

[DESCRIPTION]

[TITLE OF INVENTION]

TRAFFIC INFORMATION PROCESSING DEVICE, PROCESSING METHOD FOR
THE SAME, AND PROGRAM

5 [Technical Field]

[0001]

The present invention relates to a traffic information processing device which is
installed in a vehicle or the like and which processes traffic information such as a
traveling route of the vehicle, a processing method thereof, and a program. Priority is
10 claimed on Japanese Patent Application No. 2013-029865, filed February 19, 2013, the
content of which is incorporated herein by reference.

[Background Art]

[0002]

A car navigation device which is installed in a vehicle or the like receives
15 transmission signals transmitted from GPS satellites, measures a current position of the
vehicle, and specifies a road on which the vehicle currently travels. The car navigation
device detects a virtual position corresponding to a real current position of the vehicle on
a specific road in a map displayed on a screen. The car navigation device performs a
process of displaying a mark indicating the current position of the vehicle at the virtual
20 position, and the like.

A technique of displaying a current position on a map displayed on a display
screen is disclosed in Patent Literature 1.

A technique of automatically determining a route on which a vehicle has
actually traveled in a complicated road network in which a plurality of routes can be
25 arbitrarily selected between a specific entrance and a specific exit, calculating a toll

based on the total distance of the traveling routes, and billing the vehicle is disclosed in Patent Literature 2.

[Citation List]

[Patent Literature]

5 [0003]

[Patent Literature 1]

Japanese Unexamined Patent Application, First Publication No. 2008-134187

[Patent Literature 2]

Japanese Unexamined Patent Application, First Publication No. Hei 9-212794

10 [Summary of Invention]

[Technical Problem]

[0004]

In Europe, Singapore, and the like, collection of tolls using a billing method called road pricing in which a toll is charged based on a road on which a vehicle actually travels or the distance that it travels is being investigated. Road pricing involves specifying a traveling route based on a positioning result of a vehicle using signals received from GPS satellites and performing a billing process based on the traveling distance on the traveling route.

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[0005]

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In road pricing, there is a possibility of a driver of a vehicle being unable to clearly recognize an entrance or an exit of a road on which road pricing is enforced, like on Japanese expressways. For example, a sensor configured to notify drivers of a road on which road pricing is enforced may be attached to an entrance or an exit for road pricing. However, when the sensor is small or the like, there is a possibility of a driver

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not clearly recognizing that her or his vehicle has passed an entrance or an exit of the

road on which road pricing is enforced. In this case, for example a situation in which the driver is unable to immediately recognize a billing amount when she or he drives the vehicle past the traveling route occurs. Accordingly, there are demands for techniques capable of reducing the number of times that a situation occurs in which a driver cannot immediately recognize (i) that her or his vehicle has passed through an entrance or an exit of a road on which road pricing is enforced or (ii) a billing amount when her or his vehicle passes through a traveling route including the road on which road pricing is enforced. In addition, there are demands for techniques capable of accurately calculating a billing amount based on a traveling route of a vehicle.

10 [0006]

The present invention provides a traffic information processing device which can reduce the number of times that a situation occurs in which a driver cannot immediately recognize when her or his vehicle has passed through an entrance or an exit of a road on which road pricing is enforced or a billing amount when her or his vehicle passes through a traveling route including the road on which road pricing is enforced, a processing method thereof, and a program.

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[Solution to Problem]

[0007]

According to a first aspect of the present invention, there is provided a traffic information processing device including: a position information calculating unit configured to calculate and output a current position of a vehicle based on sensed position information of the vehicle input from a sensor unit; a first transit point passage determining unit configured to determine whether the vehicle has passed a transit point on a traveling route on which billing is enforced based on the current position and position information of the transit point; a transit point type determining unit configured

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to determine whether the transit point is a defined point at which a billing amount is determined at the time point at which the passage of the vehicle through the transit point is detected or an undefined point at which the billing amount is not determined at the time point at which the vehicle has passed the transit point; and a first transit point passage information output unit configured to output passage information indicating the passage of the vehicle through the transit point when the vehicle is determined to have passed through the transit point and the transit point is determined to be the defined point.

[0008]

According to a second aspect of the present invention, the traffic information processing device may further include: a traveling route specifying unit configured to specify and output an estimated traveling route including the transit point as a defined traveling route among estimated traveling routes, which indicate one or more traveling routes which are undefined traveling routes of the vehicle and which the vehicle is estimated to have passed through, when the vehicle is determined to have passed through the transit point and the transit point is determined to be the defined point; and a billing amount calculating unit configured to calculate a billing amount of the defined traveling route.

[0009]

According to a third aspect of the present invention, the traffic information processing device may further include: a second transit point passage determining unit configured to detect a transit point which is the closest to the current position of the vehicle and is included in the defined traveling route based on the defined traveling route outputted from the traveling route specifying unit when the transit point type determining unit determines that the transit point is the undefined point and to determine that the

current position is past the transit point; and a second transit point passage information output unit configured to output passage information indicating the passage of the vehicle through the transit point which is determined by the second transit point passage determining unit.

5 [0010]

According to a fourth aspect of the present invention, the traffic information processing device may further include a traveling route type determining unit configured to determine a type of traveling route on which billing is enforced, and the billing amount calculating unit may calculate the billing amount of the defined traveling route based on
10 the type of traveling route.

[0011]

According to a fifth aspect of the present invention, in the traffic information processing device, the second transit point passage determining unit may instruct the billing amount calculating unit to calculate the billing amount based on the distance
15 traveled on the road when the transit point is the undefined point and information indicating that the transit point is a transit point at an entrance of a road on which the distance billing is enforced-is input to the second transit point passage determining unit.

[0012]

According to a sixth aspect of the present invention, in the traffic information
20 processing device, each of the first transit point passage determining unit and the second transit point passage determining unit may acquire identification information of a current traveling route which is specified based on the current position, may determine whether the current position is past the transit point at predetermined time intervals based on the identification information of the current traveling route and the current position, may
25 determine whether the vehicle passes through a plurality of traveling routes based on (i)

identification information of the traveling route acquired when determining whether the previous transit point has been passed at predetermined time intervals and (ii)

identification information of the traveling route acquired when determining whether the current transit point has been passed, and may determine that the current position is past the transit point which is located between the position information at the time the previous transition point is determined to have been passed and the position information of the timing at which it is determined whether the current transit point has been passed the transit points included in the plurality of passed through traveling routes when the vehicle is detected to have passed through the plurality of traveling routes.

10 [0013]

According to a seventh aspect of the present invention, the traffic information processing device may further include a speed calculating unit configured to calculate a speed of the vehicle based on a time each point of a plurality of points in the defined traveling route is passed in the defined traveling route outputted from the traveling route specifying unit and distances between each of the plurality of points.

15 [0014]

According to an eighth aspect of the present invention, the traffic information processing device may further include a traffic information output unit configured to acquire the identification information of the current traveling route specified based on the current position and to read and output traffic information corresponding to the identification information of the current traveling route.

20 [0015]

According to a ninth aspect of the present invention, the traffic information processing device may further include a current position output unit configured to output the current position which is calculated by the position information calculating unit.

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[0016]

According to a tenth aspect of the present invention, there is provided a processing method of a traffic information processing device including: causing a position information calculating unit to calculate a current position of a vehicle based on sensed position information of the vehicle input from a sensor unit; causing a first transit point passage determining unit to determine whether the vehicle has passed a transit point on a traveling route on which billing is enforced based on the current position and position information of the transit point; causing a transit point type determining unit to determine whether the transit point is a defined point at which a billing amount is determined at the time point at which the passage of the vehicle through the transit point is detected or an undefined point at which the billing amount is not determined at the time point at which the vehicle passes the transit point; and causing a first transit point passage information output unit to output passage information indicating the passage of the vehicle through the transit point when the vehicle is determined to have passed through the transit point and the transit point is determined to be the defined point.

[0017]

According to an eleventh aspect of the present invention, in the processing method, a traveling route specifying unit may specify and output an estimated traveling route including the transit point as a defined traveling route among estimated traveling routes, which indicate one or more traveling routes which are undefined traveling routes of the vehicle and which the vehicle is estimated to have passed through, when the vehicle is determined to have passed through the transit point and the transit point is determined to be the defined point. A billing amount calculating unit may calculate a billing amount of the defined traveling route.

25 [0018]

According to a twelfth aspect of the present invention, in the processing method, a second transit point passage determining unit may detect a transit point which is the closest to the current position of the vehicle and is included in the defined traveling route based on the defined traveling route outputted from the traveling route specifying unit

5 when the transit point type determining unit determines that the transit point is the undefined point and may determine that the current position is past the transit point. A second transit point passage information output unit may output passage information indicating the passage of the vehicle through the transit point which is determined by the second transit point passage determining unit.

10 [0019]

According to a thirteenth aspect of the present invention, in the processing method, a traveling route type determining unit may determine a type of traveling route on which billing is enforced. The billing amount calculating unit may calculate the billing amount of the defined traveling route based on the type of traveling route.

15 [0020]

According to a fourteenth aspect of the present invention, in the processing method, the second transit point passage determining unit may instruct the billing amount calculating unit to calculate the billing amount based on the distance traveled on the road when the transit point is the undefined point and information indicating that the transit

20 point is a transit point at an entrance of a road ~~to be~~ on which the distance billing is enforced is input to the second transit point passage determining unit.

[0021]

According to a fifteenth aspect of the present invention, in the processing method, each of the first transit point passage determining unit and the second transit

25 point passage determining unit may acquire identification information of a current

traveling route which is specified based on the current position and may determine whether the current position is past the transit point at predetermined time intervals based on the identification information of the current traveling route and the current position.

