example in which the center server 50
 receives history information from the onboard unit 10 of the vehicle V that has
 arrived at a roadside communication device to calculate a variable toll will be
 described. That is, in place of the exit tollgate server 30, the center server 50
 includes the history information reception unit 301 and the variable toll
 30 calculation unit 302.

[0064]

FIG. 6 is a sequence diagram illustrating an example of processing of
 the travel route guidance system according to the second embodiment. The flow
 of processing of the travel route guidance system 100 of the present
 35 embodiment will be described with reference to FIG. 6. Note that although not
 illustrated in FIG. 6, it is assumed that the center server 50 and the roadside
 device 40 execute processing (steps S102 to S104 in FIG. 5) of generating and
 notifying of guidance information as in the first embodiment.

[0065]

In the roadside communication device, the roadside antenna 61 transmits position information (step S201). When the vehicle V arrives at the roadside communication device, the travel history recording unit 101 of the onboard unit 10 records, as a travel history, the position information received from the roadside antenna 61 of the roadside communication device (step S202). When the roadside antenna 61 requests transmission of history information (step S203), the history information transmission unit 103 of the onboard unit 10 transmits history information including travel history information and notification history information of the vehicle V to the center server 50 via the roadside antenna 61 (step S204). Note that this history information is attached with identification information of the vehicle V (identification information of the onboard unit 10 or the like). The variable toll calculation unit 302 of the center server 50 calculates a variable amount of the toll fare of the vehicle V based on the history information received by the history information reception unit 301 (step S205). The processing in step S205 is the same as that in the first embodiment (step S110 in FIG. 5). The variable toll calculation unit 302 records the identification information of the vehicle V and the calculated variable amount of the toll fare in association with each other.

[0066]

Note that when the vehicle V passes through a plurality of roadside communication devices, the series of processing of steps S201 to S205 is executed each time, and an integrated amount of the variable toll fares of the vehicle V is recorded in the center server 50.

[0067]

When the vehicle V arrives at the exit tollgate, the exit tollgate server 30 performs wireless communication with the onboard unit 10 of the vehicle V via the roadside antenna 31, and performs processing of calculating the toll fare of the vehicle V (step S206). The processing in step S206 is the same as that in the first embodiment (step S107 in FIG. 5).

[0068]

The billing processing unit 303 of the exit tollgate server 30 notifies the center server 50 of the identification information of the vehicle V to make an inquiry about the presence/absence of the variable toll (step S207). When the inquired variable toll of the vehicle V is recorded, the variable toll calculation unit 302 of the center server 50 transmits it to the exit tollgate server 30 (step S208). The billing processing unit 303 of the exit tollgate server 30 applies the toll fare calculated in step S107 to the variable toll received from the center

server 50 to calculate a final toll fare (actual billing amount) of the vehicle V (step S209). The billing processing unit 303 of the exit tollgate server 30 performs billing processing of billing the vehicle V for the toll fare calculated in step S209 (step S210) and generates and transmits, to the center server 50, billing data (step S211). The processing in steps S210 to S211 is the same as that in the first embodiment (steps S112 to S113 in FIG. 5).

[0069]

Doing this enables the travel route guidance system 100 to collect the history information of the vehicle V every time the vehicle V passes through the roadside communication device to calculate the variable toll to be applied to the vehicle V in advance. By this, when the vehicle V arrives at the exit tollgate, the exit tollgate server 30 does not need to receive the history information to calculate the variable toll and may only obtain the calculation result of the variable toll from the center server 50, and therefore it is possible to shorten the processing time at the exit tollgate.

[0070]

Third Embodiment

Hereinafter, the third embodiment will be described in detail with reference to FIGS. 7 and 8. Components common to those of the above-described embodiments are denoted by identical reference signs, and detailed description will be omitted.

