

Description

Title of Invention: ONBOARD UNIT, ONBOARD SYSTEM, APPLICATION
SYSTEM, APPLICATION METHOD, AND PROGRAM

5 Technical Field

[0001]

The present disclosure relates to an onboard unit, an onboard system, an
application system, an application method, and program.

10 Background Art

[0002]

As a technology for collecting a toll fare of a toll road, an automatic toll
collection system (also referred to as an electronic toll collection system or
referred to as ETC (registered trademark) system in Japan) has been used. The
15 automatic toll collection system wirelessly communicates with an onboard unit
mounted on a vehicle at a tollgate of a toll road to automatically collect a toll
fare according to a travel distance (travel section) traveled by the vehicle from
an entrance tollgate to an exit tollgate.

[0003]

20 The toll fare according to the travel distance from the entrance tollgate
to the exit tollgate is defined in, for example, a toll charge table, and is
distributed from a center server to the tollgate (e.g., the exit tollgate) that
performs toll collection. A discount is applied to a toll fare in some cases. For
example, Patent Document 1 describes a technique of applying a time-of-day
25 discount to a vehicle passed through an entrance tollgate in a specific time of
day. A toll charge table to which a time-of-day discount is applied, a (normal)
toll charge table to which no time-of-day discount is applied, and the like are
distributed from the center server to each tollgate at necessary timings such as
start and end timings of a discount time of day, for example. Each tollgate
30 calculates a toll fare of each vehicle by using the distributed toll charge table.

Citation List

Patent Literature

[0004]

35 Patent Document 1: JP 2009-199347 A

Summary of Invention

Technical Problem

[0005]

On a toll road, a specific event decreasing the quality of service provided to vehicles, such as a traffic jam or a road closure due to construction or weather, may occur. However, in the related art, it is not possible to flexibly respond to the occurrence of a specific event, such as changing (discounting) a toll.

[0006]

In addition, for example, it is assumed that, when a road operator detects a specific event, the road operator responds to the specific event by discounting a toll of a vehicle at a tollgate. However, when the detection of the specific event is delayed, a vehicle may exit the toll road before the start of discounting the toll. In this case, a user who has been affected by the specific event but to whom the discount is not applied feels disadvantaged.

[0007]

An object of the present disclosure is to provide an onboard unit that can generate evidence information indicating a specific event and apply for a refund of a toll when determining that a user has been affected by the specific event decreasing the quality of service of a toll road, an onboard system, an application system, an application method, and a program.

Solution to Problem

[0008]

According to an aspect of the present disclosure, an onboard unit includes: an evidence information acquisition unit configured to receive an instruction from a user and acquire evidence information recorded while a vehicle is using a toll road; and an application information generation unit configured to generate application information including the evidence information acquired and refund destination identification information that can identify a refund destination of a toll of the vehicle.

[0009]

According to an aspect of the present disclosure, an onboard system includes: a travel information recording unit configured to record travel information of a vehicle while the vehicle is traveling on a toll road; an evidence information acquisition unit configured to receive an instruction from a user and acquire evidence information including the travel information recorded by the travel information recording unit; an application information generation unit configured to generate application information in which the evidence information acquired is associated with refund destination

identification information that can identify a refund destination of a toll of the vehicle; and a wide-area communication unit configured to transmit the application information to a center server that receives an application for a refund of the toll for a specific event affecting use of the toll road by using a communication function of an information communication device possessed by the user.

[0010]

According to an aspect of the present disclosure, an application system includes: an onboard unit; and a center server. The onboard unit includes: an evidence information acquisition unit configured to receive an instruction from a user and acquire evidence information recorded while a vehicle is traveling on a toll road; an application information generation unit configured to generate application information in which the evidence information acquired is associated with refund destination identification information that can identify a refund destination of a toll of the vehicle; and a wide-area communication unit configured to transmit the application information to the center server that receives an application for a refund of the toll for a specific event affecting use of the toll road by using a communication function of an information communication device possessed by the user. The center server includes: an application information receiving unit configured to receive the application information from the onboard unit; a determination unit configured to determine whether the vehicle has been affected by the specific event on the basis of the evidence information included in the application information received; and a refund processing unit configured to refund at least part of the toll to the refund destination identified by the refund destination identification information included in the application information when determining that the vehicle has been affected by the specific event.

[0011]

According to an aspect of the present disclosure, an application method is an application method using an application system including an onboard unit and a center server and includes: at the onboard unit, a step of receiving an instruction from a user and acquiring evidence information recorded while a vehicle is using a toll road; at the onboard unit, a step of generating application information in which the acquired evidence information is associated with refund destination identification information that can identify a refund destination of a toll of the vehicle; at the onboard unit, a step of transmitting the application information to the center server that receives an application for a refund of the toll for a specific event affecting use of the toll road by using a

communication function of an information communication device possessed by the user; at the center server, a step of receiving the application information from the onboard unit; at the center server, a step of determining whether the vehicle has been affected by the specific event on the basis of the evidence information included in the application information received and specific event information in which the specific event having occurred on the toll road is recorded; and at the center server, a step of refunding at least part of the toll to the refund destination identified by the refund destination identification information included in the application information when determining that the vehicle has been affected by the specific event.

[0012]

According to an aspect of the present disclosure, a program causes an onboard unit to execute: a step of receiving an instruction from a user and acquiring evidence information recorded while a vehicle is using a toll road; and a step of generating application information in which the evidence information acquired is associated with refund destination identification information that can identify a refund destination of a toll of the vehicle.

Advantageous Effects of Invention

[0013]

The above-described aspects generate, when determining that the user has been affected by the specific event decreasing the quality of service of the toll road, the evidence information indicating the specific event and allow the user to apply for the refund of the toll.

Brief Description of Drawings

[0014]

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

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

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

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

FIG. 5 is a sequence diagram illustrating an example of processing of the application system according to the second embodiment.

FIG. 6 is a schematic block diagram illustrating a configuration of a computer according to any embodiment.

Description of Embodiments

5 [0015]

First Embodiment

The first embodiment will be described in detail below with reference to FIGS 1 to 3.

