

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. 2013-002088, 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, measures a current position of the vehicle, and specifies a road on 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 on a screen, and performs, for example, a process of displaying a mark indicating the current position of the vehicle in the virtual position.

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

Further, a technology for automatically judging a path along which a vehicle actually runs, calculating a toll according to a total extended 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 a toll using a billing method called road-pricing in which the toll is charged according to a road on or a distance which a vehicle passes is considered. In the road-pricing, 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 a running distance of the travel path.

[0005]

Here, in such road-pricing, a driver of the vehicle is likely not to clearly recognize an entrance or an exit of a road that is a road-pricing target, such as a highway in Japan. For example, a sensor for notifying that the road is a road-pricing target is likely to be attached at the entrance or the exit for road-pricing. However, for example, when the sensor is small, the driver of the vehicle is likely to be unable to clearly recognize that the vehicle has passed the entrance or the exit of the road that is a road-pricing target. In this case, there is a problem in that the driver is unable to immediately recognize an amount of billing when the driver has driven the vehicle and passed the travel path. Therefore, there is a need for a technology capable of reducing the occurrence of a situation in which a driver is unable to immediately recognize the fact indicating that the vehicle

has passed the entrance or the exit of the road that is a road-pricing target, or an amount of billing when the vehicle has passed a travel path including the road that is a road-pricing target.

[0006]

An object of the present invention is to provide a traffic information processing device and a processing method and a program therefor capable of reducing the occurrence of a situation in which a driver is unable to immediately recognize the fact indicating that a vehicle has passed an entrance or an exit of a road that is a road-pricing target, or an amount of billing when the vehicle has passed a travel path including the road that is a road-pricing target.

Solution to Problem

[0007]

According to a first aspect of the present invention, a traffic information processing device includes: a predicted position information calculation unit that calculates a predicted position indicating a position of a vehicle at a future time based on a sensed position of the vehicle input from a sensor device; a first transit point passage judgment unit that judges whether the vehicle passes the transit point at the future time correlating with the predicted position based on the predicted

position, and positional information of a transit point on a travel path that is a billing target; and a first transit point passage information output unit that outputs passage information indicating passage of the transit point at an actual time corresponding to the future time at which it is judged that the vehicle passes the transit point.

[0008]

According to a second aspect of the present invention, the traffic information processing device described above further includes a prediction information cancellation unit that judges a deviation between the predicted positions of the vehicle at the future times, the predicted positions being calculated by the predicted position information calculation unit at different times, and determines to make a request to stop a process of the first transit point passage judgment unit using at least the predicted position when the deviation is great.

[0009]

According to a third aspect of the present invention, the traffic information processing device described above further includes a prediction information cancellation unit that determines to make a request to stop the process of the first transit point passage judgment unit using at least the predicted position based on a result of

comparing a signal from a running state detection device that detects a predetermined running state of the vehicle with a threshold value of the value indicated by the signal.

[0010]

According to a fourth aspect of the present invention, in the traffic information processing device described above, the prediction information cancellation unit judges, at each predetermined timing, whether to request at least the first transit point passage judgment unit that performs a predetermined process using the predicted position to stop the process, and determines that the stop of the process is to be requested when judging to make a request to stop the process a predetermined number of times M or more among a unit number N of judgments ($N > M$).

[0011]

According to a fifth aspect of the present invention, the traffic information processing device described above further includes a travel path specification unit that specifies and outputs, as a settled travel path, the estimated travel path including the transit point to be passed at the future time from among unsettled travel paths of the vehicle, which are the estimated travel paths representing one or a plurality of travel paths estimated

to be passed by the vehicle when the first transit point passage judgment unit judges that the vehicle passes the transit point; and a billing amount calculation unit that calculates an amount of billing of the settled travel path.

[0012]

According to a sixth aspect of the present invention, the traffic information processing device described above further includes a second transit point passage judgment unit that detects the transit point closest to the predicted position of the vehicle included in the settled travel path based on the settled travel path output from the travel path specification unit to judge that the vehicle in the predicted position has passed the transit point, when the first transit point passage judgment unit judges that the vehicle passes the transit point at the future time; and a second transit point passage information output unit that outputs passage information indicating the passage of the transit point judged by the second transit point passage judgment unit at an actual time corresponding to the future time.

[0013]

According to a seventh aspect of the present invention, the traffic information processing device described above further includes a travel path type judgment unit that judges a type of a travel path that is

a billing target. The billing amount calculation unit calculates an amount of billing of the settled travel path based on the type of the travel path.

[0014]

According to an eighth aspect of the present invention, in the traffic information processing device, each of the first transit point passage judgment unit and the second transit point passage judgment unit acquires identification information of a travel path along which the vehicle runs at the future time, judges whether the vehicle in the predicted position has passed the transit point at predetermined intervals based on the identification information of the travel path and the predicted position, judges whether the vehicle runs along a plurality of travel paths based on the identification information of the travel path acquired in a previous judgment as to whether the vehicle in the predicted position has passed the transit point at the predetermined interval and the identification information of the travel path acquired in a current judgment as to whether the vehicle in the predicted position has passed the transit point, and judges that the vehicle in the predicted position has passed the transit point located between the positional information at a timing at which the previous judgment as to whether the vehicle in the predicted

position has passed the transit point is performed among the transit points included in the plurality of travel paths along which the vehicle runs and the positional information at a timing at which the current judgment as to whether the vehicle in the predicted position has passed the transit point is performed when it is detected that the vehicle runs along the plurality of travel paths.

[0015]

According to a ninth aspect of the present invention, the traffic information processing device described above further includes a speed calculation unit that calculates a speed at the future time of the vehicle based on a passage time of a plurality of points in the settled travel path output from the travel path specification unit and a distance between the plurality of points; and a speed output unit that outputs the speed at the future time, at an actual time corresponding to the future time.

[0016]

According to a tenth aspect of the present invention, the traffic information processing device described above further includes a traffic information output unit that reads and outputs the traffic information corresponding to the predicted position of the vehicle at an actual time corresponding to the future time.

[0017]

According to an eleventh aspect of the present invention, the traffic information processing device described above further includes a position output unit that outputs the predicted position of the vehicle at an actual time corresponding to the future time.

[0018]

According to a twelfth aspect of the present invention, a processing method in a traffic information processing device includes steps of: causing a predicted position information calculation unit to calculate a predicted position indicating a position of a vehicle at a future time based on a sensed position of the vehicle input from a sensor device; causing a first transit point passage judgment unit to judge whether the vehicle passes the transit point at the future time correlating with the predicted position based on the predicted position, and positional information of a transit point on a travel path that is a billing target; and causing a first transit point passage information output unit to output passage information indicating passage of the transit point at an actual time corresponding to the future time at which it is judged that the vehicle passes the transit point.

[0019]

According to a thirteenth aspect of the present invention, the processing method described above includes

a step of causing a prediction information cancellation unit to judge a deviation between the predicted positions of the vehicle at the future times, the predicted positions being calculated by the predicted position information calculation unit at different times, and determine to make a request to stop a process of at least the first transit point passage judgment unit that performs the process using the predicted position when the deviation is great.

[0020]

According to a fourteenth aspect of the present invention, a program causes a computer of a traffic information processing device to function as: predicted positional information calculation means for calculating a predicted position indicating a position of a vehicle at a future time based on a sensed position of the vehicle input from a sensor device; first transit point passage judgment means for judging whether the vehicle passes the transit point at the future time correlating with the predicted position based on the predicted position, and positional information of a transit point on a travel path that is a billing target; and first transit point passage information output means for outputting passage information indicating passage of the transit point at an actual time corresponding to the future time at which it

is judged that the vehicle passes the transit point.

[0021]

According to a fifteenth aspect of the present invention, the program further causes the computer to function as prediction information cancellation means for judging a deviation between the predicted positions of the vehicle at the future times, the predicted positions being calculated by the predicted position information calculation unit at different times, and determining to make a request to stop a process of at least the first transit point passage judgment unit that performs the process using the predicted position when the deviation is great.

Advantageous Effects of Invention

[0022]

According to the traffic information processing device and the processing method and the program therefor described above, since the fact indicating that the vehicle has passed the transit point or the amount of billing are immediately displayed when the vehicle passes the transit point, it is possible to reduce a situation in which the driver is unable to immediately recognize the fact indicating that the vehicle has passed the entrance or the exit of the road that is a road-pricing target or the amount of billing when the vehicle has passed the

travel path including the road that is a road-pricing target.

Brief Description of Drawings

[0023]

Fig. 1 illustrates a traffic information processing device according to an embodiment of the present invention.

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

Fig. 3 is a second diagram illustrating the 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 judgment process for the transit point according to an embodiment of the present invention.

Fig. 5 is a diagram illustrating predicted position time-series data stored in a prediction information cancellation unit according to an embodiment of the present invention.