[0071]

FIG. 7 is a schematic view illustrating an overall configuration of the travel route guidance system according to the third embodiment. As illustrated in FIG. 7, the travel route guidance system 100 of the present embodiment includes, as a guidance information notification unit, an electronic message board 42 in place of the roadside antenna 41. The electronic message board 42 displays guidance information to the vehicle V (driver) passing through a notification point under the control of the roadside device 40.

[0072]

By displaying, on the electronic message board 42, the guidance information received from the center server 50 and recorded, the notification processing unit 401 of the roadside device 40 notifies each vehicle V passing through the notification point of the guidance information. With reference to the guidance information displayed on the electronic message board 42, the driver of the vehicle V determines a road (travel route) after a divergence point to travel on.

[0073]

FIG. 8 is a sequence diagram illustrating an example of processing of the travel route guidance system according to the second embodiment. The flow of processing of the travel route guidance system 100 of the present embodiment will be described with reference to FIG. 8.

5 [0074]

When the vehicle V enters the toll road, the travel history recording unit 101 of the onboard unit 10 records a travel history of the vehicle V (step S301). The processing in step S301 is the same as that in the first embodiment (step S101 in FIG. 5).

10 [0075]

The center server 50 generates guidance information based on the information input by the operator and transmits it to the roadside device 40 at a notification point (e.g., the notification point 1 in FIG. 7) corresponding to the guidance information (step S302). The notification processing unit 401 of the roadside device 40 at the notification point 1 records the guidance information received from the center server 50 (step S303). The notification processing unit 401 of the roadside device 40 displays the guidance information on the electronic message board 42 at the notification point (step S304).

[0076]

20 When the vehicle V arrives at the notification point 1, the driver of the vehicle V visually confirms the guidance information displayed on the electronic message board 42. For example, it is assumed that a car navigation system, a smartphone, or the like is connected to the onboard unit 10 of the vehicle V as the positioning device 20. It is assumed that the map data of this positioning device 20 includes position information of each notification point. In this case, when determining that the vehicle V has passed through the notification point 1 from the positioning information, the positioning device 20 outputs, to the onboard unit 10, information indicating that the vehicle V has passed through the notification point 1. The notification history recording unit 102 of the onboard unit 10 records, as the notification history, the notification point 1 at which the vehicle V has passed through and the passage time based on the information acquired from the positioning device 20 (step S305).

30 [0077]

Next, when the vehicle V arrives at the exit tollgate, the exit tollgate server 30 performs wireless communication with the onboard unit 10 of the vehicle V via the roadside antenna 31, and performs processing of calculating the toll fare of the vehicle V (step S306). The history information reception unit 301 of the exit tollgate server 30 requests the history information from the

onboard unit 10 (step S307). Then, the history information transmission unit 103 of the onboard unit 10 transmits, to the exit tollgate server 30, the notification history including the travel history information and the notification history information of the vehicle V (step S308). The processing in steps S306 to S308 is the same as that in the first embodiment (steps S107 to S109 in FIG. 5).

[0078]

The variable toll calculation unit 302 of the exit tollgate server 30 calculates the variable amount of the toll fare of the vehicle V based on the received history information (step S309). The variable toll calculation unit 302 makes an inquiry, from the center server 50, or acquires in advance, from the center server 50, about a guidance information table in which the content of the guidance information notified (displayed) at each notification point and the notification period thereof are recorded. The variable toll calculation unit 302 specifies the notification point 1 and the passage time at which the vehicle V has passed through from the notification history information received from the onboard unit 10, and extracts the guidance information the vehicle V has been notified of at the notification point 1 at the time when the vehicle V passed from the guidance information table. The variable toll calculation unit 302 specifies the road on which the vehicle V has traveled from the travel history information received from the onboard unit 10, and calculates the variable amount of the toll fare of the vehicle V when the vehicle V has traveled on the road on which the vehicle V has been notified of the variation of the toll fare by the guidance information.

