

Description

Title of Invention: ENTRANCE TOLL COLLECTION FACILITY, ONBOARD UNIT, EXIT TOLL COLLECTION FACILITY, SERVICE USING SYSTEM, SERVICE USING METHOD, AND PROGRAM

5

Technical Field

[0001]

The present disclosure relates to an entrance toll collection facility, an onboard unit, an exit toll collection facility, a service using system, a service using method, and a program.

10

Background Art

[0002]

An electronic toll collection system (ETC system (registered trademark), also called "automatic toll collection system") is used as a technology for collecting a toll fare of a toll road (see, for example, Patent Document 1).

15

Citation List

Patent Literature

20 [0003]

Patent Document 1: JP 2021-92850 A

Summary of Invention

Technical Problem

25 [0004]

In recent years, services are considered that are provided in addition to travel on a road, such as a merge assistance service for an autonomous driving vehicle on a toll road and a power feeding service to an electric vehicle (EV) while driving. For example, for the power feeding service while driving, a user (a driver of a vehicle) may not want to use the service when, for example, the vehicle has already been charged. However, currently, there is no mechanism that provides the service after the user agrees to use the service.

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[0005]

An object of the present disclosure is to provide an entrance toll collection facility, an onboard unit, an exit toll collection facility, a service using system, a service using method, and a program that can make a service available on the basis of agreement of the user on a road that can provide the service to be added to travel of a vehicle.

35

Solution to Problem

[0006]

According to one aspect of the present disclosure, an entrance toll
5 collection facility includes: an entrance roadside antenna provided at each of a plurality of entrance lanes separated by a type of a service at an entrance of a road that can provide the service to be added to travel of a vehicle and configured to communicate with an onboard unit mounted on a vehicle traveling in the entrance lane; and a service flag transmission unit configured to
10 transmit, from the entrance roadside antenna to the onboard unit, service information including a type of a service that is assigned to an entrance lane that the vehicle has entered and is used by the vehicle on the road.

[0007]

According to one aspect of the present disclosure, an onboard unit
15 includes: a service setting unit configured to set, when receiving service information including a type of a service assigned to an entrance lane from an entrance roadside antenna provided at the entrance lane of a road that can provide a service to be added to travel of a vehicle, a service flag corresponding to the type of the service on; and an enabling processing unit
20 configured to enable a function of a service using device of the vehicle corresponding to the service flag when the service flag is on.

[0008]

According to one aspect of the present disclosure, an exit toll collection
25 facility includes: an exit roadside antenna that is provided at an exit lane of a road that can provide a service to be added to travel of a vehicle, and communicates with an onboard unit mounted on a vehicle traveling in the exit lane; a service flag reception unit configured to receive, from the onboard unit through the exit roadside antenna, a service flag by which a service used by the vehicle can be specified; and a usage fee collection processing unit configured
30 to collect a usage fee of a service corresponding to the service flag.

[0009]

According to one aspect of the present disclosure, a service using system includes the entrance toll collection facility described above and the onboard unit described above.

35 [0010]

According to one aspect of the present disclosure, a service using method includes: by an entrance toll collection facility, a step of transmitting, to an onboard unit mounted on a vehicle through an entrance roadside antenna

provided at each of a plurality of entrance lanes separated by a type of a service at an entrance of a road that can provide the service to be added to travel of the vehicle, service information including a type of a service that is assigned to an entrance lane that the vehicle has entered and is used by the vehicle on the road; by the onboard unit, a step of setting a service flag corresponding to a type of the service when receiving the service information; and by the onboard unit, a step of enabling a function of a service using device corresponding to the service flag when the service flag is on.

[0011]

According to one aspect of the present disclosure, a program causes an onboard unit to execute: a step of setting a service flag corresponding to a type of a service when receiving, from an entrance roadside antenna provided at an entrance lane of a road that can provide a service to be added to travel of a vehicle, service information including a type of the service assigned to the entrance lane; and a step of enabling a function of a service using device of corresponding to the service flag when the service flag is on.

Advantageous Effects of Invention

[0012]

The above aspect can make a service available on the basis of agreement of the user on a road that can provide the service to be added to travel of a vehicle.

Brief Description of Drawings

[0013]

FIG. 1 is a view illustrating an overall configuration of a service using system according to a first embodiment.

FIG. 2 is a view illustrating a functional configuration of an entrance toll collection facility according to the first embodiment.

FIG. 3 is a view illustrating a functional configuration of an exit toll collection facility according to the first embodiment.

FIG. 4 is a view illustrating a functional configuration of an onboard unit according to the first embodiment.

FIG. 5 is a view illustrating an example of service assignment processing of an entrance lane according to the first embodiment.

FIG. 6 is a view illustrating an assignment example of a service flag of the entrance lane according to the first embodiment.

FIG. 8 is a view illustrating an example of processing during service usage according to the first embodiment.

FIG. 9 is a view illustrating an example of collection processing of a service usage fee according to the first embodiment.

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

10 Description of Embodiments

[0014]

First Embodiment

Hereinafter, embodiments will be described in detail with reference to the drawings.

15 [0015]

Overall Configuration

FIG. 1 is a view illustrating the overall configuration of the service using system according to the first embodiment. A service using system 100 according to the present embodiment automatically makes a service selected by a user (a driver of a vehicle V) available on a road that can provide a service to be added to travel of the vehicle V, and automatically collects a usage fee of the service used by the user. As illustrated in FIG. 1, the service using system 100 includes an entrance toll collection facility 1, an exit toll collection facility 2, an onboard unit 3 mounted on the vehicle V, and a service providing facility 6.

25 [0016]

The entrance toll collection facility 1 is provided at an entrance tollgate of a toll road. The entrance tollgate has a plurality of entrance lanes LI (LI1, LI2,...). In the present embodiment, the entrance lanes LI are separated by a type of a service to be added to travel of the vehicle V. By operating a terminal device 5, for example, a road business operator sets the type of a service to be assigned to each of the entrance lanes LI ((1) of FIG. 1). The terminal device 5 may be, for example, a monitoring board for monitoring and remotely operating each tollgate from a remote place such as a tollgate office. The service assigned to each of the entrance lanes LI is displayed on a lane guidance sign 12 (described later) ((2) of FIG. 1). The user agrees, by looking at the lane guidance sign 12 and traveling in the entrance lane LI to which the service to be used is assigned, to use the service (to incur the usage fee of the service) ((3) of FIG. 1). The entrance toll collection facility 1 performs wireless

communication with the onboard unit 3 of the vehicle V using the automatic toll collection system, performs transmission/reception of information required for collection of the toll fare of the toll road, and performs transmission/reception of information regarding the service desired by the user ((4) of FIG. 1).

[0017]

The exit toll collection facility 2 is provided at an exit tollgate of a toll road. The exit tollgate has one or more exit lanes LO (LO1, LO2,...). The exit toll collection facility 2 performs wireless communication with the onboard unit 3 of the vehicle V using the automatic toll collection system, collects the toll fare of the toll road from the onboard unit 3, and collects the usage fee of the service used by the vehicle V ((7) of FIG. 1).

