DESCRIPTION

# CHARGING SYSTEM, CHARGING METHOD, CONTROLLER AND PROGRAM

## TECHNICAL FIELD

[0001]

The present invention relates to a charging system, a charging method, a controller, and a program for collecting predetermined tolls from owners of vehicles which have entered toll-charging facilities for vehicles, such as toll roads and toll charging areas.

Priority is claimed on Japanese Patent Application No. 2009-047188, filed February 27, 2009, the content of which is incorporated herein by reference.

## BACKGROUND ART

[0002]

An ETC (electronic toll collection) system is known as a conventional charging system for toll-charging facilities. A charging device of the ETC system includes: a communication unit that communicates with an in-vehicle device mounted on a vehicle; and a charging unit that performs a charging process. In addition, the charging device installed at an entrance of a toll road writes entrance information and vehicle type information onto an ETC card via the in-vehicle device. Further, the charging device installed at an exit of the toll road obtains the entrance information and the vehicle type information of the ETC card via the in-vehicle device mounted on the vehicle, calculates a usage fee based on the obtained entrance information and the vehicle type information, and thereby charges the usage fee based on a usage-fee paying method registered on the

ETC card in advance.

Moreover, in recent years, a charging method using a GPS (global positioning system) has been under consideration (see, for example, Patent Document 1). The charging method using the GPS is able to charge without installing a charging device at entrances and exits of toll-charging facilities.

## CITATION LIST

Patent Document

[0003]

Patent Document 1: Japanese Unexamined Patent Application, First Publication No. 2004-326263

## DISCLOSURE OF THE INVENTION

### Problems to be Solved by the Invention

[0004]

By the way, when a charging method is changed at toll-charging facilities from a charging method using the conventional ETC system to a charging method using the GPS, the following problem arises. In other words, a user is required to exchange an in-vehicle device compatible with the ETC system to an in-vehicle device compatible with the charging system using the GPS.

The present invention has been made in view of the above situations. An object of the present invention is to provide a charging system, a charging method, a controller, and a program, which use the GPS and devices of an existing ETC system.

### Means for Solving the Problems

[0005]

A charging system of the present invention includes: an in-vehicle device to be mounted on a vehicle; and a controller to be connected with the in-vehicle device. The charging system performs a charging process based on utilization of a toll-charging facility by the vehicle. The in-vehicle device includes: a writing unit for writing data onto a recoding medium based on charge information. The controller includes: a passage determining unit that determines passage through a charge position by checking positional information of the vehicle against positional information stored in a positional information storing unit; a toll computing unit that computes a toll by checking information on the passage through the charge position determined by the passage determining unit against toll information stored in a toll information storing unit; and a charging processing unit that notifies the in-vehicle device of the toll computed by the toll computing unit, and performs the charging process.

[0006]

The controller of the present invention may determine whether or not an ID of a previously communicated in-vehicle device matches that of a presently communicated in-vehicle device every time communication is performed with the in-vehicle device.

[0007]

The controller of the present invention may allocate a serial number to communication every time communication is performed with the in-vehicle device, and thereby determine the continuity of the serial number.

[0008]

A charging method of the present invention is a charging method using a charging system including: an in-vehicle device to be mounted on a vehicle; and a controller to be connected with the in-vehicle device, the charging system performing a

charging process based on utilization of a toll-charging facility by the vehicle. The charging method includes the following processes. A passage determining unit of the controller determines passage through a charge position by checking positional information of the vehicle against positional information stored in a positional information storing unit. A toll computing unit of the controller computes a toll by checking information on the passage through the charge position determined by the passage determining unit against toll information stored in a toll information storing unit. A charging processing unit of the controller notifies the in-vehicle device of the toll computed by the toll computing unit, and performs the charging process. The in-vehicle device writes data onto a recoding medium based on the charge information.

[0009]

A controller of the present invention is a controller to be connected to an in-vehicle device to be mounted on a vehicle. The in-vehicle device writes data onto a recoding medium based on charge information. The controller includes: a passage determining unit that determines passage through a charge position by checking positional information of the vehicle against positional information stored in a positional information storing unit; a toll computing unit that computes a toll by checking information on the passage through the charge position determined by the passage determining unit against toll information stored in a toll information storing unit; and a charging processing unit for notifying the in-vehicle device of the toll computed by the toll computing unit, and performs the charging process.