Each of the first transit point passage determining unit and the second transit point

- 5 passage determining unit may determine whether the vehicle passes through a plurality of traveling routes based on identification information of the traveling route acquired when determining whether the previous transit point has been passed at predetermined time intervals and identification information of the traveling route acquired when determining whether the current transit point has been passed. Each of the first transit point passage
- 10 determining unit and the second transit point passage determining unit may determine that the current position is past the transit point which is located between the position information at the time the previous transition point is determined to have been passed and the position information of the timing at which it is determined whether the current transit point has been passed the transit points included in the plurality of passed through
- 15 traveling routes when the vehicle is detected to have passed through the plurality of traveling routes.

[0022]

According to a sixteenth aspect of the present invention, there is provided a program causing a computer of a traffic information processing device to serve as:

- 20 position information calculating means configured to calculate and output a current position of a vehicle based on sensed position information of the vehicle input from a sensor unit; first transit point passage determining means configured to determine whether the vehicle has passed a transit point on a traveling route on which billing is enforced based on the current position and position information of the transit point;
- 25 transit point type determining means configured to determine whether the transit point is

a defined point at which a billing amount is determined at the time point at which the passage of the vehicle through the transit point is detected or an undefined point at which the billing amount is not determined at the time point at which the vehicle has passed the transit point; and first transit point passage information output means configured to
5 output passage information indicating the passage of the vehicle through the transit point when the vehicle is determined to have passed through the transit point and the transit point is determined to be the defined point.

[0023]

According to a seventeenth aspect of the present invention, the program may
10 further cause the computer of the traffic information processing device to serve as:
traveling route specifying means configured to specify and output an estimated traveling route including the transit point as a defined traveling route among estimated traveling routes, which indicate one or more traveling routes which are undefined traveling routes of the vehicle and which the vehicle is estimated to have passed through, when the
15 vehicle is determined to have passed through the transit point and the transit point is determined to be the defined point; and billing amount calculating means configured to calculate a billing amount of the defined traveling route.

[0024]

According to an eighteenth aspect of the present invention, the program may
20 further cause the computer of the traffic information processing device to serve as:
second transit point passage determining means configured to detect a transit point which is the closest to the current position of the vehicle and is included in the defined traveling route based on the defined traveling route outputted from the traveling route specifying means when the transit point type determining means determines that the transit point is
25 the undefined point and to determine that the current position is past the transit point; and

second transit point passage information output means configured to output passage information indicating the passage of the vehicle through the transit point which is determined by the second transit point passage determining means.

[0025]

5 According to a nineteenth aspect of the present invention, the program may further cause the computer of the traffic information processing device to serve as traveling route type determining means configured to determine a type of traveling route on which billing is enforced, and the billing amount calculating means may calculate the billing amount of the defined traveling route based on the type of traveling route.

10 [0026]

 According to a twentieth aspect of the present invention, in the program, the second transit point passage determining means may instruct the billing amount calculating means to calculate the billing amount based on the distance traveled on the road when the transit point is the undefined point and information indicating that the
15 transit point is a transit point at an entrance of a road on which the distance billing is enforced-is input to the second transit point passage determining unit.

[0027]

 According to a twenty-first aspect of the present invention, in the program, each of the first transit point passage determining means and the second transit point passage
20 determining means may acquire identification information of a current traveling route which is specified based on the current position and may determine whether the current position is past the transit point at predetermined time intervals based on the identification information of the current traveling route and the current position. Each of the first transit point passage determining means and the second transit point passage
25 determining means in the program may determine whether the vehicle passes through a

plurality of traveling routes based on identification information of the traveling route acquired when determining whether the previous transit point has been passed at predetermined time intervals and identification information of the traveling route acquired when determining whether the current transit point has been passed. Each of the first transit point passage determining means and the second transit point passage determining means in the program may determine that the current position is past the transit point which is located between the position information at the time the previous transition point is determined to have been passed and the position information of the timing at which it is determined whether the current transit point has been passed the transit points included in the plurality of passed through traveling routes when the vehicle is detected to have passed through the plurality of traveling routes.

[Advantageous Effects of Invention]

[0028]

According to the traffic information processing device, the processing method thereof, and the program, it is possible to prevent erroneous billing and to reduce the number of times that a situation occurs in which a driver cannot immediately recognize when her or his vehicle has passed through an entrance or an exit of a road on which road pricing is enforced or a billing amount when her or his vehicle passes through a traveling route including the road on which road pricing is enforced.

[Brief Description of Drawings]

[0029]

Fig. 1 is a block diagram showing a configuration of a traffic information processing device according to an embodiment of the present invention.

Fig. 2 is a first diagram showing a process flow of the traffic information processing device according to the embodiment of the present invention.

Fig. 3 is a second diagram showing the process flow of the traffic information processing device according to the embodiment of the present invention.

Fig. 4A is a diagram showing an outline of a transit point passage determining process according to the embodiment of the present invention.

5 Fig. 4B is a diagram showing an outline of a transit point passage determining process according to the embodiment of the present invention.

Fig. 5 is a block diagram showing a configuration of a traveling route specifying unit according to the embodiment of the present invention.

10 Fig. 6 is a diagram showing road information which is stored in a map data storage unit according to the embodiment of the present invention.

Fig. 7 is a first diagram showing an estimated traveling route information data table which is stored in an estimated traveling route information storage unit according to the embodiment of the present invention.

15 Fig. 8 is a diagram showing a process flow in the traveling route specifying unit according to the embodiment of the present invention.

Fig. 9 is a first diagram showing a process outline of a road information specifying unit according to the embodiment of the present invention.

Fig. 10A is a second diagram showing the process outline of the road information specifying unit according to the embodiment of the present invention.

20 Fig. 10B is a second diagram showing the process outline of the road information specifying unit according to the embodiment of the present invention.

Fig. 11 is a second diagram showing the estimated traveling route information data table which is stored in the estimated traveling route information storage unit according to the embodiment of the present invention.

25 Fig. 12 is a diagram showing a process outline of a traveling route exclusion

determining unit according to the embodiment of the present invention.

Fig. 13 is a third diagram showing the estimated traveling route information data table which is stored in the estimated traveling route information storage unit according to the embodiment of the present invention.

5 Fig. 14 is a first diagram showing a process outline of a traveling route output unit according to the embodiment of the present invention.

[Description of Embodiments]

[0030]

 Hereinafter, a traffic information processing device according to a first
10 embodiment of the present invention will be described with reference to the accompanying drawings.

 The traffic information processing device 1 is installed, for example, in a vehicle. The traffic information processing device 1 may be built in a car navigation device or an audio device.

15 The traffic information processing device 1 according to this embodiment estimates a traveling route which the vehicle has previously passed through (traveled on) and notifies a driver that the vehicle has passed a transit point when the vehicle has passed the transit point at which a billing amount occurs at an entrance or exit of a road on which road pricing is enforced among transit points disposed in the traveling route in
20 real time. The traffic information processing device 1 performs a process of outputting information of a billing amount for traversing a traveling route including the road on which road pricing is enforced in real time when the vehicle passes a transit point at which the billing amount occurs.

[0031]

25 In this embodiment, the entrance or exit of a road on which road pricing is

enforced is provided with a transit point for defining that a billing amount is applied to a vehicle. A method of billing a vehicle for an amount of money defined at the transit point includes a method (point billing) of billing a vehicle for a predetermined amount of money only when the vehicle passes the transit point, a method (cordon billing) of billing
 5 a vehicle for a predetermined amount of money when the vehicle enters an area in which a transit point is disposed, a method (expressway billing) of billing a vehicle for a predetermined amount of money when a vehicle departs from an exit like on an expressway, a method (mileage billing) of billing a vehicle for an amount of money based on the distance of a road which the vehicle passes through, and the like.

10 [0032]

Fig. 1 is a block diagram showing a configuration of the traffic information processing device according to this embodiment.

The traffic information processing device 1 includes at least a position measuring unit 10, a map matching unit 20, an application unit 30, a display unit 40, and
 15 a storage unit 50.

[0033]

The position measuring unit 10 includes a unit having a sensing function and a position information calculating unit 15. The unit having a sensing function includes a latitude and longitude sensor 11, an acceleration sensor 12, a gyro sensor 13, and a
 20 vehicle speed signal output unit 14. The latitude and longitude sensor 11 calculates current latitude and longitude of the vehicle using signals received from GPS satellites. The acceleration sensor 12 detects acceleration of the vehicle. The gyro sensor 13 detects an angular velocity when the vehicle turns in the horizontal direction. The vehicle speed signal output unit 14 outputs a pulse signal (vehicle speed signal)
 25 proportional to the rotation speed of an axle of the vehicle. The position information

calculating unit 15 calculates the sensed position of the vehicle based on sensing information such as information on the latitude and longitude input from the latitude and longitude sensor 11, information on the acceleration input from the acceleration sensor 12, information on the angle or angular velocity input from the gyro sensor 13, or the vehicle speed signal input from the vehicle speed signal output unit 14.

[0034]

The map matching unit 20 includes processing units such as a real-time processing unit 21 and a traveling route specifying unit 22.

The real-time processing unit 21 specifies the position of the vehicle on a map based on the position information of the vehicle input from the position measuring unit 10 in real time. The real-time processing unit 21 outputs the position information input from the position measuring unit 10 to the application unit 30 in real time.

The traveling route specifying unit 22 estimates the traveling route which the vehicle passes through. The traveling route specifying unit 22 specifies an estimated traveling route including a transit point as a defined traveling route defined to be passed through among estimated traveling routes which are undefined traveling routes of the vehicle and which are one or more traveling routes estimated to be passed through by the vehicle and outputs the defined traveling route. When the defined traveling route is output, the traveling route specifying unit 22 further estimates one or more traveling routes which can be estimated to have passed through by the vehicle and repeatedly performs a process of specifying an estimated traveling route including a transit point as a defined traveling route among the estimated traveling routes as the estimation result and outputting the defined traveling route.

[0035]

The application unit 30 includes a first transit point passage determining unit

301, a first transit point passage information output unit 302, a transit point type
determining unit 303, a billing amount calculating unit 304, a second transit point
passage determining unit 305, a second transit point passage information output unit 306,
a traveling route type determining unit 307, a speed calculating unit 308, a traffic
5 information output unit 309, and a current position output unit 310.