[0018]

The onboard unit 3 enables a function of a service using device 4 of the vehicle V to make the service selected by passing through the entrance lane LI ((3) of FIG. 1) available ((5) of FIG. 1). The service using device 4 can make, when the function is enabled during traveling on the road, a service provided from the service providing facility 6 available ((6) of FIG. 1).

[0019]

The service to be added to travel includes, for example, an autonomous driving assistance service, a power feeding service while driving, and an information distribution service.

[0020]

The autonomous driving assistance service is a service that provides autonomous driving assistance information so that an autonomous driving vehicle can travel on the road while automatically controlling the position and speed of the own vehicle. For example, the autonomous driving assistance service is a service that provides an autonomous driving vehicle merging into a main line from a merging lane of a toll road with merge assistance information that can detect a position of a vehicle traveling on the main line, a position where the vehicle can merge, and the like. The autonomous driving vehicle merges into the main line by controlling the position, speed, and the like of the own vehicle on the basis of the merge assistance information. The merge assistance information is an example of the autonomous driving assistance information.

[0021]

The power feeding service while driving is a service of supplying power for battery charging to an EV traveling on a panel (power feeding panel) including a power transmission coil for power feeding embedded in the road. [0022]

5 The information distribution service is a service that distributes information regarding the road where the vehicle V travels. The information distribution service includes, for example, a next-generation highway radio and a look-ahead information distribution service. The next-generation highway radio distributes traffic information and the like including a traffic jam on a
10 road on which the vehicle V travels, a closed road, and an event (a fallen object, a wrong-way driving car, and the like) occurring ahead (downstream of the road) in the traveling direction. The look-ahead information distribution service is a service that distributes information regarding an event (a fallen
15 like) occurring ahead (downstream of the road) in the traveling direction of the vehicle V before the vehicle V reaches the event occurrence point. For example, the autonomous driving vehicle may control the position, speed, and the like of the own vehicle so as to avoid an event such as a fallen object on the basis of the information distributed by the look-ahead information distribution
20 service. Note that the information distributed by the information distribution service may include map information, image information, voice information, and the like in addition to text information.
[0023]

Note that these services are examples, and other services providable to
25 the vehicle V in motion may be further included.
[0024]

The service providing facility 6 includes a management server 60 and a service device 61. The service device 61 includes, for example, a service roadside antenna 62 that can transmit/receive information by wireless
30 communication (e.g., DSRC communication) with the onboard unit 3 and the service using device 4 of the vehicle V and a power feeding panel 63 that can supply power to the EV. The management server 60 performs processing of distributing various types of information from the service roadside antenna 62 to the vehicle V, processing of starting and ending power feeding to the power
35 feeding panel 63, and the like. Note that the management server 60, and the onboard unit 3 and the service using device 4 of the vehicle V may perform transmission/reception of information directly via wireless communication (e.g., cellular communication) or indirectly via the service roadside antenna 62.

[0025]

Functional Configuration of Entrance Toll Collection Facility

FIG. 2 is a view illustrating the functional configuration of the entrance toll collection facility according to the first embodiment. As illustrated in FIG. 2, the entrance toll collection facility 1 includes an entrance roadside device 10 provided in each of the plurality of entrance lanes LI, an entrance lane server 15, and an interface (I/F) unit 16.

[0026]

As illustrated in FIGS. 1 and 2, the entrance roadside device 10 includes a first vehicle detector 11, the lane guidance sign 12, an entrance roadside antenna 13, and a second vehicle detector 14.

[0027]

The first vehicle detector 11 is, for example, a through-beam vehicle detector. The first vehicle detector 11 detects that the vehicle V has entered the entrance lane LI.

[0028]

The lane guidance sign 12 is an electronic signage that displays the type of the service assigned to the entrance lane LI. The driver of the vehicle V checks the display of the lane guidance sign 12 and enters the entrance lane LI where the type of the service to be used is displayed.

[0029]

The entrance roadside antenna 13 performs transmission/reception of information by wireless communication (e.g., DSRC communication) with the onboard unit 3 of the vehicle V. The entrance roadside antenna 13 starts radio emission for DSRC communication, for example, when the first vehicle detector 11 detects entry of the vehicle V, and stops radio emission when the second vehicle detector 14 detects passage of the vehicle V.

[0030]

The second vehicle detector 14 is, for example, a through-beam vehicle detector, similarly to the first vehicle detector 11. The second vehicle detector 14 detects that vehicle V has passed through a communication area of the entrance roadside antenna 13.

[0031]

Note that the entrance roadside device 10 may further include various devices installed at the tollgate, such as various sensors and a security camera used for discrimination of the vehicle type of the vehicle V.

[0032]

As illustrated in FIG. 2, the entrance lane server 15 includes a service flag setting unit 151, a service flag transmission unit 152, a display control unit 153, and an entrance processing unit 154. Note that one entrance lane server 15 may be provided at each of the entrance lanes LI.

5 [0033]

The service flag setting unit 151 sets a service flag corresponding to the type of the service assigned to each of the entrance lanes LI on in accordance with an instruction of the road business operator.

[0034]

10 The service flag transmission unit 152 transmits, from the entrance roadside antenna 13 to the onboard unit 3 of the vehicle V, service information including the type of the service assigned to the entrance lane LI. By this, the onboard unit 3 can specify the service used by the vehicle V based on the service information received in the entrance lane LI where the vehicle V
15 travels.

[0035]

The display control unit 153 causes the lane guidance sign 12 of each entrance lane LI to display the type of the service assigned to each entrance lane LI.

20 [0036]

The entrance processing unit 154 performs automatic toll collection processing regarding collection of the toll fare of the toll road at the entrance tollgate. This automatic toll collection processing is the same as processing of an automatic toll collection system executed at a known entrance tollgate.

25 [0037]

The I/F unit 16 relays transmission/reception of signals among each entrance roadside device 10, the entrance lane server 15, and the terminal device 5. This signal includes data of service information in addition to a control signal and a detection signal.

30 [0038]

Functional Configuration of Exit Toll Collection Facility

FIG. 3 is a view illustrating the functional configuration of the exit toll collection facility according to the first embodiment. As illustrated in FIG. 3, the exit toll collection facility 2 includes an exit roadside device 20 provided in
35 each of the one or more exit lanes LO, an exit lane server 25, and an interface (I/F) unit 26.

[0039]

As illustrated in FIGS. 1 and 3, the exit roadside device 20 includes a first vehicle detector 21, an exit roadside antenna 23, and a second vehicle detector 24.

[0040]

5 The first vehicle detector 21 is, for example, a through-beam vehicle detector. The first vehicle detector 21 detects that the vehicle V has entered the exit lane LO.

[0041]

10 The exit roadside antenna 23 performs transmission/reception of information by wireless communication (e.g., DSRC communication) with the onboard unit 3 of the vehicle V. The exit roadside antenna 23 starts radio emission for DSRC communication, for example, when the first vehicle detector 21 detects entry of the vehicle V, and stops radio emission when the second vehicle detector 24 detects passage of the vehicle V.