[0010]

A program of the present invention is a program causing a controller, the controller being to be connected to an in-vehicle device that is to be mounted on a vehicle, the in-vehicle device writing data onto a recoding medium based on charge

information, to operate as: a passage determining unit that determines passage through a charge position by checking positional information of the vehicle against positional information stored in a positional information storing unit; a toll computing unit that computes a toll by checking information on the passage through the charge position determined by the passage determining unit against toll information stored in a toll information storing unit; and a charging processing unit that notifies the in-vehicle device of the toll computed by the toll computing unit, and performs the charging process.

Effects of the Invention

[0011]

According to the present invention, the in-vehicle device is connected to the controller, communicates with the central system via the controller, and charges a toll. Thereby, a user of a vehicle in a charging system using the GPS can pay a toll by means of an in-vehicle device compatible with an ETC system.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a schematic block diagram illustrating a configuration of a charging system according to one embodiment of the present invention.

FIG. 2 is a flowchart illustrating a process of monitoring connection of an in-vehicle device with an external device.

FIG. 3 is a flowchart illustrating operations of a charging system at the time of a charging process.

## BEST MODE FOR CARRYING OUT THE INVENTION

[0013]

Hereinafter, an embodiment of the present invention is explained in detail with reference to the drawings.

FIG. 1 is a schematic block diagram illustrating a configuration of a charging system according to one embodiment of the present invention. The charging system includes: an in-vehicle device 100; an external device (controller) 200; a central system (controller) 300; and a gantry device 400. The in-vehicle device 100 is used in an ETC system, and has a function of charging a toll to an IC card. The external device 200 is connected to the in-vehicle device 100 via a serial line and the like. The external device 200 performs wireless communication with the central system 300. The central system 300 is connected to the gantry device 400 via a network and the like. The gantry device 400 is a road-side device used in the ETC system, and has a communication function of communicating with the in-vehicle device 100 and an imaging function of imaging vehicle license plates.

[0014]

The external device 200 includes: a connection unit 201; an in-vehicle device information obtaining unit 202; an in-vehicle device information storing unit 203; an in-vehicle device information comparing unit 204; a communication unit 205; a charge location storing unit (positional information storing unit) 206; a charge information storing unit (toll information storing unit) 207; a positioning processing unit 208; a charge determining unit (passage determining unit) 209; a charging unit (toll computing unit, charging processing unit) 210; and a display unit 211. The connection unit 201 performs communication with the in-vehicle device 100 via a serial line and the like. The in-vehicle device information obtaining unit 202 obtains information such as the ID of the in-vehicle device, and the like, from the in-vehicle device 100 via the connection

unit 201. The in-vehicle device information storing unit 203 stores the information obtained by the in-vehicle device information obtaining unit 202. The in-vehicle device information comparing unit 204 compares the information stored by the in-vehicle device information storing unit 203 with the information obtained by the in-vehicle device information obtaining unit 202. The communication unit 205 performs communication with the central system 300 via an antenna and the like. The charge location storing unit 206 stores charge location information which indicates a location of a charging area of a toll-charging facility. Here, the toll-charging facility indicates a facility, such as an expressway and a parking lot, which charges a toll to users of vehicles. The charge information storing unit 207 stores charge amount information which indicates a charge amount at the toll-charging facility. The positioning processing unit 208 obtains positional information of a vehicle by using the GPS. The charge determining unit 209 determines whether or not a vehicle is present at a charging area, and determines whether or not a toll charge is necessary. The charging unit 210 stores information necessary for the charging process in an internal memory, and performs the charging process on the in-vehicle device 100. The display unit 211 displays information.

[0015]

In addition, the external device 200 is connected to the in-vehicle device 100, and performs wireless communication with the central system 300. The charge determining unit 209 checks positional information of a vehicle against the charge location information stored in the charge location storing unit 206, and thereby determines passage through a charge position. When the vehicle has passed through the charge position, the charging unit 210 checks information on passage through the charge position determined by the charge determining unit 209 against information on a charge amount stored by the charge information storing unit, and thereby computes a toll.