[0036]

The first transit point passage determining unit 301 determines whether the
vehicle passes a transit point based on the current position and position information of
the transit point. A transit point is a point disposed on a road so as to detect passage of
10 a vehicle therethrough, for example, as shown in Fig. 4A. The transit point may be a
transit point device as hardware which is actually buried in the road. The transit point
may be information indicating a position which is virtually disposed on a map of map
data stored in the traffic information processing device 1.

[0037]

15 In this embodiment, transit points are classified into two types of transit points
such as a defined point at which a billing amount is determined at the time point at which
the vehicle passes the transit point and an undefined point at which a billing amount is
not determined at the time point at which the vehicle passes the transit point. More
specifically, as described above, the transit points include a transit point for point billing,
20 a transit point for cordon billing, a transit point disposed at an exit of a road on which
expressway billing is enforced, and a transit point disposed at an exit of a road on which
mileage billing is enforced, which are classified as defined points. The transit points
also include a transit point disposed at an entrance of a road on which expressway billing
is enforced and a transit point disposed at an entrance of a road on which mileage billing
25 is enforced, which are classified as undefined points. This classification of transit

points is an example and the method of classifying a transit point as a defined point or an undefined point is not limited to this example.

[0038]

5 The transit point type determining unit 303 determines whether the transit point that the vehicle is determined to have passed by the first transit point passage determining unit 301 or the second transit point passage determining unit 305 is a defined point or an undefined point.

10 The first transit point passage information output unit 302 outputs passage information indicating passage of the vehicle through a transit point when the vehicle is determined to have passed through the transit point and the transit point is a defined point. In this embodiment, the first transit point passage information output unit 302 outputs the passage information to the display unit 40.

 The billing amount calculating unit 304 calculates a billing amount of a defined traveling route.

15 [0039]

 The second transit point passage determining unit 305 detects a transit point included in the defined traveling route outputted from the traveling route specifying unit 22 and determines that the current position is past the transit point.

20 The second transit point passage information output unit 306 outputs passage information indicating the passage of the transit point which is determined by the second transit point passage determining unit 305. In this embodiment, the second transit point passage information output unit 306 outputs the passage information to the display unit 40.

[0040]

25 The traveling route type determining unit 307 determines the type of traveling

route on which billing is enforced. The type of a traveling route includes information such as an expressway, a toll road, and a bridge.

The speed calculating unit 308 calculates a speed of the vehicle based on a time each point of a plurality of points in the defined traveling route is passed in the defined
5 traveling route outputted from the traveling route specifying unit 22 and distances between each of the plurality of points.

The traffic information output unit 309 reads and outputs traffic information corresponding to the current position.

The current position output unit 310 outputs the current position output from the
10 real-time processing unit 21.

The storage unit 50 stores a variety of information used for processes in the map matching unit 20 or the application unit 30.

[0041]

By employing the above-mentioned configuration, the traffic information
15 processing device 1 performs a process of outputting information on the passage of the vehicle through an entrance or exit of a road on which road pricing is enforced or information on a billing amount for traversal of a traveling route including the road on which road pricing is enforced by the vehicle in real time when the vehicle passes a transit point at which a billing amount is charged at the entrance or exit of the road on
20 which road pricing is enforced.

[0042]

Fig. 2 is a first diagram showing a process flow of the traffic information processing device 1.

Details of the process flow of the traffic information processing device 1 will be
25 sequentially described below.

First, the position information calculating unit 15 of the position measuring unit 10 receives information from the sensor units such as the latitude and longitude sensor 11, the acceleration sensor 12, the gyro sensor 13, and the vehicle speed signal output unit 14 with traveling of the vehicle and calculates a current sensed position (latitude and longitude) of the vehicle (step S101). Then, the position information calculating unit 15 outputs the calculated sensed position (sensed position information) to the map matching unit 20. The real-time processing unit 21 of the map matching unit 20 receives the sensed position of the vehicle.

[0043]

Here, the real-time processing unit 21 specifies a road (road ID) which is within an error range from the sensed position among a plurality of pieces of road information stored in the storage unit 50 based on the sensed position of the vehicle input from the position measuring unit 10. Then, the real-time processing unit 21 specifies a current position which can be estimated to be the most likely (suitable) position on the road, a traveling direction, or a speed based on the sensed position (step S102). The current position which can be estimated to be the most likely (suitable) position on the road may be set, for example, to a position closest to the sensed position on the specified road.

Alternatively, the current position may be specified using information of the traveling direction or the speed in addition to the sensed position. The road information stored in the storage unit 50 may include position information of end points of the road indicated by the road information, position information for each predetermined interval on a line connecting the end points, or position information of the extending direction of the road.

The real-time processing unit 21 outputs the current position of the vehicle on the road and the road ID (identification information of the road) to the application unit 30 in real

time. The real-time processing unit 21 may output the current position of the vehicle on

the road and the road ID to the traveling route specifying unit 22.

[0044]

The first transit point passage determining unit 301 of the application unit 30 receives the current position specified by the real-time processing unit 21 and the road ID indicating the road on which the vehicle travels. Then, the first transit point passage determining unit 301 reads position information of one or more transit points, which is stored in the storage unit 50 in correlation with the input road ID, from the storage unit 50. The first transit point passage determining unit 301 specifies the position information of the transit point closest to the current position among the read position information of the transit points and calculates a distance between the current position and the specified position information of the transit point. The first transit point passage determining unit 301 determines whether the vehicle has passed the transit point based on the distance between the current position and the specified position information of the transit point (step S103). For example, the first transit point passage determining unit 301 determines that the vehicle has passed the transit point when the distance between the current position and the specified position information of the transit point is less than a distance at which the transit point can be determined to be passed. The first transit point passage determining unit 301 waits for an input of the current position from the real-time processing unit 21 when the transit point is determined to be not passed, and performs the determination of step S103 again when the current position and the road ID are input.

[0045]

When the transit point is determined to have been passed, the first transit point passage determining unit 301 outputs a road type determination request of the road on which the vehicle currently travels to the traveling route type determining unit 307. The

road type determination request includes the road ID input from the real-time processing unit 21. The traveling route type determining unit 307 reads information of the type of road stored in the storage unit 50 in correlation with the road ID, determines the road type (type of traveling route) (step S104), and outputs the information of the road type to the first transit point passage determining unit 301.

[0046]

Then, the first transit point passage determining unit 301 requests the transit point type determining unit 303 to determine the type of transit point. A signal for the type determination request includes the ID of the transit point. When the type determination request is input, the transit point type determining unit 303 determines whether the transit point which is determined to be passed is a defined point or an undefined point (step S105).

More specifically, the transit point type determining unit 303 reads information of the type of transit point stored in correlation with the ID from the storage unit 50 based on the ID of the transit point which is determined to be passed. The transit point type determining unit 303 determines whether the information of the type of transit point read from the storage unit 50 is information indicating a defined point or information indicating an undefined point. The transit point type determining unit 303 outputs information of the determination result indicating whether the transit point is a defined point or an undefined point to the first transit point passage determining unit 301.

[0047]

When the determination result from the transit point type determining unit 303 is the information indicating the defined point, the first transit point passage determining unit 301 immediately outputs information indicating passage of the transit point to the first transit point passage information output unit 302 (step S106). Then, the first transit

point passage information output unit 302 displays passage information indicating the passage of the transit point on the display unit 40 (step S107). At this time, the first transit point passage information output unit 302 may acquire the name of the transit point based on the ID of the transit point or the information of the type of transit point from the first transit point passage determining unit 301 and may output the acquired information to the display unit 40. The passage information or the like may be displayed as a character string on a liquid crystal display unit or a lamp configured to notify a driver of the vehicle that a certain transit point has been passed may be turned on. Alternatively, instead of the display unit 40, a speech output unit may notify what that the transit point has been passed using sound.

[0048]

After outputting the information indicating the passage of the transit point to the first transit point passage information output unit 302, the first transit point passage determining unit 301 outputs a request for specifying traveling routes that were previously passed through to the traveling route specifying unit 22. This traveling route specification request is a signal for requesting the traveling route specifying unit 22 to forcibly define the previous traveling routes up to the passed transit point. Accordingly, when the transit point has passed, the traffic information processing device 1 can output the information indicating the passage of the transit point and the information on the billing amount up to the transit point based on the definition of the traveling route to the display unit 40. This traveling route specification request may include information such as the current time, the road ID input from the real-time processing unit 21, the road type determined in step S104, the type of transit point determined in step S105, and the ID of the transit point determined in step S105. It is assumed that the ID of the transit point is read from the storage unit 50 by the first transit point passage determining unit 301.

Then, the traveling route specifying unit 22 defines the traveling routes which were previously passed through (step S108). Details of this process will be described later.

[0049]

In the process of specifying a traveling route, unlike the specification of a road which is performed based on the current position of the vehicle by the real-time processing unit 21, roads on which the vehicle previously traveled are specified with higher accuracy. More specifically, the traveling route specifying unit 22 defines the road IDs, which are included in the estimated traveling route information other than the estimated traveling route information which is determined not to be a traveling route among the estimated traveling route information including the road ID indicating a plurality of traveling routes on which the vehicle previously traveled, as the road IDs indicating the previous traveling routes and outputs the defined road IDs. Accordingly, in comparison with the process of specifying a road in the real-time processing unit 21, more time is required for defining the previous traveling routes. When the previously passed through traveling routes up to the transit point determined to be passed in step S103 are defined, the traveling route specifying unit 22 determines the type of transit point included in the traveling route specification request (step S109). When the type of transit point is a defined point, the traveling route specifying unit 22 outputs a billing amount calculation request for instructing the billing amount calculating unit 304 to calculate the billing amount in the previous traveling routes up to the transit point to the billing amount calculating unit 304. The billing amount calculation request includes information such as the road ID, the road type, the type of transit point, and the ID of the transit point which are included in the traveling route specification request.

