

{Technical Problem}

{0005}

In a toll collection system such as that described above,
because there are cases in which the road usage fee is not
5 correctly paid due to fraudulent use by users, it is necessary
to ascertain vehicle positional information in order to detect
such fraudulence. Although the vehicle positional information
is, for example, estimated on the basis of information
acquired by a GPS receiver in a vehicle-mounted device, there
10 is a problem in the above-described Patent Literature 1 in
that, even if the positional information acquired from the GPS
receiver is shifted from an original position, the shift
cannot be detected, and thus, the vehicle position cannot be
corrected.

15 {0006}

The present invention has been conceived in light of the
above-described circumstances, and an object thereof is to
provide a vehicle-mounted device and a toll collection system
that are capable of precisely correcting a vehicle position.

20 {Solution to Problem}

{0007}

In order to solve the above-described problems, the
present invention employs the following solutions.

A first aspect of the present invention provides a
25 vehicle-mounted device that is installed in a vehicle and

near the toll collection device. When the vehicle-mounted device acquires the antenna identification information, the vehicle position is estimated on the basis of the installation position of the antenna of the toll collection device and the antenna identification information included in the map information stored in the storage unit. The vehicle position estimated on the basis of the antenna identification information acquired from the toll collection device is compared with the vehicle position estimated from the positional information acquired from the positional-information acquisition unit, and when the vehicle positions do not match, the positional information acquired from the positional-information acquisition unit is corrected. In this way, the vehicle position estimated by means of the toll collection device is compared with the vehicle position estimated from the positional-information acquisition means, and, when they do not match, the positional information acquired from the positional-information acquisition means is corrected; therefore, the precision of the positional information acquired from the positional-information acquisition unit can be maintained.

{0009}

In the above-described vehicle-mounted device according to the first aspect of the present invention, in the case in which the vehicle-mounted device is communicatably connected

with a central unit, which is a superordinate device of the toll collection device, via a wide-area communication unit for utilizing wideband wireless communication and is also communicatably connected with the toll collection device via a
5 dedicated narrowband wireless communication unit for utilizing dedicated narrowband wireless communication, the map information may be such that it can be acquired from at least one of the wide-area communication unit, the dedicated narrowband wireless communication unit, and issuance
10 maintenance equipment, which is a device other than the wide-area communication unit that is communicatably connected with the central unit.

Because the map information is downloaded to the vehicle-mounted device via any of the wide-area communication unit,
15 the dedicated narrowband wireless communication unit, and the issuance maintenance equipment, the vehicle-mounted device can easily acquire the information for specifying the installation position of the toll collection device.

{0010}

20 In the map information in the above-described vehicle-mounted device according to the first aspect of the present invention, in the case in which the map information does not include the information about the installation position of the antenna of the toll collection device that corresponds to the
25 antenna identification information acquired from the toll

collection device, the most recent map information may be acquired from the central unit via the wide-area communication unit.

In the case in which information of the toll collection device (installation position thereof) corresponding to the antenna identification information acquired from the toll collection device is not included in the map information provided in the vehicle-mounted device, by obtaining the most recent map information, the vehicle-mounted device can ascertain the most recent position of the toll collection device in a simple manner.

{0011}

With regard to the information about the installation position of the antenna for the map information in the above-described vehicle-mounted device according to the first aspect of the present invention, the information about the installation position of the antenna in the map information may be information that indicates a relative position for obtaining the vehicle position on the basis of a calculation or information that indicates an absolute position for specifying the vehicle position.

By having the information about the antenna installation position that is the relative position for obtaining the vehicle position on the basis of the calculation or the absolute position for directly specifying the vehicle

position, the vehicle position can be specified reliably.

{0012}

With the identification information about the antenna of the above-described vehicle-mounted device according to the first aspect of the present invention, the antenna identification information may include new/old distinction information for distinguishing between old and new information; and in the case in which the new/old distinction information of the antenna identification information acquired from the toll collection device does not match the new/old distinction information of the antenna identification information included in the map information, the most recent map information may be acquired from the central unit via the wide-area communication unit.