Then, the charging unit 210 notifies the in-vehicle device 100 of the computed toll, and performs the charging process. The in-vehicle device 100 writes data onto an IC card based on the charge information.

Thereby, a user of the vehicle in a charging system using the GPS can pay a toll using an in-vehicle device compatible with an existing ETC system.

[0016]

Next, operations of the charging system are explained.

First, a process of monitoring the connection of the in-vehicle device 100 with the external device 200 is explained. The external device 200 intermittently monitors a state of connection with the in-vehicle device 100 in order to prevent misuse, such as replacement of the in-vehicle device 100, an identify-theft by tampering, and alteration of data.

FIG. 2 is a flowchart illustrating a process of monitoring the connection of the in-vehicle device with an external device. First, the in-vehicle device information obtaining unit 202 of the external device 200 reads out the ID of the in-vehicle device from the in-vehicle device 100 via the connection unit 201 (Step S1). At this time, the communication number is serially allocated to communication of the in-vehicle device 100 with the external device 200. When the in-vehicle device information obtaining unit 202 obtains the ID of the in-vehicle device, the in-vehicle device information comparing unit 204 determines whether or not the ID of the in-vehicle device obtained by the in-vehicle device information obtaining unit 202 matches the ID of the previously communicated in-vehicle device stored in the in-vehicle device information storing unit 203 (Step S2). At this time, when the external device 200 performs communication with the in-vehicle device 100 for the first time, the in-vehicle device information storing unit 203 does not store any ID of the in-vehicle device. However, it is assumed in this

case that the ID of the in-vehicle device is matched.

[0017]

When the in-vehicle device information obtaining unit 202 determines that the ID of the in-vehicle device obtained by the in-vehicle device information obtaining unit 202 matches the ID of the in-vehicle device stored in the in-vehicle device information storing unit 203 (Step S2: YES), the in-vehicle device information comparing unit 204 determines whether or not the communication number (serial number) allocated to the communication with the in-vehicle device 100 is a value obtained by adding 1 to the communication number stored in the in-vehicle device information storing unit 203 (Step S3). In other words, the continuity of the communication number is determined. At this time, when the external device 200 performs communication with the in-vehicle device 100 for the first time, the in-vehicle device information storing unit 203 does not store any communication number. However, it is assumed in this case that the communication number is in serial order.

[0018]

When the in-vehicle device information comparing unit 204 determines that the communication number allocated to the communication with the in-vehicle device 100 is a value obtained by adding 1 to the communication number stored in the in-vehicle device information storing unit 203 (Step S3: YES), the in-vehicle device information comparing unit 204 determines that the connection of the in-vehicle device 100 with the external device 200 is normal (Step S4). When the in-vehicle device information comparing unit 204 determines that the connection of the in-vehicle device 100 with the external device 200 is normal, the in-vehicle device information obtaining unit 202 registers, to the in-vehicle device information storing unit 203, the ID of the in-vehicle device and the communication number which are received from the in-vehicle device in

Step S1 (Step S5). When the in-vehicle device information obtaining unit 202 registers the information to the in-vehicle device information storing unit 203, the routine returns to Step S1 where communication with the in-vehicle device 100 is monitored continuously.

[0019]

On the other hand, when the in-vehicle device information obtaining unit 202 determines in Step S2 that the ID of the in-vehicle device obtained by the in-vehicle device information obtaining unit 202 does not match the ID of the in-vehicle device stored in the in-vehicle device information storing unit 203 (Step S2: NO), or when the in-vehicle device information comparing unit 204 determines in Step S3 that the communication number allocated to the communication with the in-vehicle device 100 is not a value obtained by adding 1 to the communication number stored in the in-vehicle device information storing unit 203 (Step S3: NO), the in-vehicle device information determination unit 202 determines that the connection of the in-vehicle device 100 with the external device 200 is abnormal (Step S6).

Thereby, the external device 200 detects misuse resulting from tampering with the in-vehicle device 100.

[0020]

Next, operations of the charging process using the charging system are explained.

Before execution of the charging process, the communication unit 205 of the external device 200 performs communication with the central system 300 and receives, from the central system 300, the charge location information indicating a charging area of a toll-charging facility and the charge amount information indicating a charge amount. Then, the communication unit 205 registers the charge location information and the

charge amount information to the charge location storing unit 206 and the charge information storing unit 207, respectively. Here, the charge amount information is information for uniquely calculating a charge amount based on a travel distance and a travel time inside the charging area.