[0050]

The billing amount calculating unit 304 calculates a billing amount using the

road ID of the defined traveling route, the road type, the type of transit point, and the ID of the transit point which are currently input or the road ID of the defined traveling route, the road type, the type of transit point, and the ID of the transit point which are previously input (step S110). More specifically, the distance of the road or the billing amount for traveling on the road are read from the storage unit 50 based on the road IDs of a plurality of roads or the road types of the roads. The billing amount for passing the transit point is read from the storage unit 50 based on the type of transit point or the ID of the transit point. The billing amount calculating unit 304 calculates the sum of the billing amounts. The billing amount calculating unit 304 outputs the calculated billing amount to the display unit 40 (step S111). The billing amount may be displayed as a character string on a liquid crystal display unit. Alternatively, instead of the display unit 40, a speech output unit may output speech indicating the billing amount using sound.

[0051]

By employing the above-mentioned processes, when a vehicle passes a transit point (such as a transit point for point billing, a transit point for cordon billing, a transit point disposed at an exit of a road on which expressway billing is enforced, or a transit point disposed at an exit of a road on which mileage billing is enforced) classified as a defined point at which a billing amount is determined only when the transit point has been passed, information indicating the passage of the transit point is immediately output to the display unit 40. Accordingly, even when a large mark is not installed on a road for road pricing, a driver of a vehicle can recognize passage of a transit point at which a billing amount is determined only when the transit point has been passed in real time. When a vehicle passes a transit point classified as a defined point, information indicating the passage of the transit point is output to the display unit. Thereafter, an accurate traveling route up to the position of the transit point classified as the defined point is

specified in the process of step S108, and a billing amount defined using the accurate traveling route is output to the display unit 40. Accordingly, a driver can immediately recognize the accurate billing amount in the step in which the transit point classified as the defined point has been passed. The process of defining a previous traveling route in the traveling route specifying unit 22 requires more time than that in the real-time processing unit 21, but the difference therebetween is about 1 second. The difference in process time is a time difference between the passage of the transit point at which billing is enforced and the output of the billing amount up to the transit point to the display unit 40 that does not cause the driver any discomfort.

10 [0052]

When it is determined in step S105 that the passed transit point is not a defined point at which a billing amount is determined at the time point at which the passage of the transit point is detected, the first transit point passage determining unit 301 does not perform the process of outputting information indicating the passage of the transit point to the first transit point passage information output unit 302 in step S106, but waits until next information (current position and road ID) is input from the real-time processing unit 21, and then repeatedly performs the process from step S102.

[0053]

Fig. 3 is a second diagram showing the process flow in the traffic information processing device 1.

In the map matching unit 20, the traveling route specifying unit 22 performs the process of defining the traveling routes which were previously passed through at predetermined time intervals based on the process result of the real-time processing unit 21 regardless of whether the traveling route specification request is input from the first transit point passage determining unit 301. However, even at the timing at which the

traveling route specification request is input from the first transit point passage determining unit 301, the traveling route specifying unit 22 defines the traveling routes which were previously passed through and outputs a transit point passage determination request to the second transit point passage determining unit 305. The transit point passage determination request is input to the second transit point passage determining unit 305 (step S201). The transit point passage determination request includes the road ID indicating the defined traveling route defined to be previously passed through or information of the current position (for example, position closest to the sensed position on the road of the road ID of the defined traveling route).

10 [0054]

Then, the second transit point passage determining unit 305 reads the position information of the transit points, which is stored in the storage unit 50 in correlation with the input road ID, from the storage unit 50. The second transit point passage determining unit 305 specifies the position information of the transit point closest to the current position among the read position information of the transit points and calculates a distance between the current position and the specified position information of the transit point. The second transit point passage determining unit 305 determines whether the vehicle has passed the transit point based on the distance between the current position and the specified position information of the transit point (step S202). For example, when the distance between the current position and the specified position information of the transit point is equal to or less than a distance at which the transit point can be determined to be passed, the second transit point passage determining unit 305 determines that the transit point has been passed. When the transit point is determined to not have been passed, the second transit point passage determining unit 305 waits for an input of a road ID or a current position from the traveling route specifying unit 22.

When a road ID or a current position is input, the second transit point passage determining unit 305 performs the determination of step S202 again.

[0055]

When the transit point is determined to have been passed, the second transit point passage determining unit 305 requests the transit point type determining unit 303 determine the type of transit point. The type determination request includes the ID of the transit point. When the type determination request is input, the transit point type determining unit 303 determines whether the transit point determined to be passed is the defined point or the undefined point (step S203).

More specifically, the transit point type determining unit 303 reads information of the type of transit point correlated with the ID from the storage unit 50 based on the ID of the transit point determined to be passed. The transit point type determining unit 303 determines whether the information of the type of transit point read from the storage unit 50 is information indicating the defined point or information indicating the undefined point. The transit point type determining unit 303 outputs information of the determination result indicating any one of the defined point and the undefined point to the second transit point passage determining unit 305.

[0056]

The second transit point passage determining unit 305 immediately outputs the information indicating the passage of the transit point to the second transit point passage information output unit 306 only when the determination result from the transit point type determining unit 303 is information indicating the undefined point (such as a transit point disposed at an entrance of a road on which expressway billing is enforced or a transit point disposed at an entrance of a road on which mileage billing is enforced) (step S204). Then, the second transit point passage information output unit 306 displays

passage information indicating the passage of the transit point on the display unit 40 (step S205). The passage information may be displayed as a character string on a liquid crystal display unit or a lamp configured to notify a driver of the vehicle that a certain transit point has been passed may be turned on. Alternatively, instead of the display unit 40, a speech output unit may notify what that the transit point has been passed using sound.

[0057]

When the determination result from the transit point type determining unit 303 is the information indicating the defined point, the second transit point passage determining unit 305 does not output the information indicating passage of the transit point to the second transit point passage information output unit 306. This is because information indicating the passage is displayed already by the first transit point passage determining unit 301 and the first transit point passage information output unit 302 when the transit point classified as the defined point has been passed.

[0058]

By employing the above-mentioned processes, the traveling route specifying unit 22 of the map matching unit 20 defines the previously passed through traveling routes when the transit point passed by the vehicle is the undefined point. Thereafter, information indicating whether the transit point on the traveling route is currently passed is displayed using the accurate latitude and longitude. Accordingly, when the transit point which is an undefined point at which a billing amount is not determined only when the transit point has been passed, it is possible to notify the driver of the passage timing with higher accuracy.

[0059]

When the determination result from the transit point type determining unit 303 is

the undefined point and information indicating that the transit point is disposed at an entrance of a road on which mileage billing is enforced is acquired from the storage unit 50, the second transit point passage determining unit 305 instructs the billing amount calculating unit 304 to calculate a billing amount before the transit point disposed at an exit of the road on which mileage billing is enforced has been passed. Then, the billing amount calculating unit 304 receives the traveling route specified by the traveling route specifying unit 22 and the current position. The billing amount calculating unit 304 calculates a traveling distance corresponding to the change of the current position with the lapse of time and calculates a billing amount corresponding to the traveling distance. At this time, information such as a fee per unit traveling distance acquired based on the road type or the road ID may be read from the storage unit 50 and the billing amount may be calculated using the read information.

[0060]

Figs. 4A and 4B are diagrams showing outlines of the transit point passage determining process.

Fig. 4A is a diagram showing the outline of the transit point passage determination which is performed by the first transit point passage determining unit 301 or the second transit point passage determining unit 305 in step S103 or step S202. The transit point passage determination shown in Fig. 4A is effective when the road ID input based on the previous processing result (previous map matching result) of the real-time processing unit 21 or the traveling route specifying unit 22 of the map matching unit 20 is the same as the road ID input based on the current processing result (current map matching result). That is, the transit point passage determination is effective when the vehicle travels on the same road in the previous map matching process and the current map matching process which are performed at a predetermined interval. In this case,

the first transit point passage determining unit 301 or the second transit point passage determining unit 305 reads position information of a transit point closest to the current position on the road of the road ID from the storage unit 50 using the road ID input based on the current map matching process. The first transit point passage determining unit

5 301 or the second transit point passage determining unit 305 can determine that the transit point has been passed when the read position information is within a predetermined distance from the current position.

[0061]

On the other hand, Fig. 4B shows an example of the passage determination

10 when the transit point is in the vicinity of an end of a road. Specifically, Fig. 4B shows an example of the passage determination in a T-shaped road in which a road with road ID=1, a road with road ID=2, and a road with road ID=3 are connected.

Here, when a transit point is in the vicinity of an end of the road with road ID=1, it is assumed that the first transit point passage determining unit 301 or the second transit point passage determining unit 305 determines whether the transit point shown in Fig. 4A

15 has been passed at the timing at which the vehicle travels on the road with road ID=2.

In this case, the first transit point passage determining unit 301 or the second transit point passage determining unit 305 acquires only information of the road ID (=2) based on the result of the current map matching process. The first transit point passage determining

20 unit 301 or the second transit point passage determining unit 305 acquires the position information of the transit point from the storage unit 50 based on the information of road ID=2. However, since neither the first transit point passage determining unit 301 nor the second transit point passage determining unit 305 acquires the information of road ID=1 in this process, the information of the transit point correlated with the information

25 of road ID=1 cannot be acquired from the storage unit 50. Accordingly, when the

previous passage determination is performed in the vicinity of the center of the road with road ID=1, the current passage determination is performed on the road with road ID=2, and the transit point located at an end (end on the road side of road ID=2) of the road with road ID=1 has been passed while the passage determinations are performed, a situation in which the passage of the transit point cannot be determined may occur even when the passage determination of the transit point is performed using only road ID (ID=2) acquired based on the result of the current map matching process as in the method shown in Fig. 4A.