Fig. 6 is a diagram illustrating an example of calculating a distance between two predicted positions calculated at different times according to an embodiment of the present invention.

Fig. 7 is a first diagram illustrating an overview of a process of the traffic information processing device

according to an embodiment of the present invention.

Fig. 8 is a second diagram illustrating an overview of the process of the traffic information processing device according to an embodiment of the present invention.

Fig. 9 is a third diagram illustrating an overview of the process of the traffic information processing device according to an embodiment of the present invention.

Fig. 10 is a fourth diagram illustrating an overview of the process of the traffic information processing device according to an embodiment of the present invention.

Fig. 11 is a block diagram illustrating a configuration of the travel path specification unit according to an embodiment of the present invention.

Fig. 12 is a diagram illustrating road information stored in a map data storage unit according to an embodiment of the present invention.

Fig. 13 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. 14 is a diagram illustrating the process flow of a travel path specification unit according to an embodiment of the present invention.

Fig. 15 is a first diagram illustrating a process overview of the road information specification unit

according to an embodiment of the present invention.

Fig. 16 is a second diagram illustrating a process overview of the road information specification unit according to an embodiment of the present invention.

Fig. 17 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. 18 is a diagram illustrating a process overview of a non-travel path judgment unit according to an embodiment of the present invention.

Fig. 19 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. 20 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

[0024]

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 estimates a travel path that a vehicle passes (runs), and notifies a driver that the vehicle has passed a transit point in real time when the vehicle has passed 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 has passed the travel path including the road that is a road-pricing target.

[0025]

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 has passed 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 of 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 has passed.

[0026]

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 at least includes a positioning unit 10, a map matching unit 20, an application unit 30, a display unit 40, and a storage unit 50.

[0027]

The positioning unit 10 includes a sensed position function (sensor device) such as a latitude/longitude measurement sensor 11, an acceleration sensor 12, a gyro sensor 13, and a vehicle speed signal output device 14, a position information calculation unit 15, a predicted position information calculation unit 16, and a prediction information cancellation unit 18. The latitude/longitude measurement sensor 11 is a processing unit that calculates

a 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 information such as information of the latitude and the longitude input from the latitude/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.

Further, the predicted position information calculation unit 16 is a processing unit that calculates and outputs a predicted position indicating a position after a predetermined time (a future time) of the vehicle based on the sensed position of the vehicle input from the

sensor device, or the like.

Further, the prediction information cancellation unit 18 is a processing unit that judges that a map matching process using information of a future predicted position of the vehicle, a travel path specifying process, and a transit point passage judgment process are to be stopped.

Further, the "transit point" is a point (position) that the vehicle passes on the road, and positional information of each transit point is determined in advance for each road, and is held in the storage unit 50.

[0028]

Further, the map matching unit 20 includes processing units such as a real time processing unit 21, and a travel path specification unit 22.

The real time processing unit 21 is a processing unit that outputs positional information such as the predicted position or the sensed position 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 predicted position or the sensed position 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 passes. Further, the travel path specification unit 22 is a processing unit that specifies, as a settled travel path, an unsettled vehicle travel path, which is the estimated travel path including the transit point that the vehicle will pass at the future time from among the estimated travel paths representing one or a plurality of travel paths estimated to be 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 be passed by the vehicle, and repeats a process of specifying, as a settled travel path, the estimated travel path including the transit point that the vehicle will pass at the future time from among the estimated travel paths that are the estimation result, and outputting the settled travel path.

[0029]

Further, the application unit 30 includes respective processing units such as a first transit point passage judgment unit 301, a first transit point passage information output unit 302, a transit point type judgment unit 303, a billing amount calculation unit 304, a second transit point passage judgment unit 305, a second transit point passage information output unit 306, a travel path

type judgment unit 307, a speed calculation unit 308, a traffic information output unit 309, a position output unit 310, and a passage time calculation unit 311.

[0030]

The first transit point passage judgment unit 301 is a processing unit that judges whether the vehicle passes the transit point at the future time correlating with the predicted position based on the predicted position of the vehicle and the positional information of the transit point on the travel path that is a billing target. Further, the transit point is a point that is provided on a road so as to detect that the vehicle has passed, 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.

[0031]

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 has passed 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 has passed 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 are 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.

[0032]

Further, the transit point type judgment unit 303 is a processing unit that judges whether the transit point judged to be passed by the vehicle at the future time by the first transit point passage judgment unit 301 or the second transit point passage judgment 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 at

an actual time corresponding to the future time when the vehicle is judged to pass the transit point and the transit point is judged 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.

[0033]

Further, the second transit point passage judgment unit 305 is a processing unit that detects the transit point closest to the predicted position of the vehicle among the transit points included in the settled travel path output from the travel path specification unit 22, and judges that the predicted position or the sensed 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 judged by the second transit point passage judgment unit 305 at an actual time corresponding to the future time. In this embodiment, the second transit point passage information output unit 306 outputs the passage information to the display unit 40.

[0034]

Further, the travel path type judgment unit 307 is a processing unit that judges the type of the travel path that is a billing target. The type of the travel path is, for example, information such as a highway, a toll road, or a bridge.

Further, the speed calculation unit 308 is a processing unit that calculates a speed of the vehicle at a future time based on a passage time of a plurality of points in the settled travel path output from the travel path specification unit 22 and a distance between the plurality of points.

Further, the traffic information output unit 309 is a processing unit that reads the traffic information corresponding to the predicted position at an actual time corresponding to the future time, and outputs the traffic information.

Further, the position output unit 310 is a processing unit that outputs the predicted position output from the real time processing unit 21 at the actual time corresponding to the future time.

Further, the passage time calculation unit 311 is a processing unit that calculates an expected passage time for the transit point.

Further, the storage unit 50 stores various pieces

of information used for a process by the map matching unit 20 or the application unit 30.

[0035]

Using the configuration as described above, when the vehicle has passed the transit point at which the amount of billing is generated at an entrance or an exit of the road that is a road-pricing target, the traffic information processing device 1 performs a process of outputting, in real time, the information indicating that the vehicle has passed the entrance or the exit of the road that is a road-pricing target or the information for the amount of billing when the vehicle has passed the travel path including the road that is a road-pricing target.

[0036]

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, "received" means "acquires" information output from processing unit.

First, the position information calculation unit 15 of the positioning unit 10 receives information from the sensor device such as the latitude/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 to the predicted position information calculation unit 16.

[0037]

The predicted position information calculation unit 16 may receive information of acceleration from the acceleration sensor 12, information of the angular velocity from the gyro sensor 13, and a pulse signal proportional to the number of rotations of the axle from the vehicle speed signal output device 14, in addition to the sensed position from the position information calculation unit 15. Also, the predicted position information calculation unit 16 calculates the predicted position of the vehicle at predetermined time intervals until a predetermined time based on the received information (step S102), and outputs predicted positional information calculated at predetermined time intervals (for example, at one-second intervals) to the prediction information cancellation unit 18. Further, the predicted position information calculation unit 16 outputs the predicted positional information of the vehicle after the

predetermined time to the map matching unit 20. The prediction information cancellation unit 18 records and stores information of a plurality of predicted positions, which has been received over time, on and in a memory or the like.

[0038]

Further, information regarding ña predetermined timeò used to calculate the predicted position is recorded in the memory or the like in advance, and the predicted position information calculation unit 16 reads the time information indicating predetermined timeò recorded in the memory to calculate the predicted position. For example, the information indicating ñafter a predetermined timeò indicating a time such as 3 or 4 seconds.

[0039]

Here, for a specific scheme of calculating the predicted position, for example, when the vehicle runs at a constant speed, the predicted position information calculation unit 16 calculates the predicted position using a vehicle position calculation equation (motion equation) after a predetermined time or at predetermined time intervals until the predetermined time at the time of uniform motion.

Further, when the vehicle runs at an acceleration in

a negative or positive direction, the predicted position information calculation unit 16 calculates the predicted position using a vehicle position calculation equation (motion equation) after a predetermined time or at predetermined time intervals until the predetermined time at the time of acceleration.

Further, when the vehicle takes a curve, the predicted position information calculation unit 16 calculates the predicted position using a vehicle position calculation equation (motion equation) after a predetermined time or at predetermined time intervals until the predetermined time at the time of uniform circular motion using an angular velocity detected when the vehicle turns the curve.

Further, a known technology is used for calculation of the predicted position of the vehicle after the predetermined time or at predetermined time intervals until the predetermined time.

[0040]

On the other hand, in the map matching unit 20, the real time processing unit 21 receives the predicted position after a predetermined time of the vehicle calculated in step S102. Also, based on the predicted 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 predicted 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 vehicle 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 predicted position (step S103). Further, the specified vehicle 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 specified predicted position on the road. Further, the vehicle position may be specified using information of the running direction or the speed, in addition to the predicted position. Further, positional information of the endpoints of the road indicated by the road information, positional 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 vehicle position on the road 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 vehicle position on the road and the road ID to the travel

path specification unit 22.