[0021]

FIG. 3 is a flowchart illustrating operations of the charging system at the charging process.

First, while a vehicle is traveling, the charging unit 210 of the external device 200 determines whether or not information to be used for the charging process is stored in an internal memory (Step S11). Here, the information to be used for the charging process includes, for example, a time of stay inside a charging area, a travel distance inside the charging area, or the like. When the vehicle enters the charging area, these information pieces are registered by a process that will be explained later.

[0022]

When the charging unit 210 determines that the information necessary for charge is not stored in the internal memory (Step S11: NO), the positioning processing unit 208 specifies a position of a vehicle based on a GPS signal transmitted from a GPS satellite and a vehicle speed signal obtained from the vehicle (Step S12). At this time, when the vehicle is present at a position where the vehicle can communicate with the gantry device 400, the positioning processing unit 208 may perform communication with the gantry device 400 via the communication unit 205 or the in-vehicle device 100 to obtain positional information from the gantry device 400, and thereby correct a position specified by the GPS.

[0023]

When the positioning processing unit 208 specifies the position of the vehicle,

the charge determining unit 209 checks the position of the vehicle specified by the positioning processing unit against the charge location information stored in the charge location storing unit 206, and determines whether or not the vehicle is present inside a charging area (Step S13).

[0024]

When the charge determining unit 209 determines that the vehicle is not present inside the charging area (Step S13: NO), the process returns to Step S11 since the vehicle is present outside the charging area.

On the other hand, when the charge determining unit 209 determines that the vehicle is inside the charging area (Step S13: YES), which indicates that the vehicle has entered the charging area from outside the charging area, the charging unit 210 calculates a time of stay inside the charging area and a travel distance inside the charging area, and thereby stores these information pieces (information pieces used for the charging process) in the internal memory (Step S14). When the charging unit 210 stores the information pieces to be used for the charging process, the process returns to Step S11. At this time, the display unit 211 displays information indicating that the vehicle has entered the charging area.

[0025]

When the charging unit 210 determines in step S11 that the information necessary for charge is stored in the internal memory (Step S11: YES), the positioning processing unit 208 specifies the position of the vehicle based on a GPS signal transmitted from a GPS satellite and a vehicle speed signal obtained from the vehicle (Step S15). At this time, when the vehicle is present at a position where the vehicle can communicate with the gantry device 400, the positioning processing unit 208 may communicate with the gantry device 400 via the communication unit 205 or the

in-vehicle device 100 to obtain the positional information from the gantry device 400, and thereby correct the position specified by the GPS.

[0026]

When the positioning processing unit 208 specifies the position of the vehicle, the charge determining unit 209 checks the position of the vehicle specified by the positioning processing unit against the charge location information stored in the charge location storing unit 206, and thereby determines whether or not the vehicle is present inside the charging area (Step S16).

[0027]

When the charge determining unit 209 determines that the vehicle is present inside the charging area (Step S16: YES), which indicates that the vehicle is present inside the charging area, the charging unit 210 calculates a time of stay inside the charging area and the travel distance inside the charging area, overwrites the calculated information pieces on the information pieces stored in the internal memory, and thereby stores the calculated information pieces (Step S17). When the charging unit 210 stores the information pieces to be used for the charging process, the process returns to Step S11. At this time, the display unit 211 displays a charge amount at that time.

[0028]

On the other hand, when the charge determining unit 209 determines in step S17 that no vehicle is present inside the charging area (Step S16: NO), which indicates that the vehicle has exited from the charging area, the external device 200 performs the charging process on the in-vehicle device 100. Upon the charging process, it is determined whether or not the in-vehicle device information comparing unit 204 has determined by the aforementioned processes from Step S1 to Step S6 that connection with the in-vehicle device 100 is normal (Step S18).

[0029]

When it is determined that the in-vehicle device information comparing unit 204 has determined that connection with the in-vehicle device 100 is normal (Step S18: YES), the charging unit 210 calculates a charge amount based on the information used for the charging process which is stored in the internal memory, and the charge amount information stored in the charge information storing unit 207 (Step S19). For example, when the charge information stored in the charge information storing unit is expressed as a function of calculating a charge amount where a time of stay inside the charging area and a travel distance inside the charging area are used as variables, the charge amount can be calculated by substituting the time of stay and the travel distance in the function.