[0062]

Accordingly, the first transit point passage determining unit 301 or the second transit point passage determining unit 305 determines whether two road IDs of the road ID input based on the result of the previous map matching process (the determination result on whether the previous transit point has been passed) and the road ID input based on the result of the current map matching process (the determination result on whether the current transit point has been passed) are different from each other. When the road IDs are different from each other (when the vehicle is detected to be traversing a plurality of traveling routes), the first transit point passage determining unit 301 or the second transit point passage determining unit 305 reads the position information of the transit points, which are stored in the storage unit 50 in correlation with the plurality of road IDs, from the storage unit 50. Accordingly, in the roads shown in Fig. 4B, the position information of the transit point on the road with road ID=1 and the transit point on the road with road ID=2 can be read. The first transit point passage determining unit 301 or the second transit point passage determining unit 305 specifies all the transit points located between the position information at the timing at which it is determined whether the previous transit point has been passed and the position information at the timing at

which it is determined whether the current transit point has been passed the transit points included in the plurality of passed through traveling routes. The first transit point passage determining unit 301 or the second transit point passage determining unit 305 determines that the current position of the vehicle is past all the specified transit points.

5 When a transit point is at an end of the road with road ID=1 shown in the upper part of Fig. 4B and when a transit point is at an end of the road with road ID=2 shown in the lower part of Fig. 4B, it is possible to determine that the transit point has been passed. [0063]

 The traffic information processing device 1 may perform a process of displaying
10 the current position, the traffic information, or the speed information on the display unit 40.

 For example, the real-time processing unit 21 outputs the current position of the vehicle on the road and the road ID to the current position output unit 310 and the traffic information output unit 309 after performing the process of step S102. Then, the
15 current position output unit 310 outputs and displays the input current position to and on the display unit 40.

 The traffic information output unit 309 reads the traffic information from the storage unit 50 or an external server based on the input road ID or the input current position and outputs and displays the read traffic information to and on the display unit
20 40.

 Specifically, the traffic information is stored in correlation with the road ID or the position information in the external server. The external server reads a predetermined number of pieces of traffic information which are stored in correlation with the position information close to the current position of the vehicle among the traffic
25 information stored in correlation with the same road ID based on the road ID output from

the traffic information output unit 309 and the current position of the vehicle, and transmits the read traffic information to the traffic information processing device 1. The traffic information output unit 309 outputs and displays the received traffic information to and on the display unit 40.

5 [0064]

The traveling route specifying unit 22 outputs the road IDs on the specified traveling route, the passage positions on the roads indicated by the road IDs, and the time of passage thereof to the speed calculating unit 308. Then, the speed calculating unit 308 calculates the speed between the passage positions of the vehicle using the distances
10 between the plurality of passage positions and the time differences between the time of passage at which the passage positions are passed, and outputs the average of the speeds between the plurality of passage positions as the speed of the vehicle to the display unit 40 displays it thereon.

[0065]

15 Details of the process of defining the traveling routes which were previously passed through in step S108 will be described below.

Fig. 5 is a block diagram showing the configuration of the traveling route specifying unit 22.

The traveling route specifying unit 22 includes an input unit 100, a
20 communication unit 110, a map data storage unit 120, a road information specifying unit 130, an estimated traveling position calculating unit 140, a next route road information specifying unit 150, an estimated traveling route information generating unit 160, an estimated traveling route information storage unit 170, a traveling route exclusion determining unit 180, a traveling route output unit 190, a defined traveling route storage
25 unit 200, a billing request unit 210, and processing units or storage units of a control unit

1000.

[0066]

Fig. 6 is a diagram showing road information stored in the map data storage unit.

The road information stored in the map data storage unit 120 is information of
 5 roads appearing on a map indicated by map data and includes information such as road
 IDs of the roads, positions (latitude and longitude) of the roads in a real space, extending
 directions of the roads, and connection road IDs indicating other roads connected thereto.
 The roads appearing on the map indicated by the map data are divided, for example, at
 positions of junctions, start points, or end points of the roads and road IDs are allocated
 10 to the divided roads. For example, the roads on the map shown in Fig. 6 are divided
 into nine roads from a road with ID1 to a road with ID9 based on start points or junctions
 of the roads or connection points with other roads. The map data storage unit 120 is
 shown as if it were disposed in the traveling route specifying unit 22 for the purpose of
 convenience of explanation, but may be disposed outside the traveling route specifying
 15 unit 22.

[0067]

For the roads shown in Fig. 6, nine pieces of road information from the road of
 ID1 to the road of ID9 are stored in the map data storage unit 120. One piece of road
 information may include position information of end points, such as a start point or an
 20 end point of a road, of one divided road indicated by the road ID or a plurality of pieces
 of position information of intermediate points or the like as positions on the road in the
 real space.

For example, for the road of ID1 in Fig. 6, position information of a connection
 point at which it connects with the road of ID2, position information of a connection
 25 point at which it connects with the road of ID3, position information of an intermediate

point of the road of ID1, and the like are included in the road information of the road of ID1. Alternatively, position information of points with predetermined intervals between the end points such as a start point or an end point may be included in the road information.

5 [0068]

The extending direction included in the road information is, for example, an angle from a certain reference direction. For example, when the reference direction is true north, the extending direction included in the road information corresponding to a position of a point on the road is an angle formed by a straight line that connects the point to another point adjacent thereto on the same road and the reference direction. For example, in this embodiment, the road information may include position information of a plurality of points on the road and extending directions which are expressed as angles of the position information of the plurality of points with respect to the reference direction.

[0069]

15 The road indicated by road ID1 is connected to the road indicated by road ID2 and the road indicated by road ID3. Accordingly, the road information including road ID1 includes connection road ID2 and connection road ID3 as the connection road IDs. Here, the connection road IDs are registered, for example, in correlation with the position information of the end point connected to the road indicated by the connection road ID among the position information of the end points included in the road information. That is, for example, for the road information of road ID1, the road indicated by road ID2 is connected to end point A of the road and the road indicated by road ID3 is connected to end point B of the road. Accordingly, road ID1, the position information of end point A, and the position information of end point B are stored as the road information of road ID1. Road ID2 is stored in correlation with the position information of end point A and

20

25

road ID3 is stored in correlation with the position information of end point B. A variety of information may be stored in the road information in other formats.

[0070]

Fig. 7 is a first diagram showing an estimated traveling route information data table stored in the estimated traveling route information storage unit.

The estimated traveling route information storage unit 170 stores one or more pieces of estimated traveling route information generated by the estimated traveling route information generating unit 160 in the estimated traveling route information data table.

In the example shown in Fig. 7, four pieces of road information which are estimated to be roads on which the vehicle travels among the road information stored in the map data storage unit 120 are specified and are stored in the estimated traveling route information data table, immediately after the traveling route specifying unit 22 starts the processing.

[0071]

In the example shown in Fig. 7, four pieces of road information including ID=1, 2, 4, and 5 are specified immediately after the traveling route specifying unit 22 starts the processing. Each of four pieces of corresponding estimated traveling route information includes a traveling route exclusion flag indicating whether it is determined that a route is not a traveling route and road information. In this embodiment, the traveling route exclusion flag is set to “0” when it is not determined that a route is not a traveling route and is set to “1” when it is determined that a route is not a traveling route. The road information included in the estimated traveling route information includes, for example, a road ID and an estimated likelihood. The estimated likelihood is the value indicating a degree (likelihood) at which the road is estimated to be a road on which the vehicle having the traffic information processing device 1 travels and is a value which is calculated by the estimated traveling route information generating unit 160.

The estimated traveling route information storage unit 170 is shown as if it were disposed in the traveling route specifying unit 22 for the purpose of convenience of explanation, but may be disposed outside the traveling route specifying unit 22.

[0072]

5 Fig. 8 is a diagram showing a process flow of the traveling route specifying unit 22.

Details of the process flow of the traveling route specifying unit 22 will be sequentially described below with reference to Fig. 8.

First, the control unit 1000 outputs a start request signal of the road information specifying process to the road information specifying unit 130 based on an instruction from the outside or the like. Then, the road information specifying unit 130 starts the road information specifying process (step S1010). The road information specifying unit 130 of the traveling route specifying unit 22 receives a sensed position from the position information calculating unit 15 via the input unit 100. The road information specifying unit 130 of the traveling route specifying unit 22 specifies road information of a beginning of traveling within an error range of the sensed position using the sensed position (step S1020).

[0073]

Fig. 9 is a first diagram showing the process outline of the road information specifying unit 130.

The process of step S1020 will be described below in more detail. The road information specifying unit 130 reads a distance of an error range stored in advance from a memory or the like. The road information specifying unit 130 reads one piece of road information from the map data storage unit 120. The road information specifying unit 130 calculates a distance between the input sensed position and the position information

included in the road information read from the map data storage unit 120 and determines whether the calculated distance is less than the distance of the error range. The road information specifying unit 130 estimates road information in which the distance between the sensed position and the position information is less than the distance of the error range as a possible candidate for a traveling beginning road on the traveling route and specifies the road information. Similarly, the road information specifying unit 130 determines whether a road is within the error range using the road information of the roads stored in the map data storage unit 120. The road information specifying unit 130 estimates road information indicating a road within the error range as road information indicating a possible candidate for the road on the traveling route and specifies the road information.

[0074]

Fig. 9 shows an example in which a sensed position of a vehicle is located in the vicinity of the connection point of the road of road ID1 and the road of road ID2. In this case, it is assumed that the distances between the positions of points (such as the end points) on the roads included in four pieces of road information including the road IDs of road ID1, road ID2, road ID4, and road ID5 and the current position are within the error range. Then, four pieces of road information including the road IDs of road ID1, road ID2, road ID4, and road ID5 are estimated and specified as road information indicating possible candidates for the roads on the traveling route.

The road information specifying unit 130 reads four pieces of specified road information including the road IDs of road ID1, road ID2, road ID4, and road ID5 from the map data storage unit 120 and outputs the read road information to the estimated traveling position calculating unit 140. The road information specifying unit 130 outputs the four pieces of specified road information as the road information of the

beginning of traveling to the estimated traveling route information generating unit 160.

[0075]

When the road information of the beginning of traveling is input, the estimated traveling route information generating unit 160 determines whether the estimated

5 traveling route information is stored in advance in the estimated traveling route information data table of the estimated traveling route information storage unit 170.