Because the most recent map information is acquired if the new/old distinction information does not match for the antenna identification number acquired from the toll collection device and the antenna identification number included in the map information, the vehicle-mounted device can be provided with the most recent map information. Accordingly, information about the most recent and accurate installation position of the toll collection device can be acquired.

{0013}

In the above-described vehicle-mounted device according

to the first aspect of the present invention, information about the installation position of the antenna may be acquired from the antenna of the toll collection device along with the antenna identification information.

5 Accordingly, the vehicle-mounted device can acquire the information about the installation position of the toll collection device in a simple manner.

{0014}

10 In the case in which the information about the installation position is acquired from the toll collection device in the above-described vehicle-mounted device according to the first aspect of the present invention, in the case in which information about an installation position of the toll collection device is acquired from the toll collection device, 15 information about an installation position of the toll collection device included in the map information may be replaced therewith.

20 In the case in which there are changes in the installation position due to changes in the physical position of the toll collection device, the information about the installation position of the toll collection device included in the map information in the vehicle-mounted device can be updated in a simple manner.

{0015}

25 A second aspect of the present invention provides toll

collection system including a vehicle-mounted device according to the first aspect of the present invention, wherein the antenna identification information includes new/old distinction information for distinguishing between new and old information, and, when the new/old distinction information for the antenna identification information acquired from the toll collection device does not match the new/old distinction information for the antenna identification information included in the map information, the most recent map information is acquired from the central unit via the wide-area communication unit; and the central unit that outputs the most recent map information to the vehicle-mounted device in accordance with an acquisition request for the most recent map information from the vehicle-mounted device, wherein, of the most recent map information, the central unit outputs to the vehicle-mounted device, as the most recent map information, only information corresponding to the antenna for which the new/old distinction information for an identification number of the antenna included in the map information in the vehicle-mounted device differs.

{0016}

In the case in which the new/old distinction information for the antenna identification number acquired from the toll collection device differs from the new/old distinction information that corresponds to the antenna identification

number included in the map information, the vehicle-mounted device according to the first aspect of the present invention acquires the antenna identification number that corresponds to the antenna for which the new/old distinction information differs and the information about the antenna installation position from the central unit. Accordingly, when outputting the most recent map information to the vehicle-mounted device from the central unit, it is possible to reduce the load exerted on a communication medium.

10 {Advantageous Effects of Invention}
{0017}

The present invention affords an advantage in that it is possible to precisely correct a vehicle position.

{Brief Description of Drawings}
15 {0018}

Fig. 1 is a diagram showing the overall configuration of a toll collection system according to an embodiment of the present invention.

Fig. 2 is a block diagram showing, in outline, the toll collection system according to the embodiment of the present invention.

Fig. 3 is a diagram in which an entry lane into a toll charge area is viewed from a road shoulder.

Fig. 4 is a diagram showing an example of marking laid down below a vehicle detection device shown in Fig. 3.

and, when the vehicle positions do not match, the positional information acquired from the GPS receiver 24 is corrected. In this way, the vehicle position estimated by means of the toll collection device 2 and the vehicle position estimated by means of the GPS receiver 24 are compared and, when they do not match, the positional information acquired from the GPS receiver 24 is corrected; therefore, the precision of the positional information acquired from the GPS receiver 24 can be maintained.

10 {0051}

The positional information that indicates the information about the antenna installation positions in the map information in this embodiment may be information that indicates relative positions for obtaining vehicle positions based on calculations, or it may be information that indicates absolute positions for specifying the vehicle positions. Accordingly, regardless of whether the information is about relative positions or absolute positions, the information about the antenna installation positions can reliably specify vehicle positions.

20 vehicle positions.