15 [0042]

 The second vehicle detector 24 is, for example, a through-beam vehicle detector, similarly to the first vehicle detector 21. The second vehicle detector 24 detects that vehicle V has passed through a communication area of the exit roadside antenna 23.

20 [0043]

 Note that the exit roadside device 20 may further include various devices installed at the tollgate, such as various sensors and a security camera used for discrimination of the vehicle type of the vehicle V.

[0044]

25 As illustrated in FIG. 3, the exit lane server 25 includes a service flag reception unit 251, a usage fee collection processing unit 252, and a toll fare collection processing unit 253. Note that one exit lane server 25 may be provided at each of the exit lanes LO.

[0045]

30 The service flag reception unit 251 receives, from the onboard unit 3 through the exit roadside antenna 23, a service flag by which a service used by the vehicle V can be specified.

[0046]

35 The usage fee collection processing unit 252 collects the usage fee of a service corresponding to the service flag.

[0047]

 The toll fare collection processing unit 253 performs automatic toll collection processing regarding collection of the toll fare of the toll road at the

exit tollgate. This automatic toll collection processing is the same as processing of an automatic toll collection system executed at a known exit tollgate.

[0048]

5 The I/F unit 26 relays transmission/reception of signals among each exit roadside device 20, the exit lane server 25, and the terminal device 5. This signal includes data of a service flag in addition to a control signal and a detection signal.

[0049]

Functional Configuration of Onboard Unit

10 FIG. 4 is a view illustrating the functional configuration of the onboard unit according to the first embodiment. As illustrated in FIG. 4, the onboard unit 3 includes a service setting unit 31, an enabling processing unit 32, a usage fee processing unit 33, and a toll fare processing unit 34.

[0050]

15 When receiving service information including the type of the service assigned to the entrance lane LI from the entrance roadside antenna 13 of the entrance toll collection facility 1, the service setting unit 31 sets the service flag corresponding to the type of the service on.

[0051]

20 When the service flag is on, the enabling processing unit 32 enables the function of the service using device 4 corresponding to the service flag. For example, the vehicle V includes, as the service using device 4, one or more of an autonomous driving control device 41, a charging control device 42, and an output device 43 that outputs information of an information distribution
25 service. The functions of these service using devices 4 are normally disabled, and when the service flag is on, the function of the corresponding service using device 4 is enabled by the enabling processing unit 32.

[0052]

30 The usage fee processing unit 33 processes payment of the usage fee of a service used by the vehicle V on the basis of the service flag at the exit of the road.

[0053]

The toll fare processing unit 34 processes payment of the toll fare of the vehicle V at the exit of the road.

35 [0054]

Service Assignment Processing of Entrance Lane

FIG. 5 is a view illustrating an example of the service assignment processing of an entrance lane according to the first embodiment. FIG. 6 is a

view illustrating an assignment example of the service flag of the entrance lane according to the first embodiment. A flow of processing (processing of (1) and (2) of FIG. 1) of assigning a service to each of the entrance lanes LI of the entrance tollgate will be described in detail with reference to FIGS. 5 and 6.

5 [0055]

First, as illustrated in FIG. 5, the road business operator operates the terminal device 5 to instruct assignment of a service to each of the entrance lanes LI. Then, the service flag setting unit 151 of the entrance lane server 15 sets a service flag corresponding to the type of the service assigned to each of the entrance lanes LI in accordance with the content instructed from the road business operator via the terminal device 5 (step S101).

[0056]

For example, as illustrated in FIG. 6, it is assumed that there are four entrance lanes LI1 to LI4 at an entrance tollgate. A plurality of types 1 to X of the service can be set. In the example of FIG. 6, a service flag 1 corresponds to an autonomous driving assistance service, a service flag 2 corresponds to a power feeding service to the EV while driving, a service flag 3 corresponds to an information distribution service, and service flags 4 to X are reserved for services to be added in the future. The road business operator designates on or off of the service flags 1 to X for each of the entrance lanes LI1 to LI4. The service flag setting unit 151 of the entrance lane server 15 sets the service flags 1 to X of each of the entrance lanes LI on or off in accordance with the instruction by the road business operator.

[0057]

In one entrance lane LI, only one service flag may be set on, or a plurality of service flags may be set on. In the example of FIG. 6, in the entrance lane LI1, only the service flag 1 of the autonomous driving assistance service is on. Therefore, the vehicle V traveling in the entrance lane LI1 can use only the autonomous driving assistance service. On the other hand, in the entrance lane LI4, the two service flags 1 and 2 of the autonomous driving assistance service and the power feeding service while driving are on. Therefore, the vehicle V traveling in the entrance lane LI4 can use both the autonomous driving assistance service and the power feeding service while driving.

35 [0058]

As in the entrance lane LI3 of FIG. 6, the entrance lane LI in which all the service flags are off may be prepared for the user who does not desire services other than travel on the road. By traveling in the entrance lane LI3 in

which all the service flags are set off, the user can be prevented from using services other than travel on the road (no usage fee is incurred).

[0059]

Note that when there is a service not provided on the road, the service flags may be off in all the entrance lanes LI1 to LI4. In the example of FIG. 6, the road business operator makes the service flag 3 corresponding to the information distribution service off in all the entrance lanes LI1 to LI4 for the road on which the information distribution service is not performed.

[0060]

Next, the display control unit 153 of the entrance lane server 15 notifies the lane guidance sign 12 of and causes the lane guidance sign 12 to display the display content based on the service flag set in each of the entrance lanes LI1 to LI4 (step S102). The lane guidance sign 12 of each of the entrance lanes LI displays the content having been notified (step S103).

[0061]

In the example of FIG. 6, the type of the service corresponding to the service flag having been set on is displayed on the lane guidance signs 12 of the entrance lanes LI1, LI2, and LI4. That is, "autonomous driving" indicating the autonomous driving assistance service is displayed on the lane guidance sign 12 of the entrance lane LI1, "EV" indicating the power feeding service while driving is displayed on the lane guidance sign 12 of the entrance lane LI2, and "autonomous driving/EV" indicating the autonomous driving assistance service and the power feeding service while driving is displayed on the lane guidance sign 12 of the entrance lane LI4. "ETC (automatic toll collection system)/support" indicating that a service only for road travel (automatic collection of the toll fare by the automatic toll collection system, or support for vehicle that cannot use the automatic toll collection system) is provided is displayed on the lane guidance sign 12 of the entrance lane LI3 in which all the service flags are set off.

[0062]

The road business operator executes a series of processing illustrated in FIG. 5 for each of a plurality of entrance tollgates of the road.

[0063]

Service Enabling Processing

FIG. 7 is a view illustrating an example of the service enablement processing according to the first embodiment. A flow of processing ((3) to (5) of FIG. 1) of enabling a service desired by the vehicle V (user) arriving at the entrance tollgate will be described in detail with reference to FIG. 7.