[0016]

10 Overall Configuration

FIG. 1 is a schematic diagram illustrating an overall configuration of an application system according to the first embodiment. An application system 100 is a system for applying for a refund of a toll by self-declaration of a user when the user determines that the user has been affected by a specific event on a toll road. The application system 100 may be configured as one function of an automatic toll collection system that collects a toll of a vehicle. As illustrated in FIG. 1, the application system 100 includes an onboard system 10 and a center server 30.

[0017]

20 The onboard system 10 is mounted on a vehicle traveling on a toll road. The onboard system 10 includes at least an onboard unit 11. The onboard system 10 further includes an information communication device 12, a travel information recording unit 13, and a user interface (UI) unit 14 in addition to the onboard unit 11.

25 [0018]

When the vehicle arrives at a tollgate of a toll road, the onboard unit 11 wirelessly communicates with tollgate equipment (e.g., a lane server) via a roadside antenna provided at the tollgate and automatically executes various types of processing related to collection of a toll fare. These pieces of processing are the same as the processing of the onboard unit in an automatic toll collection system in the related art, and thus detailed descriptions thereof are omitted.

[0019]

35 When determining that a user of a toll road (an occupant of the vehicle) has been affected by a specific event having occurred at the toll road, the onboard unit 11 according to the present embodiment receives an instruction operation from the user and applies for a refund of a toll according to the specific event to a road operator. The specific event is an event decreasing the

quality of traveling services of a toll road, such as a traffic jam, lane restriction or road closure due to an accident, construction, weather, or the like, or closing of a tollgate. In the present embodiment, the toll is a toll fare for a toll road.

[0020]

5 The information communication device 12 is connected to a wide-area network NW such as the Internet or a cellular network, and communicates with the center server 30. The information communication device 12 is, for example, a mobile terminal 12A or a PC 12B possessed by the user. FIG. 1 illustrates an example in which the information communication device 12 includes both the
10 mobile terminal 12A and the PC 12B, but the information communication device 12 needs to include at least one of them. The mobile terminal 12A has a wide-area wireless communication function capable of communicating with the center server 30 through a cellular network. The mobile terminal 12A is, for example, a smartphone possessed by the user. The PC 12B has a wide-area
15 communication function capable of communicating with the center server 30 via the Internet.

[0021]

 The travel information recording unit 13 records travel information that can identify when and which section of the toll road the vehicle traveled. The
20 travel information recording unit 13 is, for example, a driving recorder or a car navigation system mounted on the vehicle, or a smartphone.

[0022]

 The travel information is positioning information output by a GNSS receiver (not illustrated) of the travel information recording unit 13 or a travel
25 route that can be identified from the positioning information. The travel route is information indicating a section of the toll road on which the vehicle traveled and times of entry to and exit from the section. The travel information may be vehicle speed information indicating a vehicle speed of the vehicle at each time of day. The travel information recording unit 13 can acquire the vehicle speed
30 at each time of day on the basis of the positioning information of the GNSS receiver or data output from a sensor of the vehicle. Further, the travel information may be an image of the road on which the vehicle traveled captured by a camera (not illustrated) of the travel information recording unit 13. The travel information recording unit 13 records any one or more of the
35 positioning information, the travel route, the vehicle speed, and the image as the travel information.

[0023]

The UI unit 14 receives an instruction operation from the user, makes information notification to the user, and the like. The UI unit 14 is a touch panel or a speaker included in an external device such as a car navigation system. The UI unit 14 may be a button or a notification device (a speaker, an LED, or the like) included in the onboard unit 11.

[0024]

The center server 30 is a server owned by the road operator of the toll road, and records a specific event having occurred on the toll road, receives an application for a refund of a toll for the specific event from the user, and the like.

[0025]

Functional Configuration of Onboard Unit

Next, a functional configuration of the onboard unit 11 will be described with reference to FIG. 1. The onboard unit 11 includes a narrow-area communication unit 111, an evidence information acquisition unit 112, an application information generation unit 113, and a wide-area communication unit 114.

[0026]

The narrow-area communication unit 111 performs narrow area communication (e.g., DSRC communication) with a roadside antenna provided at a tollgate, and performs communication regarding collection of a toll fare. The narrow-area communication unit 111 may perform narrow-area communication with a roadside antenna of a roadside communication device through which the vehicle passes while traveling on the toll road. In that case, the narrow-area communication unit 111 records information that can identify the roadside communication device and a communication history including a communication time of day.

[0027]

The evidence information acquisition unit 112 acquires evidence information recorded while the vehicle is using the toll road. In the present embodiment, the evidence information acquisition unit 112 acquires information that can identify a travel route of the vehicle as the evidence information. Specifically, the evidence information acquisition unit 112 acquires the travel information recorded by the travel information recording unit 13 as the evidence information. Note that in a toll road provided with roadside communication devices, it is possible to determine when and which roadside communication device the vehicle passed (a travel route of the vehicle) from the communication history with the roadside communication

devices recorded by the narrow-area communication unit 111. Therefore, the evidence information acquisition unit 112 may acquire the communication history recorded by the narrow-area communication unit 111 as the evidence information instead of or in addition to the travel information recorded by the travel information recording unit 13.

[0028]

The application information generation unit 113 generates application information including the acquired evidence information and refund destination identification information that can identify a refund destination of a toll of the vehicle. The refund destination identification information is, for example, information associated with a means for paying the toll (e.g., a credit card or a bank account) or a point card. In the present embodiment, the refund destination identification information is IC card information of an IC card 20 (e.g., an ETC card used in an ETC system in Japan) inserted into the onboard unit 11. In the present embodiment, an example of refunding a toll by giving a point will be described. In another embodiment, the refund may be made by a partial refund or a discount of a toll. The application information may include identification information (e.g., an onboard unit ID) that can identify the onboard unit 11.

[0029]

The wide-area communication unit 114 transmits the application information to the center server 30 by using a communication function of the information communication device 12 possessed by the user. In another embodiment, the onboard unit 11 may have a communication function capable of communicating with the center server 30 by connecting to the wide-area network NW. In that case, the wide-area communication unit 114 transmits the application information to the center server 30 by using the communication function of the onboard unit 11, and thus the information communication device 12 may be omitted.

[0030]

Functional Configuration of Center Server

FIG. 2 is a block diagram illustrating a functional configuration of the center server according to the first embodiment. As illustrated in FIG. 2, the center server 30 includes a specific event recording unit 301, an application information receiving unit 302, a determination unit 303, and a refund processing unit 304.

