

DESCRIPTION

Title of Invention

TRAFFIC INFORMATION PROCESSING DEVICE AND PROCESSING METHOD AND PROGRAM THEREFOR

Technical Field

[0001]

The present invention relates to a traffic information processing device installed in a vehicle or the like for processing traffic information such as a travel path of the vehicle and a processing method and a program therefor.

Priority is claimed on Japanese Patent Application No. 2013-001961, filed January 09, 2013, the content of which is incorporated herein by reference.

Background Art

[0002]

A car navigation device installed in a vehicle or the like receives a transmission signal that is transmitted from a GPS satellite, specifies a current position of the vehicle, and specifies a road along which the vehicle is currently running. Further, the car navigation device detects a virtual position corresponding to the actual current position of the vehicle on the

specified road of a map displayed in a screen, and performs, for example, a process of displaying a mark indicating the current position of the vehicle in the virtual position.

A technology for displaying a current position on a map output in a display screen is disclosed in PTL 1.

A technology for automatically determining a path along which a vehicle actually runs, calculating a toll according to the total distance of the path along which the vehicle runs, and performing billing in a complicated road network in which a plurality of paths are able to be arbitrarily selected between a specific entrance and a specific exit is disclosed in PTL 2.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Unexamined Patent Application
Publication No. 2008-134187

[PTL 2] Japanese Unexamined Patent Application
Publication No. 9-212794

Summary of Invention

Technical Problem

[0004]

Incidentally, in Europe, Singapore, or the like, collecting of a toll using a billing method called road-

pricing in which the toll is charged according to a road on or a distance a vehicle travels is being considered. In the road-pricing method, a travel path will be specified based on a result of measuring a position of the vehicle based on a signal received from a GPS satellite, and billing will be performed according to the distance of the travel path.

[0005]

In a technology where billing called road-pricing is performed, a traffic information processing device such as a car navigation device may falsely detect that the vehicle has passed a transit point provided on a travel path multiple times due to a deviation of a detection position of the vehicle based on a signal received from a GPS satellite. For example, it is assumed that a vehicle does not actually pass the transit point, the traffic information processing device determines that the vehicle does not pass the transit point, a driver stops the engine of the vehicle in front of the transit point, and the traffic information processing device is powered off. In such a situation, the driver starts the engine of the vehicle again, and thus, the traffic information processing device is powered on to detect a position of the vehicle. In this case, when the traffic information processing device falsely detects that the position of the

vehicle first detected after power ON is a point that is present after the transit point has been passed, it is not determined that the transit point has been passed. Also, when the transit point is a point at which an amount of billing is applied to the vehicle, there is a problem in that the amount of billing at the time of passage of the transit point is not added to calculation of the amount of billing of the travel path of the vehicle.

[0006]

Further, for example, after the vehicle has actually passed the transit point, the traffic information processing device determines that the vehicle has passed the transit point and stores information of the transit point, and in this case, the driver stops the engine of the vehicle in a position in which the vehicle has passed the transit point, and the traffic information processing device is powered off. In such a situation, the driver starts the engine of the vehicle again, and thus, the traffic information processing device is powered on to detect the position of the vehicle. In this case, if the traffic information processing device falsely detects that the position of the vehicle first detected after power on is a point that has already been passed, which does not pass the transit point, it may be determined that the same transit point has been passed twice due to the detection

of movement of the vehicle from the point again. When the transit point is a point at which an amount of billing is applied to the vehicle, there is a problem in that the amount of billing at the time of passage of the transit point is added twice to the calculation of the amount of billing of the travel path of the vehicle.

[0007]

Therefore, there is a need for a technology in which there is no omission of a passage determination of such a transit point or in which a process of multiple wrong passage determinations of the transit point is not performed.

[0008]

An object of the present invention is to provide a traffic information processing device and a processing method and a program therefor capable of more accurately determining whether or not a vehicle passes a transit point provided in a travel path.

Solution to Problem

[0009]

According to a first aspect of the present invention, a traffic information processing device includes: an operation stop information recording unit that records stop detection position information indicating a position of a vehicle at a time point of detection of operation

stop when the operation stop of the vehicle is detected based on input of an operation stop signal; an operation start information acquisition unit that acquires start detection position information indicating the position of the vehicle at a time point of detection of operation start when the operation start of the vehicle is detected based on input of an operation start signal; and a transit point passage determination unit that determines whether a transit point recorded on a storage unit in advance is located between a position indicated by the stop detection position information and a position indicated by the start detection position information after the detection of the operation start, and determines that the vehicle has passed the transit point based on a determination result.

[0010]

According to a second aspect of the present invention, the above-described traffic information processing device further includes: a transit point passage presence or absence determination unit that determines whether or not the transit point has been passed based on whether or not identification information of the transit point which is already determined to have been passed has been recorded on the storage unit when the operation start has been detected; a road identification information matching determination unit that determines

whether stop road identification information indicating identification information of a road along which the vehicle has last run in a travel path settled until the detection of the operation stop and start road identification information indicating identification information of the road detected at a time point of the detection of the operation start match when the operation start has been detected; and a passage determination cancellation unit that cancels a result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination unit when the stop road identification information and the start road identification information match and when the identification information of the transit point read by the transit point passage presence or absence determination unit and the identification information of the transit point determined to have been passed by the transit point passage determination unit match.

[0011]

According to a third aspect of the present invention, the above-described traffic information processing device further includes: a last transit point passage time acquisition unit that acquires a last passage time that is a passage time of the transit point determined to have

last been passed among transit points already determined to have been passed before the detection of the operation stop when the operation start has been detected. The operation stop information recording unit further records a time of the detection of the operation stop, the operation start information acquisition unit further acquires a time of the detection of the operation start, and when the identification information of the transit point read by the transit point passage presence or absence determination unit and the identification information of the transit point determined to have been passed by the transit point passage determination unit match, and when a sum of a time from the last passage time to the time of the detection of the operation stop, and a time from a time of the detection of the operation start to a time at which the transit point has first been determined to have been passed in the transit point passage determination unit after the detection of the operation start is shorter than a predetermined time, the passage determination cancellation unit cancels the result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination unit.

[0012]

According to a fourth aspect of the present invention, a processing method in a traffic information processing device includes steps of: causing an operation stop information recording unit to record stop detection position information indicating a position of a vehicle at a time point of detection of operation stop when the operation stop of the vehicle is detected based on input of an operation stop signal; causing an operation start information acquisition unit to acquire start detection position information indicating the position of the vehicle at a time point of detection of operation start when the operation start of the vehicle is detected based on input of an operation start signal; and causing a transit point passage determination unit to determine whether a transit point recorded on a storage unit in advance is located between a position indicated by the stop detection position information and a position indicated by the start detection position information after the detection of the operation start, and determines that the vehicle has passed the transit point based on a determination result.

[0013]

According to a fifth aspect of the present invention, the processing method further includes steps of: causing a transit point passage presence or absence determination

unit to determine whether or not the transit point has been passed based on whether or not identification information of the transit point already determined to have been passed has been recorded on the storage unit when the operation start has been detected; causing a road identification information matching determination unit to determine whether stop road identification information indicating identification information of a road along which the vehicle has last run in a travel path settled until the detection of the operation stop and start road identification information indicating identification information of the road detected at a time point of the detection of the operation start match when the operation start has been detected; and causing a passage determination cancellation unit to cancel a result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination unit when the stop road identification information and the start road identification information match and when the identification information of the transit point read by the transit point passage presence or absence determination unit and the identification information of the transit point determined to have been passed by the transit point passage determination unit match.

[0014]

According to a sixth aspect of the present invention, the processing method further includes a step of: causing a last transit point passage time acquisition unit to acquire a last passage time that is a passage time of the transit point determined to have last been passed among transit points already determined to have been passed before the detection of the operation stop when the operation start has been detected, wherein the operation stop information recording unit further records a time of the detection of the operation stop, the operation start information acquisition unit further acquires a time of the detection of the operation start, and when the identification information of the transit point read by the transit point passage presence or absence determination unit and the identification information of the transit point determined to have been passed by the transit point passage determination unit match, and when a sum of a time from the last passage time to the time of the detection of the operation stop, and a time from a time of the detection of the operation start to a time at which the transit point has first been determined to have been passed in the transit point passage determination unit after the detection of the operation start is shorter than a predetermined time, the passage determination

cancellation unit cancels the result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination unit.

[0015]

According to a seventh aspect of the present invention, a program causes a computer of a traffic information processing device to function as: operation stop information recording means for recording stop detection position information indicating a position of a vehicle at a time point of detection of operation stop when the operation stop of the vehicle is detected based on input of an operation stop signal; operation start information acquisition means for acquiring start detection position information indicating the position of the vehicle at a time point of detection of operation start when the operation start of the vehicle is detected based on input of an operation start signal; and transit point passage determination means for determining whether a transit point recorded on a storage unit in advance is located between a position indicated by the stop detection position information and a position indicated by the start detection position information after the detection of the operation start, and determining that the vehicle has passed the transit point based on a determination result.

[0016]

According to an eighth aspect of the present invention, the above-described program further causes the computer to function as: transit point passage determination means for determining whether or not the transit point has been passed based on whether or not identification information of the transit point already determined to have been passed has been recorded on the storage unit when the operation start has been detected; road identification information matching determination means for determining whether stop road identification information indicating identification information of a road along which the vehicle has last run in a travel path settled until the detection of the operation stop and start road identification information indicating identification information of the road detected at a time point of the detection of the operation start match when the operation start has been detected; and passage determination cancellation means for canceling a result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination means when the stop road identification information and the start road identification information match and when the identification information of the transit point read by

the transit point passage presence or absence determination means and the identification information of the transit point determined to have been passed by the transit point passage determination means match.

[0017]

According to a ninth aspect of the present invention, the above-described program further causes the computer to function as: last transit point passage time acquisition means for acquiring a last passage time that is a passage time of the transit point determined to have last been passed among transit points already determined to have been passed before the detection of the operation stop when the operation start has been detected, in which the operation stop information recording means further records a time of the detection of the operation stop, the operation start information acquisition means further acquires a time of the detection of the operation start, and when the identification information of the transit point read by the transit point passage presence or absence determination means and the identification information of the transit point determined to have been passed by the transit point passage determination means match, and a sum of a time from the last passage time to the time of the detection of the operation stop, and a time from a time of the detection of the operation start

to a time at which the transit point has first been determined to have been passed in the transit point passage determination means after the detection of the operation start is shorter than a predetermined time, the passage determination cancellation means cancels the result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination means.

Advantageous Effects of Invention

[0018]

According to the traffic information processing device and the processing method, and the program therefor described above, it is possible to more accurately determine whether or not the vehicle passes the transit point provided in the travel path.

Brief Description of Drawings

[0019]

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

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

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

Fig. 4 is a diagram illustrating an overview of a passage determination process for the transit point according to an embodiment of the present invention.

Fig. 5 is a third diagram illustrating a process flow of the traffic information processing device according to an embodiment of the present invention.