[0079]

Next, the variable toll calculation unit 302 of the exit tollgate server 30 applies the toll fare calculated in step S306 to the variable toll calculated in step S309 to calculate a final toll fare (actual billing amount) of the vehicle V (step S310). The billing processing unit 303 of the exit tollgate server 30 performs billing processing of billing the vehicle V for the toll fare calculated in step S310 (step S311) and generates and transmits, to the center server 50, billing data (step S312). The processing in steps S310 to S312 is the same as that in the first embodiment (steps S111 to S113 in FIG. 5).

[0080]

Doing this enables the travel route guidance system 100 to guide the travel route of the vehicle V as desired by the road business operator by notifying the vehicle V of the guidance information on the electronic message board 42. The driver of the vehicle V can select a travel route with a lower toll

fare with reference to the guidance information displayed on the electronic message board 42.

[0081]

5 Note that FIG. 8 illustrates an example in which the notification history recording unit 102 of the onboard unit 10 records this notification point and the passage time as the notification history when the positioning device 20 determines in step S305 that the vehicle has passed the notification point, but the present invention is not limited to this. In other embodiments, the onboard unit 10 side (the onboard unit 10 and the positioning device 20) does not
10 determine whether the vehicle V has passed a notification point, and the exit tollgate server 30 may determine whether the vehicle V has passed the notification point. In this case, the onboard unit 10 records only the travel history and does not record the notification history (step S305 is omitted). In step S308, the history information transmission unit 103 of the onboard unit 10
15 transmits only the travel history information to the exit tollgate server 30. In step S309, the variable toll calculation unit 302 of the exit tollgate server 30 specifies when and which notification point the vehicle V has passed based on the travel history information received from the onboard unit 10 and the map data including the position of the notification point. The subsequent processing
20 is the same as the processing in step S309 described above. That is, the variable toll calculation unit 302 extracts the guidance information that is notified of at the notification point at the time when the vehicle V passed through from the guidance information table. The variable toll calculation unit 302 specifies the road on which the vehicle V has traveled from the travel history information
25 received from the onboard unit 10, and calculates the variable amount of the toll fare of the vehicle V when the vehicle V has traveled on the road on which the vehicle V has been notified of the variation of the toll fare by the guidance information.

[0082]

30 In FIG. 8, an example of changing part of the processing of the first embodiment has been described, but the present invention is not limited to this, and similarly to the second embodiment, an aspect in which the center server 50 acquires history information of the vehicle V via the roadside antenna 61 of the roadside communication device to calculate a variable toll may be
35 employed. That is, in place of steps S306 to S312 of FIG. 8, steps S206 to S211 of the second embodiment (FIG. 6) may be executed.

[0083]

As described above, in the travel route guidance system 100 according to the present embodiment, the guidance information notification unit is the electronic message board 42 that displays the guidance information to the vehicle V, the notification history information includes information indicating a notification point and a passage time at which the vehicle V passed, and the variable toll calculation unit 302 specifies guidance information that has been notified to the vehicle V, based on the notification history information and a guidance information table in which guidance information and a display period displayed at each of a plurality of the notification points are recorded.

[0084]

Doing this enables the travel route guidance system 100 to simultaneously notify a plurality of the vehicles V of the guidance information by the electronic message board 42 in place of the roadside antenna 41.

[0085]

The onboard unit 10 may record and transmit, to the exit tollgate server 30, only the travel history information. In this case, based on the travel history information and the guidance information table in which the guidance information and the display period displayed at each of the plurality of notification points are recorded, the variable toll calculation unit 302 of the exit tollgate server 30 specifies the guidance information that has been notified to the vehicle V, and specifies whether the vehicle V has traveled on the road on which the vehicle V has been notified of a variation in the toll fare by the guidance information.

[0086]

By doing this, it is not necessary for the onboard unit 10 side (the onboard unit 10 and the positioning device 20) to determine whether the vehicle has passed through the notification point, and therefore it is possible to simplify the configuration of the onboard unit 10. Also when the position of the notification point is added or changed, only the map data of the exit tollgate server 30 may be updated, and even if the map data of the positioning device 20 remains old, there is no adverse effect such as erroneous determination of whether the vehicle has passed the notification point.