[0041]

Next, the first transit point passage judgment unit 301 of the application unit 30 receives the vehicle 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 judgment unit 301 reads the IDs and the positional information of one or a plurality of 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 judgment unit 301 specifies the positional information of the transit point closest to the vehicle position among the read pieces of positional information of the transit point, and calculates a distance between the vehicle position and the specified positional information of the transit point. Also, the first transit point passage judgment unit 301 judges whether the vehicle passes the transit point after a predetermined time based on the distance between the vehicle position and the specified positional information of the transit point (step S104). For example, when the distance between the vehicle position and the specified positional information of the transit point is equal to or smaller than a distance at which the vehicle can be judged

to pass the transit point, the first transit point passage judgment unit 301 judges that the vehicle passes the transit point. When the first transit point passage judgment unit 301 judges that the vehicle does not pass the transit point, the first transit point passage judgment unit 301 waits for the vehicle position to be input from the real time processing unit 21, and performs the judgment of step S104 again when the vehicle position is received.

[0042]

Also, when the first transit point passage judgment unit 301 judges that the vehicle passes the transit point after the predetermined time, the first transit point passage judgment unit 301 requests the passage time calculation unit 311 to calculate an expected passage time for the transit point. Here, the passage time calculation unit 311 reads a time at which the request for calculation of the expected passage time is input from an RTC (Real Time Clock). Further, since information on a predetermined time indicating whether position calculated by the predicted position information calculation unit 16 is a position of the vehicle after certain seconds is recorded on the storage unit 50 by the predicted position information calculation unit 16, the passage time calculation unit 311 reads the information.

Also, the passage time calculation unit 311 adds information (time) indicating ñ a f t e r p r e d e t e r m i n e d t i m e ò to the reception time of a request for calculation of the passage time (a current time) to calculate the expected transit point passage time (step S105). Also, the passage time calculation unit 311 records the expected transit point passage time on the timing latency storage unit (not illustrated). Further, the expected transit point passage time may be the expected passage time of the vehicle for the predicted position calculated through the same process by the predicted position information calculation unit 16, which is recorded as the expected transit point passage time in the timing latency storage unit.

[0043]

Further, when the first transit point passage judgment unit 301 judges that the vehicle passes the transit point after the predetermined time, the first transit point passage judgment unit 301 outputs a road type judgment request for a road including the vehicle position to the travel path type judgment unit 307. The road ID input with the vehicle position from the real time processing unit 21 is included in the road type judgment request. The travel path type judgment unit 307 reads information of the type of the road recorded on the storage unit 50 in association with the road ID, and

judges the road type (a type of the travel path) (step S106), and outputs information of the road type to the first transit point passage judgment unit 301.

[0044]

Next, the first transit point passage judgment unit 301 requests the transit point type judgment unit 303 to judge a type of the transit point. The ID of the transit point is included in a signal of the request for a judgment of the type of the transit point. When the transit point type judgment unit 303 receives the request for a judgment of the type of the transit point, the transit point type judgment unit 303 judges whether the transit point judged to be passed after the predetermined time is a settled point or a non-settled point (step S107). More specifically, the transit point type judgment 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 judged to be passed after the predetermined time. Also, the transit point type judgment unit 303 judges 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 judgment unit 303 outputs information of the judgment result indicating the settled

point or the non-settled point to the first transit point passage judgment unit 301.

[0045]

Also, when the judgment result from the transit point type judgment unit 303 is the information indicating the settled point, the first transit point passage judgment unit 301 outputs the information indicating the transit point passage to the first transit point passage information output unit 302 (step S108). Then, the first transit point passage information output unit 302 reads the expected transit point passage time from the timing latency storage unit. Also, the first transit point passage information output unit 302 reads the current time from the RTC unit, and judges whether the current time has reached the expected transit point passage time (step S109). Also, when the first transit point passage information output unit 302 detects that the current time has reached the expected transit point passage time, 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 S110). When the current time has not reached the expected transit point passage time, the first transit point passage information output unit 302 waits, and repeats the judgment of step S109.

[0046]

Further, when the first transit point passage information output unit 302 displays the passage information, 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 judgment 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 has passed the transit point.

[0047]

The first transit point passage judgment unit 301 outputs information indicating the transit point passage to the first transit point passage information output unit 302, and then outputs the travel path specifying request 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 travel path to the transit point judged to be passed after a predetermined time. Accordingly, the traffic information

processing device 1 can output the information indicating that the vehicle has passed 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 has passed 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 judged in step S106, the type of the transit point judged in step S107, and the ID of the transit point read from the storage unit 50 may be included in the travel path specifying request. Then, the travel path specification unit 22 settles the travel path to the transit point judged to be passed after the predetermined time (step S111). Details of this process will be described below.

[0048]

The process of specifying the travel path is a process of more accurately specifying the travel path to the transit point judged to be passed after a predetermined time, unlike the specifying of the road based on the vehicle position in the real time processing unit 21. More specifically, the travel path specification unit 22 specifies, as a settled travel path, the estimated travel path including the transit point judged to be passed after a predetermined time from among unsettled

travel paths of the vehicle, which are the estimated travel paths representing one or a plurality of travel paths estimated to be passed by the vehicle, and outputs an ID of each road to the settled travel path. By performing such a process, some time is taken until the travel path to the transit point judged to be passed after a predetermined time is settled, in comparison with time taken for the process of specifying the road in the real time processing unit 21. Also, when the travel path to the transit point judged to be passed is settled in step S104, the travel path specification unit 22 judges the type of the transit point included in the travel path specifying request (step S112). 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 travel path to the transit point judged to be passed after a predetermined time. Information such as a road ID of a road specified currently and newly as a road on the travel path among respective road IDs of the roads indicating the travel path (settled travel path) to the transit point judged to be passed after a predetermined time, 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.

[0049]

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 S113). More specifically, the billing amount calculation unit 304 reads the distance of the road or an amount of billing when the vehicle runs 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.

[0050]

Also, the billing amount calculation unit 304 reads

the expected transit point passage time from the timing latency storage unit. Also, the billing amount calculation unit 304 reads the current time from the RTC unit, and judges whether the current time exceeds the expected transit point passage time (step S114). Further, when the current time does not exceed the expected transit point passage time, the billing amount calculation unit 304 judges whether the current time has reached the expected transit point passage time (step S115). Also, when the billing amount calculation unit 304 detects that the current time exceeds the expected transit point passage time or when the billing amount calculation unit 304 detects that the current time has reached the expected transit point passage time, the billing amount calculation unit 304 displays the amount of billing on the display unit 40 (step S116). When the current time has not reached the expected transit point passage time, the billing amount calculation unit 304 waits and repeats the judgment of step S115.

[0051]

According to the above-described process, a time at which the vehicle passes the transit point belonging to the settled 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) is predicted, and when the vehicle has passed the transit point, information indicating that the vehicle has passed 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 has passed 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 has passed the transit point belonging to the settled point, the information indicating that the vehicle has passed 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 S111, 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 has passed 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 a sense of incongruity to the driver.

[0052]

When it is judged in step S107 described above that the transit point that the vehicle has passed 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 passes the transit point, the first transit point passage judgment unit 301 waits for next information (the vehicle 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 S108, and then, repeats the process from step S103.

[0053]

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 to be passed 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 judgment unit 301. Here, when the travel path specification unit 22 receives the travel path specifying request from the first transit point passage judgment unit 301, the travel path specification unit 22 settles the travel path to the transit point judged to be passed after a predetermined time even at a timing at which the specifying request is received, and outputs the transit point passage judgment request to the second transit point passage judgment unit 305. Also, the second transit point passage judgment unit 305 receives the transit point passage judgment request (step S201). Information such as a road ID indicating a road along which there is the transit point judged to be passed after a predetermined time or the information of a vehicle position (for example, a position closest to a predicted position on the road on which there is the transit point judged to pass) is included in the transit point passage judgment request.

[0054]

Next, the second transit point passage judgment unit 305 reads the positional information of the transit point recorded on the storage unit 50 in association with the road ID included in the received transit point passage judgment request from the storage unit 50. Also, the

second transit point passage judgment unit 305 specifies the positional information of the transit point closest to the vehicle position among the pieces of read positional information of the transit point, and calculates a distance between the vehicle position and the specified positional information of the transit point. Also, the second transit point passage judgment unit 305 judges whether the vehicle passes the transit point after a predetermined time based on the distance between the vehicle position and the specified positional information of the transit point (step S202). For example, when the distance between the vehicle position and the specified positional information of the transit point is equal to or less than a distance for judging that the vehicle passes the transit point, the second transit point passage judgment unit 305 judges that the vehicle passes the transit point after a predetermined time. When the second transit point passage judgment unit 305 judges that the vehicle does not pass the transit point, the second transit point passage judgment unit 305 waits for the road ID indicating a road on which there is the transit point judged to be passed after a predetermined time or the vehicle position to be input from the travel path specification unit 22, and performs the judgment of step S202 again when the road ID or the vehicle position is

input.