The charging unit 210 calculates the charge amount, and then notifies the in-vehicle device 100 of a charge order via the connection unit 201 (Step S20). At this time, the display unit 211 displays information indicating that the vehicle has exited from the charging area, and the calculated charge amount.

[0030]

On the other hand, when it is determined in step S18 that the in-vehicle device information comparing unit 204 has determined that connection with the in-vehicle device 100 is abnormal (Step S18: NO), the in-vehicle device information comparing unit 204 notifies the central system 300 of an improper charge via the communication unit 205 (Step S21). Here, notification of the improper charge includes information such as the time at which the in-vehicle device information comparing unit 204 determines connection with the in-vehicle 100 to be an abnormal connection, content of tampering of the in-vehicle device 100, the ID of the in-vehicle device 100, the ID of the external device 200, and the like.

[0031]

Next, operations of the charging system when the external device 200 receives notification of improper charge are explained.

When the external device 200 notifies the central system 300 of the improper charge, the central system 300 obtains the vehicle number of an improper vehicle from a vehicle number database and the like which stores the ID of the in-vehicle device or the ID of the external device in association with the vehicle number. Upon obtaining the vehicle number of the improper vehicle, the central system 300 notifies the gantry device 400 of the vehicle number. When obtaining the vehicle number of the improper vehicle, and if a vehicle having a vehicle license plate with the obtained-vehicle number is imaged by an imaging function, the gantry device 400 registers the vehicle as the improper vehicle. A process of extracting the vehicle number from the vehicle license plate can be realized by, for example, extracting from each frame of image information, character string information using OCR (optical character recognition) technology.

Thereby, based on information imaged by the gantry device 400, a business operator of a toll-charging facility can, for example, send a summons to an owner of the improper vehicle.

[0032]

As explained above, according to the present embodiment, the in-vehicle device 100 compatible with an ETC system is connected to the external device 200, and thereby can be compatible with the charging system using the GPS. Thereby, a user can utilize the charging system using the GPS without replacing the in-vehicle device compatible with the ETC system with an in-vehicle device compatible with the charging system using the GPS.

[0033]

Additionally, according to the present embodiment, the charging system uses the

gantry device 400 to correct the positional information of the external device 200 and to detect an improper vehicle. Therefore, investment in the gantry device 400 of the ETC system will not be wasteful for a business operator of a toll-charging facility. Thus, the gantry device 400 can be effectively used as well in the charging system using the GPS.

[0034]

Although preferred embodiments of the present invention have been explained above, the present invention is not limited to the above embodiments. The present invention may be subjected to addition of the configuration, omission, replacement, and other modifications without departing from the scope of the present invention. The present invention is not limited to the above description, but may be limited only by the scope of the attached claims.

For example, although a case where the in-vehicle device 100 is connected to the external device 200 by using cables such as a serial line has been explained in the present embodiment, the present invention is not limited thereto. For example, the in-vehicle device 100 may be wirelessly connected to the external device 200 by utilizing a wireless function of the in-vehicle device 100 used in an ETC system.

[0035]

Although a case where the charge determining unit 209 of the external device 200 determines whether or not a vehicle is present inside a charging area has been explained in the present embodiment, the present invention is not limited thereto. For example, the communication unit 205 may transmit the positional information specified by the positioning processing unit 208 to the central system 300 to determine whether or not a vehicle is present inside a charging area by using functions of the central system 300.

[0036]

The aforementioned external device 200 includes a computer system. Additionally, operations of each of the aforementioned processing units are stored as in a program format, in a computer-readable recording medium. This program is read by the computer to execute the aforementioned process. Here, the computer-readable recording medium includes a magnetic disk, a magneto-optical disk, CD-ROM, DVD-ROM, a semiconductor memory, and the like. Alternatively, the computer program may be distributed through communication lines to the computer so that the computer receiving the distributed program can execute the program.

[0037]

Further, the above program may be a program for realizing some of the aforementioned functions. Moreover, the program may be a program which can realize the aforementioned functions in combination with a program which has been already stored in a computer system, that is, a difference file (difference program).