[0087]

Computer Configuration

FIG. 9 is a schematic block diagram illustrating the configuration of a computer according to each 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 onboard unit 10, the exit tollgate server 30, the roadside

device 40, and the center server 50 described above are mounted on 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 to
 5 deploy 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.

[0088]

10 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
 15 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
 20 may be implemented by the integrated circuit.

[0089]

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
 25 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
 30 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.

[0090]

35 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.

[0091]

Supplementary Notes

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

[0092]

 (1) According to a first aspect, the travel route guidance system 100 includes: the guidance information notification units 41 and 42 that notify the
10 vehicle V of guidance information indicating which of a plurality of roads to travel at a notification point before a divergence point at which a road diverges into the plurality of roads; the history information reception unit 301 that receives, from the vehicle V, travel history information that can specify a road on which the vehicle V has traveled and notification history information that
15 can specify whether the vehicle V has been notified of guidance information corresponding to the road on which the vehicle V has traveled; and the variable toll calculation unit 302 that calculates a variable amount of a toll fare of the vehicle V based on the travel history information and the notification history information.

20 [0093]

 Doing this enables the travel route guidance system 100 to guide the vehicle V to another road with no traffic jam by notifying the vehicle V of the guidance information before a divergence point, for example, when one of a plurality of roads that diverge has a traffic jam. That is, the travel route
25 guidance system 100 can guide the vehicle V to a road (route) desired by a business operator of a toll road depending on a road situation or the like. Since the driver of the vehicle V can know in advance which road the vehicle V should travel on by the guidance information, the vehicle V can travel by selecting a travel route advantageous for the driver by selecting a road on
30 which no traffic jam has occurred.

[0094]

 (2) According to a second aspect, in the travel route guidance system 100 according to the first aspect, the guidance information includes variable toll information indicating a variation in the toll fare of at least one road of the
35 plurality of roads, and the variable toll calculation unit 302 calculates the variable amount of the toll fare corresponding to travel of the vehicle V on the road when the road on which the vehicle V has been notified of the variation in the toll fare by the guidance information and the road on which the vehicle V

has traveled that is specified from the travel history information match each other.

[0095]

Doing this enables the travel route guidance system 100 to apply the vehicle V to the variable toll only when the vehicle V has actually been notified of the guidance information and the vehicle V has traveled on the road where the vehicle V has been notified of the variation in the toll fare by this guidance information. For example, when the vehicle V is notified of guidance information for adding an extra to the toll fare of the road 2B due to an occurrence of a traffic jam, it is possible not to apply the extra toll to the vehicle V that has entered the road 2B before the vehicle V is notified of this guidance information. Therefore, it is possible not to cause a disadvantage (an extra in the toll fare) from occurring to the vehicle V that has traveled on the road 2B before starting guidance of the travel route by the guidance information. When the vehicle V is notified of the guidance information for discount of the toll fare of the road 2A in order to alleviate a traffic jam of the road 2B, it is possible to provide an advantage (a discount in the toll fare) only to the vehicle V that has traveled on the route (the road 2A) desired by the road business operator in accordance with the guidance information.

[0096]

(3) According to a third aspect, in the travel route guidance system 100 according to the first or second aspect, the travel history information includes a time series of positioning information recorded by the onboard unit 10 of the vehicle V, or a road on which the vehicle V has traveled that is specified from the time series of the positioning information.

[0097]

Doing this enables the travel route guidance system 100 to accurately specify which road the vehicle V has traveled on based on the positioning information collected by the onboard unit 10 of the vehicle V or the list of the roads on which the vehicle V has traveled.

[0098]

(4) According to a fourth aspect, in the travel route guidance system 100 according to the first or second aspect, the travel history information includes position information of a roadside communication device received by the onboard unit 10 of the vehicle V from the roadside antenna 61 of the roadside communication device provided on the road.