[0055]

Also, when the second transit point passage judgment unit 305 judges that the vehicle passes the transit point, the second transit point passage judgment unit 305 requests the transit point type judgment unit 303 to judge a type of the transit point. The ID of the transit point is assumed to be included in the type judgment. When the transit point type judgment unit 303 receives the request for a type judgment, the transit point type judgment unit 303 judges whether the transit point judged to be passed after a predetermined time is the settled point or the non-settled point (step S203). More specifically, based on the ID of the transit point judged to be passed after a predetermined time, the transit point type judgment 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 judgment unit 303 judges 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 judgment unit 303 outputs information of a judgment result indicating the settled point or the non-settled point to the second transit point passage judgment unit 305.

[0056]

Also, the second transit point passage judgment unit 305 immediately outputs information indicating the transit point passage to the second transit point passage information output unit 306 only when the judgment result from the transit point type judgment 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 reads the expected transit point passage time from a timing latency storage unit (not illustrated). Also, the second transit point passage information output unit 306 reads a current time from the RTC unit, and judges whether the current time exceeds the expected transit point passage time (step S205). Further, when the current time does not exceed the expected transit point passage time, the second transit point passage information output unit 306 judges whether the current time has reached the expected transit point passage time (step S206). Also, when the second transit point passage information output unit 306 detects that the current time exceeds the expected transit point passage time or when the second transit point passage information output unit

306 detects that the current time has reached the expected transit point passage time, 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 S207). When the current time has not reached the expected transit point passage time, the second transit point passage information output unit 306 waits and repeats the judgment of step S206. Further, 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 has passed the transit point. That is, output of sound, or the like is also included in the "output of the passage information," in addition to the displaying of characters on the screen. Further, the output device (for example, a display unit or a speaker) may constitute the traffic information processing device 1 or may be provided separately from the traffic information processing device 1.

[0057]

Further, when the judgment result from the transit point type judgment unit 303 is the information indicating

the settled point, the second transit point passage judgment 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 passes is displayed by the first transit point passage judgment unit 301 and the first transit point passage information output unit 302 when the vehicle passes the transit point belonging to the settled point.

[0058]

Through the above-described process, when the transit point judged to be passed after a predetermined time based on the predicted position is the non-settled point, the travel path specification unit 22 of the map matching unit 20 displays information indicating whether the vehicle has currently passed the transit point on the travel path using an accurate latitude path after a process of settling the travel path to the transit point judged to be passed. Accordingly, it is possible to notify of a transit timing more accurately when the vehicle has passed 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.

[0059]

Fig. 4 is a diagram illustrating an overview of the

passage judgment process for the transit point.

Fig. 4(a) is a diagram illustrating an overview of the passage judgment for the transit point performed in the first transit point passage judgment unit 301 or the second transit point passage judgment unit 305 in step S104 or S202 described above. In the passage judgment for the transit point illustrated in Fig. 4(a), this passage judgment 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) are the same in the real time processing unit 21 or the travel path specification unit 22 of the map matching unit 20. That is, the passage judgment 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 judgment unit 301 or the second transit point passage judgment unit 305 reads the positional information of the transit point on the road having the road ID, which is the transit point closest to the vehicle position, from the storage unit 50 using the road ID input based on the current map matching process. Also, if the read positional information is within a predetermined distance from the vehicle position, the

first transit point passage judgment unit 301 or the second transit point passage judgment unit 305 can judge that the vehicle passes the transit point after a predetermined time.

[0060]

Meanwhile, Fig. 4(b) illustrates an example of the passage judgment when there is the transit point near an end of the road. Specifically, Fig. 4(b) illustrates an example of the passage judgment 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 judgment unit 301 or the second transit point passage judgment unit 305 performs the passage judgment 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 judgment unit 301 or the second transit point passage judgment 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 judgment unit 301 or the second transit point passage judgment unit 305 acquires the positional 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 judgment unit 301 or the second transit point passage judgment unit 305 does not acquire information of the road ID = 1, and thus, the first transit point passage judgment unit 301 or the second transit point passage judgment 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 judgment is performed near the center of the road having a road ID = 1, the current passage judgment 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 judgments, a situation in which it is unable to be judged that the vehicle passes the transit point occurs even when the passage judgment 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).

[0061]

So as to solve such a problem, the first transit point passage judgment unit 301 or the second transit point passage judgment unit 305 judges 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 judgment as to whether the vehicle passes the transit point) and the road ID input based on the current map matching process (a result of the current judgment as to whether the vehicle passes the transit point) in the process of step S104 or step S202 described above 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 judgment unit 301 or the second transit point passage judgment unit 305 reads the positional 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 positional 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 judgment unit 301 or the second transit point passage judgment unit 305 specifies all the transit points located between the positional information at a timing at which the previous judgment as to whether the vehicle passes the transit point is performed and the positional information at a timing at which the current judgment as to whether the vehicle passes the transit point is performed among the transit

points included on the plurality of travel paths along which the vehicle passes, and judges that the current position of the vehicle passes all the specified transit points.

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 judged that the vehicle passes the transit point after a predetermined time.

[0062]

In addition to the above-described process, the traffic information processing device 1 may perform a process of displaying the vehicle position, the traffic information, or the speed information on the display unit 40.

For example, the real time processing unit 21 outputs the vehicle position and the road ID of the road including the vehicle position to the position output unit 310 and the traffic information output unit 309 after the process of step S103. Then, the position output unit 310 reads the expected transit point passage time from the timing latency storage unit. Also, the position output unit 310 reads the current time from the RTC unit and

judges whether the current time has reached the expected transit point passage time. Also, when the position output unit 310 detects that the current time has reached the expected transit point passage time, the position output unit 310 displays the vehicle position input from the real time processing unit 21 on the display unit 40. When the vehicle position has not reached the expected transit point passage time, the position output unit 310 waits and repeats the judgment as to whether the current time has reached the expected transit point passage time.

[0063]

Further, the traffic information output unit 309 reads the traffic information from the storage unit 50 or an external server based on the road ID or the vehicle position input from the real time processing unit 21, outputs the traffic information to the display unit 40, and displays the traffic information on the display unit 40. Specifically, the traffic information is stored in the external server in association with the road ID or the positional information. Also, the external server reads the traffic information recorded in association with the positional information close to the vehicle position of the vehicle among the pieces of traffic information recorded in association with the same road ID based on the road ID and the vehicle position output from the traffic

information output unit 309, and transmits the traffic information to the traffic information processing device 1. Also, the traffic information output unit 309 reads the expected transit point passage time from the timing latency storage unit. Also, the traffic information output unit 309 reads the current time from the RTC unit and judges whether the current time has reached the expected transit point passage time. Also, when the traffic information output unit 309 detects that the current time has reached the expected transit point passage time, the traffic information output unit 309 displays the traffic information input from the outside on the display unit 40. When the vehicle position has not reached the expected transit point passage time, the traffic information output unit 309 waits and repeats the judgment as to whether the current time has reached the expected transit point passage time.

[0064]

Further, the travel path specification unit 22 outputs the road IDs on the travel path along which the vehicle is going to run in the future, the predicted position on the road indicated by each road ID, or the passage time to the speed calculation unit 308. Then, the speed calculation unit 308 calculates the speed between different predicted positions of the vehicle in the future

using future distances of a plurality of predicted positions of the vehicle and a time difference between the expected passage times at which the vehicle passes the predicted position, outputs an average of speeds between a plurality of passage positions to the display unit 40, and displays the average as speed of the vehicle on the display unit 40.

[0065]

Next, a first process of the prediction information cancellation unit 18 described above will be described.

Fig. 5 is a diagram illustrating predicted position time-series data stored in the prediction information cancellation unit 18.

The prediction information cancellation unit 18 receives, over time, a plurality of pieces of predicted positional information at predetermined time intervals until the predetermined time, which are calculated based on the process of step S102, and records and stores the predicted positional information on and in a predicted position time-series data table (Fig. 5) in an input memory.

Here, when the current time is a time t , the prediction information cancellation unit 18 receives predicted positions (a predicted position X_{p_t-6} , a predicted position X_{p_t-5} , a predicted position X_{p_t-4} , a

predicted position X_{p_t-3} , a predicted position X_{p_t-2} , a predicted position X_{p_t-1} , a predicted position X_{p_t} , and a predicted position X_{p_t+1}) calculated for respective times (time $t-6$, time $t-5$, time $t-4$, time $t-3$, time $t-2$, time $t-1$, time t , and time $t+1$) from the time $t-6$ to the time $t+1$ that is after a predetermined time at a past time of the time $t-6$, and records the predicted positions as the predicted position time-series data.