{0052}

{Modification}

In the above-described embodiment, whether or not the map information provided in the storage device 25 is the most recent information is judged on the basis of the update

{CLAIMS}

{Claim 1}

A vehicle-mounted device that is installed in a vehicle
5 and exchanges information regarding toll charging with a toll
collection device installed at a toll booth in a toll charge
area, comprising:

a storage unit that stores map information in which
information about an installation position of an antenna
10 provided in the toll collection device is associated with
antenna identification information; and

a positional-information acquisition unit that acquires
positional information of the vehicle,

wherein the antenna identification information is
15 acquired from the toll collection device when passing near the
toll collection device, and when a vehicle position estimated
on the basis of the acquired antenna identification
information and the map information does not match a vehicle
position estimated on the basis of the positional information
20 acquired from the positional-information acquisition unit, the
positional information acquired from the positional-
information acquisition unit is corrected on the basis of the
vehicle position estimated from the acquired antenna
identification information.

{Claim 2}

A vehicle-mounted device according to Claim 1, wherein,
in the case in which the vehicle-mounted device is
communicatably connected with a central unit, which is a
5 superordinate device of the toll collection device, via a
wide-area communication unit for utilizing wideband wireless
communication and is also communicatably connected with the
toll collection device via a dedicated narrowband wireless
communication unit for utilizing dedicated narrowband wireless
10 communication,

the map information can be acquired from at least one of
the wide-area communication unit, the dedicated narrowband
wireless communication unit, and issuance maintenance
equipment which is a device other than the wide-area
15 communication unit that is communicatably connected with the
central unit.

{Claim 3}

A vehicle-mounted device according to Claim 2, wherein,
20 in the case in which the map information does not include the
information about the installation position of the antenna of
the toll collection device that corresponds to the antenna
identification information acquired from the toll collection
device, the most recent map information is acquired from the
25 central unit via the wide-area communication unit.

{Claim 4}

A vehicle-mounted device according to Claim 1 or 2,
wherein the information about the installation position of the
5 antenna in the map information is information that indicates a
relative position for obtaining the vehicle position on the
basis of a calculation or information that indicates an
absolute position for specifying the vehicle position.

10 {Claim 5}

A vehicle-mounted device according to any one of Claims 2
to 4, wherein

the antenna identification information includes new/old
distinction information for distinguishing between old and new
15 information; and

in the case in which the new/old distinction information
of the antenna identification information acquired from the
toll collection device does not match the new/old distinction
information of the antenna identification information included
20 in the map information, the most recent map information is
acquired from the central unit via the wide-area communication
unit.

{Claim 6}

25 A vehicle-mounted device according to any one of Claims 1

to 5, wherein information about the installation position of the antenna is acquired from the antenna of the toll collection device along with the antenna identification information.

5

{Claim 7}

A vehicle-mounted device according to Claim 6, wherein, in the case in which information about an installation position of the toll collection device is acquired from the toll collection device, information about the installation position of the toll collection device included in the map information is replaced therewith.

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{Claim 8}

15

A toll collection system comprising:

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a vehicle-mounted device according to any one of Claims 2 to 4, wherein the antenna identification information includes new/old distinction information for distinguishing between new and old information, and, when the new/old distinction information for the antenna identification information acquired from the toll collection device does not match the new/old distinction information for the antenna identification information included in the map information, the most recent map information is acquired from the central unit via the wide-area communication unit; and

25

the central unit that outputs the most recent map information to the vehicle-mounted device in accordance with an acquisition request for the most recent map information from the vehicle-mounted device,

5 wherein, of the most recent map information, the central unit outputs to the vehicle-mounted device, as the most recent map information, only information corresponding to the antenna for which the new/old distinction information for an identification number of the antenna included in the map
10 information in the vehicle-mounted device differs.