[0031]

The specific event recording unit 301 creates specific event information in which a specific event having occurred on a toll road is recorded. The specific event information includes information such as a type of a specific event, an extent of an impact of the specific event, and an occurrence time of day and a resolution time of day of the specific event. For example, when the type of specific event is traffic jam, the extent of an impact of the specific event includes information that can identify a section with a traffic jam. The specific event recording unit 301 creates the specific event information on the basis of a content input by an operator. The operator detects the occurrence or resolution of a specific event by monitoring using roadside equipment (e.g., a sensor or a monitoring camera) provided on a road or at a tollgate or from a notice from a monitoring person or a user and information provided from an external system (e.g., a traffic jam information service system). The specific event recording unit 301 may automatically create the specific event information on the basis of information provided from an external system or the like without the operation by the operator.

[0032]

The application information receiving unit 302 receives the application information generated by the onboard unit 11.

[0033]

The determination unit 303 determines whether the vehicle has been affected by the specific event on the basis of the evidence information included in the received application information and the specific event information in which the specific event having occurred on the toll road is recorded.

[0034]

When it is determined that the vehicle has been affected by the specific event, the refund processing unit 304 make a refund to the refund destination identified by the refund destination identification information included in the application information.

[0035]

Example of Processing of Application System

FIG. 3 is a sequence diagram illustrating an example of processing of the application system according to the first embodiment. The flow of the processing of the application system 100 will be described below with reference to FIG. 3. In FIG. 3, an example in which the onboard unit 11 acquires the travel information recorded by the travel information recording unit 13 as the evidence information will be described. In the present

embodiment, an example in which the onboard unit 11 uses the mobile terminal 12A as the information communication device 12 will be described.

[0036]

It is assumed that the vehicle travels on a toll road where a toll is
 5 changed (e.g., discounted) according to a specific event. At this time, the travel information recording unit 13 records the travel information of the vehicle (step S101). This processing is repeatedly executed until the vehicle exits the toll road.

[0037]

10 It is also assumed that a traffic jam occurs in a section A of the toll road. Upon receiving information indicating the traffic jam, the specific event recording unit 301 of the center server 30 creates and records specific event information related to the traffic jam (step S102). The specific event information includes a type of the specific event (traffic jam), a section affected
 15 by the traffic jam (section A), and the occurrence time of day of the traffic jam. The information indicating the traffic jam is information input from an operator or an external system. The specific event recording unit 301 executes processing of recording the specific event information (step S102) every time information indicating a specific event is received in this manner. When
 20 information indicating that the traffic jam in the section A has been resolved is newly input, in step S102, the specific event recording unit 301 adds and records (overwrites) the resolution time of day of the traffic jam to the specific event information related to the traffic jam in the section A. The center server 30 can determine that the vehicle that traveled through the section A during a
 25 period from the occurrence time of day of the traffic jam to the resolution time of day of the traffic jam recorded in the specific event information is subject to change or refund of the toll.

[0038]

When the user cannot receive a change of the toll (discount) though the
 30 vehicle has traveled on the section A with the traffic jam (for example, when the user has exited the toll road before the specific event information is recorded), the user applies for a refund of the toll for the impact of the traffic jam (delay) in the section A with the road operator. The user can know that the toll has not been changed by checking the bill of the toll. The user operates the
 35 UI unit 14 while the vehicle is stopped at home or the like to instruct the onboard unit 11 to apply for a refund. At this time, the user designates the date on which the vehicle traveled on the toll road including the section A. The onboard unit 11 receives the instruction from the user via the UI unit 14 (step

S103). Then, the evidence information acquisition unit 112 of the onboard unit 11 acquires, as the evidence information, travel information recorded on the date designated by the user out of the travel information recorded by the travel information recording unit 13 (step S104). The user may further designate a time at which the vehicle traveled on the toll road including the section A. In that case, the evidence information acquisition unit 112 may narrow down the travel information to be acquired as the evidence information from the date and time designated by the user.

[0039]

Next, the application information generation unit 113 of the onboard unit 11 acquires refund destination identification information of the toll (step S105). In the present embodiment, IC card information of the IC card 20 inserted into the onboard unit 11 is acquired as the refund destination identification information.

[0040]

The application information generation unit 113 of the onboard unit 11 generates application information including the evidence information and the refund destination identification information (step S106).

[0041]

When the application information is generated, the wide-area communication unit 114 of the onboard unit 11 transmits the application information to the center server 30 via the mobile terminal 12A, and applies for a refund of the toll (step S107).

[0042]

In the center server 30, when the application information receiving unit 302 receives the application information from the onboard unit 11 (step S108), the determination unit 303 compares the application information with the specific event information recorded in step S102, and determines whether the vehicle has been actually affected by the specific event (step S109).

[0043]

For example, when the specific event information records that a traffic jam occurred in the section A from 10:00 to 12:00 on a certain day of a certain month, and the travel information records that the vehicle entered the section A at 10:05 on the same day, the determination unit 303 determines that the vehicle has been actually affected by the specific event (step S109; YES). In this case, the refund processing unit 304 performs refund processing of giving a point to the refund destination designated by the refund destination identification information in the application information (step S110). A Point to

be given may be set in advance according to types of specific events or the like, or a value designated by the operator in step S102 may be recorded in the specific event information. The refund processing unit 304 also notifies the refund destination that the point has been given. In the present embodiment, since the IC card 20 of the onboard unit 11 is the refund destination, the refund processing unit 304 makes a notification about the given point to the onboard unit 11 into which the IC card 20 is inserted. Upon receiving the notification via the mobile terminal 12A, the application information generation unit 113 of the onboard unit 11 records the given point in the IC card 20.

10 [0044]

When the travel information included in the application information does not match the specific event information, the determination unit 303 determines that the vehicle has not been affected by the specific event (step S109; NO). That is, for example, in a case where the road operator determines that no specific event (traffic jam) occurred in the section A and the specific event information of the section A was recorded, or in a case where the traveling through the section A is not recorded in the travel information, or in a case where the traveling through the section A in a time zone in which there was no traffic jam (before start of the traffic jam or after resolution of the traffic jam) is recorded in the travel information, it is determined that the vehicle has not been affected by the specific event. In this case, the refund processing unit 304 does not perform the refund processing in response to the application information (step S112).