Fig. 6 is a block diagram illustrating a configuration of a travel path specification unit according to an embodiment of the present invention.

Fig. 7 is a diagram illustrating road information stored in a map data storage unit according to an embodiment of the present invention.

Fig. 8 is a first diagram illustrating an estimated travel path information data table stored in an estimated travel path information storage unit according to an embodiment of the present invention.

Fig. 9 is a diagram illustrating a process flow of a travel path specification unit according to an embodiment of the present invention.

Fig. 10 is a first diagram illustrating a process overview of the road information specification unit according to an embodiment of the present invention.

Fig. 11 is a second diagram illustrating a process overview of the road information specification unit according to an embodiment of the present invention.

Fig. 12 is a second diagram illustrating the estimated travel path information data table stored in the estimated travel path information storage unit according to an embodiment of the present invention.

Fig. 13 is a diagram illustrating a process overview of a non-travel path determination unit according to an embodiment of the present invention.

Fig. 14 is a third diagram illustrating an estimated travel path information data table stored in an estimated travel path information storage unit according to an embodiment of the present invention.

Fig. 15 is a first diagram illustrating a process overview of a travel path output unit according to an embodiment of the present invention.

Description of Embodiments

[0020]

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

A traffic information processing device 1 is installed, for example, in a vehicle. Further, the

traffic information processing device 1 may be built into a car navigation device or an audio device.

The traffic information processing device 1 in this embodiment performs a process of more accurately determining whether or not the vehicle passes a transit point provided in a travel path.

Further, the traffic information processing device 1 in this embodiment estimates a travel path that a vehicle has passed (run) in the past, and notifies a driver that the vehicle passes a transit point in real time when the vehicle passes the transit point at which an amount of billing is generated at an entrance or an exit of a road that is a road-pricing target among transit points provided on the travel path. Further, when the vehicle passes the transit point at which the amount of billing is generated, the traffic information processing device 1 performs a process of outputting, in real time, information regarding the amount of billing when the vehicle passes the travel path including the road that is a road-pricing target.

[0021]

Further, in this embodiment, a transit point for settling that an amount of billing is applied to the vehicle is provided at the entrance or the exit of the road that is a road-pricing target. Schemes of billing a

settled vehicle at the transit point include a scheme (point billing) of billing the vehicle for a predetermined amount of money when the vehicle passes the transit point, a scheme (codon billing) of billing the vehicle for a predetermined amount of money when the vehicle enters an area in which the transit point is provided, a scheme (highway billing) of billing the vehicle for a predetermined amount of money when the vehicle goes out of an exit on a highway or the like, and a scheme (distance billing) of billing the vehicle for an amount of money according to a distance of a road that the vehicle passes over.

[0022]

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

In Fig. 1, reference numeral 1 is a traffic information processing device. The traffic information processing device 1 includes at least a positioning unit 10, a map matching unit 20, an application unit 30, a display unit 40, and a storage unit 50.

[0023]

The positioning unit 10 includes a configuration having a sensing function such as a latitude and longitude measurement sensor 11, an acceleration sensor 12, a gyro

sensor 13, and a vehicle speed signal output device 14, and a position information calculation unit 15. The latitude and longitude measurement sensor 11 is a processing unit that calculates the current latitude and longitude of a vehicle using a signal received from a GPS satellite. Further, the acceleration sensor 12 is a processing unit that detects an acceleration of the vehicle. Further, the gyro sensor 13 is a processing unit that detects angular velocity, for example, when a vehicle rotates in a horizontal direction. Further, the vehicle speed signal output device 14 is a processing unit that outputs a pulse signal (vehicle speed signal) that is proportional to the number of rotations of an axle of the vehicle. Also, the position information calculation unit 15 is a processing unit that calculates a sensed position of the vehicle based on sensing information such as information of the latitude and the longitude input from the latitude and longitude measurement sensor 11, information of the acceleration input from the acceleration sensor 12, information of an angle or the angular velocity input from the gyro sensor 13, and the pulse signal (vehicle speed signal) proportional to the number of rotations of the axle input from the vehicle speed signal output device 14.

[0024]

Further, the map matching unit 20 includes processing units such as a real time processing unit 21, a travel path specification unit 22, an operation stop information recording unit 23, an operation start information acquisition unit 24, a transit point passage presence or absence determination unit 25, a road identification information matching determination unit 26, a last transit point passage time acquisition unit 27, and a passage determination cancellation unit 28.

The real time processing unit 21 is a processing unit that outputs position information input from the positioning unit 10 to the application unit 30 in real time, in addition to performing a process of specifying the position of the vehicle on the map in real time based on the position information of the vehicle input from the positioning unit 10.

Further, the travel path specification unit 22 is a processing unit that estimates the travel path that the vehicle has passed through. Further, the travel path specification unit 22 is a processing unit that specifies, as a settled travel path that is settled to have been passed, an unsettled vehicle travel path, which is the estimated travel path including the transit point from among the estimated travel paths indicating one or a plurality of travel paths estimated to have been passed by

the vehicle, and outputs the settled travel path. When the travel path specification unit 22 outputs the settled travel path, the travel path specification unit 22 then further estimates one or a plurality of travel paths that can be estimated to have been passed by the vehicle, and repeats a process of specifying, as a settled travel path, the estimated travel path including the transit point from among the estimated travel paths that are the estimation result, and outputting of the settled travel path.

[0025]

Further, the operation stop information recording unit 23 is a processing unit that records stop information including stop detection position information indicating the position of the vehicle at a time point of detection of the operation stop, stop road identification information indicating the identification information of the road along which the vehicle has last run in the travel path settled until the detection of the operation stop, a time of the detection of the operation stop on the storage unit 50 when the operation stop has been detected based on the input of the operation stop signal.

Further, the operation start information acquisition unit 24 is a processing unit that acquires start information including start detection position information indicating the position of the vehicle at a time point of

detection of the operation start, start road identification information indicating the identification information of the road detected at a time point of the detection of the operation start, a time of the detection of the operation start when the operation start has been detected based on the input of the operation start signal.

[0026]

Further, the transit point passage presence or absence determination unit 25 is a processing unit that determines whether or not the transit point has been passed based on whether the identification information of the transit point already determined to have been passed has been recorded on the storage unit 50 when the operation start has been detected. Further, the transit point is a point that is provided on a road so as to detect that the vehicle passes, for example, as illustrated in Fig. 4(a). The transit point may be a transit point device such as hardware actually buried in the road or may be information indicating a position virtually provided on a map of map data stored in the traffic information processing device 1. Further, the position information of each transit point is determined in advance for each road and held in the storage unit 50.

Further, the road identification information matching determination unit 26 is a processing unit that

determines whether the stop road identification information and the start road identification information match when the operation start has been detected.

Further, the last transit point passage time acquisition unit 27 is a processing unit that acquires a last passage time that is a passage time of the transit point determined to have last been passed among the transit points already determined to have been passed before the detection of the operation stop when the operation start has been detected.

The passage determination cancellation unit 28 is a processing unit that performs a cancellation process regarding a determination that the transit point determined to have been passed has been passed.

[0027]

Further, the application unit 30 includes respective processing units including a first transit point passage determination unit 301, a first transit point passage information output unit 302, a transit point type determination unit 303, a billing amount calculation unit 304, a second transit point passage determination unit 305, a second transit point passage information output unit 306, and a travel path type determination unit 307.

[0028]

The first transit point passage determination unit 301 is a processing unit that determines whether the vehicle has passed the transit point based on the current position and the position information of the transit point.

In this embodiment, the transit points are classified into two transit points including a settled point in which an amount of billing is determined at a time point at which the vehicle passes the transit point, and a non-settled point in which the amount of billing is not determined at the time point at which the vehicle passes the transit point. More specifically, the transit points include a transit point for performing point billing, a transit point for performing codon billing, a transit point provided at an exit of a road that is a highway billing target, and a transit point provided at an exit of a road that is a distance billing target, as described above, and these transit points are classified as the settled points. Further, there is a transit point provided at an entrance of a road that is a highway billing target, and a transit point provided at an entrance of a road that is a distance billing target, and these transit points are classified as the non-settled points. Further, the classification of these transit points is one example, and a method of classifying the

transit point as the settled point or as the non-settled point is not limited thereto.

[0029]

Further, the transit point type determination unit 303 is a processing unit that determines whether the transit point determined to have been passed by the vehicle by the first transit point passage determination unit 301 or the second transit point passage determination unit 305 is a settled point or a non-settled point.

Further, the first transit point passage information output unit 302 is a processing unit that outputs passage information indicating the passage of the transit point when the vehicle is determined to have passed the transit point and the transit point is determined to be the settled point.

In this embodiment, the first transit point passage information output unit 302 outputs the passage information to the display unit 40.

Further, the billing amount calculation unit 304 is a processing unit that calculates the amount of billing of the settled travel path.

[0030]

Further, the second transit point passage determination unit 305 is a processing unit that detects the transit point closest to the current position of the

vehicle among the transit points included in the settled travel path output from the travel path specification unit 22, and determines that the current position has passed the transit point.

Further, the second transit point passage information output unit 306 is a processing unit that outputs passage information indicating the passage of the transit point determined by the second transit point passage determination unit 305. In this embodiment, the second transit point passage information output unit 306 outputs the passage information to the display unit 40.

Further, the travel path type determination unit 307 is a processing unit that determines the type of the travel path that is a billing target. The type of the travel path is, for example, information indicating a highway, a toll road, or a bridge.

Further, the storage unit 50 stores various pieces of information used for a process performed by the map matching unit 20 or the application unit 30.

[0031]

Also, in this embodiment, the second transit point passage determination unit 305 determines whether the transit point recorded on the storage unit 50 in advance is located between a position indicated by a stop detection position information and a position indicated by

a start detection position information after the detection of the operation start, and determines that the vehicle has passed the transit point based on the determination result.

[0032]

Further, in this embodiment, when the stop road identification information and the start road identification information match and when the identification information of the transit point read by the transit point passage presence or absence determination unit 25 and the identification information of the transit point determined to have been passed by the second transit point passage determination unit 305 match, the passage determination cancellation unit 28 cancels the result of determining that the transit point has been passed after the detection of the operation start in the second transit point passage determination unit 305.

[0033]

Further, in this embodiment, when the identification information of the transit point read by the transit point passage presence or absence determination unit 25 and the identification information of the transit point determined to have been passed by the second transit point passage determination unit 305 match, and a sum of a time from the last passage time indicating a passage time of the transit

point determined to have last been passed among the transit points already determined to have been passed before the time of the detection of the operation stop to a time of the detection of the operation stop, and a time from a time of the detection of the operation start to a time at which the transit point has first been determined to have been passed in the second transit point passage determination unit 305 after the detection of the operation start is shorter than a predetermined time, the passage determination cancellation unit 28 cancels the result of determining that the transit point has been passed after the detection of the operation start in the second transit point passage determination unit 305.

[0034]

Through such a process, the traffic information processing device 1 according to this embodiment more accurately determines whether the transit point provided in the travel path has been passed.