[0064]

When the first vehicle detector 11 detects entry of the vehicle V into the entrance lane LI, the entrance processing unit 154 of the entrance lane server 15 performs wireless communication with the onboard unit 3 of this vehicle V via the entrance roadside antenna 13, and executes automatic toll collection processing similar to the processing of the automatic toll collection system at a known entrance tollgate (step S201). For example, the entrance processing unit 154 transmits, from the entrance roadside antenna 13 to the onboard unit 3 of the vehicle V, identification information on the entrance tollgate and entrance information including the passage time at the entrance tollgate. The onboard unit 3 records the entrance information into an IC card (IC card for automatic toll collection system, for example, an ETC card) inserted into the onboard unit 3.

[0065]

Upon completion of the automatic toll collection processing, the service flag transmission unit 152 of the entrance lane server 15 transmits, to the onboard unit 3 via the entrance roadside antenna 13, service information including the type of the service assigned to the entrance lane LI that the vehicle V has entered (step S202).

[0066]

Upon receiving the service information, the service setting unit 31 of the onboard unit 3 sets the service flag corresponding to the type of the service included in the service information on (step S203). For example, it is assumed that the vehicle V has traveled in the entrance lane LI2 to which the power feeding service while driving is assigned (display of the lane guidance sign 12 is "EV"). In this case, in step S202, the service flag transmission unit 152 of the entrance lane server 15 transmits service information including the service flag 2 indicating the power feeding service while driving to the onboard unit 3. Then, in step S203, the service setting unit 31 of the onboard unit 3 sets the service flag 2 included in the service information on.

[0067]

Next, the enabling processing unit 32 of the onboard unit 3 instructs the service using device 4 of the target service whose service flag is set on to enable the function (step S204). Then, the service using device 4 enables the function to make the service available (step S205).

[0068]

For example, when the service flag 1 indicating the autonomous driving assistance service is set on, the enabling processing unit 32 of the onboard unit

3 instructs the autonomous driving control device 41 to enable the autonomous driving function based on the autonomous driving assistance information. Then, the autonomous driving control device 41 enables the function of controlling the position and speed of the vehicle V on the basis of the autonomous driving assistance information transmitted from the service roadside antenna 62, for example. When the autonomous driving assistance information is encrypted, the autonomous driving control device 41 enables a function of decrypting this information. Note that when the function is not enabled, even if receiving the autonomous driving assistance information, the autonomous driving control device 41 does not use and discards or does not decode this autonomous driving assistance information.

[0069]

When the service flag 2 indicating the power feeding service while driving is set on, the enabling processing unit 32 of the onboard unit 3 instructs the charging control device 42 to enable the function regarding the power feeding while driving. Then, the charging control device 42 switches, for example, a power reception device and a battery of the vehicle V to a connected state, and enables a function of supplying (charging) the battery with the power received by the power reception device from the power feeding panel 63. Note that when the function is not enabled, the power reception device and the battery are in a disconnected state, and even if the power reception device receives power from the power feeding panel 63, this power is not supplied to the battery.

[0070]

When the service flag 3 indicating the information distribution service is set on, the enabling processing unit 32 of the onboard unit 3 instructs the output device 43 to enable the function. Then, the output device 43 enables a function of outputting the information distributed from the service roadside antenna 62 toward the passenger of the vehicle V. When the distributed information is encrypted, the output device 43 enables a function of decrypting this information. Note that when the function is not enabled, even if receiving the information, the output device 43 does not output and discards or does not decode this information.

[0071]

Note that when the vehicle V travels in the entrance lane LI (the entrance lane LI3 in FIG. 6) in which all the service flags are set off, the service flag transmission unit 152 of the entrance lane server 15 transmits, to the onboard unit 3, service information including information indicating

absence of a service in step S202. Then, in step S203, the service setting unit 31 of the onboard unit 3 sets all the service flags off. When all the service flags are off, the enabling processing unit 32 of the onboard unit 3 does not execute step S204. By this, when the user does not desire to use any service, all the services can be disabled by traveling in the entrance lane LI3 corresponding to absence of a service.

[0072]

When a vehicle mounted with an onboard unit (known onboard unit) that executes only known automatic toll collection processing travels in the entrance lane LI to which a service is assigned, this known onboard unit does not have a function of processing service information. Therefore, even if receiving service information in step S203 after the automatic toll collection processing in step S201 ends, the known onboard unit discards this service information and ends the processing. For this reason, even if this vehicle is mounted with the service using device 4, the enablement processing (steps S203 to S204) of the function by the known onboard unit is not executed, and therefore this vehicle travels on the road without using the service.

[0073]

When the vehicle V arrives at an entrance tollgate provided with a known entrance tollgate facility not compatible with service provision, this known entrance tollgate facility does not have a function of executing the processing of step S202, and thus the processing is ended when the automatic toll collection processing of step S201 is completed. At this time, the onboard unit 3 compatible with service usage processing times out when in a case of being not able to receive the service information from the entrance tollgate facility even after a certain period of time has elapsed from the completion of the automatic toll collection processing. In this case, the service setting unit 31 of the onboard unit 3 sets all the service flags off in step S203. Doing this can disable all the services of the vehicle V on the toll road not compatible with service provision.

[0074]

Processing Example during Service Usage

FIG. 8 is a view illustrating an example of the processing during service usage according to the first embodiment. A flow of processing ((6) of FIG. 1) of service use in the service providing facility 6 and the service using device 4 will be described with reference to FIG. 8. FIG. 8 describes an example of using the power feeding service while driving. That is, it is assumed that the vehicle V is traveling in the entrance lane LI2 to which the power feeding

service while driving is assigned at the entrance tollgate, and the function of the charging control device 42 is enabled by the series of processing of FIG. 7. [0075]

For example, it is assumed that the service roadside antenna 62 is
 5 installed at the entrance of the section providing the service where the power feeding panel 63 for the power feeding service while driving is installed. When detecting entry of the vehicle V into the section providing the service, the management server 60 of the service providing facility 6 confirms whether the power feeding service while driving is enabled to the charging control device
 10 42 of this vehicle V via the service roadside antenna 62 (step S301). Note that the method of detecting that the vehicle V has entered the section providing the service may be any method such as detection by establishment of communication with the service roadside antenna 62, detection by a sensor not illustrated (a vehicle detector, a camera, or the like), or the like.
 15 [0076]

Upon receiving an inquiry from the management server 60 of the service providing facility 6, the charging control device 42 of the vehicle V determines whether the function of the power feeding service while driving is enabled (step S302). When the function is enabled (step S302; YES), the charging
 20 control device 42 responds to the management server 60 that the function is "enabled" (step S303). On the other hand, when the function is not enabled (step S302; NO), the charging control device 42 responds to the management server 60 that the function is "disabled" (step S304), and ends the processing.
 [0077]

When receiving a response that the function is "enabled" from the vehicle V (the charging control device 42) (step S305; YES), the management server 60 of the service providing facility 6 instructs the power feeding panel 63 to start power feeding (step S306). Then, the power feeding panel 63 starts power feeding in accordance with the instruction (step S307). When the vehicle
 30 V travels on this power feeding panel 63, the power reception device of the vehicle V receives the power of the power feeding panel 63 and supplies (charges) it to the battery. At this time, the charging control device 42 records the amount of power received by the vehicle V (power reception device) (step S308).
 35 [0078]

When detecting that the vehicle V has exited the section providing the service, the management server 60 of the service providing facility 6 instructs the power feeding panel 63 to stop the power feeding (step S309). Then, the

power feeding panel 63 stops the power feeding in accordance with the instruction (step S310).