[0045]

The determination unit 303 of the center server 30 notifies the onboard unit 11 of the processing result for the application information (step S113). When the determination unit 303 recognizes that the vehicle has been affected by the specific event, information of the point given by the refund processing unit 304 may be included in the processing result.

30 [0046]

The wide-area communication unit 114 of the onboard unit 11 receives the processing result via the mobile terminal 12A. Then, the application information generation unit 113 of the onboard unit 11 notifies the user of the processing result (step S114). For example, the application information generation unit 113 notifies the user of the processing result by causing the UI unit 14 to output a voice, a message, or the like.

[0047]

Note that FIG. 3 illustrates an example in which the onboard unit 11 consecutively performs generation of the application information and transmission of the application information to the center server 30, but the present disclosure is not limited thereto. In another embodiment, the onboard unit 11 may temporarily stop the processing when the generation of the application information (step S106) is completed, and may resume the processing from the transmission of the application information (step S107) when the user performs an instruction operation next time. For example, the user may execute the processing up to the generation of the application information (step S106) while parking (stopping) at a rest area or the like before exiting the toll road and resume the processing from step S107 of transmitting the application information at a later date when checking the bill of the toll fare indicating that the toll has not been refunded for the impact of the traffic jam.

[0048]

In addition, FIG. 3 illustrates an example in which the onboard unit 11 transmits the application information to the center server 30 via the mobile terminal 12A (the information communication device 12), but the present disclosure is not limited thereto. In another embodiment, the onboard unit 11 may be capable of transferring the application information generated in step S106 to the mobile terminal 12A or the PC 12B through a portable recording medium or wireless communication (e.g., Bluetooth (registered trademark)). In that case, instead of the onboard unit 11, the mobile terminal 12A or the PC 12B executes step S107 of transmitting the application information to the center server 30. That is, in the onboard system 10 according to this aspect, the mobile terminal 12A or the PC 12B may function as the wide-area communication unit 114.

[0049]

In still another embodiment, the onboard unit 11 may temporarily stop the processing when the generation of the application information (step S106) is completed, and then the narrow-area communication unit 111 may transmit the application information (step S107) via a roadside antenna when the vehicle arrives at a tollgate or a roadside communication device. The narrow-area communication unit 111 receives a notification of a processing result from the center server 30 via the roadside antenna of the tollgate or the roadside communication device. In that case, the configurations of the information communication device 12 and the wide-area communication unit 114 of the onboard unit 11 may be omitted.

[0050]

Further, FIG. 3 illustrates an example in which the determination unit 303 of the center server 30 determines whether the vehicle has been actually affected by the specific event by comparing the travel information included in the application information with the specific event information, but the present disclosure is not limited thereto. In another embodiment, the determination unit 303 may determine whether the vehicle has been affected by the specific event using vehicle speed information included in the travel information or an image. For example, when the road operator cannot detect the traffic jam in the section A due to a failure of a monitoring camera or the like, the specific event information is not recorded. In consideration of such a case, even when the specific event is not recorded in step S109 in FIG. 3, the determination unit 303 may determine that the vehicle has been affected by the specific event (traffic jam) in the section A when it is determined that the vehicle has traveled through the section A at a predetermined speed or less for a certain time period or more from the travel information (travel route and vehicle speed information). Similarly, in step S109, when it is determined that a traffic jam occurred in the section A while the vehicle was traveling from the travel information (a travel route and an image), the determination unit 303 may determine that the vehicle has been affected by the specific event (traffic jam) in the section A. At this time, the determination unit 303 may determine whether a traffic jam occurred in the section A on the basis of the traffic volume of the section A detected from an image, or the speed or travel amount of the vehicle detected from consecutive images by, for example, using a known image processing technique. Further, the determination unit 303 may perform determination by combining vehicle speed information and information detected from images, such as determining that the vehicle has not been affected by a traffic jam when the traffic jam is not detected from the images even when the vehicle speed is equal to or lower than the predetermined speed.

[0051]

In still another embodiment, when a communication history recorded by the narrow-area communication unit 111 of the onboard unit 11 and the identification information of the onboard unit 11 are included in the evidence information, in step S109, the determination unit 303 of the center server 30 may acquire a communication history with the onboard unit 11 from a roadside antenna of a roadside communication device and perform processing of checking the acquired communication history against the communication

history included in the evidence information. When both the communication histories do not match, the determination unit 303 of the center server 30 determines that the communication history included in the evidence information has been falsified, and determines that the vehicle has not been affected by the specific event (step S109; NO). In this case, the determination unit 303 of the center server 30 may register the identification information of the onboard unit 11 in a blacklist, and may issue a warning, a report to a regulatory agency, or the like when receiving fraudulent (falsified) evidence information from the same onboard unit 11 a predetermined number of times or more. When both the communication histories match, it is determined that the communication history is an application, and subsequently, collation with the specific event information and determination by vehicle speed information and/or images are performed. This can reliably suppress the fraudulent act of users.

[0052]

Further, FIG. 3 illustrates an example in which the center server 30 receives the application information and then consecutively executes an examination for determining whether there is an impact of a specific event (step S109), processing of refunding a point (step S110), and notification of the processing result (step S113), but the present disclosure is not limited thereto. In another embodiment, the processing of steps S109 to S113 may be performed on a later date. For example, it may take time for the center server 30 to complete the examination for determining whether there is an impact of a specific event (step S109) after receiving the application information. In that case, the onboard unit 11 transmits the application information in step S107 and ends the processing. Upon completion of the processing in steps S109 to S110, the center server 30 records data so that the processing result can be displayed (notified) on a website of the road operator. The user accesses the website of the road operator (e.g., a screen after login with the ID of the user) and confirms whether a point has been refunded.

[0053]

Actions and Effects

As described above, the onboard unit 11 according to the present embodiment includes: the evidence information acquisition unit 112 that receives an instruction from a user and acquires evidence information recorded while a vehicle is using a toll road; and the application information generation unit 113 that generates application information including the acquired evidence

information and refund destination identification information that can identify a refund destination of a toll of the vehicle.