[0035]

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

Hereinafter, details of the process of the traffic information processing device 1 will be described in order. In the following description, "receive" means a processing

unit "acquires" information output from the other processing unit.

First, the position information calculation unit 15 of the positioning unit 10 receives information from the sensor device such as the latitude and longitude measurement sensor 11, the acceleration sensor 12, the gyro sensor 13, and the vehicle speed signal output device 14 according to the movement of the vehicle, and calculates a current sensed position (latitude and longitude) of the vehicle (step S101). Also, the position information calculation unit 15 outputs the calculated sensed position (position sensing information) to the map matching unit 20. The real time processing unit 21 in the map matching unit 20 receives the sensed position of the vehicle.

[0036]

Here, based on the sensed position of the vehicle input from the positioning unit 10, the real time processing unit 21 specifies a road (road ID) in a position in an error range from the sensed position from a plurality of pieces of the road information recorded on the storage unit 50. Also, the real time processing unit 21 specifies a current position that can be estimated to be a position that is most likely to be (appropriate) on the road, a running direction, or a speed, based on the

sensed position (step S102). Further, the specified current position that can be estimated to be a position that is most likely to be (appropriate) on the road can be, for example, a position closest to the sensed position on the road. Further, the current position may be specified using information of the running direction or the speed, in addition to the sensed position. Positional information of the endpoints of the road indicated by the road information, position information at predetermined intervals on a line connecting the endpoints, information of an extension direction of the road, or the like may be included in the road information recorded on the storage unit 50. Also, the real time processing unit 21 outputs the current position on the road of the vehicle and the road ID (identification information of the road) to the application unit 30 in real time. Further, the real time processing unit 21 may also output the current position on the road of the vehicle and the road ID to the travel path specification unit 22.

[0037]

Next, the first transit point passage determination 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 along which the vehicle runs. Then, the first transit point passage

determination unit 301 reads the IDs of one or a plurality of transit points and the position information of the transit points recorded on the storage unit 50 in association with the input road ID from the storage unit 50. Also, the first transit point passage determination unit 301 specifies the position information of the transit point closest to the current position among the read pieces of position information of the transit point, and calculates a distance between the current position and the specified position information of the transit point. Also, the first transit point passage determination 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, when the distance between the current position and the specified position information of the transit point is equal to or smaller than a distance at which the vehicle can be determined to have passed the transit point, the first transit point passage determination unit 301 determines that the vehicle has passed the transit point. When the first transit point passage determination unit 301 determines that the vehicle does not pass the transit point, the first transit point passage determination unit 301 waits for the current position to be input from the real time processing unit 21.

When the current position is input, the first transit point passage determination unit 301 performs the determination of step S103 again.

[0038]

Also, when the first transit point passage determination unit 301 determines that the vehicle has passed the transit point, the first transit point passage determination unit 301 outputs a road type determination request for a road along which the vehicle currently runs to the travel path type determination unit 307. The road ID input from the real time processing unit 21 is included in the road type determination request. The travel path type determination unit 307 reads information of the type of the road recorded on the storage unit 50 in association with the road ID, and determines the road type (a type of the travel path) (step S104), and outputs information of the road type to the first transit point passage determination unit 301.

[0039]

Next, the first transit point passage determination unit 301 requests the transit point type determination unit 303 to determine a type of the transit point. The ID of the transit point is included in a signal of the request for the type determination. When the transit point type determination unit 303 receives the request for

a type determination, the transit point type determination unit 303 determines whether the transit point determined to have been passed is a settled point or a non-settled point (step S105). More specifically, the transit point type determination unit 303 reads the information of the type of the transit point stored in the association with the ID from the storage unit 50 based on the ID of the transit point determined to have been passed. Also, the transit point type determination unit 303 determines whether the information of the type of the transit point read from the storage unit 50 is information indicating the settled point or information indicating the non-settled point. Also, the transit point type determination unit 303 outputs information of the determination result indicating the settled point or the non-settled point to the first transit point passage determination unit 301.

[0040]

Also, when the determination result from the transit point type determination unit 303 is the information indicating the settled point, the first transit point passage determination unit 301 outputs the information indicating the transit point passage to the first transit point passage information output unit 302 (step S106). Then, the first transit point passage information output unit 302 displays the passage information indicating that

the vehicle has passed the transit point on the display unit 40 (step S107). Further, at this time, the first transit point passage information output unit 302 may also acquire information of a name of the transit point or a type of the transit point based on the ID of the transit point from the first transit point passage determination unit 301 and output the information on the display unit 40. Further, the passage information or the like may be displayed as a character string on a liquid crystal display unit, or a lamp may be turned on to notify the driver of the vehicle that the vehicle has passed a transit point. Further, in place of the display unit 40, an audio output unit may output sound to indicate that the vehicle passes the transit point.

[0041]

The first transit point passage determination unit 301 outputs information indicating the transit point passage to the first transit point passage information output unit 302, and then outputs the specifying request for the travel path passed in the past to the travel path specification unit 22. The travel path specifying request is a signal for requesting the travel path specification unit 22 to forcibly settle the past travel path to the transit point passed. Accordingly, the traffic information processing device 1 can output the information

indicating that the vehicle passes the transit point and the information of the amount of billing to the transit point based on the settlement of the travel path when the vehicle passes the transit point to the display unit 40. Information such as the current time, the road ID input from the real time processing unit 21, the type of the road determined in step S104, the type of the transit point determined in step S105, and the ID of the transit point determined in step S105 may be included in the travel path specifying request. Further, the ID of the transit point is assumed to be read from the storage unit 50 by the first transit point passage determination unit 301. Then, the travel path specification unit 22 settles the travel path passed in the past (step S108). Details of this process will be described below.

[0042]

The process of specifying the travel path is a process of more accurately specifying the road along which the vehicle has run in the past, unlike the specifying of the road performed based on the current position in the real time processing unit 21. More specifically, the travel path specification unit 22 is a processing unit that settles and outputs the road ID included in the estimated travel path information other than the estimated travel path information determined not to be the travel

path among the pieces of estimated travel path information including the road IDs indicating the plurality of travel paths estimated in the past, as the road ID indicating a past travel path. By performing such a process, some time is taken for settlement of the travel path passed in the past, in comparison with time taken for the process of specifying the road in the real time processing unit 21. Also, when the travel path, passed in the past, to the transit point determined to have been passed in step S103, the travel path specification unit 22 determines the type of the transit point included in the travel path specifying request (step S109). Also, when the type of the transit point indicates a settled point, the travel path specification unit 22 outputs a billing amount calculation request to the billing amount calculation unit 304 to instruct to calculate the amount of billing in the past travel path to the transit point. Information such as a road ID of a road currently and newly specified as a road on the travel path among respective road IDs of the roads indicating the travel path to the transit point determined to have been passed, the road type included in the travel path specifying request, the type of the transit point, and the ID of the transit point is included in the billing amount calculation request.

[0043]

Also, the billing amount calculation unit 304 calculates an amount of billing using information regarding a road ID of a new settled travel path, the type of the road, the type of the transit point, and the ID of the transit point that are input at this time, and the road ID of the settled travel path, the type of the road, the type of the transit point, and the ID of the transit point that were input in the past (step S110). More specifically, the billing amount calculation unit 304 reads the distance of the road or an amount of billing when the vehicle has run on the road from the storage unit 50 based on the plurality of the road IDs or the types of the roads having the road IDs, and reads an amount of billing when the vehicle passes the transit point from the storage unit 50 based on the type of the transit point or the ID of the transit point. Also, the billing amount calculation unit 304 calculates a sum of the amount of billing. Further, the billing amount calculation unit 304 may calculate a sum of the amount of billing calculated in the past and the amount of billing in the travel path newly calculated at this time. Also, the billing amount calculation unit 304 outputs the calculated amount of billing to the display unit 40 (step S111). The amount of billing may be displayed as a character string on a liquid crystal display unit, or, in place of the display unit 40,

an audio output unit may output sound or the like indicating the amount of billing through sound.

[0044]

According to the above-described process, when the vehicle has passed the transit point belonging to the settled point at which an amount of billing is determined by only the passage of the transit point (for example, a transit point for performing point billing, a transit point for performing codon billing, a transit point provided at an exit of the road that is a highway billing target, or a transit point provided at an exit of the road that is a distance billing target), the information indicating that the vehicle passes the transit point is immediately output to the display unit 40. Accordingly, in a road to which road-pricing is applied, the driver of the vehicle can recognize, in real time, that the vehicle passes the transit point at which the amount of billing is determined by only the passage even though there is no large mark. Further, when the vehicle passes the transit point belonging to the settled point, the information indicating that the vehicle passes the transit point is output to the display unit, an accurate travel path to the position of the transit point belonging to the settled point is specified through the process of step S108, and then, an amount of billing settled using the accurate

travel path is output to the display unit 40. Accordingly, the driver can immediately recognize an accurate amount of billing in a step in which the vehicle passes the transit point belonging to the settled point. Further, although a settlement process for a past travel path in the travel path specification unit 22 takes time in comparison with the real time processing unit 21, the difference in the processing time is about one second. This difference in the processing time is a difference in time between the passage of the transit point that is a billing target and the output of the amount of billing to the transit point to the display unit 40 without giving sense of incongruity to the driver.

[0045]

When it is determined in step S105 described above that the transit point that the vehicle passes is not the settled point at which the amount of billing is determined at a time point at which it is detected that the vehicle has passed the transit point, the first transit point passage determination unit 301 waits for next information (the current position and the road ID) to be input from the real time processing unit 21 without performing the process of outputting information indicating the transit point passage to the first transit point passage

information output unit 302 in step S106, and then, repeats the process from step S102.

[0046]

Fig. 3 is a second diagram illustrating a process flow of the traffic information processing device 1.

In the map matching unit 20, the travel path specification unit 22 performs a process of settling a travel path passed in the past based on the processing result of the real time processing unit 21 at predetermined timing intervals regardless of whether the travel path specifying request is input from the first transit point passage determination unit 301. However, the travel path specification unit 22 receives the travel path specifying request input from the first transit point passage determination unit 301, settles the travel path passed in the past even at a timing at which the specifying request is received, and outputs the transit point passage determination request to the second transit point passage determination unit 305. Also, the second transit point passage determination unit 305 receives the transit point passage determination request (step S201). Information such as a road ID indicating the settled travel path settled to have been passed in the past or a current position (for example, a position estimated to be a position most likely to be (appropriate) on the settled

road having the road ID) is included in the transit point passage determination request.

[0047]

Next, the second transit point passage determination unit 305 reads the position information of the transit point recorded on the storage unit 50 in association with the input road ID from the storage unit 50. Also, the second transit point passage determination unit 305 specifies the position information of the transit point closest to the current position among the pieces of read position information of the transit point, and calculates a distance between the current position and the specified position information of the transit point. Also, the second transit point passage determination 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 for determining that the vehicle has passed the transit point, the second transit point passage determination unit 305 determines that the vehicle has passed the transit point. When the second transit point passage determination unit 305 determines that the vehicle

does not pass the transit point, the second transit point passage determination unit 305 waits for the road ID or the current position to be input from the travel path specification unit 22, and performs the determination of step S202 again when the road ID or the current position is input.