Here, in the initial state, the estimated traveling route information is not stored in the estimated traveling route information data table of the estimated traveling route

information storage unit 170. The estimated traveling route information generating unit

10 160 reads the road IDs from the road information of the beginning of traveling specified by the road information specifying unit 130 and generates the estimated traveling route information including the road IDs (step S1030). That is, the estimated traveling route information generating unit 160 generates estimated traveling route information 1

including road ID1, estimated traveling route information 2 including road ID2,

15 estimated traveling route information 3 including road ID4, and estimated traveling route information 4 including road ID5. The estimated traveling route information generating unit 160 registers information of estimated traveling route information 1 to 4 in the estimated traveling route information data table.

[0076]

20 At this time, for estimated traveling route information 1, the estimated traveling route information generating unit 160 correlates a traveling route exclusion flag "0" indicating a situation in which it is not determined that a route is not a traveling route with road ID1 as the road information and stores the correlated information in the estimated traveling route information data table of the estimated traveling route

25 information storage unit 170.

For estimated traveling route information 2, the estimated traveling route information generating unit 160 correlates a traveling route exclusion flag “0” indicating a situation in which it is not determined that a route is not a traveling route with road ID2 as the road information and stores the correlated information in the estimated traveling route information data table of the estimated traveling route information storage unit 170.

For estimated traveling route information 3, the estimated traveling route information generating unit 160 correlates a traveling route exclusion flag “0” indicating a situation in which it is not determined that a route is not a traveling route with road ID4 as the road information and stores the correlated information in the estimated traveling route information data table of the estimated traveling route information storage unit 170.

For estimated traveling route information 4, the estimated traveling route information generating unit 160 correlates a traveling route exclusion flag “0” indicating a situation in which it is not determined that a route is not a traveling route with road ID5 as the road information and stores the correlated information in the estimated traveling route information data table of the estimated traveling route information storage unit 170.

Accordingly, the estimated traveling route information generating unit 160 generates the estimated traveling route information data table shown in Fig. 7.

[0077]

Figs. 10A and 10B are second diagrams showing process outlines of the road information specifying unit 130.

On the other hand, when the specified road information of the beginning of traveling is input from the road information specifying unit 130, the estimated traveling position calculating unit 140 specifies the position information of one end point close to the current position in the real space of the vehicle among the end points in the position information included in the road information. For example, the position information of

one end point close to the current position is read from four pieces of road information including road ID1, road ID2, road ID4, and road ID5. The traveling distance is sequentially calculated using the vehicle speed signal, the acceleration, the angular velocity, and the latitude and longitude input from the position measuring unit 10 with the lapse of time. The estimated traveling position calculating unit 140 sequentially calculates the estimated traveling position (see Fig. 10A) corresponding to the traveling distance from each specified end point in the four pieces of specified road information (step S1040) and outputs the road information specified by the road information specifying unit 130 and the estimated traveling position repeatedly calculated with the lapse of time in the specified road information to the next route road information specifying unit 150.

[0078]

The next route road information specifying unit 150 sequentially receives the road information specified by the road information specifying unit 130 and the estimated traveling position in the specified road information from the estimated traveling position calculating unit 140. The next route road information specifying unit 150 repeatedly calculates the distances between the position information of the end points other than the one end points specified in the four pieces of specified road information and the estimated traveling position for the road information indicated by road ID1, road ID2, road ID4, and road ID5 and determines whether the distance is less than a predetermined distance for each piece of road information (step S1050). The next route road information specifying unit 150 specifies the road information in which the distance most rapidly becomes less than the predetermined distance (step S1060). Accordingly, when it is estimated that the vehicle travels the traveling distance indicated by the estimated traveling position on the roads indicated by the road information specified by the road

information specifying unit 130, the road which most rapidly reaches a junction or a connection point to another road is specified.

[0079]

The next route road information specifying unit 150 specifies the road information of the connection road connected to the other end point in the road information in which the current position of the vehicle is estimated to be closest to the position of the other end point among the road information indicated by road ID1, road ID2, road ID4, and road ID5 as road information of a road (see Fig. 10B) indicating a candidate for the next route (step S1070). For example, the next route road information specifying unit 150 detects a connection road ID stored in correlation with the position information of the other end point in the road information of the road in which the current position of the vehicle is specified to be closest to the position of the other end point of each road indicated by road ID1, road ID2, road ID4, and road ID5. The next route road information specifying unit 150 reads the road information including the same road ID as the connection road ID from the map data storage unit 120 and specifies the read road information as road information indicating a candidate road of the next route. In the example shown in Fig. 10B, the road information of road ID4 and the road information of road ID5 are specified as road information serving as candidates for the next route. The next route road information specifying unit 150 outputs the road information which is a candidate for the current traveling route and which is specified by the road information specifying unit 130 and the road information of the road which is a candidate for the next route and which is specified by the next route road information specifying unit 150 to the estimated traveling route information generating unit 160.

[0080]

When the road information which is a candidate for the current traveling route

and which is specified by the road information specifying unit 130 and the road information of the road which is a candidate for the next route and which is specified by the next route road information specifying unit 150 are input from the next route road information specifying unit 150, the estimated traveling route information generating unit

5 160 calculates the estimated likelihoods of the roads indicated by the road information which is a candidate for the current traveling route. The estimated likelihood is an index value indicating a degree of possibility (likelihood) that the vehicle will travel on the road indicated by the road information which is a candidate for the current traveling route.

10 [0081]

As a specific calculation method, for example, the estimated traveling route information generating unit 160 acquires position information P1 of the vehicle at each processing timing while traveling on the road which is a candidate for the current traveling route from the position measuring unit 10 and first calculates a traveling

15 distance L1 and a traveling direction D1 in which the vehicle travels on the road. The estimated traveling route information generating unit 160 reads the position information P2 included in the road information which is a candidate for the current traveling position, an extending distance L2 between the end points of the road, and the extending direction D2. The estimated traveling route information generating unit 160 calculates a

20 difference between the position information P1 at each processing timing and position information P2 closest to the position indicated by the position information P1, a difference between the traveling distance L1 and the extending distance L2, and a difference between the angle (angle with respect to a reference direction such as true north) indicated by the traveling direction D1 and the angle (angle with respect to a

25 reference direction such as true north) indicated by the extending direction D2 using an

estimated likelihood calculating equation, and calculates the total sum of weighted values thereof as the estimated likelihood. The estimated likelihood calculating method is not particularly limited as long as it can be used to calculate an index value indicating a degree of possibility that the vehicle will travel on the road which is a candidate for the current traveling position. The estimated traveling route information generating unit 160 correlates the estimated likelihood calculated for the road information which is a candidate for the current traveling route with the road ID of the road information and stores the correlated information in the estimated traveling route information data table shown in Fig. 7 (step S1080). The estimated traveling route information generating unit 160 performs the calculation of the estimated likelihood and the storage in the estimated traveling route information data table for the road information which are all candidates for the current traveling route.

[0082]

After the process of step S1060, the next route road information specifying unit 150 sets the road information which has been specified as a candidate for the next route as a candidate for the current traveling route and outputs the road information indicating the candidate for the current traveling route to the estimated traveling position calculating unit 140. The estimated traveling position calculating unit 140 calculates the estimated traveling position using the road information which is a candidate for the current traveling route and which is input from the next route road information specifying unit 150 as described above. The next route road information specifying unit 150 specifies the road information of the road which is a candidate for the next route based on the estimated traveling position. The estimated traveling position calculating unit 140 and the next route road information specifying unit 150 repeatedly perform the same process at predetermined time intervals (T1, T2, ...). The next route road information

specifying unit 150 outputs the road information which is a candidate for the current traveling route and the road information of the road which is a candidate for the next route to the estimated traveling route information generating unit 160 at a predetermined interval.

5 [0083]

The road information which is a candidate for the current traveling route and the road information of the road which is a candidate for the next route are input to the estimated traveling route information generating unit 160 from the next route road information specifying unit 150 at a predetermined interval. The estimated traveling route information generating unit 160 updates or generates the estimated traveling route information with every input (step S1090). More specifically, the estimated traveling route information generating unit 160 determines whether the estimated traveling route information is stored in advance in the estimated traveling route information data table of the estimated traveling route information storage unit 170. Here, the estimated traveling route information including the road IDs of the road information of the beginning of traveling is stored in advance in the estimated traveling route information data table through the above-mentioned processes. Then, the estimated traveling route information generating unit 160 specifies the road information including the same road ID as the connection road ID which is correlated with the position information of the end points included in the road information specified as a candidate for the next route among the road information specified as a candidate for the current traveling route. The estimated traveling route information in which the road ID included in the road information is correlated with the road ID included in the road information specified as a candidate for the next route is generated for all the road information specified as a candidate for the next route.

[0084]

That is, referring to the examples shown in Figs. 9, 10A, and 10B, the road information specified as a candidate for the current traveling route is road information including road ID1, road ID2, road ID4, and road ID 5. The road information specified as a candidate for the next route is road information including road ID4 and road ID5. The estimated traveling route information generating unit 160 reads the connection road IDs correlated with the position information of the end points among the road information of road ID4 and road ID5 specified as a candidate for the next route. The connection road IDs include connection road ID2. The estimated traveling route information generating unit 160 specifies the road information including the same road ID as the read connection road ID from the road information including road ID1, road ID2, road ID4, and road ID5. That is, the road information including road ID2 is specified.

[0085]

The estimated traveling route information generating unit 160 copies the estimated traveling route information (estimated traveling route information 2 in Fig. 7) including connection road ID2 as a road ID of the road information which is previously specified (at timing T1). New estimated traveling route information 2-2 in which road ID4 of the road information specified as a candidate for the next route (at timing T2) is stored in correlation with road ID2 in the copied estimated traveling route information is generated. Similarly, the estimated traveling route information generating unit 160 copies the estimated traveling route information (estimated traveling route information 2 in Fig. 7) including connection road ID2 as a road ID of the road information which is previously specified (at timing T1). New estimated traveling route information 2-3 in which road ID5 of the road information specified as a candidate for the next route (at

timing T2) is stored in correlation with road ID2 in the copied estimated traveling route information is generated.