[0054]

5 This allows, when the user determines that the service of the toll road has been degraded due to an impact of a specific event, the onboard unit 11 to generate the application information including the evidence information that can fairly identify the presence or absence of the impact of the specific event without the subjectivity of the user.

[0055]

10 The onboard unit 11 further includes the wide-area communication unit 114 configured to transmit the application information to the center server 30 that receives an application for a refund of a toll for a specific event affecting the use of a toll road by using a communication function included in the onboard unit 11 or a communication function of the information
15 communication device 12 connected to the onboard unit 11.

[0056]

This allows, after generating the application information, the onboard unit 11 to subsequently request the center server 30 to refund the toll. This allows the user to cause the onboard unit 11 to execute a series of processing
20 including acquisition of the evidence information, generation of the application information, and transmission of the application information in one operation.

[0057]

The onboard unit 11 may include, instead of the wide-area communication unit 114, the narrow-area communication unit 111 configured
25 to wirelessly communicate with a roadside antenna provided at a roadside communication device or a tollgate of a toll road and transmit the application information to the center server 30.

[0058]

This allows the onboard unit 11 to transmit the application information
30 via the narrow-area communication unit 111 and the roadside antenna used in the conventional automatic toll collection system. This eliminates the need for the wide-area communication unit 114 of the onboard unit 11 and the information communication device 12, and thus a simple configuration can be achieved.

35 [0059]

The evidence information acquisition unit 112 acquires evidence information including travel information which is recorded by the travel

information recording unit 13 mounted on the vehicle and that can identify a travel route of the vehicle.

[0060]

5 This allows the onboard unit 11 to use the travel information recorded by the travel information recording unit 13 as the evidence information that can prove which section of the toll road the vehicle has traveled.

[0061]

10 Further, in wirelessly communicating with the roadside antenna of the roadside communication device, the narrow-area communication unit 111 records a communication history including information that can identify the roadside communication device, and the evidence information acquisition unit 112 acquires the evidence information including the communication history recorded by the narrow-area communication unit 111.

[0062]

15 This allows the onboard unit 11 to use the communication history between the conventional narrow-area communication unit 111 and roadside antennas of roadside communication devices as the evidence information that can prove which locations of the roadside communication devices the vehicle has passed in what order, that is, the travel route of the vehicle. The data
20 transmitted and received through the wireless communication between the roadside antennas and the narrow-area communication unit 111 may be encrypted so as to be decrypted only by the road operator. This can prevent the user from making a fraudulent application by falsifying the data (travel information) of the onboard unit 11.

25 [0063]

The application system 100 according to the present embodiment includes the onboard unit 11 and the center server 30 described above. The center server 30 includes the application information receiving unit 302 that receives application information from the onboard unit 11, the determination
30 unit 303 configured to determine whether the vehicle has been affected by a specific event on the basis of evidence information included in the received application information, and the refund processing unit 304 configured to refund at least part of a toll to a refund destination identified by refund destination identification information included in the application information
35 when it is determined that the vehicle has been affected by the specific event.

[0064]

Accordingly, the application system 100 can prevent the user from making a false application by requesting the user to submit the application

information including the evidence information. The center server 30 makes a determination on the basis of the evidence information that is objective evidence, and the application system 100 can thus appropriately refund the toll only to the vehicle that has been actually affected by the specific event without
5 refunding the toll for a false application.

[0065]

The center server 30 further includes the specific event recording unit 301 that creates specific event information in which a specific event having occurred on a toll road is recorded, and the determination unit 303 of the center
10 server 30 determines whether the vehicle has been affected by the specific event by checking the evidence information against the specific event information.

[0066]

When there are a plurality of users who have used a certain section A of
15 a toll road in the same time zone, for example, the determination on whether a traffic jam occurred in the section A may be different depending on the subjectivities of the users. However, the application system 100 according to the present embodiment can objectively and fairly determine whether the vehicle has been affected by the traffic jam without depending on the
20 subjectivities of the users by further referring to the specific event information recorded when the road operator recognizes that the traffic jam occurred in the section A.

[0067]

In the onboard unit 11, the evidence information acquisition unit 112
25 acquires the evidence information including a communication history recorded by the narrow-area communication unit 111, and the application information generation unit 113 generates the application information including identification information that can identify the onboard unit 11. In the center server 30, when the communication history included in the application
30 information matches a communication history of a roadside antenna of a roadside communication device associated with the identification information of the onboard unit 11, the determination unit 303 determines whether the vehicle has been affected by the specific event on the basis of the evidence information.

35 [0068]

This allows the application system 100 to check whether the user has falsified the evidence information (communication history) and prevent the user from fraudulently receiving a refund of the toll by falsification.

[0069]

Second Embodiment

The second embodiment will be described in detail below with reference to FIGS. 4 and 5. The same components as those in the above-described
5 embodiment will be denoted by the same reference signs, and the detailed description thereof will be omitted. In the second embodiment, a specific event is an event in which a service provided at a facility of a toll road is unavailable and includes an event in which, for example, a rest area is unavailable for parking (is full) or an event in which a facility (e.g., a shower) of the rest area
10 is unavailable due to a failure. In the present embodiment, a toll may be a toll of the facility.

[0070]

FIG. 4 is a schematic diagram illustrating an overall configuration of an application system according to the second embodiment. As illustrated in FIG.
15 4, the manager of the facility presents a two-dimensional code (e.g., a QR code (registered trademark)) in which facility information indicating that the service of the facility is unavailable is recorded to a user. The user reads the facility information from the two-dimensional code with the mobile terminal 12A. The evidence information acquisition unit 112 of the onboard unit 11 acquires the
20 facility information read by the mobile terminal 12A as evidence information.

[0071]

FIG. 5 is a sequence diagram illustrating an example of processing of the application system according to the second embodiment. The flow of the processing of the application system 100 will be described below with
25 reference to FIG. 5. Note that the processing of the travel information recording unit 13 is the same as that in the first embodiment, and thus the description thereof will be omitted in the present embodiment.