[0048]

Also, when the second transit point passage determination unit 305 determines that the vehicle has passed the transit point, the second transit point passage determination unit 305 requests the transit point type determination unit 303 to determine a type of the transit point. The ID of the transit point is assumed to be included in the type determination. When the transit point type determination unit 303 receives the request for a type determination, the transit point type determination unit 303 determines whether the transit point determined to have been passed is the settled point or the non-settled point (step S203). More specifically, based on the ID of the transit point determined to have been passed, the transit point type determination unit 303 reads the information of the type of the transit point associated with the ID from the storage unit 50. Also, the transit point type determination unit 303 determines whether the information of the type of the transit point read from the

storage unit 50 is information indicating the settled point or information indicating the non-settled point. Also, the transit point type determination unit 303 outputs information of a determination result indicating the settled point or the non-settled point to the second transit point passage determination unit 305.

[0049]

Also, the second transit point passage determination unit 305 immediately outputs information indicating the transit point passage to the second transit point passage information output unit 306 only when the determination result from the transit point type determination unit 303 is the information indicating the non-settled point (for example, a transit point provided at an entrance of a road that is a highway billing target, or a transit point provided at an entrance of a road that is a distance billing target) (step S204). Then, the second transit point passage information output unit 306 displays the passage information indicating that the vehicle has passed 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 may be turned on to notify the driver of the vehicle that the vehicle has passed a transit point. Further, in place of the

display unit 40, an audio output unit may output sound to indicate that the vehicle passes the transit point.

[0050]

Further, when the determination result from the transit point type determination unit 303 is the information indicating the settled point, the second transit point passage determination unit 305 does not output the information indicating the transit point passage to the second transit point passage information output unit 306. This is because the information indicating that the vehicle has passed has already been displayed by the first transit point passage determination unit 301 and the first transit point passage information output unit 302 when the vehicle has passed the transit point belonging to the settled point.

[0051]

Through the above-described process, when the transit point passed by the vehicle is the non-settled point, the travel path specification unit 22 of the map matching unit 20 displays information indicating whether the vehicle currently passes the transit point on the travel path using an accurate latitude path after a process of settling the travel path passed in the past. Accordingly, it is possible to notify of a transit timing more accurately when the vehicle passes the transit point

that is a non-settled point in which the amount of billing is not determined by only the transit of the point.

[0052]

Fig. 4 is a diagram illustrating an overview of the passage determination process for the transit point.

Fig. 4(a) is a diagram illustrating an overview of the passage determination for the transit point performed in the first transit point passage determination unit 301 or the second transit point passage determination unit 305 in step S103 or S202 described above. In the passage determination for the transit point illustrated in Fig. 4(a), this passage determination is effective when the road ID input based on the result of a previous process (a previous map matching result) and a road ID input based on the result of a current process (a current map matching result) of the real time processing unit 21 or the travel path specification unit 22 of the map matching unit 20 are the same. That is, the passage determination is effective when the vehicle moves along the same road in the previous map matching process and the current map matching process performed at a predetermined interval. In this case, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 reads the position information of the transit point on the road having the road ID, which is the transit point closest to

the current position, from the storage unit 50 using the road ID input based on the current map matching process. Also, if the read position information is within a predetermined distance from the current position, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 can determine that the vehicle has passed the transit point.

[0053]

Meanwhile, Fig. 4(b) illustrates an example of the passage determination when there is the transit point near an end of the road. Specifically, Fig. 4(b) illustrates an example of the passage determination at a T-shaped road on which a road having a road ID = 1, a road having a road ID = 2, and a road having a road ID = 3 are connected.

Here, when there is the transit point near the end of the road having a road ID = 1, a case in which the first transit point passage determination unit 301 or the second transit point passage determination unit 305 performs the passage determination for the transit point as illustrated in Fig. 4(a) at a timing at which the vehicle runs on the road having a road ID = 2 is considered. In such a case, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 acquires only information of the road ID (= 2) based on a result of the current map

matching process. Also, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 acquires the position information of the transit point from the storage unit 50 based on the information of the road ID = 2. However, in such a process, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 does not acquire information of the road ID = 1, and thus, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 is unable to acquire the information of the transit point associated with the information of the road ID = 1 from the storage unit 50. Therefore, when the previous passage determination is performed near the center of the road having a road ID = 1, the current passage determination is performed on the road having a road ID = 2, and the vehicle passes the transit point at the end of the road having a road ID = 1 (the end on the side of the road having the road ID = 2) during these passage determinations, a situation in which it is unable to be determined that the vehicle has passed the transit point occurs even when the passage determination for the transit point is performed using only the acquired road ID (ID = 2) based on a result of the current map matching process as in the scheme illustrated in Fig. 4(a).

[0054]

So as to solve such a problem, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 determines whether the two road IDs including the road ID input based on the result of the previous map matching process (a result of the previous determination as to whether the vehicle has passed the transit point) and the road ID input based on the current map matching process (a result of the current determination as to whether the vehicle has passed the transit point) are different. Also, when the road IDs are different (when it is detected that the vehicle runs along a plurality of travel paths), the first transit point passage determination unit 301 or the second transit point passage determination unit 305 reads the position information of the transit points recorded in association with the plurality of the road IDs on the storage unit 50 from the storage unit 50. Accordingly, in the roads as illustrated in Fig. 4(b), respective pieces of position information of the transit point on the road having a road ID = 1 and the transit point on the road having a road ID = 2 can be read. Also, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 specifies the position information of the transit point closest to the current position among

the read position information of the transit point, and calculates a distance between the current position and the position information of the specified transit point. Also, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 determines whether the vehicle has passed the transit points based on the distance between the current position and the position information of the specified transit point.

Through such a process, when there is the transit point at the end of the road having a road ID = 1 as illustrated in an upper portion of Fig. 4(b) or when there is the transit point at the end of the road having road ID = 2 as illustrated in a lower portion of Fig. 4(b), it can be determined that the vehicle has passed the transit point. Further, the first transit point passage determination unit 301 or the second transit point passage determination unit 305 may record the information of the transit point determined to have been passed and the time at which it is determined that the transit point has been passed on the storage unit 50.

[0055]

Fig. 5 is a third diagram illustrating a process flow of the traffic information processing device 1.

Next, a case in which the traffic information processing device 1 is powered OFF and then ON will be described.

When a driver stops or parks a vehicle, the driver turns the engine OFF. In this case, in the traffic information processing device 1, the operation stop information recording unit 23 in the map matching unit 20 receives an operation stop signal from an external device, such as a vehicle control device or the like that controls the vehicle, and detects operation stop based on the input of the operation stop signal. Here, the operation stop information recording unit 23 receives the road ID of the road which the vehicle last runs in the travel path settled by the travel path specification unit 22 at each processing timing repeated in each processing unit of the traffic information processing device 1, and receives a current position at the time of operation stop from the real time processing unit 21. Also, the operation stop information recording unit 23 records stop information in which the latest road ID input when the operation stop has been detected, the current position at the time of operation stop (stop detection position information), and an operation stop detection time are associated on the storage unit 50.

[0056]

Also, when the driver starts the vehicle, the engine is turned ON. In this case, power is supplied to the traffic information processing device 1. First, in the traffic information processing device 1, after the power is supplied, the operation start information acquisition unit 24 receives an operation start signal from the external device such as the vehicle control device, and detects operation start based on the input of the operation start signal (step S301). Also, the operation start information acquisition unit 24 receives the road ID of the travel path (start road identification information) first settled by the travel path specification unit 22 after the detection of operation start, and also receives the latest current position (start detection position information) from the real time processing unit 21. Further, the operation start information acquisition unit 24 acquires a time at which the operation start has been detected from an RTC (Real Time Clock). Further, the operation start information acquisition unit 24 outputs the input road ID (start road identification information) to the road identification information matching determination unit 26. Further, the operation start information acquisition unit 24 outputs the current position (start detection position information) and the time at which the operation start has been detected, to

the passage determination cancellation unit 28. Further, the operation start information acquisition unit 24 records start information in which the road ID (start road identification information), the current position (start detection position information), and the time at which the operation start has been detected are associated on the storage unit 50.

[0057]

Here, the second transit point passage determination unit 305 determines whether or not the vehicle passes the transit point, in parallel to the power being supplied to the traffic information processing device 1. Also, the second transit point passage determination unit 305 reads the stop information and the start information from the storage unit 50. Further, the second transit point passage determination unit 305 reads the position information of the plurality of transit points that have been recorded on the storage unit 50 in advance.

[0058]

Also, the second transit point passage determination unit 305 calculates a distance between a line segment connecting stop detection position information (latitude x_1 , longitude y_1) included in the stop information and start detection position information (latitude x_2 , longitude y_2) included in the start information, and

position information of each transit point read from the storage unit 50. Also, second transit point passage determination unit 305 determines whether a vehicle has passed the transit point (step S302). In the specific process of step S302, first, the second transit point passage determination unit 305 determines whether the distance between the line segment connecting the stop detection position information (latitude x1, longitude y1) and the start detection position information (latitude x2, longitude y2), and any one of the pieces of position information of the respective transit points read from the storage unit 50 is smaller than a threshold value. Further, the second transit point passage determination unit 305 determines whether a shortest line from the position indicated by the position information of the transit point read from the storage unit 50 to a line segment connecting the stop detection position information to the start detection position information is orthogonal to a line segment connecting the stop detection position information to the start detection position information. Also, when the distance from the position indicated by the position information of the transit point to the line segment is smaller than the threshold value, and the shortest line from the position indicated by the position information of the transit point to the line segment

connecting the stop detection position information to the start detection position information is orthogonal to the line segment connecting the stop detection position information to the start detection position information, the second transit point passage determination unit 305 determines that the vehicle has passed the transit point. This process is a process for determining whether there is the transit point on the travel path of the vehicle connecting the stop detection position information (latitude x_1 , longitude y_1) to the start detection position information (latitude x_2 , longitude y_2). Accordingly, it is possible to determine whether the transit point on the travel path of the vehicle between the stop detection position information (latitude x_1 , longitude y_1) and the start detection position information (latitude x_2 , longitude y_2) has been passed, and prevent omission of a passage determination for the transit point.

Further, when the distance from the position indicated by the position information of the transit point to the line segment is smaller than the threshold value, the second transit point passage determination unit 305 may immediately determine that the vehicle has passed the transit point.

[0059]

Further, the second transit point passage determination unit 305 reads the position information of all the transit point recorded on the storage unit 50 upon reading the position information of the transit points from the storage unit 50, and determines whether the transit point has been passed. However, the second transit point passage determination unit 305 may read, from the storage unit 50, the position information of the transit points recorded on the storage unit 50 in association with two road IDs including the road ID included in the stop information and the road ID included in the start information. Further, the second transit point passage determination unit 305 may merely read the stop detection position information (latitude x1, longitude y1) included in the stop information and the start detection position information (latitude x2, longitude y2) included in the start information without using the road ID, specify the transit point associated with the position information (in a predetermined distance range from the stop detection position information or the start detection position information) near the position indicated by the position information from the transit points recorded on the storage unit 50, and read the position information of the transit point from the storage unit 50.