[0079]

When receiving a response that the function is "disabled" from the vehicle V (step S305; NO), the management server 60 of the service providing facility 6 ends the processing without causing the power feeding panel 63 to feed the power.

[0080]

Note that there is a case where a vehicle that uses the power feeding service while driving and a vehicle that does not use it enter the section providing the service in a line. At this time, in the vehicle that does not use the power feeding service while driving, since the function of the charging control device 42 is not enabled (the power reception device and the battery are disconnected), the power received by the power reception device from the power feeding panel 63 is not supplied (charged) to the battery. Therefore, only the vehicle in which the function of the power feeding service while driving is enabled can use the fed power for charging of the battery.

[0081]

Note that while FIG. 8 illustrates an example in which the service providing facility 6 detects the vehicle V at the entrance and the exit of the providing section of the service, and the power feeding panel 63 can feed power only when the vehicle V in which the service is enabled travels in the service providing section, the present invention is not limited to this. In other embodiments, the service providing facility 6 needs not detect the vehicle V at the entrance and the exit of the providing section, and the power feeding panel 63 may be always in a power feeding-enabled state. The power feeding panel 63 may output power for power feeding only when the vehicle V exists on the panel. The power output by the power feeding panel 63 can be used for charging the battery only in the vehicle V in which the function of the power feeding service while driving is enabled.

[0082]

Collection Processing of Service Usage Fee

FIG. 9 is a view illustrating an example of the collection processing of the service usage fee according to the first embodiment. A flow of the toll collection processing ((7) of FIG. 1) of the vehicle V arriving at the exit tollgate will be described in detail with reference to FIG. 9.

[0083]

When the first vehicle detector 21 detects entry of the vehicle V into the exit lane LO, the toll fare collection processing unit 253 of the exit lane server 25 performs wireless communication with the onboard unit 3 of this vehicle V via the exit roadside antenna 23, and executes automatic toll collection processing at a known exit tollgate (step S401). For example, as the automatic toll collection processing, the toll fare collection processing unit 253 of the exit lane server 25 requests the onboard unit 3 for transmission of information required for the collection processing of the toll fare. The toll fare processing unit 34 of the onboard unit 3 transmits the requested information to the exit lane server 25. The information required for the collection processing of the toll fare includes entrance information, the vehicle type of the vehicle V, and a payment means of the toll fare (ETC card number or the like). The toll fare collection processing unit 253 of the exit lane server 25 calculates a toll fare corresponding to a distance from the entrance tollgate specified from entrance information to the exit tollgate at which the machine (the exit lane server 25) is installed and the vehicle type of the vehicle V, and performs collection processing (credit settlement processing or the like) of the toll fare based on the payment means.

[0084]

Next, the service flag reception unit 251 of the exit lane server 25 makes an inquiry about the service flag having been set to the onboard unit 3 of the vehicle V via the exit roadside antenna 23 (step S402). The usage fee processing unit 33 of the onboard unit 3 transmits information including the service flag having been set on as a response to the inquiry (step S403). When all the service flags are set off, the usage fee processing unit 33 transmits information indicating absence of the service flag.

[0085]

Upon receiving the service flag from the onboard unit 3 of the vehicle V, the usage fee collection processing unit 252 of the exit lane server 25 determines presence/absence of use of the service of this vehicle V (step S404). When receiving information indicating absence of the service flag from the onboard unit 3, the usage fee collection processing unit 252 determines that this vehicle V has not used the service (step S404; NO), and proceeds to step S413 without performing the collection processing of the service usage fee. In this case, the exit lane server 25 creates only the breakdown of the toll fare of the vehicle V calculated in step S401 by the toll fare collection processing unit 253 (step S413), and ends the processing. The onboard unit (known onboard unit) that executes only known automatic toll collection processing does not have a

function of responding to the inquiry about this service flag. Therefore, even if the onboard unit receives the inquiry about this service flag after the automatic toll collection processing in step S401 ends, the known onboard unit discards this inquiry and ends the processing. Also when timeout occurs without receiving a response to the inquiry about the service flag or when the second vehicle detector 24 detects passage of the vehicle before receiving the response, the usage fee collection processing unit 252 of the exit lane server 25 determines that this vehicle has not used the service (step S404; NO).

[0086]

On the other hand, when receiving information including at least one service flag from the onboard unit 3 of the vehicle V, the usage fee collection processing unit 252 of the exit lane server 25 determines that this vehicle V has used the service corresponding to the service flag (step S404; YES). In this case, the usage fee collection processing unit 252 further makes an inquiry about service usage information to the onboard unit 3 (step S405).

[0087]

Upon receiving the inquiry about the service usage information, the usage fee processing unit 33 of the onboard unit 3 notifies the service using device 4 of this. The service using device 4 generates service usage information and transmits it to the onboard unit 3 (step S406). The usage fee processing unit 33 of the onboard unit 3 transmits, to the exit lane server 25, the service usage information generated by the service using device 4. The service usage information includes a message indicating service content used by the service using device 4. For example, the autonomous driving control device 41 generates service usage information including a reception result of the autonomous driving assistance information provided from the service providing facility 6. The charging control device 42 generates service usage information including the amount of power received by the vehicle V (power reception device). The output device 43 generates service usage information including a reception result of the information distributed from the service providing facility 6.

[0088]

The usage fee collection processing unit 252 of the exit lane server 25 executes processing of collecting the usage fee of the service used by the vehicle V on the basis of the service usage information received from the onboard unit 3 (step S407). For example, it is assumed that the autonomous driving assistance service has a fixed price regardless of the provided information amount. In this case, the usage fee collection processing unit 252

collects the fixed fee for the autonomous driving assistance service set on this road from the onboard unit 3 as a service usage fee. In a case of a service of usage-based pricing in which the price varies depending on the usage amount (power reception amount) of the vehicle V such as the power feeding service while driving, the usage fee collection processing unit 252 collects, from the onboard unit 3, the service usage fee in which the usage amount of the vehicle V is multiplied by the unit price of the service. Note that the payment means of the service usage fee may be different from the payment means of the toll fare. In this case, the usage fee collection processing unit 252 acquires the service usage information and the payment means of the service usage fee from the onboard unit 3, and performs collection processing (credit settlement processing or the like).