[0086]

The estimated traveling route information generating unit 160 reads the road IDs
 5 for estimated traveling route information 1 to 4 which are stored in advance in the
 estimated traveling route information storage unit 170 and updates the read road IDs in
 correlation with the same road IDs in the estimated traveling route information. That is,
 for estimated traveling route information 1, road ID1 which is information of the road
 specified as the estimated traveling route at timing T1 and road ID1 which is information
 10 of the road specified as the estimated traveling route at timing T2 are updated in
 correlation with each other. Similarly, for estimated traveling route information 2, road
 ID2 which is information of the road specified as the estimated traveling route at timing
 T1 and road ID2 which is information of the road specified as the estimated traveling
 route at timing T2 are updated in correlation with each other. Similarly, for estimated
 15 traveling route information 3, road ID4 which is information of the road specified as the
 estimated traveling route at timing T1 and road ID4 which is information of the road
 specified as the estimated traveling route at timing T2 are updated in correlation with
 each other. Similarly, for estimated traveling route information 4, road ID5 which is
 information of the road specified as the estimated traveling route at timing T1 and road
 20 ID5 which is information of the road specified as the estimated traveling route at timing
 T2 are updated in correlation with each other.

[0087]

Fig. 11 is a second diagram showing the estimated traveling route information
 data table stored in the estimated traveling route information storage unit.

25 Through the processing of the estimated traveling route information generating

unit 160, estimated traveling route information 1, estimated traveling route information 2, estimated traveling route information 2-2, estimated traveling route information 2-3, estimated traveling route information 3, and estimated traveling route information 4 shown in Fig. 11 are stored in the estimated traveling route information data table. As shown in Fig. 11, in the step of ending the process of the estimated traveling route information generating unit 160, the road ID of the road information (road information 1) specified at the beginning of traveling (timing T1) and the estimated likelihood thereof are stored in the estimated traveling route information in the estimated traveling route information data table. In the estimated traveling route information, the road ID of the road information (road information 2) which is specified as a candidate for the next route by the next route road information specifying unit 150 at timing T2 is stored in correlation with the road ID thereof. However, the estimated likelihoods correlated with the road IDs in road information 2 are not registered yet at this time.

[0088]

When the road information which is a candidate for the current traveling route and which is specified by the road information specifying unit 130 and the road information of the road which is a candidate for the next route and which is specified by the next route road information specifying unit 150 are input from the next route road information specifying unit 150 the next time, the estimated traveling route information generating unit 160 performs the same process as in the above-mentioned estimated likelihood calculating method. The estimated traveling route information generating unit 160 calculates the estimated likelihood of the road of each road ID in road information 2 and stores the estimated likelihood calculated for each piece of the road information which is a candidate for the current traveling route in the estimated traveling route information data table in correlation with the road ID of the corresponding road

information. Accordingly, the estimated likelihoods are stored in correlation with the road IDs stored as road information 2 of the estimated traveling route information in Fig. 11.

[0089]

5 Then, the traveling route exclusion determining unit 180 excludes the estimated traveling route information in which the road ID of the road considered to have a low possibility as a traveling route is stored as the road ID of the most recently specified road information among the estimated traveling route information stored in the estimated traveling route information storage unit 170 from the candidates (step S1100).

10 For example, when a traveling route specification request including the road ID is input from the first transit point passage determining unit 301 of the traffic information processing device 1, the estimated traveling route information in which a road ID other than the road ID read from the traveling route specification request is stored as a road ID of the finally-specified road information is excluded from the candidates.

15 Alternatively, for example, the estimated traveling route information in which the estimated likelihood equal to or less than a threshold value is stored among the estimated likelihoods which are stored in the estimated traveling route information in correlation with the road IDs of the finally-specified road information is excluded from the candidates.

20 [0090]

Fig. 12 is a diagram showing a process outline of the traveling route exclusion determining unit.

Fig. 12 shows the estimated traveling route information shown in Fig. 11 in a tree diagram. The respective estimated traveling route information includes road
25 information specified at timing T1 and timing T2. In this state, the traveling route

exclusion determining unit 180 excludes estimated traveling route information 1, estimated traveling route information 3, and estimated traveling route information 4 in which the estimated likelihoods equal to or less than a threshold value (for example, estimated likelihood 0.3) are stored in correlation with the newest road information (at timing T2) from the candidates based on the estimated likelihoods.

[0091]

Fig. 13 is a third diagram showing the estimated traveling route information data table stored in the estimated traveling route information storage unit 170.

When the estimated traveling route information in which the road ID of the road considered to have a low possibility as a traveling route is stored as the road ID of the road information which is finally specified (at timing T2) is excluded among the estimated traveling route information stored in the estimated traveling route information storage unit 170, the traveling route exclusion determining unit 180 changes the traveling route exclusion flag stored in the estimated traveling route information determined to be excluded from “0” to “1” as shown in Fig. 13. The traveling route exclusion determining unit 180 outputs a traveling route defining request to the traveling route output unit 190.

[0092]

When a traveling route defining request is input from the traveling route exclusion determining unit 180, the traveling route output unit 190 specifies a road ID to be defined as the traveling route among the road IDs indicating the roads estimated as the previous traveling route using the road IDs included in the estimated traveling route information including the traveling route exclusion flag “0” stored in the estimated traveling route information storage unit 170 (step S1110). Specifically, for example, the traveling route output unit 190 sequentially compares the road IDs from the road ID

which is first stored in all the estimated traveling route information including the traveling route exclusion flag “0” stored in the estimated traveling route information storage unit 170 and extracts the road ID which is continuously common. The traveling route output unit 190 specifies the road indicated by the extracted road ID which is continuously common from the first road ID as the defined traveling route and stores the “road ID which is continuously common from the first road ID,” which indicates the defined traveling route, in the defined traveling route storage unit 200.

[0093]

Fig. 14 is a first diagram showing a process outline of the traveling route output

unit.

In this drawing, estimated traveling route information including the road information specified at timings T1, T2, T3, and T4 is shown in a tree diagram. Based on the estimated traveling route information, the road indicated by the road ID which is continuously common from the first road ID specified at timing T1 is specified as the defined traveling route. Fig. 14 shows an example in which there are three pieces of estimated traveling route information which include the traveling route exclusion flag “0” and are stored in the estimated traveling route information storage unit 170. The traveling route output unit 190 stores road ID2 specified at timing T1 and road ID4 specified at timing T2 as the road ID which is continuously common from the first road ID in the defined traveling route storage unit 200 using the three pieces of estimated traveling route information.

[0094]

The map matching unit 20 performs a map matching process of plotting and displaying current position on a map displayed on a display unit such as a monitor in parallel with the processes of steps S1010 to S1110 which are performed by the traveling

route specifying unit 22. The control unit 1000 of the traveling route specifying unit 22 determines whether to end the process flow based on an input of a primary process stop request signal included in a radio signal received from an external device, a billing request signal from the outside, or the like when a power supply is turned off or the vehicle enters a parking lot (step S1130). When the control unit 1000 of the traveling route specifying unit 22 determines that the process flow is not ended, the process flow is repeated from the process of step S1040. Accordingly, processes of storing new estimated traveling route information in the estimated traveling route information data table of the estimated traveling route information storage unit 170, updating the estimated traveling route information, excluding the estimated traveling route information from the candidates for the estimated traveling route information, and the like are performed. Through repetition of the process, the traveling route output unit 190 sequentially stores the road ID indicating the defined traveling route in the defined traveling route storage unit 200 after the process of step S1110. When a determination result indicating that a transit point has been passed is input from the control unit 1000, the billing request unit 210 of the traveling route specifying unit 22 outputs a billing amount calculation request including information such as the road ID stored in the defined traveling route storage unit 200 to the billing amount calculating unit 304 of the application unit 30. Accordingly, the billing amount calculating unit 304 calculates a billing amount.

[0095]

The above-mentioned traffic information processing device has a computer system therein. The above-mentioned processes are stored in the form of a program on a computer-readable recording medium and the processes are performed by causing a computer to read and execute the program. Here, examples of the computer-readable

recording medium include a magnetic disk, a magneto-optical disc, a CD-ROM, a DVD-ROM, and a semiconductor memory. The computer program may be transmitted to a computer via a communication line and the computer having received the computer program may execute the program.

5 [0096]

The program may be configured to realize a part of the above-mentioned functions.

The program may be a program, that is, a so-called differential file (differential program), capable of realizing the above-mentioned functions in combination with a
10 program recorded in advance in a computer system.

[Industrial Applicability]

[0097]

According to the traffic information processing device, the processing method thereof, and the program, it is possible to prevent erroneous billing and to reduce the
15 number of times that the situation occurs in which a driver cannot immediately recognize when her or his vehicle has passed through an entrance or an exit of a road for road pricing or a billing amount when her or his vehicle passes through a traveling route including the road for road pricing.