[0060]

Further, other processing schemes may be used as a process for preventing omission of a passage determination for the transit point at the time of operation stop and at the time of operation start of the traffic information processing device 1. For example, the second transit point passage determination unit 305 determines whether there is position information of the transit point included in a predetermined rectangular range having the stop detection position information (latitude x1, longitude y1) and the start detection position information (latitude x2, longitude y2) as two of four vertexes using the transit point position information recorded on the storage unit 50 in association with the road ID included in the stop information and the road ID included in the start information. Also, when there is position information of the transit point included in the rectangular range, the second transit point passage determination unit 305 may determine that the transit point corresponding to the position information included in the rectangular range has been passed.

[0061]

Further, the second transit point passage determination unit 305 reads the information of a plurality of points (latitude and longitude) on each road

recorded on the storage unit 50 in association with the road ID included in the stop information and the road ID included in the start information. Also, when a distance between any point (latitude and longitude) on the road and the position information of the transit point on the road along which the vehicle has passed before the operation stop or the position information of the transit point on the road after the operation start is smaller than a threshold value, the second transit point passage determination unit 305 may determine that the transit point in which the distance is smaller than the threshold value has been passed.

[0062]

That is, the second transit point passage determination unit 305 may determine whether or not the transit point has been passed through any process as long as such a process is a process of determining whether there is a transit point on the travel path between the stop detection position information and the start detection position information.

When it is not determined that the transit point has been passed in step S302, it is determined that the cancellation process for a passage determination ends (step S309).

[0063]

Also, when it is determined that the transit point has been passed in the process of step S302, the second transit point passage determination unit 305 outputs the ID of the transit point determined to have first been passed after the operation start, and a passage time at which the transit point is determined to have been passed to the map matching unit 20. Further, the second transit point passage determination unit 305 records the ID of the transit point determined to have been passed or the passage time to be associated with each other on the storage unit 50. Before the operation stop, the second transit point passage determination unit 305 also records the ID of the transit point determined to have been passed or the passage time to be associated with each other on the storage unit 50.

[0064]

On the other hand, in the map matching unit 20, the transit point passage presence or absence determination unit 25 determines whether the ID of the transit point last detected before the operation stop (detected before power OFF) among the transit points already determined to have been passed has been recorded on the storage unit 50 (step S303). Accordingly, when the ID of the transit point has been recorded storage unit 50, the transit point passage presence or absence determination unit 25 can

determine that the transit point has been passed. Further, the ID of the transit point detected last is an ID recorded on the storage unit 50 as a result of the process of determining the passage in the second transit point passage determination unit 305 in step S202 described above. When the transit point is not recorded, the transit point passage presence or absence determination unit 25 notifies the passage determination cancellation unit of information indicating that the transit point is not recorded, and determines that the passage determination cancellation unit 28 ends the cancellation process for the passage determination (step S309). Further, when the transit point last detected before the operation stop has been recorded on the storage unit 50, the transit point passage presence or absence determination unit 25 outputs the ID of the transit point to the passage determination cancellation unit 28.

[0065]

Then, the road identification information matching determination unit 26 receives the road ID (start road identification information) from the operation start information acquisition unit 24. Further, the road identification information matching determination unit 26 reads the road ID (stop road identification information) of the road along which the vehicle runs, which has been

last detected before the operation start from the stop information recorded on the storage unit 50 by the operation stop information recording unit 23. Also, the road identification information matching determination unit 26 determines whether the road ID (start road identification information) input from the operation start information acquisition unit 24 and the road ID (stop road identification information) read from the storage unit 50 match (step S304). Also, when the road ID (start road identification information) input from the operation start information acquisition unit 24 and the road ID (stop road identification information) read from the storage unit 50 do not match, the road identification information matching determination unit 26 notifies the passage determination cancellation unit of information indicating that the road IDs do not match, and determines that the passage determination cancellation unit 28 ends the cancellation process for a passage determination (step S309). Further, when the road ID (start road identification information) input from the operation start information acquisition unit 24 and the road ID (stop road identification information) read from the storage unit 50 match, the road identification information matching determination unit 26 notifies the last transit point passage time acquisition unit 27 of start of the process.

[0066]

Then, the last transit point passage time acquisition unit 27 acquires the last passage time that is a passage time for the transit point determined to have been last passed among the transit points already determined to have been passed before the detection of the operation stop from the storage unit 50. Also, the last transit point passage time acquisition unit 27 outputs the acquired last passage time (T1) to the passage determination cancellation unit 28.

[0067]

Here, the passage determination cancellation unit 28 has already received the current position (start detection position information), and a time (T3) when the operation start has been detected, from the operation start information acquisition unit 24 through above-described process.

Further, the passage determination cancellation unit 28 has already received the ID (P1) of the transit point detected last from the transit point passage presence or absence determination unit 25 through the above-described process.

Further, the passage determination cancellation unit 28 receives the last passage time (T1) that is the passage time for the transit point determined to have been last

passed before the operation stop from the last transit point passage time acquisition unit 27.

Further, the passage determination cancellation unit 28 receives the ID (P2) of the transit point determined to have been first passed after the operation start, and the passage time (T4) from the second transit point passage determination unit 305.

[0068]

Then, the passage determination cancellation unit 28 determines whether the ID (P1) of the transit point last detected before the operation stop and the ID (P2) of the transit point first determined to have been passed after the operation start match (step S305). When the compared IDs of the transit points do not match, the passage determination cancellation unit 28 determines that the cancellation process for a passage determination is to be ended (step S309).

[0069]

Further, when the ID (P1) of the transit point last detected before the operation stop and the ID (P2) of the transit point first determined to have been passed after the operation start match, the passage determination cancellation unit 28 reads the operation stop detection time (T2) from the stop information recorded on the storage unit 50.

Also, the passage determination cancellation unit 28 sums a time from a last passage time (T1) to a time (T2) of the detection of the operation stop and a time from a time (T3) at which the operation start has been detected to a time (T4) at which the transit point is first determined to have been passed in the transit point passage determination unit after the detection of the operation start (step S306). Also, the passage determination cancellation unit 28 determines whether the sum is smaller than a predetermined time (for example, five minutes) (step S307), and determines that the passage determination result for the transit point (P2) determined to have been passed after the detection of the operation start by the second transit point passage determination unit 305 is to be canceled when the sum is smaller than a predetermined time (step S308).

[0070]

Also, the passage determination cancellation unit 28 deletes the information (the transit point ID and the passage time) for the transit point (P2) determined to have been passed after the detection of the operation start by the second transit point passage determination unit 305 from the storage unit 50. Further, the passage determination cancellation unit 28 sends, to the billing amount calculation unit 304, a notification to stop the

billing processing when the billing process occurs when the vehicle has passed the transit point (P2). Accordingly, the billing amount calculation unit 304 stops the billing process when the transit point (P2) is a settled point.

When it is not determined that the passage determination result is to be canceled, and the transit point (P2) determined to have been passed after the detection of the operation start by the second transit point passage determination unit 305 is the settled point as usual, the billing process is performed.

Here, while the example in which the cancellation process for the passage determination for the transit point performed in the second transit point passage determination unit 305 is performed has been described in the above-described example, a cancellation process for the passage determination for the transit point performed in the first transit point passage determination unit 301 may be performed.

[0071]

Here, the process in which the above-described passage determination cancellation unit 28 cancels the second passage determination when it is determined that the same transit point has been passed twice within a predetermined time is illustrated, but the passage

determination cancellation unit 28 may also determine that all passage determination results after the second determination are to be canceled when it is determined that the same transit point has been continuously passed twice or more within a predetermined time.

[0072]

Further, when the stop road identification information and the start road identification information match and the ID of the transit point read by the transit point passage presence or absence determination unit 25 and the ID of the transit point determined to have been passed by the second transit point passage determination unit 305 match, the passage determination cancellation unit 28 may immediately cancel the result of determining that the transit point has been passed after the detection of the operation start in the second transit point passage determination unit 305 without performing the process of steps S306 and S307 described above.

[0073]

According to the process of the above-described passage determination cancellation unit 28, when the same transit point is passed multiple times or when the same transit point is passed multiple times within a predetermined time, the passage determinations subsequent to the first passage determination can be canceled and an

billing process can be performed. Accordingly, it is possible to prevent double billing caused by false detection of the position performed based on a signal from a GPS satellite.

[0074]

Next, details of the process of settling the travel path passed in the past in step S108 described above will be described.

Fig. 6 is a block diagram illustrating a configuration of the travel path specification unit 22.

The travel path specification unit 22 includes each processing unit or storage unit of an input unit 100, a communication unit 110, a map data storage unit 120, a road information specification unit 130, an estimated displacement position calculation unit 140, a next path road information specification unit 150, an estimated travel path information generation unit 160, an estimated travel path information storage unit 170, a non-travel path determination unit 180, a travel path output unit 190, a settled travel path storage unit 200, a billing request unit 210, and a control unit 1000.

[0075]

Fig. 7 is a diagram illustrating road information stored in the map data storage unit.

The road information stored in the map data storage unit 120 is information of respective roads shown on a map indicated in map data, and information of the road IDs of the roads, positions (latitude and longitude) in a real space of the roads, an extension direction, and a connection road ID indicating another connected road is stored. The road shown on the map indicated in the map data is divided, for example, in a position such as a branch point, a start point, or an end point of the road, and a road ID is assigned to each divided road. For example, the road on the map as illustrated in Fig. 7 is divided into nine roads from a road having ID 1 to a road having ID9 based on the start point or a branch point of the road, or a connection point to the other road. Further, the map data storage unit 120 is illustrated as provided within the travel path specification unit 22 for convenience of description, but may be provided outside the travel path specification unit 22.

[0076]

Also, for the roads as illustrated in Fig. 7, nine pieces of the road information of the road having ID 1 to the road having ID9 are recorded on the map data storage unit 120. Also, position information of an endpoint such as a start point or an end point of the road for one divided road indicated by the road ID, or a plurality of

pieces of position information of a midpoint or the like may be stored, as a position in a real space of the road, in one piece of the road information.

For example, for the road having ID 1 in Fig. 7, position information of a connection point connected to the road having ID 2, position information of a connection point connected to the road having ID3, position information of a midpoint of the road having ID 1, and the like are stored in the road information of the road having ID 1. Further, position information of respective points at predetermined intervals between the endpoints such as the start point and the end point may be stored in the road information.

[0077]

Further, the extension direction stored in the road information is, for example, an angle formed with a certain reference direction. For example, if the reference direction is a due north direction, an extension direction corresponding to a position of a point on a certain road included in the road information is an angle formed by the reference direction and a straight line connecting the position to a position of the other point on the same road adjacent to the point. Also, in this embodiment, position information of a plurality of points on the road, and extension directions indicated by the

angle with respect to the reference direction for the position information of the plurality of points may be stored in the road information.