[0099]

Doing this enables the travel route guidance system 100 to accurately specify which road the vehicle V has traveled on based on the position information recorded each time the onboard unit of the vehicle V passes through the roadside communication device.

5 [0100]

(5) According to a fifth aspect, in the travel route guidance system 100 according to any one of the first to fourth aspects, the history information reception unit 301 and the variable toll calculation unit 302 are provided at the exit tollgate server 30 of an exit tollgate.

10 [0101]

Doing this enables the travel route guidance system 100 to determine the billing amount applied with a variable toll corresponding to the road on which the vehicle V has traveled with respect to the toll fare of the vehicle V at the exit tollgate.

15 [0102]

(6) According to a sixth aspect, in the travel route guidance system 100 according to any one of the first to fourth aspects, the history information reception unit 301 and the variable toll calculation unit 302 are provided at the center server 50, the history information reception unit 301 of the center server 50 receives the travel history information and the notification history information from the vehicle via the roadside antenna 61 of the roadside communication device provided on the road when the vehicle V passes through the roadside communication device, and the variable toll calculation unit 302 of the center server 50 calculates the variable amount of the toll fare of the vehicle V when receiving the travel history information and the notification history information from the vehicle V.

[0103]

Doing this enables the travel route guidance system 100 to collect the history information of the vehicle V every time the vehicle V passes through the roadside communication device to calculate the variable toll to be applied to the vehicle V in advance. By this, when the vehicle V arrives at the exit tollgate, the exit tollgate server 30 does not need to receive the history information to calculate the variable toll and may only obtain the calculation result of the variable toll from the center server 50, and therefore it is possible to shorten the processing time at the exit tollgate.

[0104]

(7) According to a seventh aspect, in the travel route guidance system 100 according to any one of the first to sixth aspects, the guidance information

notification unit is the roadside antenna 41 that transmits the guidance information to the onboard unit 10 of the vehicle V, and the notification history information includes guidance information received by the onboard unit 10 from the roadside antenna 41.

5 [0105]

As in the third embodiment, when the electronic message board 42 notifies of the guidance information, there is a possibility that the driver of the vehicle V overlooks the guidance information. On the other hand, by notifying the onboard unit 10 of the guidance information via the roadside antenna 41 as
10 described above, it is possible to more reliably notify the driver of the vehicle V of the guidance information via the onboard unit 10.

[0106]

(8) According to an eighth aspect, in the travel route guidance system 100 according to any one of the first to sixth aspects, the guidance information
15 notification unit is the electronic message board 42 that displays the guidance information to the vehicle V, the notification history information includes information indicating a notification point and a passage time at which the vehicle V passed, and the variable toll calculation unit 302 specifies guidance information that has been notified to the vehicle V, based on the notification
20 history information and a guidance information table in which guidance information and a display period displayed at each of a plurality of the notification points are recorded.

[0107]

Doing this enables the travel route guidance system 100 to guide the
25 travel route of the vehicle V as desired by the road business operator by notifying the vehicle V of the guidance information on the electronic message board 42. The driver of the vehicle V can select a travel route with a lower toll fare with reference to the guidance information displayed on the electronic message board 42.

30 [0108]

(9) According to a ninth aspect, the travel route guidance system 100 includes: the guidance information notification unit that notifies the vehicle V of guidance information indicating which of a plurality of roads to travel on at a notification point before a divergence point at which a road diverges into the
35 plurality of roads; the history information reception unit 301 that receives, from the vehicle V, travel history information that can specify a road on which the vehicle V has traveled; and the variable toll calculation unit 302 that calculates a variable amount of a toll fare of the vehicle V based on the travel history

information and the guidance information, in which the guidance information notification unit is the electronic message board 42 that displays the guidance information to the vehicle V, and based on the travel history information and a guidance information table in which guidance information and a display period
 5 displayed at each of a plurality of the notification points are recorded, the variable toll calculation unit 302 specifies guidance information that the vehicle V has been notified of and specifies whether the vehicle V has traveled on a road on which the vehicle V has been notified of a variation in a toll fare by the guidance information to calculate a variable amount of a toll fare.