[0072]

For example, it is assumed that equipment of a rest area B has failed and
30 become unavailable. In this case, the manager of the rest area B notifies the center server 30 of facility information indicating that the equipment of the rest area B has become unavailable. The manager of the rest area B may notify an operator by telephone or the like, and the operator may input the facility information to the center server 30. Then, the specific event recording unit 301
35 of the center server 30 records the notified (input) facility information as specific event information (step S201). The facility information includes information indicating the facility (rest area B), a type of a specific event (unavailability of the equipment), and an impact period (a time of day at which

the equipment became unavailable). The specific event recording unit 301 executes processing of recording specific event information (step S201) every time the facility information is notified. When information indicating that the equipment of the rest area B has become available is newly input, the specific event recording unit 301 adds and records (overwrites) a time of day at which the unavailability was resolved to the impact period of the specific event information in step S201. Accordingly, by referring to the specific event information, it is possible to determine that only a vehicle (user) who tried to use the equipment in the rest area B during a period from when the equipment became unavailable to when the unavailability was resolved has been affected by the unavailability of the equipment.

[0073]

It is assumed that a vehicle (user) stops by the rest area B and tries to use equipment. However, this equipment is out of order and unavailable. In this case, the manager of the rest area B presents a two-dimensional code in which facility information is recorded to the user. For example, the two-dimensional code is presented to the user by a poster indicating that the equipment is out of order (unavailable). The user operates the mobile terminal 12A to read the two-dimensional code. The mobile terminal 12A reads the facility information from the two-dimensional code and records the facility information (step S202). With a presentation method using a poster, a person who does not use the equipment can read the two-dimensional code. Therefore, it is desirable to employ a presentation method in which the manager presents the two-dimensional code to a person who desires to use the equipment only when an inquiry is received from the person who desires to use the equipment. This makes it possible to limit the reading of the two-dimensional code to only the person who desires to use the equipment.

[0074]

The user operates the UI unit 14 while the vehicle is stopped, and instructs the onboard unit 11 to make an application about the unavailability of the equipment of the rest area B to the road operator. At this time, the user may designate a date on which the equipment was unavailable. The onboard unit 11 receives the instruction from the user via the UI unit 14 (step S203). Then, the evidence information acquisition unit 112 of the onboard unit 11 acquires, as evidence information, facility information recorded on the date designated by the user out of the facility information recorded by the mobile terminal 12A (step S204).

[0075]

The subsequent processing in steps S205 to S214 is the same as the processing in the first embodiment (steps S105 to S114 in FIG. 3). The application information generated in step S206 includes the facility information acquired in step S204 as the evidence information. In step S209, the

5 determination unit 303 of the center server 30 compares the facility information recorded as the specific event information with the facility information included in the application information, and determines whether the vehicle has been actually unable to use the equipment of the rest area B.

[0076]

10 As described above, in the onboard unit 11 according to the present embodiment, the evidence information acquisition unit 112 acquires the evidence information including the facility information presented by the manager of the facility when the service of the facility of the toll road is unavailable.

15 [0077]

This allows the onboard unit 11 to generate, from the facility information provided from the manager of the facility, the application information that can objectively prove that the user has been actually unable to use the service of the facility.

20 [0078]

Computer Configuration

FIG. 6 is a schematic block diagram illustrating a configuration of a computer according to any embodiment. A computer 900 includes a processor 901, a main storage device 902, an auxiliary storage device 903, and an

25 interface 904. The onboard unit 11 and the center server 30 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, loads the program into the main storage device 902, and

30 executes the above processing in accordance with the program. The processor 901 secures a storage area used in the above processing in the main storage device 902 in accordance with the program.

[0079]

The program may be for implementing some of the functions to be

35 exerted by the computer 900. For example, the program may exert the function by being combined with another program already stored in the auxiliary storage device 903 or by being combined with another program mounted on another device. Note that in another embodiment, the computer may include a custom

large scale integrated circuit (LSI) such as a programmable logic device (PLD) in addition to or in place of the above configuration. Examples of the PLD include a programmable array logic (PAL), a generic array logic (GAL), a complex programmable logic device (CPLD), and a field programmable gate array (FPGA). In this case, some or all of the functions implemented by the processor may be implemented by the integrated circuit.

[0080]

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 load the program into 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.

[0081]

Other Embodiments

While the embodiments have been described in detail with reference to the drawings, the specific configurations are not limited to those 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 changed as needed. Parts of processing may be executed in parallel.

[0082]

Supplementary Notes

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

[0083]

(1) According to a first aspect, an onboard unit 11 includes: an evidence information acquisition unit 112 configured to receive an instruction from a user and acquires evidence information recorded while a vehicle is using a toll road; and an application information generation unit 113 configured to generate application information including the evidence information acquired and refund destination identification information that can identify a refund destination of a toll of the vehicle.

[0084]

This allows, when the user determines that the service of the toll road has been degraded due to an impact of a specific event, the onboard unit 11 to generate the application information including the evidence information that can fairly identify the presence or absence of the impact of the specific event without the subjectivity of the user.

[0085]

(2) According to a second aspect, the onboard unit 11 according to the first aspect further includes a wide-area communication unit 114 configured to transmit the application information to a center server 30 that receives an application for a refund of the toll for a specific event affecting the use of the toll road by using a communication function included in the onboard unit 11 or a communication function of an information communication device 12 connected to the onboard unit 11.

[0086]

This allows, after generating the application information, the onboard unit 11 to subsequently request the center server 30 to refund the toll. This allows the user to cause the onboard unit 11 to execute a series of processing including acquisition of the evidence information, generation of the application information, and transmission of the application information in one operation.

[0087]

(3) According to a third aspect, the onboard unit 11 according to the first aspect further includes a narrow-area communication unit 111 configured to wirelessly communicate with a roadside antenna provided at a roadside communication device or a tollgate of the toll road and transmit the application information to a center server 30 that receives an application for a refund of the toll for a specific event affecting the use of the toll road.

[0088]

This allows the onboard unit 11 to transmit the application information via the narrow-area communication unit 111 and the roadside antenna used in the conventional automatic toll collection system. This eliminates the need for the wide-area communication unit 114 of the onboard unit 11 and the information communication device 12, and thus a simple configuration can be achieved.

[0089]

(4) According to a fourth aspect, in the onboard unit 11 according to any one of the first to third aspects, the evidence information acquisition unit 112 acquires the evidence information including travel information which is

recorded by a travel information recording unit 13 mounted on the vehicle and can identify a travel route of the vehicle.