[0078]

Further, since a road indicated by the road ID 2 and a road indicated by the road ID3 are connected to the road indicated by the road ID 1, a connection road ID 2 and a connection road ID3 are stored, as connection road IDs, in the road information including the road ID 1. Here, these connection road IDs are registered to be associated with, for example, the position information of the endpoints on the sides to which the roads indicated by the connection road IDs are connected among pieces of position information of the endpoints included in the road information. That is, for example, for the road information of the road ID 1, the road ID 2 is connected to an endpoint A of the road, and the road ID3 is connected to an endpoint B of the road. Therefore, as the road information of the road ID 1, the road ID 1, the position information of the endpoint A, and the position information of the endpoint B are stored, the road ID 2 is stored to be associated with the position information of the endpoint A, and the road ID3 is stored to be associated with the position information of the endpoint B.

Further, various pieces of information in the road information may be stored in other formats.

[0079]

Fig. 8 is a first diagram illustrating an estimated travel path information data table stored in the estimated travel path information storage unit.

The estimated travel path information storage unit 170 stores one or a plurality of pieces of estimated travel path information generated by the estimated travel path information generation unit 160 in the estimated travel path information data table. An example of Fig. 8 is an example in which four pieces of the road information estimated as roads along which the vehicle runs are specified from among the road information recorded on the map data storage unit 120 immediately after the travel path specification unit 22 starts the process, and recorded in the estimated travel path information data table.

[0080]

The example of Fig. 8 is an example in which four pieces of road information including ID = 1, 2, 4, and 5 are specified immediately after the travel path specification unit 22 starts the process, and a non-travel path flag indicating whether the road information is determined not to be a travel path, and the road

information are stored in the four corresponding pieces of estimated travel path information. In the non-travel path flag of this embodiment, "0" is set in a situation in which the road information is not determined not to be a travel path, and "1" is set in a situation in which the road information is determined not to be a travel path. Further, the road information stored in the estimated travel path information includes, for example, a road ID, and estimation likelihood. The estimation likelihood is a value indicating a degree (likelihood) of the road being estimated to be a road that the vehicle with the traffic information processing device 1 runs, and is a value calculated by the estimated travel path information generation unit 160.

Further, the estimated travel path information storage unit 170 is illustrated as provided within the travel path specification unit 22 for convenience of description, but may be provided outside the travel path specification unit 22.

[0081]

Fig. 9 is a diagram illustrating a process flow of the travel path specification unit 22.

Next, details of the process of the travel path specification unit 22 will be described in order using Fig. 9.

First, the control unit 1000 outputs a start request signal for a road information specifying process to the road information specification unit 130 based on an instruction from the outside or the like. Then, the road information specification unit 130 starts the road information specifying process (step S1010). Also, the road information specification unit 130 of the travel path specification unit 22 receives the sensed position from the position information calculation unit 15 in the input unit 100, and specifies the road information at the time of initial operation start in the error range of the the sensed position using the sensed position (step S1020).

[0082]

Fig. 10 is a first diagram illustrating a process overview of the road information specification unit 130.

The process of step S1020 will be described in greater detail. The road information specification unit 130 reads the distance in the error range, which has been recorded in advance, from the memory or the like. Further, the road information specification unit 130 reads one piece of the road information from the map data storage unit 120, 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 distance is smaller than the

distance indicated by the error range. Also, the road information specification unit 130 estimates and specifies the road information in which the distance between the sensed position and the position information is smaller than the distance shown in the error range as a candidate of the possible road during initial movement on the travel path. Also, the road information specification unit 130 similarly performs a determination as to whether there is a road in the error range using the road information for each road stored in the map data storage unit 120, and estimates and specifies the road information indicating the road in the error range as road information indicating the candidate of the possible road on the travel path.

[0083]

Fig. 10 illustrates an example in which there is the sensed position of the vehicle near a connection point of a road having a road ID 1 and a road having a road ID 2. In this case, it is assumed that a distance between a position of a point (for example, an endpoint) on a road included in each of four pieces of the road information including respective road IDs of the road ID 1, the road ID 2, a road ID 4, and a road ID 5 and the current position is in the error range. Then, the four pieces of the road information including respective road IDs of the road ID 1, the road ID 2, the road ID 4, and the road ID 5

are estimated and specified as the road information indicating the candidate of the possible road on the travel path.

Also, the road information specification unit 130 reads the four specified pieces of the road information including respective road IDs of the road ID 1, the road ID 2, the road ID 4, and the road ID 5 from the map data storage unit 120 and outputs the specified pieces of the road information to the estimated displacement position calculation unit 140. Further, the road information specification unit 130 outputs the four specified pieces of the road information to the estimated travel path information generation unit 160 as road information at the time of initial operation start.

[0084]

When the estimated travel path information generation unit 160 receives the road information at the time of initial operation start, the estimated travel path information generation unit 160 determines whether estimated travel path information has been already recorded on an estimated travel path information data table of the estimated travel path information storage unit 170. Here, in an initial state, the estimated travel path information is not recorded on the estimated travel path information data table of the estimated travel path

information storage unit 170. The estimated travel path information generation unit 160 reads the road ID from each piece of the road information at the time of initial operation start specified by the road information specification unit 130, and generates estimated travel path information individually including the road ID (step S1030). That is, the estimated travel path information generation unit 160 generates estimated travel path information 1 including the road ID 1, estimated travel path information 2 including the road ID 2, estimated travel path information 3 including the road ID 4, and estimated travel path information 4 including the road ID 5. Also, the estimated travel path information generation unit 160 registers information of the estimated travel path information 1 to 4 in the estimated travel path information data table.

[0085]

In this case, the estimated travel path information generation unit 160 associates a non-travel path flag "0" indicating a situation that the road information is not determined not to be a travel path with the road ID 1 as the road information, and records the flag and the road ID 1 on the estimated travel path information data table in the estimated travel path information storage unit 170 for the estimated travel path information 1.

Further, the estimated travel path information generation unit 160 associates the non-travel path flag "0" indicating a situation that the road information is not determined not to be a travel path with the road ID 2 as the road information, and records the flag and the road ID 2 on the estimated travel path information data table in the estimated travel path information storage unit 170 for the estimated travel path information 2.

Further, the estimated travel path information generation unit 160 associates the non-travel path flag "0" indicating a situation that the road information is not determined not to be a travel path with the road ID 4 as the road information, and records the flag and the road ID 4 on the estimated travel path information data table in the estimated travel path information storage unit 170 for the estimated travel path information 3.

Further, the estimated travel path information generation unit 160 associates the non-travel path flag "0" indicating a situation that the road information is not determined not to be a travel path with the road ID 5 as the road information, and records the flag and the road ID 5 on the estimated travel path information data table in the estimated travel path information storage unit 170 for the estimated travel path information 4.

Accordingly, the estimated travel path information generation unit 160 creates the estimated travel path information data table as illustrated in Fig. 8.

[0086]

Fig. 11 is a second diagram illustrating a process overview of the road information specification unit 130.

Meanwhile, when the estimated displacement position calculation unit 140 receives road information at the time of initial operation start, which is specified by the road information specification unit 130, the estimated displacement position calculation unit 140 specifies position information of one endpoint close to the current position in a real space of the vehicle from among endpoints in the position information included in the road information. For example, the estimated displacement position calculation unit 140 reads the position information of one endpoint close to the current position from four pieces of the road information including road ID 1, road ID 2, road ID 4, and road ID 5. Also, the estimated displacement position calculation unit 140 sequentially calculates movement distances using vehicle speed signals, accelerations, respective speeds, and latitudes and longitudes input from the positioning unit 10 over time. The estimated displacement position calculation unit 140 sequentially calculates an estimated

displacement position (see Fig. 11(a)) according to the movement distance from each endpoint specified in the four pieces of specified road information (step S1040), and outputs the road information specified by the road information specification unit 130, and the estimated displacement position repeatedly calculated over time for each specified road information to the next path road information specification unit 150.

[0087]

The next path road information specification unit 150 sequentially receives the road information specified by the road information specification unit 130, and the estimated displacement position for each specified piece of road information from the estimated displacement position calculation unit 140. Also, the next path road information specification unit 150 repeatedly calculates a distance between the position information of the other endpoint different from the one endpoint specified in each of the four pieces of specified road information and the estimated displacement position, for each of the pieces of road information indicated by road ID 1, road ID 2, road ID 4, and road ID 5, and determines whether the distance is within a predetermined distance for each piece of road information (step S1050). Also, the next path road information specification unit 150 specifies the road

information for which the distance becomes within the predetermined distance earliest (step S1060). Accordingly, the next path road information specification unit 150 specifies a road reaching a branch point or a connection point with the other road earliest when a movement according to the movement distance indicated by the estimated displacement position is estimated to be performed on each road indicated by the road information specified by the road information specification unit 130.

[0088]

Also, the next path road information specification unit 150 specifies the road information of the connection road connected to the other endpoint of the road information in which the current position of the vehicle is specified to most approach the position of the other endpoint in the respective pieces of road information indicated by the road ID 1, the road ID 2, the road ID 4, and the road ID 5, as the road information (see Fig. 11(b)) of the road indicating the candidate of the next path (step S1070). For example, the next path road information specification unit 150 detects the connection road ID held in association with the position information of the other endpoint in the road information of the road in which the current position of the vehicle is specified to most approach the position of the other endpoint of

each of the roads indicated by the road ID 1, the road ID 2, the road ID 4, and the road ID 5. Also, the next path road information specification unit 150 reads the road information including the road ID that is the same as the connection road ID from the map data storage unit 120, and specifies the road information as the road information indicating the road of the candidate of the next path. In the example of Fig. 11(b), the road information of the road ID 4 and the road information of the road ID 5 are specified as road information that is a candidate of the next path. Also, the next path road information specification unit 150 outputs road information that is a candidate of the current travel path specified by the road information specification unit 130 and the road information that is a candidate of the next path specified by the next path road information specification unit 150 to the estimated travel path information generation unit 160.

[0089]

When the estimated travel path information generation unit 160 receives the road information that is a candidate of the current travel path specified by the road information specification unit 130 and the road information that is a candidate of the next path specified by the next path road information specification unit 150

from the next path road information specification unit 150, the estimated travel path information generation unit 160 calculates an estimation likelihood of the respective roads indicated by the road information that is the candidate of the current travel path. The estimation likelihood is an index value indicating a degree (likelihood) of a possibility that the vehicle runs on the road indicated by the road information that is the candidate of the current travel path.