[0089]

Upon completion of the collection processing of the service usage fee, the usage fee collection processing unit 252 of the exit lane server 25 requests the onboard unit 3 to make the service flag off (step S408). Then, the service setting unit 31 of the onboard unit 3 switches the service flag from on to off in accordance with the request of the exit lane server 25 (step S409). When the service flag is made off, the enabling processing unit 32 of the onboard unit 3 notifies the service using device 4 of the end of use of the service (step S410). The service using device 4 sets the used service to paid and disables the function (step S411). For example, when the service flag 2 corresponding to the power feeding service while driving is made off, the enabling processing unit 32 of the onboard unit 3 notifies the charging control device 42 of the end of use of the power feeding service while driving. Then, the charging control device 42 sets the power amount recorded in step S308 of FIG. 8 to paid and disables the charging function (brings the power reception device and the battery into the disconnected state).

[0090]

The service setting unit 31 of the onboard unit 3 notifies the exit lane server 25 of the fact that the service flag has been made off (step S412). Then, the toll fare collection processing unit 253 and the usage fee collection processing unit 252 of the exit lane server 25 create the breakdown of the toll fare of the vehicle V calculated in step S401 and the breakdown of the service usage fee of the vehicle V calculated in step S407, respectively (step S413).

[0091]

In FIG. 9, an example in which the service using device 4 generates the service usage information when the vehicle V arrives at the exit tollgate has

been described, but the present invention is not limited to this. In other embodiments, the service using device 4 may generate and transmit, to the onboard unit 3, service usage information each time the service using device 4 receives a service in a service providing section of the toll road. In this case, in
 5 step S406, the usage fee processing unit 33 of the onboard unit 3 transmits, to the exit lane server 25, the service usage information received in advance from the service using device 4. Doing this eliminates the need for the generation processing of the service usage information in the service using device 4 and the communication processing between the onboard unit 3 and the service using
 10 device 4, and therefore it is possible to shorten the processing time at the exit tollgate. Therefore, it is possible to suppress the collection processing of the service usage fee from not being finished before the vehicle V exits the exit tollgate due to taking time to generate and transmit/receive the service usage information.

15 [0092]

Computer Configuration

FIG. 10 is a schematic block diagram illustrating the configuration of the computer according to the first embodiment. A computer 900 includes a processor 901, a primary storage device 902, an auxiliary storage device 903,
 20 and an interface 904. The entrance lane server 15, the exit lane server 25, and the onboard unit 3 described above are mounted in respective different computers 900. Then, the operation of each processing unit described above is stored in the auxiliary storage device 903 in the form of a program. The processor 901 reads the program from the auxiliary storage device 903, deploys
 25 it in the primary storage device 902, and executes the above processing in accordance with the program. The processor 901 secures a storage area used in the above processing in the primary storage device 902 in accordance with the program.

[0093]

30 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
 35 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.

[0094]

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 primary 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.

[0095]

Operational Effects

As described above, the entrance toll collection facility 1 according to the present embodiment includes: the entrance roadside antenna 13 that is provided at each of the plurality of entrance lanes LI separated by the type of the service at the entrance of the road that can provide the service to be added to travel of the vehicle V, and transmits/receives information to and from the onboard unit 3 mounted on the vehicle V traveling in the entrance lane LI; and the service flag transmission unit 152 that transmits, from the entrance roadside antenna 13 to the onboard unit 3, service information including the type of the service that is assigned to the entrance lane LI that the vehicle V has entered and is used by the vehicle V on the road.

[0096]

Doing this enables the entrance toll collection facility 1 to determine the passage of the vehicle V through the entrance lane LI to which the service is assigned to be a declaration of intention to use the service and to notify the onboard unit 3 that this vehicle V can use the service while traveling on the road. That is, only by passing through the entrance lane LI in which a desired service is assigned, the user can automatically agree to use this service and make the service available in the vehicle V while traveling on the road.

[0097]

The entrance toll collection facility 1 further includes the lane guidance sign 12 provided at each of the plurality of entrance lanes LI, and the display

control unit 153 that causes the lane guidance sign 12 to display the type of the service assigned to the entrance lane LI.

[0098]

Doing this enables the entrance toll collection facility 1 to easily
 5 recognize the type of the service that can be provided to the vehicle V on the road and which entrance lane LI to travel enables the usage of the desired service.

[0099]

In the entrance toll collection facility 1, a plurality of services can be
 10 assigned to at least one of the entrance lanes LI, and the service flag transmission unit 152 transmits, from the entrance roadside antenna 13 to the onboard unit 3, the service information including each type of a plurality of services assigned to the entrance lanes LI.

[0100]

Doing this enables the entrance toll collection facility 1 to allow the
 15 vehicle V to simultaneously use a plurality of services on a road that can provide a plurality of different services. The user can arbitrarily select and use one or more of a plurality of services.

[0101]

The onboard unit 3 according to the present embodiment includes: the
 20 service setting unit 31 that sets a service flag corresponding to the type of the service when service information including the type of the service assigned to the entrance lane LI is received from the entrance roadside antenna 13 provided at the entrance lane LI of the road on which the service to be added to travel of
 25 the vehicle V is providable; and the enabling processing unit 32 that enables the function of the service using device 4 of the vehicle V corresponding to the service flag when the service flag is on.

[0102]

Doing this enables the onboard unit 3 to automatically agree to use this
 30 service and make the service available only by traveling in the entrance lane LI to which the service desired by the user is assigned.

[0103]

The onboard unit 3 further includes the usage fee processing unit 33 that
 performs wireless communication with the exit roadside antenna 23 provided at
 35 the exit lane LO at the exit of the road and processes payment of the usage fee of the service whose service flag is on.

[0104]

Doing this enables the onboard unit 3 to automatically pay the usage fee of the used service at the exit of the road.

[0105]

When the service flag corresponding to the information distribution service is on, the enabling processing unit 32 of the onboard unit 3 makes information provided from the service providing facility 6 available at the output device 43 of the vehicle V.

[0106]

Doing this enables the onboard unit 3 to enable the function of the output device 43 only when the vehicle V (user) agrees to use the information distribution service. By this, for example, even in a case where the service roadside antenna 62 of the service providing facility 6 performs broadcast distribution to all nearby vehicles, it is possible to enable only the vehicle V that has agreed to use the service to use the distributed information and to disable the vehicle V that has not agreed to use the service to use the distributed information.

[0107]

When the service flag corresponding to the autonomous driving assistance service is on, the enabling processing unit 32 of the onboard unit 3 enables use of the autonomous driving function based on the autonomous driving assistance information provided from the service providing facility 6 at the autonomous driving control device 41 of the vehicle V.

[0108]

Doing this enables the onboard unit 3 to enable the function based on the autonomous driving assistance information of the autonomous driving control device 41 only when the vehicle V (user) agrees to use the autonomous driving assistance service. By this, for example, even in a case where the service roadside antenna 62 of the service providing facility 6 performs broadcast distribution to all nearby vehicles, it is possible to enable only the vehicle V that has agreed to use the service to use the distribute autonomous driving assistance information and to disable the vehicle V that has not agreed to use the service to use the distribute autonomous driving assistance information.

[0109]

When a service flag corresponding to a power feeding service while driving is on, the enabling processing unit 32 of the onboard unit 3 makes power supplied from the service providing facility 6 available for charging a battery of the vehicle at the charging control device 42 of the vehicle V.