10 [0109]

Doing this enables the travel route guidance system 100 to guide the travel route of the vehicle V as desired by the road business operator by notifying the vehicle V of the guidance information on the electronic message board 42. It is not necessary for the onboard unit 10 side (the onboard unit 10
 15 and the positioning device 20) to determine whether the vehicle has passed through the notification point, and therefore it is possible to simplify the configuration of the onboard unit 10. Furthermore, also when the position of the notification point is added or changed, only the map data of the exit tollgate server 30 may be updated, and even if the map data of the positioning device 20
 20 remains old, there is no adverse effect such as erroneous determination of whether the vehicle has passed the notification point.

[0110]

(10) According to a tenth aspect, in the travel route guidance system 100 according to the ninth aspect, the history information reception unit 301 and the
 25 variable toll calculation unit 302 are provided at the exit tollgate server 30 of an exit tollgate.

[0111]

Doing this enables the travel route guidance system 100 to determine the billing amount applied with a variable toll corresponding to the road on which
 30 the vehicle V has traveled with respect to the toll fare of the vehicle V at the exit tollgate.

[0112]

(11) According to an eleventh aspect, in the travel route guidance system 100 according to the ninth aspect, the history information reception unit 301
 35 and the variable toll calculation unit 302 are provided at the center server 50, the history information reception unit 301 of the center server 50 receives the travel history information from the vehicle via the roadside antenna 61 of a roadside communication device provided on the road when the vehicle V passes

Doing this enables the travel route guidance system 100 to collect the history information of the vehicle V every time the vehicle V passes through the roadside communication device to calculate the variable toll to be applied to the vehicle V in advance. By this, when the vehicle V arrives at the exit tollgate, the exit tollgate server 30 does not need to receive the history information to calculate the variable toll and may only obtain the calculation result of the variable toll from the center server 50, and therefore it is possible to shorten the processing time at the exit tollgate.

(12) According to a twelfth aspect, a travel route guidance method includes: a step of notifying the vehicle V of guidance information indicating which of a plurality of roads to travel on at a notification point before a divergence point at which a road diverges into the plurality of roads; a step of receiving, from the vehicle V, travel history information that can specify a road on which the vehicle V has traveled and notification history information that can specify whether the vehicle V has been notified of guidance information corresponding to the road on which the vehicle V has traveled; and a step of calculating a variable amount of a toll fare of the vehicle V based on the travel history information and the notification history information.

[0115]

- | | |
|-----|---|
| 100 | Travel route guidance system |
| 10 | Onboard unit |
| 101 | Travel history recording unit |
| 30 | 102 Notification history recording unit |
| 103 | History information transmission unit |
| 20 | Positioning device |
| 21 | Output device |
| 30 | Exit tollgate server |
| 35 | 301 History information reception unit |
| 302 | Variable toll calculation unit |
| 303 | Billing processing unit |
| 31 | Roadside antenna |

- 40 Roadside device
- 401 Notification processing unit
- 41 Roadside antenna (Guidance information notification unit)
- 42 Electronic message board (Guidance information notification unit)
- 5 50 Center server
- 61 Roadside antenna
- V Vehicle

Claims

[Claim 1]

A travel route guidance system comprising:

- a guidance information notification unit that notifies a vehicle of guidance information indicating which of a plurality of roads to travel on at a notification point before a divergence point at which a road diverges into the plurality of roads;
- a history information reception unit that receives, from the vehicle, travel history information that can specify a road on which the vehicle has traveled and notification history information that can specify whether the vehicle has been notified of guidance information corresponding to the road on which the vehicle has traveled; and
- a variable toll calculation unit that calculates a variable amount of a toll fare of the vehicle based on the travel history information and the notification history information.