[0090]

In a specific calculation scheme, for example, the estimated travel path information generation unit 160 acquires position information P1 of the vehicle at each processing timing during running on the road that is the candidate of the current travel path from the positioning unit 10, and first calculates a movement distance L1 and a running direction D1 during running of the road. Further, the estimated travel path information generation unit 160 reads each piece of position information P2, an extension distance L2 between respective endpoints of the road, and an extension direction D2 included in the road information that is the candidate of the current travel path. Also, using an estimation likelihood calculation equation, the estimated travel path information generation unit 160 calculates a difference between the position information

P1 at each processing timing and the position information P2 closest to the position indicated by P1, a difference between the movement distance L1 and the extension distance L2, and a difference between an angle indicated by the running direction D1 (an angle with respect to a reference direction such as a due north) and an angle indicated by the extension direction D2 (an angle with respect to a reference direction such as a due north), and calculates a sum of values obtained by weighting the differences as the estimation likelihood. Further, a scheme of calculating the estimation likelihood may be any scheme capable of calculating an index value indicating a degree of a possibility that the vehicle runs on the road that is the candidate of the current travel path. Also, the estimated travel path information generation unit 160 records the estimation likelihood calculated for the road information that is the candidate of the current travel path in association with the road ID of the road information on the estimated travel path information data table illustrated in Fig. 8 (step S1080). Also, the estimated travel path information generation unit 160 performs the calculation of the estimation likelihood and recording on the estimated travel path information data table on all road information that is the candidate of the current travel path.

[0091]

Further, after the process of step S1060 described above, the next path road information specification unit 150 sets the road information specified as the candidate of the next path as the candidate of the current travel path, and outputs road information indicating the candidate of the current travel path to the estimated displacement position calculation unit 140. Also, using the road information that is the candidate of the current travel path input from the next path road information specification unit 150, the estimated displacement position calculation unit 140 calculates an estimated displacement position as described above. Further, based on the estimated displacement position, the next path road information specification unit 150 specifies specific information that is the candidate of the next path. Also, the estimated displacement position calculation unit 140 and the next path road information specification unit 150 repeat the same process at intervals of predetermined timings (T1, T2, ...), and the next path road information specification unit 150 outputs the road information that is the candidate of the current travel path and the road information that is the candidate of the next path to the estimated travel path information generation unit 160 at predetermined intervals.

[0092]

The estimated travel path information generation unit 160 receives the road information that is the candidate of the current travel path and the road information that is the candidate of the next path at predetermined intervals from the next path road information specification unit 150. Also, the estimated travel path information generation unit 160 updates or generates the estimated travel path information each time the road information is input (step S1090). More specifically, the estimated travel path information generation unit 160 determines whether the estimated travel path information has been already recorded on the estimated travel path information data table of the estimated travel path information storage unit 170. Here, through the above-described process, the respective pieces of estimated travel path information including the road IDs of the road information at the time of initial operation start have been already recorded on the estimated travel path information data table. Then, the estimated travel path information generation unit 160 specifies the road information holding the same road ID as the connection road ID associated with the position information of the endpoint included in the road information specified as the candidate of the next path,

from among the road information specified as the candidate of the current travel path. Also, the estimated travel path information generation unit 160 separately generates, for all pieces of road information specified as the candidates of the next path, the estimated travel path information in which the road ID included in the road information and the road ID included in the road information specified as the candidate of the next path are associated.

[0093]

That is, a description will be given using examples of Figs. 10 and 11. Road information specified as a candidate of a current travel path is road information including a road ID 1, a road ID 2, a road ID 4, a road ID 5. Further, road information specified as a candidate of a next path includes the road ID 4 and the road ID 5. Also, the estimated travel path information generation unit 160 reads connection road IDs associated with position information of the endpoints from among respective pieces of road information of the road ID 4 and the road ID 5 specified as candidates of the next path. The connection road ID 2 is included in these connection road IDs. Also, the estimated travel path information generation unit 160 specifies road information holding the same road IDs as the read connection road IDs from the

road information including the road ID 1, the road ID 2, the road ID 4, and the road ID 5.

That is, the road information including the road ID 2 is specified.

[0094]

Also, the estimated travel path information generation unit 160 copies the estimated travel path information (estimated travel path information 2 of Fig. 8) including the connection road ID 2 as the road ID of the road information specified previously (at a timing T1), and generates new estimated travel path information 2-2 in which the road ID 4 of the road information specified as the candidate of the next (timing T2) path is stored in the copied estimated travel path information to be associated with the road ID 2. Further, the estimated travel path information generation unit 160 similarly copies the estimated travel path information (estimated travel path information 2 of Fig. 8) including the connection road ID 2 as the road ID of the road information specified previously (at a timing T1), and generates new estimated travel path information 2-3 in which the road ID 5 of the road information specified as the candidate of the next (timing T2) path is stored in the copied estimated travel path information to be associated with the road ID 2.

[0095]

Further, the estimated travel path information generation unit 160 reads the respective road IDs for the pieces of estimated travel path information 1 to 4 already recorded on the estimated travel path information storage unit 170, and updates the road IDs in association with the same road IDs within the estimated travel path information. That is, for the estimated travel path information 1, the road ID 1 that is information of the road specified as the estimated travel path at the timing T1 and the road ID 1 that is information of the road specified as the estimated travel path at the timing T2 are updated in association with each other. Further, similarly, for the estimated travel path information 2, the road ID 2 that is information of the road specified as the estimated travel path at the timing T1 and the road ID 2 that is information of the road specified as the estimated travel path at the timing T2 are updated in association with each other. Further, similarly, for the estimated travel path information 3, the road ID 4 that is information of the road specified as the estimated travel path at the timing T1 and the road ID 4 that is information of the road specified as the estimated travel path at the timing T2 are updated in association with each other. Further, similarly, for the estimated travel path information 4,

the road ID 5 that is information of the road specified as the estimated travel path at the timing T1 and the road ID 5 that is information of the road specified as the estimated travel path at the timing T2 are updated in association with each other.

[0096]

Fig. 12 is a second diagram illustrating the estimated travel path information data table stored in the estimated travel path information storage unit.

Through the process of the above-described estimated travel path information generation unit 160, estimated travel path information 1, estimated travel path information 2, estimated travel path information 2-2, estimated travel path information 2-3, estimated travel path information 3, and estimated travel path information 4 as illustrated in Fig. 12 are stored in the estimated travel path information data table. Further, as illustrated in Fig. 12, in a termination step of the process of the estimated travel path information generation unit 160 described above, the road ID and the estimation likelihood of the road information (road information 1) specified at the time of initial operation start (timing T1) are recorded in the respective pieces of estimated travel path information within the estimated travel path information data table, and the road ID of the

road information (road information 2) specified as the candidate of the next path by the next path road information specification unit 150 at the timing T2 is recorded to be associated with the road ID. However, the estimation likelihood associated with each road ID shown in the road information 2 has not been yet registered at a time point of this process.

[0097]

Also, when the estimated travel path information generation unit 160 receives road information that is a candidate of the current travel path specified by the road information specification unit 130 and the road information that is a candidate of the next path specified by next path road information specification unit 150 from the next path road information specification unit 150, the estimated travel path information generation unit 160 then performs the same process as the scheme of calculating the estimation likelihood described above. Also, the estimated travel path information generation unit 160 calculates the estimation likelihood for each road having the road ID shown in the road information 2, and records the estimation likelihood calculated for each piece of road information that is the candidate of the current travel path on the estimated travel path information data table to be associated with the road ID of the

corresponding road information. Accordingly, the estimation likelihood is recorded to be associated with each road ID recorded as road information 2 of each piece of estimated travel path information of Fig. 12.

[0098]

Also, the non-travel path determination unit 180 performs a process of excluding, from the candidates, the estimated travel path information in which the road ID of the road considered as having a lower possibility of the travel path is recorded as the road ID of the recently specified road information among the pieces of estimated travel path information recorded on the estimated travel path information storage unit 170 (step S1100).

In this process, for example, when the specifying request for the travel path in which the road ID is stored is input from the first transit point passage determination unit 301 of the traffic information processing device 1, the estimated travel path information in which the road ID other than the road ID read from the travel path specifying request is recorded as the road ID of the last specified road information is excluded from the candidates.

Further, for example, the estimated travel path information in which the estimation likelihood equal to or smaller than a threshold value among the estimation

likelihoods recorded in the estimated travel path information in association with the road ID of the road information specified lastly is recorded is excluded from the candidates.

[0099]

Fig. 13 is a diagram illustrating a process overview of the non-travel path determination unit.

Fig. 13 illustrates the pieces of estimated travel path information illustrated in Fig. 12 in a tree diagram. Pieces of road information specified at a timing T1 and a timing T2 are stored in respective pieces of estimated travel path information. An example in which, in such a state, the non-travel path determination unit 180 excludes estimated travel path information 1, estimated travel path information 3, and estimated travel path information 4, in which an estimation likelihood equal to or smaller than a threshold value (for example, estimation likelihood 0.3) is recorded to be associated with latest (timing T2) road information, from candidates based on the estimation likelihood is illustrated.

[0100]

Fig. 14 is a third diagram illustrating the estimated travel path information data table stored in the estimated travel path information storage unit 170.

When the non-travel path determination unit 180 excludes the estimated travel path information in which the road ID of the road considered as having a low possibility of the travel path is recorded as a road ID of the road information specified lastly (timing T2), from among the pieces of estimated travel path information recorded on the estimated travel path information storage unit 170, the non-travel path determination unit 180 rewrites the non-travel path flag stored in the estimated travel path information determined to be excluded, from "0" to "1" as illustrated in Fig. 14. Also, the non-travel path determination unit 180 outputs a travel path settlement request to the travel path output unit 190.

[0101]

Next, when the travel path output unit 190 receives the travel path settlement request from the non-travel path determination unit 180, the travel path output unit 190 specifies the road ID to be settled as the travel path from among the road IDs indicating roads estimated to be past travel paths using the road ID included in the estimated travel path information including the non-travel path flag "0" recorded on the estimated travel path information storage unit 170 (step S1110). Specifically, for example, the travel path output unit 190 compares the road IDs sequentially from the first recorded road ID in

all the estimated travel path information including the non-travel path flag "0" recorded on the estimated travel path information storage unit 170, and extracts the road ID that is continuously common. Also, the travel path output unit 190 specifies the road indicated by the extracted road ID that is continuously common from the first road ID as the settled travel path, and records the "road ID that is continuously common from the first road ID" indicating the settled travel path on the settled travel path storage unit 200.

[0102]

Fig. 15 is a first diagram illustrating a process overview of the travel path output unit.

Fig. 15 illustrates respective pieces of estimated travel path information including road information specified at respective timings T1, T2, T3, and T4 in a tree diagram. Further, an example in which roads indicated by road IDs that are continuously common from a first road ID specified at the timing T1 are specified as a settled travel path based on the estimated travel path information is illustrated. The example of Fig. 15 is an example in which there are three pieces of estimated travel path information including the non-travel path flag "0" recorded on the estimated travel path information storage unit 170. Also, an example in which the travel

path output unit 190 records the road ID 2 specified at the timing T1 and the road ID 4 specified at the timing T2 on the settled travel path storage unit 200 as road IDs that are continuously common from the first road ID using the three pieces of estimated travel path information is illustrated.