Further, the prediction information cancellation unit 18 receives predicted positions (the predicted position X_{p_t-5} , the predicted position X_{p_t-4} , the predicted position X_{p_t-3} , the predicted position X_{p_t-2} , the predicted position X_{p_t-1} , the predicted position X_{p_t} , the predicted position X_{p_t+1} , and a predicted position X_{p_t+2}) calculated for respective times (time $t-5$, time $t-4$, time $t-3$, time $t-2$, time $t-1$, time t , time $t+1$, and time $t+2$) from the time $t-5$ to the time $t+2$ that is after a predetermined time at a past time of the time $t-5$, and records the predicted positions as the predicted position time-series data.

[0066]

Further, similarly, the prediction information cancellation unit 18 receives predicted positions (the predicted position X_{p_t-4} , the predicted position X_{p_t-3} , the predicted position X_{p_t-2} , the predicted position

$X_{p,t-1}$, the predicted position $X_{p,t}$, the predicted position $X_{p,t+1}$, the predicted position $X_{p,t+2}$, and a predicted position $X_{p,t+3}$) calculated for respective times (time $t-4$, time $t-3$, time $t-2$, time $t-1$, time t , time $t+1$, time $t+2$, and time $t+3$) from the time $t-4$ to the time $t+3$ that is after a predetermined time at a past time of the time $t-4$, and records the predicted positions as the predicted position time-series data.

Further, similarly, the prediction information cancellation unit 18 receives predicted positions (the predicted position $X_{p,t-3}$, the predicted position $X_{p,t-2}$, the predicted position $X_{p,t-1}$, the predicted position $X_{p,t}$, the predicted position $X_{p,t+1}$, the predicted position $X_{p,t+2}$, the predicted position $X_{p,t+3}$, and a predicted position $X_{p,t+4}$) calculated for respective times (time $t-3$, time $t-2$, time $t-1$, time t , time $t+1$, time $t+2$, time $t+3$, and time $t+4$) from the time $t-3$ to the time $t+4$ that is after a predetermined time at a past time of the time $t-3$, and records the predicted positions as the predicted position time-series data.

[0067]

Further, similarly, the prediction information cancellation unit 18 receives predicted positions (the predicted position $X_{p,t-2}$, the predicted position $X_{p,t-1}$, the predicted position $X_{p,t}$, the predicted position $X_{p,t+1}$,

the predicted position Xp_{t+2} , the predicted position Xp_{t+3} , the predicted position Xp_{t+4} , and a predicted position Xp_{t+5}) calculated for respective times (time $t-2$, time $t-1$, time t , time $t+1$, time $t+2$, time $t+3$, time $t+4$, and time $t+5$) from the time $t-2$ to the time $t+5$ that is after a predetermined time at a past time of the time $t-2$, and records the predicted positions as the predicted position time-series data.

Further, similarly, the prediction information cancellation unit 18 receives predicted positions (the predicted position Xp_{t-1} , the predicted position Xp_t , the predicted position Xp_{t+1} , the predicted position Xp_{t+2} , the predicted position Xp_{t+3} , the predicted position Xp_{t+4} , the predicted position Xp_{t+5} , and a predicted position Xp_{t+6}) calculated for respective times (time $t-1$, time t , time $t+1$, time $t+2$, time $t+3$, time $t+4$, time $t+5$, and time $t+6$) from the time $t-1$ to the time $t+6$ that is after a predetermined time at a past time of the time $t-1$, and records the predicted positions as the predicted position time-series data.

[0068]

Further, similarly, the prediction information cancellation unit 18 receives predicted positions (the predicted position Xp_t , the predicted position Xp_{t+1} , the predicted position Xp_{t+2} , the predicted position

X_{p_t+3} , the predicted position X_{p_t+4} , the predicted position X_{p_t+5} , the predicted position X_{p_t+6} , and a predicted position X_{p_t+7}) calculated for respective times (time t , time $t+1$, time $t+2$, time $t+3$, time $t+4$, time $t+5$, time $t+6$, and time $t+7$) from the time t to the time $t+7$ that is after a predetermined time at a past time of the time t , and records the predicted positions as the predicted position time-series data.

Accordingly, the prediction position time-series data as illustrated in Fig. 5 is produced.

[0069]

Also, the prediction information cancellation unit 18 performs a prediction information cancellation process (the first process) each time the prediction information cancellation unit 18 receives the predicted position at a timing of each time. In the prediction information cancellation process, the prediction information cancellation unit 18 first acquires the predicted position X_{p_t+1} that is calculated currently or was calculated in the past as a position of the vehicle at the time $t+1$ after 1 timing of the time t that is the current time. That is, the prediction information cancellation unit 18 acquires the predicted position X_{p_t+1} calculated at the time $t-6$, the predicted position X_{p_t+1} calculated at the time $t-5$, the predicted position X_{p_t+1} calculated at the

time $t-4$, the predicted position Xp_{t+1} calculated at the time $t-3$, the predicted position Xp_{t+1} calculated at the time $t-2$, the predicted position Xp_{t+1} calculated at the time $t-1$, and the predicted position Xp_{t+1} calculated at the time t from Fig. 5. Also, the prediction information cancellation unit 18 calculates a distance between the two predicted positions among the plurality of predicted positions Xp_{t+1} in a round robin manner, and specifies a maximum value of the distance between the two predicted positions with a position error in the predicted position Xp_{t+1} .

[0070]

Further, the prediction information cancellation unit 18 similarly calculates a position error of the predicted position Xp_{t+2} that is calculated currently or was calculated in the past as a position of the vehicle at the time $t+2$ after 2 timings of the time t that is the current time.

Further, the prediction information cancellation unit 18 similarly calculates a position error of the predicted position Xp_{t+3} that is calculated currently or was calculated in the past as a position of the vehicle at the time $t+3$ after 3 timings of the time t that is the current time.

Further, the prediction information cancellation

unit 18 similarly calculates a position error of the predicted position X_{p_t+4} that is calculated currently or was calculated in the past as a position of the vehicle at the time $t+4$ after 4 timings of the time t that is the current time.

Further, the prediction information cancellation unit 18 similarly calculates a position error of the predicted position X_{p_t+5} that is calculated currently or was calculated in the past as a position of the vehicle at the time $t+5$ after 5 timings of the time t that is the current time.

Further, the prediction information cancellation unit 18 similarly calculates a position error of the predicted position X_{p_t+6} that is calculated currently or was calculated in the past as a position of the vehicle at the time $t+6$ after 6 timings of the time t that is the current time.

Further, the prediction information cancellation unit 18 may calculate the position error for the predicted position at a time after an appropriately set timing from the time t that is the current time.

[0071]

Also, the prediction information cancellation unit 18 judges whether a difference (deviation) between the minimum value and the maximum value of the calculated

position error exceeds a threshold value, and judges that the prediction information is to be canceled when the difference exceeds the threshold value. The prediction information indicates the predicted position calculated in step S102 or the expected transit point passage time calculated in step S105. Also, when the difference between the minimum value and the maximum value of the calculated position error exceeds the threshold value, the prediction information cancellation unit 18 outputs a prediction information cancellation signal to the application unit 30. Then, the application unit 30 deletes the expected transit point passage time recorded on the timing latency storage unit after step S105.

[0072]

Here, when the expected transit point passage time is not recorded on the timing latency storage unit, the application unit 30 stops the process of displaying information to be displayed on the display unit 40. For example, in step S109 described above, the first transit point passage information output unit 302 stops the judgment as to whether the current time reaches the expected transit point passage time, and stops displaying the passage information.

Further, when the expected transit point passage time is not recorded on the timing latency storage unit,

in step S114 and step S115 described above, the billing amount calculation unit 304 stops the judgment as to whether the current time exceeds the expected transit point passage time and the judgment as to whether the current time reaches the expected transit point passage time, and stops the display of the amount of billing.

Further, when the expected transit point passage time is not recorded on the timing latency storage unit, in step S205 and step S206 described above, the second transit point passage information output unit 306 stops the judgment as to whether the current time exceeds the expected transit point passage time and the judgment as to whether the current time reaches the expected transit point passage time, and stops displaying the passage information.

[0073]

Further, when the expected transit point passage time is not recorded on the timing latency storage unit, the above-described position output unit 310 stops the judgment as to whether the current time has reached the expected transit point passage time, and stops the display of the vehicle position.

Further, when the expected transit point passage time is not recorded on the timing latency storage unit, the above-described traffic information output unit 309

stops the judgment as to whether the current time has reached the expected transit point passage time, and stops display of the traffic information.