{Technical Problem}

{0005}

In a toll collection system such as that described above, because there are cases in which the road usage fee is not
5 correctly paid due to fraudulent use by users, it is necessary to ascertain vehicle positional information in order to detect such fraudulence. Although the vehicle positional information is, for example, estimated on the basis of information acquired by a GPS receiver in a vehicle-mounted device, there
10 is a problem in the above-described Patent Literature 1 in that, even if the positional information acquired from the GPS receiver is shifted from an original position, the shift cannot be detected, and thus, the vehicle position cannot be corrected.

15 {0006}

The present invention has been conceived in light of the above-described circumstances, and implementation of the techniques disclosed herein may provide a vehicle-mounted device and a toll collection system that are capable of
20 precisely correcting a vehicle position.

{Solution to Problem}

{0007}

The invention is defined in the independent claims. Some optional features of the invention are defined in the
25 dependent claims. In order to solve the above-described problems, a vehicle-mounted device and a toll collection system employs the following solutions.

A first exemplary technique provides a vehicle-mounted device that is installed in a vehicle and

near the toll collection device. When the vehicle-mounted device acquires the antenna identification information, the vehicle position is estimated on the basis of the installation position of the antenna of the toll collection device and the antenna identification information included in the map information stored in the storage unit. The vehicle position estimated on the basis of the antenna identification information acquired from the toll collection device is compared with the vehicle position estimated from the positional information acquired from the positional-information acquisition unit, and when the vehicle positions do not match, the positional information acquired from the positional-information acquisition unit is corrected. In this way, the vehicle position estimated by means of the toll collection device is compared with the vehicle position estimated from the positional-information acquisition means, and, when they do not match, the positional information acquired from the positional-information acquisition means is corrected; therefore, the precision of the positional information acquired from the positional-information acquisition unit can be maintained.

{0009}

In the above-described vehicle-mounted device according to the first exemplary technique, in the case in which the vehicle-mounted device is communicatably connected

with a central unit, which is a superordinate device of the toll collection device, via a wide-area communication unit for utilizing wideband wireless communication and is also communicatably connected with the toll collection device via a
5 dedicated narrowband wireless communication unit for utilizing dedicated narrowband wireless communication, the map information may be such that it can be acquired from at least one of the wide-area communication unit, the dedicated narrowband wireless communication unit, and issuance
10 maintenance equipment, which is a device other than the wide-area communication unit that is communicatably connected with the central unit.

Because the map information is downloaded to the vehicle-mounted device via any of the wide-area communication unit,
15 the dedicated narrowband wireless communication unit, and the issuance maintenance equipment, the vehicle-mounted device can easily acquire the information for specifying the installation position of the toll collection device.

{0010}

20 In the map information in the above-described vehicle-mounted device according to the first exemplary technique, in the case in which the map information does not include the information about the installation position of the antenna of the toll collection device that corresponds to the antenna
25 identification information acquired from the toll

collection device, the most recent map information may be acquired from the central unit via the wide-area communication unit.

In the case in which information of the toll collection device (installation position thereof) corresponding to the antenna identification information acquired from the toll collection device is not included in the map information provided in the vehicle-mounted device, by obtaining the most recent map information, the vehicle-mounted device can ascertain the most recent position of the toll collection device in a simple manner.

{0011}

With regard to the information about the installation position of the antenna for the map information in the above-described vehicle-mounted device according to the first exemplary technique, the information about the installation position of the antenna in the map information may be information that indicates a relative position for obtaining the vehicle position on the basis of a calculation or information that indicates an absolute position for specifying the vehicle position.

By having the information about the antenna installation position that is the relative position for obtaining the vehicle position on the basis of the calculation or the absolute position for directly specifying the vehicle

position, the vehicle position can be specified reliably.

{0012}

With the identification information about the antenna of the above-described vehicle-mounted device according to the first exemplary technique, the antenna identification information may include new/old distinction information for distinguishing between old and new information; and in the case in which the new/old distinction information of the antenna identification information acquired from the toll collection device does not match the new/old distinction information of the antenna identification information included in the map information, the most recent map information may be acquired from the central unit via the wide-area communication unit.