[Claim 2]

The travel route guidance system according to claim 1, wherein

- the guidance information includes variable toll information indicating a variation in a toll fare of at least one road of the plurality of roads, and
- when a road on which the vehicle has been notified of a variation in a toll fare by the guidance information matches a road on which the vehicle has traveled that is specified from the travel history information, the variable toll calculation unit calculates a variable amount of a toll fare corresponding to travel of the vehicle on the road.

[Claim 3]

The travel route guidance system according to claim 1, wherein

- the travel history information includes a time series of positioning information recorded by an onboard unit of the vehicle, or a road on which the vehicle has traveled that is specified from the time series of the positioning information.

[Claim 4]

The travel route guidance system according to claim 1, wherein

- the travel history information includes position information of a roadside communication device received by the onboard unit of the vehicle

from a roadside antenna of the roadside communication device provided on the road.

[Claim 5]

The travel route guidance system according to any one of claims 1 to 4, wherein

the history information reception unit and the variable toll calculation unit are provided at an exit tollgate server of an exit tollgate.

[Claim 6]

The travel route guidance system according to any one of claims 1 to 4, wherein

the history information reception unit and the variable toll calculation unit are provided at a center server,

the history information reception unit of the center server receives the travel history information and the notification history information from the vehicle via a roadside antenna of a roadside communication device provided on the road when the vehicle passes through the roadside communication device, and

the variable toll calculation unit of the center server calculates a variable amount of a toll fare of the vehicle when receiving the travel history information and the notification history information from the vehicle.

[Claim 7]

The travel route guidance system according to any one of claims 1 to 4, wherein

the guidance information notification unit is a roadside antenna that transmits the guidance information to the onboard unit of the vehicle, and

the notification history information includes guidance information received by the onboard unit from the roadside antenna.

[Claim 8]

The travel route guidance system according to any one of claims 1 to 4, wherein

the guidance information notification unit is an electronic message board that displays the guidance information to the vehicle,

the notification history information includes information indicating a notification point and a passage time at which the vehicle passed, and

the variable toll calculation unit specifies guidance information that the vehicle has been notified of, based on the notification history information and a guidance information table in which guidance information and a display period displayed at each of a plurality of the notification points are recorded.

[Claim 9]

A travel route guidance system comprising:

a guidance information notification unit that notifies a vehicle of guidance information indicating which of a plurality of roads to travel on at a notification point before a divergence point at which a road diverges into the plurality of roads;

a history information reception unit that receives, from the vehicle, travel history information that can specify a road on which the vehicle has traveled; and

a variable toll calculation unit that calculates a variable amount of a toll fare of the vehicle based on the travel history information and the guidance information, wherein

the guidance information notification unit is an electronic message board that displays the guidance information to the vehicle, and

based on the travel history information and a guidance information table in which guidance information and a display period displayed at each of a plurality of the notification points are recorded, the variable toll calculation unit specifies guidance information that the vehicle has been notified of and specifies whether the vehicle has traveled on a road on which the vehicle has been notified of a variation in a toll fare by the guidance information to calculate a variable amount of a toll fare.

[Claim 10]

The travel route guidance system according to claim 9, wherein

the history information reception unit and the variable toll calculation unit are provided at an exit tollgate server of an exit tollgate.

[Claim 11]

The travel route guidance system according to claim 9, wherein

the history information reception unit and the variable toll calculation unit are provided at a center server,

the history information reception unit of the center server receives the travel history information from the vehicle via a roadside antenna of a roadside

communication device provided on the road when the vehicle passes through the roadside communication device, and

the variable toll calculation unit of the center server calculates a variable amount of a toll fare of the vehicle when receiving the travel history information from the vehicle.

[Claim 12]

A travel route guidance method comprising:

notifying a vehicle of guidance information indicating which of a plurality of roads to travel on at a notification point before a divergence point at which a road diverges into the plurality of roads;

receiving, from the vehicle, travel history information that can specify a road on which the vehicle has traveled and notification history information that can specify whether the vehicle has been notified of guidance information corresponding to the road on which the vehicle has traveled; and

calculating a variable amount of a toll fare of the vehicle based on the travel history information and the notification history information.