[0090]

5 This allows the onboard unit 11 to use the travel information recorded by the travel information recording unit 13 as the evidence information that can prove which section of the toll road the vehicle has traveled.

[0091]

10 (5) According to a fifth aspect, the onboard unit 11 according to any one of the first to fourth aspects further includes a narrow-area communication unit 111 configured to wirelessly communicate with a roadside antenna provided at a roadside communication device of the toll road and record a communication history including information that can identify the roadside communication device. The evidence information acquisition unit 112 acquires the evidence information including the communication history recorded by the narrow-area
15 communication unit 111.

[0092]

20 This allows the onboard unit 11 to use the communication history between the conventional narrow-area communication unit 111 and roadside antennas of roadside communication devices as the evidence information that can prove which locations of the roadside communication devices the vehicle has passed in what order, that is, the travel route of the vehicle.

[0093]

25 (6) According to a sixth aspect, in the onboard unit 11 according to any one of the first to fifth aspects, the evidence information acquisition unit 112 acquires the evidence information including facility information presented by a manager of a facility of the toll road when a service of the facility is unavailable.

[0094]

30 This allows the onboard unit 11 to generate, from the facility information provided from the manager of the facility, the application information that can objectively prove that the user has been actually unable to use the service of the facility.

[0095]

35 (7) According to a seventh aspect, an onboard system 10 includes: a travel information recording unit 13 configured to record travel information of a vehicle while the vehicle is traveling on a toll road; an evidence information acquisition unit 112 configured to receive an instruction from a user and acquire evidence information including the travel information recorded by the

travel information recording unit 13; an application information generation unit 113 configured to generate application information in which the evidence information acquired is associated with refund destination identification information that can identify a refund destination of a toll of the vehicle; and a
5 wide-area communication unit 114 configured to transmit the application information to a center server 30 that receives an application for a refund of the toll for a specific event affecting use of the toll road by using a communication function of an information communication device 12 possessed by the user.

[0096]

10 This allows, when the user determines that the service of the toll road has been degraded due to the impact of the specific event, the onboard system 10 to generate the application information including the evidence information that can fairly identify the presence or absence of the impact of the specific event without the subjectivity of the user by using the record of the travel
15 information recording unit 13 mounted on the vehicle and transmit the application information to the center server 30.

[0097]

(8) According to an eighth aspect, an application system 100 includes: an onboard unit 11; and a center server 30. The onboard unit 11 includes: an
20 evidence information acquisition unit 112 configured to receive an instruction from a user and acquire evidence information recorded while a vehicle is traveling on a toll road; an application information generation unit 113 configured to generate application information in which the evidence information acquired is associated with refund destination identification
25 information that can identify a refund destination of a toll of the vehicle; and a wide-area communication unit 114 configured to transmit the application information to the center server 30 that receives an application for a refund of the toll for a specific event affecting use of the toll road by using a communication function of an information communication device 12 possessed
30 by the user. The center server 30 includes: an application information receiving unit 302 configured to receive the application information from the onboard unit 11; a determination unit 303 configured to determine whether the vehicle has been affected by the specific event on the basis of the evidence information included in the application information received; and a refund processing unit
35 304 configured to refund at least part of the toll to the refund destination identified by the refund destination identification information included in the application information when determining that the vehicle has been affected by the specific event.

[0098]

Accordingly, the application system 100 can prevent the user from making a false application by requesting the user to submit the application information including the evidence information. The center server 30 makes a
 5 determination on the basis of the evidence information that is objective evidence, and the application system 100 can thus appropriately refund the toll only to the vehicle that has been actually affected by the specific event without refunding the toll for a false application.

[0099]

10 (9) According to a ninth aspect, in the application system 100 according to the eighth aspect, the center server 30 further includes a specific event recording unit 301 configured to create specific event information in which the specific event having occurred on the toll road is recorded. The determination
 15 unit 303 of the center server 30 determines whether the vehicle has been affected by the specific event by checking the evidence information against the specific event information.

[0100]

When there are a plurality of users who have used a certain section A of the toll road in the same time zone, for example, the determination on whether
 20 a traffic jam occurred in the section A may be different depending on the subjectivities of the users. However, the application system 100 according to the present aspect can objectively and fairly determine whether the vehicle has been affected by the traffic jam without depending on the subjectivity of the user by further referring to the specific event information recorded when the
 25 road operator recognizes that the traffic jam occurred in the section A.

[0101]

(10) According to a tenth aspect, in the application system 100 according to the eighth or ninth aspect, the onboard unit 11 further includes a narrow-area communication unit 111 configured to wirelessly communicate
 30 with a roadside antenna provided at a roadside communication device of the toll road and record a communication history including information that can identify the roadside communication device. The evidence information acquisition unit 112 of the onboard unit 11 acquires the evidence information including the communication history recorded by the narrow-area
 35 communication unit 111. The application information generation unit 113 of the onboard unit 11 generates the application information including identification information that can identify the onboard unit 11. The determination unit 303 of the center server 30 determines whether the vehicle has been affected by the

specific event on the basis of the evidence information when the communication history included in the application information matches a communication history of the roadside antenna of the roadside communication device associated with the identification information of the onboard unit 11.

5 [0102]

This allows the application system 100 to check whether the user has falsified the evidence information (communication history) and prevent the user from fraudulently receiving a refund of the toll by falsification.

[0103]

10 (11) According to an eleventh aspect, an application method is an application method using an application system 100 including an onboard unit 11 and a center server 30 and includes: at the onboard unit 11, a step of receiving an instruction from a user and acquiring evidence information recorded while a vehicle is using a toll road; at the onboard unit 11, a step of
15 generating application information in which the evidence information acquired is associated with refund destination identification information that can identify a refund destination of a toll of the vehicle; at the onboard unit 11, a step of transmitting the application information to the center server 30 that receives an application for a refund of the toll for a specific event affecting use of the toll
20 road by using a communication function of an information communication device 12 possessed by the user; at the center server 30, a step of receiving the application information from the onboard unit 11; at the center server 30, a step of determining whether the vehicle has been affected by the specific event on the basis of the evidence information included in the application information
25 received; and at the center server 30, a step of refunding at least part of the toll to the refund destination identified by the refund destination identification information included in the application information when determining that the vehicle has been affected by the specific event.