[Reference Signs List]

20 [0098]

1 Traffic information processing device

10 Position measuring unit

20 Map matching unit

30 Application unit

25 40 Display unit

	50 Storage unit
	11 Latitude and longitude sensor
	12 Acceleration sensor
	13 Gyro sensor
5	14 Vehicle speed signal output unit
	15 Position information calculating unit
	21 Real-time processing unit
	22 Traveling route specifying unit
	301 First transit point passage determining unit
10	302 First transit point passage information output unit
	303 Transit point type determining unit
	304 Billing amount calculating unit
	305 Second transit point passage determining unit
	306 Second transit point passage information output unit
15	307 Traveling route type determining unit
	308 Speed calculating unit
	309 Traffic information output unit
	310 Current position output unit
	100 Input unit
20	110 Communication unit
	120 Map data storage unit
	130 Road information specifying unit
	140 Estimated traveling position calculating unit
	150 Next route road information specifying unit
25	160 Estimated traveling route information generating unit

170 Estimated traveling route information storage unit

180 Traveling route exclusion determining unit

190 Traveling route output unit

200 Defined traveling route storage unit

5 210 Billing request unit

1000 Control unit

[CLAIMS]

[Claim 1]

A traffic information processing device comprising:

a position information calculating unit configured to calculate and output a current position of a vehicle based on sensed position information of the vehicle input from a sensor unit;

a first transit point passage determining unit configured to determine whether the vehicle has passed a transit point on a traveling route on which billing is enforced based on the current position and position information of the transit point;

a transit point type determining unit configured to determine whether the transit point is a defined point at which a billing amount is determined at the time point at which the passage of the vehicle through the transit point is detected or an undefined point at which the billing amount is not determined at the time point at which the vehicle passes the transit point;

a first transit point passage information output unit configured to output passage information indicating the passage of the vehicle through the transit point when the vehicle is determined to have passed through the transit point and the transit point is determined to be the defined point;

a traveling route specifying unit configured to specify and output an estimated traveling route including the transit point as a defined traveling route among estimated traveling routes, which indicate one or more traveling routes which are undefined traveling routes of the vehicle and which the traveling route specifying unit estimates that the vehicle has passed through based on a plurality of current positions of the vehicle which are calculated at predetermined time intervals, when the vehicle is determined to have passed the transit point and the transit point is determined to be the defined point; and

a billing amount calculating unit configured to calculate a billing amount based on the defined traveling route.

[Claim 2]

The traffic information processing device according to claim 1, further comprising:

a second transit point passage determining unit configured to detect a transit point which is the closest to the current position of the vehicle and is included in the defined traveling route based on the defined traveling route outputted from the traveling route specifying unit when the transit point type determining unit determines that the transit point is the undefined point and to determine that the current position is past the transit point; and

a second transit point passage information output unit configured to output passage information indicating the passage of the vehicle through the transit point which is determined by the second transit point passage determining unit.

[Claim 3]

The traffic information processing device according to claim 2, further comprising a traveling route type determining unit configured to determine a type of traveling route on which billing is enforced,

wherein the billing amount calculating unit calculates the billing amount of the defined traveling route based on the type of traveling route.

[Claim 4]

The traffic information processing device according to claim 2 or 3, wherein the second transit point passage determining unit instructs the billing amount calculating unit to calculate the billing amount based on the distance traveled on the road when the transit point is the undefined point and information indicating that the transit point is a transit point at an entrance of a road on which the distance billing is enforced is input to the second transit point passage determining unit.

[Claim 5]

The traffic information processing device according to any one of claims 2 to 4, wherein each of the first transit point passage determining unit and the second transit point passage determining unit acquires identification information of a current traveling route which is specified based on the current position, determines whether the current position is past the transit point at predetermined time intervals based on the identification information

of the current traveling route and the current position, determines whether the vehicle passes through a plurality of traveling routes based on identification information of the traveling route acquired when determining whether the previous transit point has been passed at predetermined time intervals and identification information of the traveling route acquired when determining whether the current transit point has been passed, and determines that the current position is past the transit point which is located between the position information at the time the previous transition point is determined to have been passed and the position information of the timing at which it is determined whether the current transit point has been passed the transit points included in the plurality of passed through traveling routes when the vehicle is detected to have passed through the plurality of traveling routes.

[Claim 6]

The traffic information processing device according to any one of claims 2 to 5, further comprising a speed calculating unit configured to calculate a speed of the vehicle based on a time each point of a plurality of points in the defined traveling route is passed in the defined traveling route outputted from the traveling route specifying unit and distances between each of the plurality of points.

[Claim 7]

The traffic information processing device according to any one of claims 1 to 6, further comprising a traffic information output unit configured to acquire the identification information of the current traveling route specified based on the current position and to read and output traffic information corresponding to the identification information of the current traveling route.

[Claim 8]

The traffic information processing device according to any one of claims 1 to 7, further comprising a current position output unit configured to output the current position which is calculated by the position information calculating unit.

[Claim 9]

A processing method of a traffic information processing device comprising:

- causing a position information calculating unit to calculate a current position of a vehicle based on sensed position information of the vehicle input from a sensor unit;
- causing a first transit point passage determining unit to determine whether the vehicle has passed a transit point on a traveling route on which billing is enforced based on the current position and position information of the transit point;
- causing a transit point type determining unit to determine whether the transit point is a defined point at which a billing amount is determined at the time point at which the passage of the vehicle through the transit point is detected or an undefined point at which the billing amount is not determined at the time point at which the vehicle has passed the transit point;
- causing a first transit point passage information output unit to output passage information indicating the passage of the vehicle through the transit point when the vehicle is determined to have passed through the transit point and the transit point is determined to be the defined point;
- causing a traveling route specifying unit to specify and output an estimated traveling route including the transit point as a defined traveling route among estimated traveling routes, which indicate one or more traveling routes which are undefined traveling routes of the vehicle and which the traveling route specifying unit estimates that the vehicle has passed through based on a plurality of current positions of the vehicle which are calculated at predetermined time intervals, when the vehicle is determined to have passed the transit point and the transit point is determined to be the defined point; and
- causing a billing amount calculating unit to calculate a billing amount based on the defined traveling route.

[Claim 10]

The processing method according to claim 9, further comprising:

- causing a second transit point passage determining unit to detect a transit point which is the closest to the current position of the vehicle and is included in the defined traveling route based on the defined traveling route outputted from the traveling route

specifying unit when the transit point type determining unit determines that the transit point is the undefined point and to determine that the current position is past the transit point; and

causing a second transit point passage information output unit to output passage information indicating the passage of the vehicle through the transit point which is determined by the second transit point passage determining unit.

[Claim 11]

The processing method according to claim 10, further comprising causing a traveling route type determining unit to determine a type of traveling route on which billing is enforced,

wherein the billing amount calculating unit calculates the billing amount of the defined traveling route based on the type of traveling route.

[Claim 12]

The processing method according to claim 10 or 11, wherein the second transit point passage determining unit instructs the billing amount calculating unit to calculate the billing amount based on the distance traveled on the road when the transit point is the undefined point and information indicating that the transit point is a transit point at an entrance of a road on which the distance billing is enforced is input to the second transit point passage determining unit.

[Claim 13]

The processing method according to any one of claims 10 to 12, wherein each of the first transit point passage determining unit and the second transit point passage determining unit acquires identification information of a current traveling route which is specified based on the current position, determines whether the current position is past the transit point at predetermined time intervals based on the identification information of the current traveling route and the current position, determines whether the vehicle passes through a plurality of traveling routes based on identification information of the traveling route acquired when determining whether the previous transit point has been passed at predetermined time

intervals and identification information of the traveling route acquired when determining whether the current transit point has been passed, and determines that the current position is past the transit point which is located between the position information at the time the previous transition point is determined to have been passed and the position information of the timing at which it is determined whether the current transit point has been passed the transit points included in the plurality of passed through traveling routes when the vehicle is detected to have passed through the plurality of traveling routes.

[Claim 14]

A program causing a computer of a traffic information processing device to serve as:
position information calculating means configured to calculate and output a current position of a vehicle based on sensed position information of the vehicle input from a sensor unit;

first transit point passage determining means configured to determine whether the vehicle has passed a transit point on a traveling route on which billing is enforced based on the current position and position information of the transit point;

transit point type determining means configured to determine whether the transit point is a defined point at which a billing amount is determined at the time point at which the passage of the vehicle through the transit point is detected or an undefined point at which the billing amount is not determined at the time point at which the vehicle has passed the transit point;

first transit point passage information output means configured to output passage information indicating the passage of the vehicle through the transit point when the vehicle is determined to have passed through the transit point and the transit point is determined to be the defined point;

traveling route specifying means configured to specify and output an estimated traveling route including the transit point as a defined traveling route among estimated traveling routes, which indicate one or more traveling routes which are undefined traveling routes of the vehicle and which the traveling route specifying unit estimates that the vehicle has passed through based on a plurality of current positions of the vehicle which are

calculated at predetermined time intervals, when the vehicle is determined to have passed the transit point and the transit point is determined to be the defined point; and

billing amount calculating means configured to calculate a billing amount based on the defined traveling route.

[Claim 15]

The program according to claim 14, further causing the computer of the traffic information processing device to serve as:

second transit point passage determining means configured to detect a transit point which is the closest to the current position of the vehicle and is included in the defined traveling route based on the defined traveling route outputted from the traveling route specifying means when the transit point type determining means determines that the transit point is the undefined point and to determine that the current position is past the transit point; and

second transit point passage information output means configured to output passage information indicating the passage of the vehicle through the transit point which is determined by the second transit point passage determining means.

[Claim 16]

The program according to claim 15, further causing the computer of the traffic information processing device to serve as traveling route type determining means configured to determine a type of traveling route on which billing is enforced,

wherein the billing amount calculating means calculates the billing amount of the defined traveling route based on the type of traveling route.

[Claim 17]

The program according to claim 15 or 16, wherein the second transit point passage determining means instructs the billing amount calculating means to calculate the billing amount based on the distance traveled on the road when the transit point is the undefined point and information indicating that the transit point is a transit point at an entrance of a road

on which the distance billing is enforced-is input to the second transit point passage determining unit.

[Claim 18]

The program according to any one of claims 15 to 17, wherein each of the first transit point passage determining means and the second transit point passage determining means acquires identification information of a current traveling route which is specified based on the current position, determines whether the current position is past the transit point at predetermined time intervals based on the identification information of the current traveling route and the current position, determines whether the vehicle passes through a plurality of traveling routes based on identification information of the traveling route acquired when determining whether the previous transit point has been passed at a predetermined intervals and identification information of the traveling route acquired when determining whether the current transit point has been passed, and determines that the current position is past the transit point which is located between the position information at the time the previous transition point is determined to have been passed and the position information of the timing at which it is determined whether the current transit point has been passed the transit points included in the plurality of passed through traveling routes when the vehicle is detected to have passed through the plurality of traveling routes.