## INDUSTRIAL APPLICABILITY

[0038]

The present invention relates to a charging system including: an in-vehicle device to be mounted on a vehicle; and a controller to be connected to the in-vehicle device. The charging system performs a charging process based on utilization of a toll-charging facility by the vehicle. The in-vehicle device includes a writing unit for writing data onto a recording medium based on charge information. The controller includes: a passage determining unit that determines passage through a charge position by checking positional information of the vehicle against information stored in a positional information storing unit; a toll computing unit that computes a toll by checking information on the passage through the charge position determined by the passage

determining unit against toll information stored in a toll information storing unit; and a charging processing unit that notifies the in-vehicle device of the toll computed by the toll computing unit, and performs the charging process.

According to the charging system of the present invention, a user of a vehicle in a charging system using the GPS is able to pay a toll using an in-vehicle device compatible with an ETC system.

## DESCRIPTION OF REFERENCE NUMERALS

[0039]

100: In-vehicle device

200: External device (controller)

201: Connection unit

202: In-vehicle device information obtaining unit

203: In-vehicle device information storing unit

204: In-vehicle device information comparing unit

205: Communication unit

206: Charge location storing unit

207: Charge information storing unit

208: Positioning processing unit

209: Charge determining unit

210: Charging unit

211: Display unit

300: Central system

400: Gantry device

# CLAIMS

1. A charging system comprising:

an in-vehicle device to be mounted on a vehicle; and

a controller to be connected to the in-vehicle device,

the charging system performing a charging process based on utilization of a toll-charging facility by the vehicle,

wherein the in-vehicle device comprises:

a writing unit that writes data onto a recording medium based on charge information, and

the controller comprises:

a passage determining unit that determines passage through a charge position by checking positional information of the vehicle against positional information stored in a positional information storing unit;

a toll computing unit that computes a toll by checking information on the passage through the charge position determined by the passage determining unit against toll information stored in a toll information storing unit; and

a charging processing unit that notifies the in-vehicle device of the toll computed by the toll computing unit, and performs the charging process.

2. The charging system according to claim 1, wherein the controller determines whether or not an ID of a currently communicated in-vehicle device matches an ID of a presently communicated in-vehicle device every time communication is performed with the in-vehicle device.

3. The charging system according to claim 1 or 2, wherein every time communication is performed with the in-vehicle device, the controller allocates a serial number to the communication, and determines the continuity of the serial number.

4. A charging method using a charging system comprising: an in-vehicle device to be mounted on a vehicle; and a controller to be connected to the in-vehicle device, the charging system performing a charging process based on utilization of a toll-charging facility by the vehicle, the charging method comprising:

determining, by a passage determining unit of the controller, passage through a charge position by checking positional information of the vehicle against positional information stored in a positional information storing unit;

computing, by a toll computing unit of the controller, a toll by checking information on the passage through the charge position determined by the passage determining unit against toll information stored in a toll information storing unit;

notifying, by a charging processing unit of the controller, the in-vehicle device of the toll computed by the toll computing unit and performing the charging process; and

writing, by the in-vehicle device, data onto a recording medium based on charge information.

5. A controller to be connected to an in-vehicle device that is to be mounted on a vehicle, the in-vehicle device writing data onto a recording medium based on charge information, and the controller comprising:

a passage determining unit that determines passage through a charge position by checking positional information of the vehicle against positional information stored in a positional information storing unit;

a toll computing unit that computes a toll by checking information on the passage through the charge position determined by the passage determining unit against toll information stored in a toll information storing unit; and

a charging processing unit that notifies the in-vehicle device of the toll computed by the toll computing unit, and performs the charging process.

6. A program causing a controller, the controller being to be connected to an in-vehicle device that is to be mounted on a vehicle, the in-vehicle device writing data onto a recording medium based on charge information, to operate as:

a passage determining unit that determines passage through a charge position by checking positional information on the vehicle against positional information stored in a positional information storing unit;

a toll computing unit that computes a toll by checking information on the passage through the charge position determined by the passage determining unit against toll information stored in a toll information storing unit; and

a charging processing unit that notifies the in-vehicle device of the toll computed by the toll computing unit, and performs the charging process.