[0104]

30 (12) According to a twelfth aspect, a program causes an onboard unit 11 to execute: a step of receiving an instruction from a user and acquire evidence information recorded while a vehicle is using a toll road; and a step of generating application information in which the evidence information acquired is associated with refund destination identification information that can identify
35 a refund destination of a toll of the vehicle.

Reference Signs List

[0105]

- 100 Application system
- 10 Onboard system
- 11 Onboard unit
- 111 Narrow-area communication unit
- 5 112 Evidence information acquisition unit
- 113 Application information generation unit
- 114 Wide-area communication unit
- 12 Information communication device
- 12A Mobile terminal (information communication device)
- 10 12B PC (information communication device)
- 13 Travel information recording unit
- 14 UI unit
- 20 IC card
- 30 Center server
- 15 301 Specific event recording unit
- 302 Application information receiving unit
- 303 Determination unit
- 304 Refund processing unit

Claims

[Claim 1]

An onboard unit, comprising:
an evidence information acquisition unit configured to receive an instruction from a user and acquire evidence information recorded while a vehicle is using a toll road; and
an application information generation unit configured to generate application information including the evidence information acquired and refund destination identification information that can identify a refund destination of a toll of the vehicle.

[Claim 2]

The onboard unit according to claim 1, further comprising
a wide-area communication unit configured to transmit the application information to a center server that receives an application for a refund of the toll for a specific event affecting use of the toll road by using a communication function included in the onboard unit or a communication function of an information communication device connected to the onboard unit.

[Claim 3]

The onboard unit according to claim 1, further comprising
a narrow-area communication unit configured to wirelessly communicate with a roadside antenna provided at a roadside communication device or a tollgate of the toll road and transmit the application information to a center server that receives an application for a refund of the toll for a specific event affecting use of the toll road.

[Claim 4]

The onboard unit according to claim 1 or 2, wherein the evidence information acquisition unit acquires the evidence information including travel information which is recorded by a travel information recording unit mounted on the vehicle and can identify a travel route of the vehicle.

[Claim 5]

The onboard unit according to claim 1 or 2, further comprising
a narrow-area communication unit configured to wirelessly communicate with a roadside antenna provided at a roadside communication

device of the toll road and record a communication history including information that can identify the roadside communication device, wherein the evidence information acquisition unit acquires the evidence information including the communication history recorded by the narrow-area communication unit.

[Claim 6]

The onboard unit according to claim 1 or 2, wherein the evidence information acquisition unit acquires the evidence information including facility information presented by a manager of a facility of the toll road when a service of the facility is unavailable.

[Claim 7]

An onboard system, comprising:
 a travel information recording unit configured to record travel information of a vehicle while the vehicle is traveling on a toll road;
 an evidence information acquisition unit configured to receive an instruction from a user and acquire evidence information including the travel information recorded by the travel information recording unit;
 an application information generation unit configured to generate application information in which the evidence information acquired is associated with refund destination identification information that can identify a refund destination of a toll of the vehicle; and
 a wide-area communication unit configured to transmit the application information to a center server that receives an application for a refund of the toll for a specific event affecting use of the toll road by using a communication function of an information communication device possessed by the user.

[Claim 8]

An application system, comprising:
 an onboard unit; and
 a center server,
 the onboard unit comprising:
 an evidence information acquisition unit configured to receive an instruction from a user and acquire evidence information recorded while a vehicle is traveling on a toll road;
 an application information generation unit configured to generate application information in which the evidence information acquired is

associated with refund destination identification information that can identify a refund destination of a toll of the vehicle; and

a wide-area communication unit configured to transmit the application information to the center server that receives an application for a refund of the toll for a specific event affecting use of the toll road by using a communication function of an information communication device possessed by the user,

the center server comprising:

an application information receiving unit configured to receive the application information generated by the onboard unit;

a determination unit configured to determine whether the vehicle has been affected by the specific event on the basis of the evidence information included in the application information received; and

a refund processing unit configured to refund at least part of the toll to the refund destination identified by the refund destination identification information included in the application information when determining that the vehicle has been affected by the specific event.

[Claim 9]

The application system according to claim 8, wherein

the center server further comprises a specific event recording unit configured to create specific event information in which the specific event having occurred on the toll road is recorded, and

the determination unit of the center server determines whether the vehicle has been affected by the specific event by checking the evidence information against the specific event information.

[Claim 10]

The application system according to claim 8 or 9, wherein

the onboard unit further comprises a narrow-area communication unit configured to wirelessly communicate with a roadside antenna provided at a roadside communication device of the toll road and record a communication history including information that can identify the roadside communication device,

the evidence information acquisition unit of the onboard unit acquires the evidence information including the communication history recorded by the narrow-area communication unit,

the application information generation unit of the onboard unit generates the application information including identification information that can identify the onboard unit, and

the determination unit of the center server determines whether the vehicle has been affected by the specific event on the basis of the evidence information when the communication history included in the application information matches a communication history of the roadside antenna of the roadside communication device associated with the identification information of the onboard unit.

[Claim 11]

An application method using an application system provided with an onboard unit and a center server, the application method comprising:

at the onboard unit, a step of receiving an instruction from a user and acquiring evidence information recorded while a vehicle is using a toll road;

at the onboard unit, a step of generating application information in which the evidence information acquired is associated with refund destination identification information that can identify a refund destination of a toll of the vehicle;

at the onboard unit, a step of transmitting the application information to the center server that receives an application for a refund of the toll for a specific event affecting use of the toll road by using a communication function of an information communication device possessed by the user;

at the center server, a step of receiving the application information from the onboard unit;

at the center server, a step of determining whether the vehicle has been affected by the specific event on the basis of the evidence information included in the application information received; and

at the center server, a step of refunding at least part of the toll to the refund destination identified by the refund destination identification information included in the application information when determining that the vehicle has been affected by the specific event.

[Claim 12]

A program causing an onboard unit to execute:

a step of receiving an instruction from a user and acquiring evidence information recorded while a vehicle is using a toll road; and

a step of generating application information in which the evidence information acquired is associated with refund destination identification information that can identify a refund destination of a toll of the vehicle.