[0074]

Further, when the prediction information cancellation unit 18 judges that the prediction information is to be canceled since the difference between the minimum value and the maximum value of the calculated position error exceeds the threshold value, the prediction information cancellation unit 18 notifies the predicted position information calculation unit 16 of the prediction information cancellation signal. Then, the predicted position information calculation unit 16 stops the calculation of the predicted position, and outputs the information of the sensed position (current position) input from the position information calculation unit 15 to the map matching unit 20 in place of the predicted position. The predicted position information calculation unit 16 outputs the information of the sensed position (current position) input from the position information calculation unit 15 to the map matching unit 20 in place of the predicted position until the input of the prediction information cancellation signal stops. Also, the real time processing unit 21 of the map matching unit 20 calculates the vehicle position using the input sensed

position. Further, the travel path specification unit 22 of the map matching unit 20 performs a process of settling the travel path using the input sensed position at predetermined timing intervals.

[0075]

Next, a second process of the prediction information cancellation unit 18 described above will be described.

The prediction information cancellation unit 18 may perform a prediction information cancellation process through a second process to be described below, in place of the first process described above.

Specifically, when the current time is a time t , the prediction information cancellation unit 18 receives the predicted position calculated for each time from the time t to $t+7$ that is after a predetermined time, and generates predicted position time-series data as illustrated in Fig. 5. Also, the prediction information cancellation unit 18 performs the prediction information cancellation process each time the prediction information cancellation unit 18 receives the predicted position at a timing of each time. In the prediction information cancellation process, the prediction information cancellation unit 18 judges whether a beacon signal was received from the outside in the past. When the prediction information cancellation unit 18 judges that the beacon signal was received from the

outside in the past, the prediction information cancellation unit 18 acquires a predicted position X_{p_t+n} calculated after a reception time of the beacon signal. That is, for example, the traffic information processing device 1 is assumed to receive the beacon signal between the past time $t-3$ and the past time $t-2$. In this case, the prediction information cancellation unit 18 acquires the predicted position X_{p_t+1} calculated currently or after the past time $t-2$ as the position of the vehicle at a time $t+1$ that is a time after 1 timing of the time t that is a current time. That is, the predicted position X_{p_t+1} calculated at the time $t-2$, the predicted position X_{p_t+1} calculated at the time $t-1$, and the predicted position X_{p_t+1} calculated at the time t are acquired from Fig. 5. Also, the prediction information cancellation unit 18 calculates a distance (difference) between the predicted position X_{p_t+1} calculated at a time t that is the current time and the predicted position X_{p_t+1} calculated at a past time (time $t-2$ or time $t-1$). Details of the scheme of calculating this distance will be described below. Also, the prediction information cancellation unit 18 specifies a maximum value of the distance of the predicted position as a position error in the predicted position X_{p_t+1} .

[0076]

Further, the prediction information cancellation unit 18 similarly calculates a position error of the predicted position Xp_{t+2} calculated after current or past beacon reception as a position of the vehicle at the time $t+2$ that is a time after 2 timings of the time t that is the current time.

Further, the prediction information cancellation unit 18 similarly calculates a position error of the predicted position Xp_{t+3} calculated after current or past beacon reception as a position of the vehicle at the time $t+3$ that is a time after 3 timings of the time t that is the current time.

Further, the prediction information cancellation unit 18 similarly calculates a position error of the predicted position Xp_{t+4} calculated after current or past beacon reception as a position of the vehicle at the time $t+4$ that is a time after 4 timings of the time t that is the current time.

Further, the prediction information cancellation unit 18 similarly calculates a position error of the predicted position Xp_{t+5} calculated after current or past beacon reception as a position of the vehicle at the time $t+5$ that is a time after 5 timings of the time t that is the current time.

Further, the prediction information cancellation

unit 18 similarly calculates a position error of the predicted position X_{p_t+6} calculated after current or past beacon reception as a position of the vehicle at the time $t+6$ that is a time after 6 timings of the time t that is the current time.

Further, the prediction information cancellation unit 18 may calculate the position error for the predicted position at a time after an appropriately set timing from the time t that is the current time.

[0077]

Also, the prediction information cancellation unit 18 judges whether the maximum values of the plurality of calculated position errors exceed the threshold value. Further, the prediction information cancellation unit 18 judges whether a current speed of the vehicle exceeds the minimum speed (for example, 5m/s) for performing a prediction information cancellation process. Also, when the position error exceeds the threshold value and the current speed exceeds the minimum speed, the prediction information cancellation unit 18 records a cancellation signal indicating "1" on a memory or the like. Further, when the position error does not exceed the threshold value or when the current speed does not exceed the minimum speed, the prediction information cancellation unit 18 records a cancellation signal indicating "0" on

the memory. Then, the prediction information cancellation unit 18 judges whether M or more values of the cancellation signal among N values of the cancellation signal ($N > M$) recorded on the memory in the past is "1". Also, when the M or more values of the cancellation signal among the N values of the cancellation signal ($N > M$) recorded on the memory in the past is "1", the prediction information cancellation unit 18 determines that the prediction information is to be canceled. On the other hand, when the M or more values of the cancellation signal among the N values of the cancellation signal ($N > M$) recorded on the memory in the past is "0", the prediction information cancellation unit 18 determines that the prediction information is not to be canceled. A subsequent process when the prediction information cancellation unit 18 determines that the prediction information is to be canceled is as described above.

[0078]

Fig. 6 is a diagram illustrating an example of calculating a distance between the two predicted positions calculated at different times described above.

Here, the position of the vehicle at a time t that is a current time is $X(\text{Lat}, \text{Lon})$, the predicted position of the vehicle at a time $t+n$ calculated at the time t is $X1(\text{Lat}1, \text{Lon}1)$, and the predicted position of the vehicle

at the time $t+n$ calculated at a time $t-m$ that is a past time is $X_2(\text{Lat}_2, \text{Lon}_2)$.

In this case, a difference $(\Delta \text{Lat}_1, \Delta \text{Lon}_1)$ latitude and the longitude between the position $X(\text{Lat}, \text{Lon})$ of the vehicle at the time t (the current time) and the predicted position $X_1(\text{Lat}_1, \text{Lon}_1)$ of the vehicle at the time $t+n$ calculated at the time t can be calculated using a calculation equation:

$$(\Delta \text{Lat}_1, \Delta \text{Lon}_1) = (X_1(\text{Lat}_1, \text{Lon}_1) - X(\text{Lat}, \text{Lon}))$$

Also, the prediction information cancellation unit 18 calculates a movement vector x_a from the position $X(\text{Lat}, \text{Lon})$ of the vehicle at the time t (the current time) to the predicted position $X_1(\text{Lat}_1, \text{Lon}_1)$ of the vehicle at the time $t+n$ using:

[0079]

[Equation 1]

$$\begin{aligned} \mathbf{x}_a &= (\Delta E_a, \Delta N_a) \\ &= ((R \times \cos(\text{Lat}_1 \div 180 \times \pi) \times \sin(\Delta \text{Lon}_1 \div 180 \times \pi), R \times \sin(\Delta \text{Lat}_1 \div 180 \times \pi)) \\ &\quad \dots (1) \end{aligned}$$

[0080]

Further, a difference $(\Delta \text{Lat}_2, \Delta \text{Lon}_2)$ of latitude and the longitude between the position $X(\text{Lat}, \text{Lon})$ of the vehicle at the time t (the current time) and the predicted position $X_2(\text{Lat}_2, \text{Lon}_2)$ of the vehicle at the time $t+n$

calculated at the past time $t-m$ can be calculated using a calculation equation:

$$(\Delta Lat2, \Delta Lon2) = (-(Lat_t, Lon_t) Lon2)$$

Also, the prediction information cancellation unit 18 calculates a movement vector x_b from the position $X(Lat, Lon)$ of the vehicle at the time t (the current time) to the predicted position $X2(Lat2, Lon2)$ of the vehicle at the time $t+n$ using:

[0081]

[Equation 2]

$$\begin{aligned} \mathbf{x}_b &= (\Delta Eb, \Delta Nb) \\ &= ((R \times \cos(Lat2 \div 180 \times \pi) \times \sin(\Delta Lon2 \div 180 \times \pi), R \times \sin(\Delta Lat2 \div 180 \times \pi)) \\ &\quad \dots (2) \end{aligned}$$

[0082]

Further, R is a value indicating a radius of the earth in Equations (1) and (2). Also, the prediction information cancellation unit 18 calculates [m] between a predicted position $X1$ calculated at a time t that is a current time and a predicted position $X2$ calculated at a past time (time $t-m$)

[0083]

[Equation 3]

$$\Delta x = (x_a \cdot x_b) \div (|x_a| - |x_b|) \quad \dots (3)$$

[0084]

Further, the value calculated using Equation (3) is a "+" value when the predicted position calculated at the past time is after a corresponding position calculated at the time t that is a current time, and a "-" value when the predicted position calculated at the past time is before the corresponding position calculated at the time t that is a current time. That is, in the example of Fig. 6, since the predicted position calculated at the past time is before the corresponding position calculated at the time t that is the current time, the value calculated using Equation (3) indicates "-".