Because the most recent map information is acquired if the new/old distinction information does not match for the antenna identification number acquired from the toll collection device and the antenna identification number included in the map information, the vehicle-mounted device can be provided with the most recent map information. Accordingly, information about the most recent and accurate installation position of the toll collection device can be acquired.

{0013}

In the above-described vehicle-mounted device according

to the first exemplary technique, information about the installation position of the antenna may be acquired from the antenna of the toll collection device along with the antenna identification information.

5 Accordingly, the vehicle-mounted device can acquire the information about the installation position of the toll collection device in a simple manner.

{0014}

 In the case in which the information about the
10 installation position is acquired from the toll collection device in the above-described vehicle-mounted device according to the first exemplary technique, in the case in which information about an installation position of the toll collection device is acquired from the toll collection device,
15 information about an installation position of the toll collection device included in the map information may be replaced therewith.

 In the case in which there are changes in the installation position due to changes in the physical position
20 of the toll collection device, the information about the installation position of the toll collection device included in the map information in the vehicle-mounted device can be updated in a simple manner.

{0015}

25 A second exemplary technique provides a toll

collection system including a vehicle-mounted device according to the first exemplary technique, wherein the antenna identification information includes new/old distinction information for distinguishing between new and old information, and, when the new/old distinction information for the antenna identification information acquired from the toll collection device does not match the new/old distinction information for the antenna identification information included in the map information, the most recent map information is acquired from the central unit via the wide-area communication unit; and the central unit that outputs the most recent map information to the vehicle-mounted device in accordance with an acquisition request for the most recent map information from the vehicle-mounted device, wherein, of the most recent map information, the central unit outputs to the vehicle-mounted device, as the most recent map information, only information corresponding to the antenna for which the new/old distinction information for an identification number of the antenna included in the map information in the vehicle-mounted device differs.

{0016}

In the case in which the new/old distinction information for the antenna identification number acquired from the toll collection device differs from the new/old distinction information that corresponds to the antenna identification

number included in the map information, the vehicle-mounted device according to the first exemplary technique acquires the antenna identification number that corresponds to the antenna for which the new/old distinction information differs and the
5 information about the antenna installation position from the central unit. Accordingly, when outputting the most recent map information to the vehicle-mounted device from the central unit, it is possible to reduce the load exerted on a communication medium.

10 {Advantageous Effects of Invention}
{0017}

Implementation of the techniques disclosed herein may afford an advantage in that it is possible to precisely correct a vehicle position.

15 {Brief Description of Drawings}
{0018}

Fig. 1 is a diagram showing the overall configuration of a toll collection system according to an embodiment of the present invention.

20 Fig. 2 is a block diagram showing, in outline, the toll collection system according to the embodiment of the present invention.

Fig. 3 is a diagram in which an entry lane into a toll charge area is viewed from a road shoulder.

25 Fig. 4 is a diagram showing an example of marking laid down below a vehicle detection device shown in Fig. 3.

and, when the vehicle positions do not match, the positional information acquired from the GPS receiver 24 is corrected. In this way, the vehicle position estimated by means of the toll collection device 2 and the vehicle position estimated by means of the GPS receiver 24 are compared and, when they do not match, the positional information acquired from the GPS receiver 24 is corrected; therefore, the precision of the positional information acquired from the GPS receiver 24 can be maintained.

10 {0051}

The positional information that indicates the information about the antenna installation positions in the map information in this embodiment may be information that indicates relative positions for obtaining vehicle positions based on calculations, or it may be information that indicates absolute positions for specifying the vehicle positions. Accordingly, regardless of whether the information is about relative positions or absolute positions, the information about the antenna installation positions can reliably specify vehicle positions.

20 vehicle positions.