[0110]

Doing this enables the onboard unit 3 to enable the function regarding the power feeding while driving of the charging control device 42 only when the vehicle V (user) agrees to use the power feeding service while driving. By this, even in a case where a vehicle that has agreed to use the power feeding service while driving and a vehicle that has not agreed to do so are traveling in a mixed manner in the section providing the service of power feeding while driving, for example, only the vehicle V that has agreed can charge the battery, and the vehicle V that has not agreed cannot charge the battery.

[0111]

The exit toll collection facility 2 according to the present embodiment includes: the exit roadside antenna 23 that is provided at the exit lane LO and communicates with the onboard unit 3 mounted on the vehicle V traveling in the exit lane LO; the service flag reception unit 251 that receives, from the onboard unit 3 through the exit roadside antenna 23, a service flag by which the service used by the vehicle V can be specified; and the usage fee collection processing unit 252 that collects the usage fee of the service corresponding to the service flag.

[0112]

Doing this enables the exit toll collection facility 2 to automatically collect the usage fee of the service used by the vehicle V from the onboard unit 3 of the vehicle V about to exit from the road. That is, while the vehicle V travels on the exit lane LO, the exit toll collection facility 2 can perform both the known automatic toll collection processing for the toll fare and the collection processing for the service usage fee.

[0113]

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.

[0114]

Supplementary Notes

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

[0115]

(1) According to a first aspect, an entrance toll collection facility 1 includes: an entrance roadside antenna 13 provided at each of a plurality of

entrance lanes LI separated by a type of a service at an entrance of a road that can provide the service to be added to travel of a vehicle V and configured to communicate with an onboard unit 3 mounted on a vehicle V traveling in the entrance lane LI; and a service flag transmission unit 152 configured to
 5 transmit, from the entrance roadside antenna 13 to the onboard unit 3, service information including a type of a service that is assigned to an entrance lane LI that the vehicle V has entered and is used by the vehicle V on the road.
 [0116]

Doing this enables the entrance toll collection facility 1 to determine the
 10 passage of the vehicle V through the entrance lane LI to which the service is assigned to be a declaration of intention to use the service and to notify the onboard unit 3 that this vehicle V can use the service while traveling on the road. That is, only by passing through the entrance lane LI in which a desired service is assigned, the user can automatically agree to use this service and
 15 make the service available in the vehicle V while traveling on the road.
 [0117]

(2) According to a second aspect, the entrance toll collection facility 1 according to the first aspect further includes: a lane guidance sign 12 provided in each of the plurality of entrance lanes LI; and a display control unit 153 that
 20 causes the lane guidance sign 12 to display a type of a service assigned to the entrance lane LI.
 [0118]

Doing this enables the entrance toll collection facility 1 to easily recognize the type of the service that can be provided to the vehicle V on the
 25 road and which entrance lane LI to travel enables the usage of the desired service.
 [0119]

(3) According to a third aspect, in the entrance toll collection facility 1 according to the first or second aspect, a plurality of services can be assigned to
 30 at least one of the entrance lanes LI, and the service flag transmission unit 152 transmits, from the entrance roadside antenna 13 to the onboard unit 3, the service information including a type of each of the plurality of services assigned to the entrance lanes LI.
 [0120]

Doing this enables the entrance toll collection facility 1 to allow the
 35 vehicle V to simultaneously use a plurality of services on a road that can provide a plurality of different services. The user can arbitrarily select and use one or more of a plurality of services.

[0121]

(4) According to a fourth aspect, an onboard unit 3 includes: a service setting unit 31 configured to set, when receiving service information including a type of the service assigned to an entrance lane LI from an entrance roadside antenna 13 provided at the entrance lane LI of a road that can provide a service to be added to travel of a vehicle V, a service flag corresponding to the type of the service on; and an enabling processing unit 32 that enables a function of a service using device 4 of the vehicle V corresponding to the service flag when the service flag is on.

[0122]

Doing this enables the onboard unit 3 to automatically agree to use this service and make the service available only by traveling in the entrance lane LI to which the service desired by the user is assigned.

[0123]

(5) According to a fifth aspect, the onboard unit 3 according to the fourth aspect further includes a usage fee processing unit 33 configured to communicate with an exit roadside antenna 23 provided at an exit lane LO at an exit of the road and to process payment of a usage fee of a service whose service flag is on.

[0124]

Doing this enables the onboard unit 3 to automatically pay the usage fee of the used service at the exit of the road.

[0125]

(6) According to a sixth aspect, in the onboard unit 3 according to the fourth or fifth aspect, the enabling processing unit 32 enables, when a service flag corresponding to an information distribution service is on, an output device 43 of the vehicle V to use information provided from a service providing facility 6.

[0126]

Doing this enables the onboard unit 3 to enable the function of the output device 43 only when the vehicle V (user) agrees to use the information distribution service. By this, for example, even in a case where the service roadside antenna 62 of the service providing facility 6 performs broadcast distribution to all nearby vehicles, it is possible to enable only the vehicle V that has agreed to use the service to use the distributed information and to disable the vehicle V that has not agreed to use the service to use the distributed information.

[0127]

(7) According to a seventh aspect, in the onboard unit 3 according to any one of the fourth to sixth aspects, the enabling processing unit 32 enables, when a service flag corresponding to an autonomous driving assistance service is on, an autonomous driving control device 41 of the vehicle V to use an autonomous driving function based on autonomous driving assistance information provided from a service providing facility 6.

[0128]

Doing this enables the onboard unit 3 to enable the function based on the autonomous driving assistance information of the autonomous driving control device 41 only when the vehicle V (user) agrees to use the autonomous driving assistance service. By this, for example, even in a case where the service roadside antenna 62 of the service providing facility 6 performs broadcast distribution to all nearby vehicles, it is possible to enable only the vehicle V that has agreed to use the service to use the distribute autonomous driving assistance information and to disable the vehicle V that has not agreed to use the service to use the distribute autonomous driving assistance information.

[0129]

(8) According to an eighth aspect, in the onboard unit 3 according to any one of the fourth to seventh aspects, when a service flag corresponding to a power feeding service while driving is on, the enabling processing unit 32 makes power supplied from a service providing facility 6 available for charging a battery of the vehicle V at a charging control device 42 of the vehicle V.

[0130]

Doing this enables the onboard unit 3 to enable the function regarding the power feeding while driving of the charging control device 42 only when the vehicle V (user) agrees to use the power feeding service while driving. By this, even in a case where a vehicle that has agreed to use the power feeding service while driving and a vehicle that has not agreed to do so are traveling in a mixed manner in the section providing the service of power feeding while driving, for example, only the vehicle V that has agreed can charge the battery, and the vehicle V that has not agreed cannot charge the battery.

[0131]

(9) According to a ninth aspect, an exit toll collection facility 2 includes: an exit roadside antenna 23 that is provided at an exit lane LO of a road that can provide a service to be added to travel of a vehicle V, and communicates with an onboard unit 3 mounted on a vehicle V traveling in the exit lane LO; a service flag reception unit 251 that receives, from the onboard unit 3 through the exit roadside antenna 23, a service flag by which a service used by the

vehicle V can be specified; and a usage fee collection processing unit 252 that collects a usage fee of a service corresponding to the service flag.