[0085]

Further, in addition to the above-described process, the prediction information cancellation unit 18 may determine to make a request to stop a process for the processing unit that performs a predetermined process using the predicted position based on a result of comparing the signal from the running state detection device that detects the predetermined running state of the vehicle with a threshold value of a value indicated by the signal, and output a prediction information cancellation signal to the application unit 30. For example, the

running state detection device is an acceleration sensor 12. When the acceleration input from the acceleration sensor 12, that is, the currently detected acceleration rather than the previously detected acceleration increases or decreases from a threshold value relative to the previously detected acceleration per unit time, the prediction information cancellation unit 18 may judge that the predicted position calculated by the predicted position information calculation unit 16 is to be canceled, and output the prediction information cancellation signal to the application unit 30. Further, the running state detection device may be the gyro sensor 13 or the vehicle speed signal output device 14.

[0086]

Fig. 7 is a first diagram illustrating an overview of the process of the traffic information processing device.

Fig. 7 illustrates a first example in which the vehicle passes the transit point after a predicted position passage time $t+3$ that is after 3 timings from a current time t . If ~~after a predetermined time~~ is after 2 timings, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+2$) at a time t , and performs the passage judgment. As a result, when the vehicle does not pass the transit point,

the traffic information processing device 1 judges that there is no billing. Further, at a time $t+1$, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+3$), and performs the passage judgment. As a result, when the vehicle does not pass the transit point, the traffic information processing device 1 judges that there is no billing. Further, at a time $t+2$, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+4$), and performs the passage judgment. As a result, when it is judged that the vehicle passes the transit point, the traffic information processing device 1 judges that there is billing, and calculates the expected transit point passage time (time $t+3.1$). Also, at the time $t+3.1$, passage information or an amount of billing is displayed.

[0087]

Fig. 8 is a second diagram illustrating an overview of the process of the traffic information processing device.

Fig. 8 illustrates a second example in which the vehicle passes the transit point after a predicted position passage time $t+3$ that is after 3 timings from a current time t . If "after a predetermined time" is after 2 timings, the traffic information processing device 1

calculates a predicted position after a predetermined time ($t+2$) at a time t , and performs the passage judgment. As a result, when the vehicle does not pass the transit point, the traffic information processing device 1 judges that there is no billing. Further, at a time $t+1$, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+3$), and performs the passage judgment. As a result, when the vehicle does not pass the transit point, the traffic information processing device 1 judges that there is no billing. Further, at a time $t+2$, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+4$), and performs the passage judgment. As a result, when it is judged that the vehicle passes the transit point, the traffic information processing device 1 judges that there is billing, and calculates the expected transit point passage time (time $t+3.9$). Also, display of the passage information or the amount of billing is waited for until the time $t+3.9$, and performed at the expected transit point passage time.

[0088]

Fig. 9 is a third diagram illustrating an overview of the process of the traffic information processing device.

Fig. 9 illustrates an example in which the vehicle

suddenly turns left after a time $t+2$ that is after 2 timings from a time t . If after a predetermined time is after 2 timings, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+2$) at a time t , and performs the passage judgment. As a result, when the vehicle does not pass the transit point, the traffic information processing device 1 judges that there is no billing. Further, at a time $t+1$, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+3$), and performs the passage judgment. As a result, when the vehicle does not pass the transit point, the traffic information processing device 1 judges that there is no billing. Further, at a time $t+2$, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+4$), and performs the passage judgment. As a result, when it is judged that the vehicle passes the transit point, the traffic information processing device 1 judges that there is billing, and calculates the expected transit point passage time (time $t+3.1$). Also, display of the passage information or the amount of billing is waited for until the time $t+3.1$. Meanwhile, the traffic information processing device 1 judges a presence or absence of cancellation of the prediction information at each time. In the case as

illustrated in Fig. 9, when the vehicle turns left immediately after the time $t+2$ and runs, a position error of the predicted position becomes equal to or greater than a threshold value. In this case, the traffic information processing device 1 judges that the prediction information is canceled. Also, the traffic information processing device 1 stops display of the transit or display of the amount of billing.

[0089]

Fig. 10 is a fourth diagram illustrating an overview of the process of the traffic information processing device.

Fig. 10 illustrates an example in which the vehicle stops after a time $t+4$ that is after 4 timings from a time t . If after a predetermined time Δ is after 2 timings, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+2$) at a time t , and performs the passage judgment. As a result, when the vehicle does not pass the transit point, the traffic information processing device 1 judges that there is no billing. Further, at a time $t+1$, the traffic information processing device 1 calculates a predicted position after a predetermined time ($t+3$), and performs the passage judgment. As a result, when it is judged that the vehicle passes the transit point, the traffic

information processing device 1 judges that there is billing, and calculates the expected transit point passage time (time $t+2.1$). Also, display of the passage information or the amount of billing is waited for until the time $t+2.1$. Meanwhile, the traffic information processing device 1 judges a presence or absence of cancellation of the prediction information at a time $t+1$. In the case as illustrated in Fig. 10, since the vehicle decelerates immediately after the time $t+1$, a position error of the predicted position becomes equal to or greater than a threshold value. In this case, the traffic information processing device 1 judges that the prediction information is canceled. Also, the traffic information processing device 1 stops display of the transit or display of the amount of billing.

[0090]

Next, details of the process of settling the travel path to the transit point judged to be passed in step S111 described above will be described.

Fig. 11 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 judgment 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.

[0091]

Fig. 12 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. 12 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.

[0092]

Also, for the roads as illustrated in Fig. 12, 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, positional 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 positional 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. 12, positional information of a connection point connected to the road having ID 2, positional information of a connection point connected to the road having ID3, positional 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, positional 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.

[0093]

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, positional information of a plurality of points on the road, and extension directions indicated by the angle with respect to the reference direction for the positional information of the plurality of points may be stored in the road information.

[0094]

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 positional information of the endpoints on the sides to which the roads indicated by the connection road IDs are connected among pieces of positional 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 positional information of the endpoint A, and the positional information of the endpoint B are stored, the road ID 2 is stored to be associated with the positional information of the endpoint A, and the road ID3 is stored to be associated with the positional information of the endpoint B. Further, various pieces of information in the road information may be stored in other formats.

[0095]

Fig. 13 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. 13 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.

[0096]

The example of Fig. 13 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 judged 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 judged not to be a travel path, and "1" is set in a situation in which the road information is judged 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.

[0097]

Fig. 14 is a diagram illustrating a process flow of the travel path specification unit 22.

Next, details of the processing of the travel path specification unit 22 will be described in order using Fig. 14.

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 (the travel path specifying request from the first transit point passage judgment unit 301). 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 predicted position (or 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 movement start in the error range of the predicted position (or the sensed position) using the predicted position (or the sensed position) (step S1020).

[0098]

Fig. 15 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 predicted position (or the sensed position) and the positional information included in the road information read from the map data storage unit 120, and judges whether the distance is smaller than the distance in the error range. Also, the road information specification unit 130 estimates and specifies the road information in which the distance between the predicted position (or the sensed position) and the positional information is smaller than the distance shown in the error range as a candidate of the possible road in initial movement on the travel path. Also, the road information specification unit 130 similarly performs a judgment 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.

[0099]

Fig. 15 illustrates an example in which there is the predicted position (or 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 predicted position calculated by the predicted position information calculation unit 16 (or the sensed position calculated by the position information calculation unit 15) 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 movement start.

[0100]

When the estimated travel path information generation unit 160 receives the road information at the time of initial movement start, the estimated travel path information generation unit 160 judges 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 movement 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.

[0101]

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 judged 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 judged 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 judged 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 judged 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. 13.

[0102]

Fig. 16 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 movement start, which is specified by the road information specification unit 130, the estimated displacement position calculation unit 140 specifies

positional information of one endpoint close to the predicted position (or the sensed position) from among endpoints in the positional information included in the road information. For example, the estimated displacement position calculation unit 140 reads the positional information of one endpoint close to the predicted position (or the sensed 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. 16(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.

[0103]

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 positional 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 judges 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.

[0104]

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 predicted position (or the sensed 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. 16(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 positional information of the other endpoint in the road information of the road in which the predicted position (or the sensed 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. 16(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.

[0105]

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.

[0106]

In a specific calculation scheme, for example, the

estimated travel path information generation unit 160 acquires positional 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 positional 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 positional information P1 at each processing timing and the positional 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 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. 13 (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.