{0052}

{Modification}

In the above-described exemplary techniques, whether or not the map information provided in the storage device 25 is the most recent information is judged on the basis of the update

25

{CLAIMS}

{Claim 1}

A vehicle-mounted device for installation in a vehicle
5 and configured to exchange information regarding toll charging
with a toll collection device installed at a toll booth in a
toll charge area, comprising:

a storage unit configured to store map information in
which information about an installation position of an antenna
10 provided in the toll collection device is associated with
antenna identification information; and

a positional-information acquisition unit configured to
acquire positional information of the vehicle,

wherein the vehicle-mounted device is configured to
15 acquire the antenna identification information from the toll
collection device when passing near the toll collection
device, and when a vehicle position estimated on the basis of
the acquired antenna identification information and the map
information does not match a vehicle position estimated on the
20 basis of the positional information acquired from the
positional-information acquisition unit, to correct the
positional information acquired from the positional-
information acquisition unit on the basis of the vehicle
position estimated from the acquired antenna identification
25 information.

{Claim 2}

A vehicle-mounted device according to Claim 1,
configured, in the case in which the vehicle-mounted device is
communicatably connected with a central unit, which is a
5 superordinate device of the toll collection device, via a
wide-area communication unit for utilizing wideband wireless
communication and is also communicatably connected with the
toll collection device via a dedicated narrowband wireless
communication unit for utilizing dedicated narrowband wireless
10 communication,

for the map information to be acquired from at least one
of the wide-area communication unit, the dedicated narrowband
wireless communication unit, and issuance maintenance
equipment which is a device other than the wide-area
15 communication unit that is communicatably connected with the
central unit.

{Claim 3}

A vehicle-mounted device according to Claim 2,
20 configured, in the case in which the map information does not
include the information about the installation position of the
antenna of the toll collection device that corresponds to the
antenna identification information acquired from the toll
collection device, to acquire the most recent map information
25 from the central unit via the wide-area communication unit.

{Claim 4}

A vehicle-mounted device according to Claim 1 or 2,
configured for the information about the installation position
of the antenna in the map information to be information that
5 indicates a relative position for obtaining the vehicle
position on the basis of a calculation or information that
indicates an absolute position for specifying the vehicle
position.

10 {Claim 5}

A vehicle-mounted device according to any one of Claims 2
to 4, configured for

the antenna identification information to include new/old
distinction information for distinguishing between old and new
15 information; and

in the case in which the new/old distinction information
of the antenna identification information acquired from the
toll collection device does not match the new/old distinction
information of the antenna identification information included
20 in the map information, to acquire the most recent map
information from the central unit, which is a superordinate
device of the toll collection device, via the wide-area
communication unit for utilizing wideband wireless
communication.

25

{Claim 6}

A vehicle-mounted device according to any one of Claims 1 to 5, configured for information about the installation position of the antenna to be acquired from the antenna of the toll collection device along with the antenna identification information.

{Claim 7}

A vehicle-mounted device according to Claim 6, configured, in the case in which information about an installation position of the toll collection device is acquired from the toll collection device, for information about the installation position of the toll collection device included in the map information to be replaced therewith.

{Claim 8}

A vehicle-mounted device according to any one of claims 3 to 7, wherein, the toll collection device has a plurality of antennas.

{Claim 9}

A toll collection system comprising:

a vehicle-mounted device according to any one of Claims 2 to 4, configured for the antenna identification information to include new/old distinction information for distinguishing between new and old information, and, when the new/old distinction information for the antenna identification

information acquired from the toll collection device does not match the new/old distinction information for the antenna identification information included in the map information, to acquire the most recent map information from the central unit, 5 which is a superordinate device of the toll collection device, via the wide-area communication unit for utilizing wideband wireless communication; and

the central unit is configured to output the most recent map information to the vehicle-mounted device in accordance 10 with an acquisition request for the most recent map information from the vehicle-mounted device,

wherein, of the most recent map information, the central unit is configured to output to the vehicle-mounted device, as the most recent map information, only information 15 corresponding to the antenna for which the new/old distinction information for an identification number of the antenna included in the map information in the vehicle-mounted device differs.