[0103]

Further, in the map matching unit 20, the travel path specification unit 22 performs a map matching process of plotting and displaying a current position on a map displayed on the display unit, such as a monitor, in parallel to performing steps S1010 to S1110 described above. Also, the control unit 1000 of the travel path specification unit 22 determines whether to end the process based on power supply OFF, or input of a request signal for first process stop included in a radio signal received from an external device when the vehicle enters a parking lot, a billing request signal from the outside, or the like (step S1130), and the process is repeated from the process of step S1040 when the process is not ended. Accordingly, a process of recording of new estimated travel path information on the estimated travel path information data table of the estimated travel path information storage unit 170, updating of the estimated travel path information, or excluding from candidates of

the estimated travel path information is performed. Through repetition of the process, the travel path output unit 190 sequentially records the road IDs indicating the settled travel path on the settled travel path storage unit 200 after step S1110. Also, when the billing request unit 210 of the travel path specification unit 22 receives the fact that it is determined that the vehicle passes the transit point from the control unit 1000, the billing request unit 210 outputs the billing amount calculation request including information such as the road IDs recorded on the settled travel path storage unit 200 to the billing amount calculation unit 304 of the application unit 30. Accordingly, the billing amount calculation unit 304 calculates the amount of billing.

[0104]

Further, the above-described traffic information processing device includes a computer system therein. Also, the above-described processes are stored in a computer-readable recording medium in the form of a program, and the computer reads and executes this program to perform the processes. Here, the computer-readable recording medium refers to a magnetic disk, a magnetic optical disc, a CD-ROM, a DVD-ROM, a semiconductor memory, or the like. Further, this computer program may be

distributed to the computer via a communication line, and the computer receiving the program may execute the program.

[0105]

Further, the program may be intended to realize some of the above-described functions. Further, the program may be a program capable of realizing the above-described functions through a combination with a program previously stored in a computer system, that is, a differential file (a differential program).

Industrial Applicability

[0106]

According to the traffic information processing device and the processing method and the program therefor described above, it is possible to more accurately determine whether or not the vehicle passes the transit point provided in the travel path.

Reference Signs List

[0107]

1: TRAFFIC INFORMATION PROCESSING DEVICE

10: POSITIONING UNIT

20: MAP MATCHING UNIT

30: APPLICATION UNIT

40: DISPLAY UNIT

50: STORAGE UNIT

11: LATITUDE AND LONGITUDE MEASUREMENT SENSOR

12: ACCELERATION SENSOR
13: GYRO SENSOR
14: VEHICLE SPEED SIGNAL OUTPUT DEVICE
15: POSITION INFORMATION CALCULATION UNIT
21: REAL TIME PROCESSING UNIT
22: TRAVEL PATH SPECIFICATION UNIT
23 OPERATION STOP INFORMATION RECORDING UNIT
24 OPERATION START INFORMATION ACQUISITION UNIT
25 TRANSIT POINT PASSAGE PRESENCE OR ABSENCE DETERMINATION
UNIT
26 ROAD IDENTIFICATION INFORMATION MATCHING DETERMINATION
UNIT
27 LAST TRANSIT POINT PASSAGE TIME ACQUISITION UNIT
28 PASSAGE DETERMINATION CANCELLATION UNIT
301: FIRST TRANSIT POINT PASSAGE DETERMINATION UNIT
302: FIRST TRANSIT POINT PASSAGE INFORMATION OUTPUT UNIT
303: TRANSIT POINT TYPE DETERMINATION UNIT
304: BILLING AMOUNT CALCULATION UNIT
305: SECOND TRANSIT POINT PASSAGE DETERMINATION UNIT
306: SECOND TRANSIT POINT PASSAGE INFORMATION OUTPUT UNIT
307: TRAVEL PATH TYPE DETERMINATION UNIT
100: INPUT UNIT
110: COMMUNICATION UNIT
120: MAP DATA STORAGE UNIT
130: ROAD INFORMATION SPECIFICATION UNIT

140: ESTIMATED DISPLACEMENT POSITION CALCULATION UNIT
150: NEXT PATH ROAD INFORMATION SPECIFICATION UNIT
160: ESTIMATED TRAVEL PATH INFORMATION GENERATION UNIT
170: ESTIMATED TRAVEL PATH INFORMATION STORAGE UNIT
180: NON-TRAVEL PATH DETERMINATION UNIT
190: TRAVEL PATH OUTPUT UNIT
200: SETTLED TRAVEL PATH STORAGE UNIT
210: BILLING REQUEST UNIT
1000: CONTROL UNIT

Claims

[Claim 1]

A traffic information processing device comprising:

an operation stop information recording unit that records stop detection position information indicating a position of a vehicle at a time point of detection of operation stop when the operation stop of the vehicle is detected based on input of an operation stop signal;

an operation start information acquisition unit that acquires start detection position information indicating the position of the vehicle at a time point of detection of operation start when the operation start of the vehicle is detected based on input of an operation start signal; and

a transit point passage determination unit that determines whether a transit point recorded on a storage unit in advance is located between a position indicated by the stop detection position information and a position indicated by the start detection position information after the detection of the operation start, and determines that the vehicle has passed the transit point based on a determination result.

[Claim 2]

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

a transit point passage presence or absence determination unit that determines whether or not the transit point has been passed based on whether or not identification information of the transit point already determined to have been passed has been recorded on the storage unit when the operation start has been detected;

a road identification information matching determination unit that determines whether stop road identification information indicating identification information of a road along which the vehicle has last run in a travel path settled until the detection of the operation stop and start road identification information indicating identification information of the road detected at a time point of the detection of the operation start match when the operation start has been detected; and

a passage determination cancellation unit that cancels a result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination unit when the stop road identification information and the start road identification information match and when the identification information of the transit point read by the transit point passage presence or absence

determination unit and the identification information of the transit point determined to have been passed by the transit point passage determination unit match.

[Claim 3]

The traffic information processing device according to claim 2, further comprising:

a last transit point passage time acquisition unit that acquires a last passage time that is a passage time of the transit point determined to have last been passed among transit points already determined to have been passed before the detection of the operation stop when the operation start has been detected,

wherein the operation stop information recording unit further records a time of the detection of the operation stop,

the operation start information acquisition unit further acquires a time of the detection of the operation start, and

when the identification information of the transit point read by the transit point passage presence or absence determination unit and the identification information of the transit point determined to have been passed by the transit point passage determination unit match, and when a sum of a time from the last passage time to the time of the detection of the operation stop, and a

time from a time of the detection of the operation start to a time at which the transit point has first been determined to have been passed in the transit point passage determination unit after the detection of the operation start is shorter than a predetermined time, the passage determination cancellation unit cancels the result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination unit.

[Claim 4]

A processing method in a traffic information processing device, the processing method comprising steps of:

causing an operation stop information recording unit to record stop detection position information indicating a position of a vehicle at a time point of detection of operation stop when the operation stop of the vehicle is detected based on input of an operation stop signal;

causing an operation start information acquisition unit to acquire start detection position information indicating the position of the vehicle at a time point of detection of operation start when the operation start of the vehicle is detected based on input of an operation start signal; and

causing a transit point passage determination unit to determine whether a transit point recorded on a storage unit in advance is located between a position indicated by the stop detection position information and a position indicated by the start detection position information after the detection of the operation start, and determines that the vehicle has passed the transit point based on a determination result.

[Claim 5]

The processing method according to claim 4, further comprising steps of:

causing a transit point passage presence or absence determination unit to determine whether or not the transit point has been passed based on whether or not identification information of the transit point already determined to have been passed has been recorded on the storage unit when the operation start has been detected;

causing a road identification information matching determination unit to determine whether stop road identification information indicating identification information of a road along which the vehicle has last run in a travel path settled until the detection of the operation stop and start road identification information indicating identification information of the road detected

at a time point of the detection of the operation start match when the operation start has been detected; and

causing a passage determination cancellation unit to cancel a result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination unit when the stop road identification information and the start road identification information match and when the identification information of the transit point read by the transit point passage presence or absence determination unit and the identification information of the transit point determined to have been passed by the transit point passage determination unit match.

[Claim 6]

The processing method according to claim 5, further comprising a step of:

causing a last transit point passage time acquisition unit to acquire a last passage time that is a passage time of the transit point determined to have last been passed among transit points already determined to have been passed before the detection of the operation stop when the operation start has been detected,

wherein the operation stop information recording unit further records a time of the detection of the operation stop,

the operation start information acquisition unit further acquires a time of the detection of the operation start, and

when the identification information of the transit point read by the transit point passage presence or absence determination unit and the identification information of the transit point determined to have been passed by the transit point passage determination unit match, and when a sum of a time from the last passage time to the time of the detection of the operation stop, and a time from a time of the detection of the operation start to a time at which the transit point has first been determined to have been passed in the transit point passage determination unit after the detection of the operation start is shorter than a predetermined time, the passage determination cancellation unit cancels the result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination unit.

[Claim 7]

A program that causes a computer of a traffic information processing device to function as:

operation stop information recording means for recording stop detection position information indicating a position of a vehicle at a time point of detection of

operation stop when the operation stop of the vehicle is detected based on input of an operation stop signal;

operation start information acquisition means for acquiring start detection position information indicating the position of the vehicle at a time point of detection of operation start when the operation start of the vehicle is detected based on input of an operation start signal; and

transit point passage determination means for determining whether a transit point recorded on a storage unit in advance is located between a position indicated by the stop detection position information and a position indicated by the start detection position information after the detection of the operation start, and determining that the vehicle has passed the transit point based on a determination result.

[Claim 8]

The program according to claim 7, further causing the computer to function as:

transit point passage determination means for determining whether or not the transit point has been passed based on whether or not identification information of the transit point already determined to have been passed has been recorded on the storage unit when the operation start has been detected;

road identification information matching determination means for determining whether stop road identification information indicating identification information of a road along which the vehicle has last run in a travel path settled until the detection of the operation stop and start road identification information indicating identification information of the road detected at a time point of the detection of the operation start match when the operation start has been detected; and

passage determination cancellation means for canceling a result of determining that the transit point has been passed after the detection of the operation start in the transit point passage determination means when the stop road identification information and the start road identification information match and when the identification information of the transit point read by the transit point passage determination means and the identification information of the transit point determined to have been passed by the transit point passage determination means match.

[Claim 9]

The program according to claim 8, further causing the computer to function as:

last transit point passage time acquisition means for acquiring a last passage time that is a passage time

of the transit point determined to have last been passed among transit points already determined to have been passed before the detection of the operation stop when the operation start has been detected,

wherein the operation stop information recording means further records a time of the detection of the operation stop,

the operation start information acquisition means further acquires a time of the detection of the operation start, and

when the identification information of the transit point read by the transit point passage determination means and the identification information of the transit point determined to have been passed by the transit point passage determination means match, and a sum of a time from the last passage time to the time of the detection of the operation stop, and a time from a time of the detection of the operation start to a time at which the transit point has first been determined to have been passed in the transit point passage determination means after the detection of the operation start is shorter than a predetermined time, the passage determination cancellation means cancels the result of determining that the transit point has been passed after the detection of

the operation start in the transit point passage
determination means.