[0107]

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.

[0108]

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 judges 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 movement 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 positional 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.

[0109]

That is, a description will be given using examples of Figs. 15 and 16. 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 positional 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.

[0110]

Also, the estimated travel path information generation unit 160 copies the estimated travel path information (estimated travel path information 2 of Fig. 13) 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. 13) 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.

[0111]

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.

[0112]

Fig. 17 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. 17 are stored in the estimated travel path information data table. Further, 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 movement 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.

[0113]

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. 17.

[0114]

Also, the non-travel path judgment 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 judgment 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.

[0115]

Fig. 18 is a diagram illustrating a process overview of the non-travel path judgment unit.

Fig. 18 illustrates the pieces of estimated travel path information illustrated in Fig. 17 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 judgment 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.

[0116]

Fig. 19 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 judgment 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 judgment unit 180 rewrites the non-travel path flag stored in the estimated travel path information judged to be excluded, from "0" to "1" as illustrated in Fig. 19. Also, the non-travel path judgment unit 180 outputs a travel path settlement request to the travel path output unit 190.

[0117]

Next, when the travel path output unit 190 receives the travel path settlement request from the non-travel path judgment 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.

[0118]

Fig. 20 is a first diagram illustrating a process overview of the travel path output unit.

Fig. 20 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. 20 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.

[0119]

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 judges 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 judged 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.

[0120]

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.

[0121]

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

[0122]

According to the traffic information processing device and the processing method and the program therefor described above, since the fact indicating that the vehicle has passed the transit point or the amount of

billing are immediately displayed when the vehicle passes the transit point, it is possible to reduce a situation in which the driver is unable to immediately recognize the fact indicating that the vehicle has passed the entrance or the exit of the road that is a road-pricing target or the amount of billing when the vehicle has passed the travel path including the road that is a road-pricing target.

Reference Signs List

[0123]

1: TRAFFIC INFORMATION PROCESSING DEVICE

10: POSITIONING UNIT

20: MAP MATCHING UNIT

30: APPLICATION UNIT

40: DISPLAY UNIT

50: STORAGE UNIT

11: LATITUDE/LONGITUDE MEASUREMENT SENSOR

12: ACCELERATION SENSOR

13: GYRO SENSOR

14: VEHICLE SPEED SIGNAL OUTPUT DEVICE

15: POSITION INFORMATION CALCULATION UNIT

16: PREDICTED POSITION INFORMATION CALCULATION UNIT

18: PREDICTION INFORMATION CANCELLATION UNIT

21: REAL TIME PROCESSING UNIT

22: TRAVEL PATH SPECIFICATION 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
308: SPEED CALCULATION UNIT
309: TRAFFIC INFORMATION OUTPUT UNIT
310: POSITION OUTPUT UNIT
311: PASSAGE TIME CALCULATION 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:

a predicted position information calculation unit that calculates a predicted position indicating a position of a vehicle at a future time based on a sensed position of the vehicle input from a sensor device;

a first transit point passage judgment unit that judges whether the vehicle passes the transit point at the future time correlating with the predicted position based on the predicted position, and positional information of a transit point on a travel path that is a billing target; and

a first transit point passage information output unit that outputs passage information indicating passage of the transit point at an actual time corresponding to the future time at which it is judged that the vehicle passes the transit point.

[Claim 2]

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

a prediction information cancellation unit that judges a deviation between the predicted positions of the vehicle at the future times, the predicted positions being

calculated by the predicted position information calculation unit at different times, and determines to make a request to stop a process of the first transit point passage judgment unit using at least the predicted position when the deviation is great.

[Claim 3]

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

a prediction information cancellation unit that determines to make a request to stop the process of the first transit point passage judgment unit using at least the predicted position based on a result of comparing a signal from a running state detection device that detects a predetermined running state of the vehicle with a threshold value of the value indicated by the signal.

[Claim 4]

The traffic information processing device according to claim 2 or 3,

wherein the prediction information cancellation unit judges, at each predetermined timing, whether to request at least the first transit point passage judgment unit that performs a predetermined process using the predicted position to stop the process, and determines that the stop of the process is to be requested when judging to make a request to stop the process a predetermined number of

times M or more among a unit number N of judgments ($N > M$).

[Claim 5]

The traffic information processing device according to any one of claims 1 to 4, further comprising:

a travel path specification unit that specifies and outputs, as a settled travel path, the estimated travel path including the transit point to be passed at the future time from among unsettled travel paths of the vehicle, which are the estimated travel paths representing one or a plurality of travel paths estimated to be passed by the vehicle when the first transit point passage judgment unit judges that the vehicle passes the transit point; and

a billing amount calculation unit that calculates an amount of billing of the settled travel path.

[Claim 6]

The traffic information processing device according to claim 5, further comprising:

a second transit point passage judgment unit that detects the transit point closest to the predicted position of the vehicle included in the settled travel path based on the settled travel path output from the travel path specification unit to judge that the vehicle in the predicted position has passed the transit point, when the first transit point passage judgment unit judges

that the vehicle passes the transit point at the future time; and

a second transit point passage information output unit that outputs passage information indicating the passage of the transit point judged by the second transit point passage judgment unit at an actual time corresponding to the future time.

[Claim 7]

The traffic information processing device according to claim 6, further comprising:

a travel path type judgment unit that judges a type of a travel path that is the billing target,

wherein the billing amount calculation unit calculates an amount of billing of the settled travel path based on the type of the travel path.

[Claim 8]

The traffic information processing device according to claim 6 or 7,

wherein each of the first transit point passage judgment unit and the second transit point passage judgment unit acquires identification information of a travel path along which the vehicle runs at the future time, judges whether the vehicle in the predicted position has passed the transit point at predetermined intervals based on the identification information of the travel path

and the predicted position, judges whether the vehicle runs along a plurality of travel paths based on the identification information of the travel path acquired in a previous judgment as to whether the vehicle in the predicted position has passed the transit point at the predetermined interval and the identification information of the travel path acquired in a current judgment as to whether the vehicle in the predicted position has passed the transit point, and judges that the vehicle in the predicted position has passed the transit point located between the positional information at a timing at which the previous judgment as to whether the vehicle in the predicted position has passed the transit point is performed among the transit points included in the plurality of travel paths along which the vehicle runs and the positional information at a timing at which the current judgment as to whether the vehicle in the predicted position has passed the transit point is performed when it is detected that the vehicle runs along the plurality of travel paths.

[Claim 9]

The traffic information processing device according to any one of claims 5 to 8, further comprising:

a speed calculation unit that calculates a speed at the future time of the vehicle based on a passage time of

a plurality of points in the settled travel path output from the travel path specification unit and a distance between the plurality of points; and

a speed output unit that outputs the speed at the future time, at an actual time corresponding to the future time.

[Claim 10]

The traffic information processing device according to any one of claims 1 to 9, further comprising:

a traffic information output unit that reads and outputs the traffic information corresponding to the predicted position of the vehicle at an actual time corresponding to the future time.

[Claim 11]

The traffic information processing device according to any one of claims 1 to 10, further comprising:

a position output unit that outputs the predicted position of the vehicle at an actual time corresponding to the future time.

[Claim 12]

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

causing a predicted position information calculation unit to calculate a predicted position indicating a

position of a vehicle at a future time based on a sensed position of the vehicle input from a sensor device;

causing a first transit point passage judgment unit to judge whether the vehicle passes the transit point at the future time correlating with the predicted position based on the predicted position, and positional information of a transit point on a travel path that is a billing target; and

causing a first transit point passage information output unit to output passage information indicating passage of the transit point at an actual time corresponding to the future time at which it is judged that the vehicle passes the transit point.

[Claim 13]

The processing method according to claim 12, including a step of:

causing a prediction information cancellation unit to judge a deviation between the predicted positions of the vehicle at the future times, the predicted positions being calculated by the predicted position information calculation unit at different times, and determine to make a request to stop a process of at least the first transit point passage judgment unit that performs the process using the predicted position when the deviation is great.

[Claim 14]

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

predicted positional information calculation means for calculating a predicted position indicating a position of a vehicle at a future time based on a sensed position of the vehicle input from a sensor device;

first transit point passage judgment means for judging whether the vehicle passes the transit point at the future time correlating with the predicted position based on the predicted position, and positional information of a transit point on a travel path that is a billing target; and

first transit point passage information output means for outputting passage information indicating passage of the transit point at an actual time corresponding to the future time at which it is judged that the vehicle passes the transit point.

[Claim 15]

The program according to claim 14, including

causing the computer to function as prediction information cancellation means for judging a deviation between the predicted positions of the vehicle at the future times, the predicted positions being calculated by the predicted position information calculation unit at different times, and determining to make a request to stop

a process of at least the first transit point passage judgment unit that performs the process using the predicted position when the deviation is great.