[0132]

Doing this enables the exit toll collection facility 2 to automatically collect the usage fee of the service used by the vehicle V from the onboard unit 3 of the vehicle V about to exit from the road. That is, while the vehicle V travels on the exit lane LO, the exit toll collection facility 2 can perform both the known automatic toll collection processing for the toll fare and the collection processing for the service usage fee.

[0133]

(10) According to a tenth aspect, a service using system 100 includes: the entrance toll collection facility 1 according to any one of the first to third aspects; and the onboard unit 3 according to any one of the fourth to eighth aspects.

[0134]

(11) According to an eleventh aspect, a service using method includes: by an entrance toll collection facility 1, a step of transmitting, to an onboard unit 3 mounted on a vehicle V through an entrance roadside antenna 13 provided at each of a plurality of entrance lanes LI separated by a type of a service at an entrance of a road that can provide the service to be added to travel of the vehicle V, service information including a type of a service that is assigned to an entrance lane LI that the vehicle V has entered and is used by the vehicle V on the road; by the onboard unit 3, a step of setting a service flag corresponding to a type of the service when receiving the service information; and by the onboard unit 3, a step of enabling a function of a service using device 4 corresponding to the service flag when the service flag is on.

[0135]

(12) According to a twelfth aspect, a program causes an onboard unit 3 to execute: a step of setting a service flag corresponding to a type of a service when receiving, from an entrance roadside antenna 13 provided at an entrance lane LI of a road that can provide a service to be added to travel of a vehicle V, service information including a type of the service assigned to the entrance lane LI; and a step of enabling a function of a service using device 4 of corresponding to the service flag when the service flag is on.

Reference Signs List

[0136]

100 Service using system

- 1 Entrance toll collection facility
- 10 Entrance roadside device
- 11 First vehicle detector
- 12 Lane guidance sign
- 5 13 Entrance roadside antenna
- 14 Second vehicle detector
- 15 Entrance lane server
- 151 Service flag setting unit
- 152 Service flag transmission unit
- 10 153 Display control unit
- 154 Entrance processing unit
- 16 Interface (I/F) unit
- 2 Exit toll collection facility
- 20 Exit roadside device
- 15 21 First vehicle detector
- 23 Exit roadside antenna
- 24 Second vehicle detector
- 25 Exit lane server
- 251 Service flag reception unit
- 20 252 Usage fee collection processing unit
- 253 Toll fare collection processing unit
- 26 Interface (I/F) unit
- 3 Onboard unit
- 31 Service setting unit
- 25 32 Enabling processing unit
- 33 Usage fee processing unit
- 34 Toll fare processing unit
- 4 Service using device
- 41 Autonomous driving control device
- 30 42 Charging control device
- 43 Output device
- 5 Terminal device
- 6 Service providing facility
- 60 Management server
- 35 61 Service device
- 62 Service roadside antenna
- 63 Power feeding panel
- LI Entrance lane

LO Exit lane

V Vehicle

Claims

[Claim 1]

An entrance toll collection facility, comprising:

an entrance roadside antenna provided at each of a plurality of entrance lanes separated by a type of a service at an entrance of a road that can provide the service to be added to travel of a vehicle and configured to communicate with an onboard unit mounted on a vehicle traveling in the entrance lane; and

a service flag transmission unit configured to transmit, from the entrance roadside antenna to the onboard unit, service information including a type of a service that is assigned to an entrance lane that the vehicle has entered and is used by the vehicle on the road.

[Claim 2]

The entrance toll collection facility according to claim 1, further comprising:

a lane guidance sign provided in each of the plurality of entrance lanes; and

a display control unit configured to cause the lane guidance sign to display a type of a service assigned to the entrance lane.

[Claim 3]

The entrance toll collection facility according to claim 1 or 2, wherein a plurality of services can be assigned to at least one of the entrance lanes, and

the service flag transmission unit transmits, from the entrance roadside antenna to the onboard unit, the service information including a type of each of the plurality of services assigned to the entrance lanes.

[Claim 4]

An onboard unit, comprising:

a service setting unit configured to set, when receiving service information including a type of a service assigned to an entrance lane from an entrance roadside antenna provided at the entrance lane of a road that can provide a service to be added to travel of a vehicle, a service flag corresponding to the type of the service on; and

an enabling processing unit configured to enable a function of a service using device of the vehicle corresponding to the service flag when the service flag is on.

[Claim 5]

The onboard unit according to claim 4, further comprising
a usage fee processing unit configured to communicate with an exit roadside antenna provided at an exit lane at an exit of the road and to process payment of a usage fee of a service whose service flag is on.

[Claim 6]

The onboard unit according to claim 4 or 5, wherein the enabling processing unit enables, when a service flag corresponding to an information distribution service is on, an output device of the vehicle to use information provided from a service providing facility.

[Claim 7]

The onboard unit according to claim 4 or 5, wherein the enabling processing unit enables, when a service flag corresponding to an autonomous driving assistance service is on, an autonomous driving control device of the vehicle to use an autonomous driving function based on autonomous driving assistance information provided from a service providing facility.

[Claim 8]

The onboard unit according to claim 4 or 5, wherein the enabling processing unit enables, when a service flag corresponding to a power feeding service while driving is on, a charging control device of the vehicle to use power supplied from a service providing facility available for charging a battery of the vehicle.

[Claim 9]

An exit toll collection facility comprising:
an exit roadside antenna provided at an exit lane of a road that can provide a service to be added to travel of a vehicle, the exit roadside antenna being configured to communicate with an onboard unit mounted on a vehicle traveling in the exit lane;

a service flag reception unit configured to receive, from the onboard unit through the exit roadside antenna, a service flag by which a service used by the vehicle can be specified; and

a usage fee collection processing unit configured to collect a usage fee of a service corresponding to the service flag.

[Claim 10]

A service using system comprising:

the entrance toll collection facility according to claim 1 or 2; and

the onboard unit according to claim 4 or 5.

[Claim 11]

A service using method, comprising:

by an entrance toll collection facility, a step of transmitting, to an onboard unit mounted on a vehicle through an entrance roadside antenna provided at each of a plurality of entrance lanes separated by a type of a service at an entrance of a road that can provide the service to be added to travel of the vehicle, service information including a type of a service that is assigned to an entrance lane that the vehicle has entered and is used by the vehicle on the road;

by the onboard unit, a step of setting a service flag corresponding to a type of the service when receiving the service information; and

by the onboard unit, a step of enabling a function of a service using device corresponding to the service flag when the service flag is on.

[Claim 12]

A program that causes an onboard unit to execute:

a step of setting a service flag corresponding to a type of a service when receiving, from an entrance roadside antenna provided at an entrance lane of a road that can provide a service to be added to travel of a vehicle, service information including a type of the service assigned to the entrance lane; and

a step of enabling a function of a service using device of corresponding to the service flag when the service flag is on.