

DESCRIPTION

MOVEMENT PATH SPECIFICATION DEVICE AND MOVEMENT PATH
SPECIFICATION METHOD AND PROGRAM

5

TECHNICAL FIELD

[0001]

The present invention relates to a movement path specification device installed in a vehicle, etc. and configured to specify a movement path of the vehicle, a movement path specification method, and its program.

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Priority is claimed on Japanese Patent Application No. 2011-242144, filed November 4, 2011, the content of which is incorporated herein by reference.

BACKGROUND ART

15 [0002]

A car navigation device installed in a vehicle, etc. measures a current location of a vehicle by receiving a transmission signal transmitted from a Global Positioning System (GPS) satellite and specifies a road on which the vehicle is currently traveling. The car navigation device performs a process of specifying a virtual location corresponding to a real current location of the vehicle on the specified road of a map displayed on a screen of the car navigation device and indicating a mark representing the current location of the vehicle at the virtual location, etc.

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Also, technology for indicating the current location on the map output to the display screen is disclosed in Patent Literature 1.

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PRIOR ART LITERATURE

PATENT LITERATURE

[0003]

[Patent Literature 1]

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

DISCLOSURE OF INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004]

- 10 Incidentally, a toll is collected using a charging method called road pricing for charging the toll according to a road through which a vehicle has actually passed or a distance in Europe, Singapore, or the like. In the road pricing, a movement path is specified based on a positioning result of the vehicle according to a signal received from the GPS satellite and charging, etc. are performed according to a travel distance in the
- 15 movement path.

[0005]

- Here, the technology of the car navigation device of the above-described Patent Literature 1 is technology for accurately mapping the current location of the vehicle on the map and displaying the mapping result even when a branch of the road is a branch of
- 20 a small angle. However, there are cases in which it is erroneously determined that the vehicle is located on another road on which the vehicle does not travel when the movement path of the vehicle is calculated by such a car navigation device and the movement path is used in charging calculation of the road pricing. In this case, the calculation of a toll for charging using the erroneous path as the movement path is likely
- 25 to be performed and highly accurate toll calculation is difficult.

[0006]

Here, an object of the present invention is to provide a movement path specification device and a movement path specification method capable of solving the above-described problem and its program.

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MEANS FOR SOLVING THE PROBLEMS

[0007]

In order to achieve the aforementioned object, according to the present invention, there is provided a movement path specification device including: a movement path
10 output unit configured to output identification information of a road included in any estimated movement path information other than that determined to be outside a movement path among the estimated movement path information including the identification information of the road representing the movement path of past estimation as the identification information of the road representing an established past movement
15 path.

[0008]

According to the present invention, in the above-described movement path specification device, the movement path output unit specifies the identification information of a continuously included common road as the established past movement
20 path within the estimated movement path information other than that determined to be outside the movement path, and outputs the identification information of the road representing the past movement path.

[0009]

According to the present invention, the above-described movement path
25 specification device includes: a road information specification unit configured to specify

road information at a location within an error range from a current location of its own device as a candidate for a current movement path; an estimated movement location computation unit configured to sequentially compute estimated movement locations from one endpoint closest to the current location on each road of a candidate for the current

5 movement path specified by the road information specification unit according to passage of time based on a movement distance of a vehicle including its own device according to the passage of time; a next path road information specification unit configured to specify the road information in which the estimated movement location computed for the road information specified by the road information specification unit first approaches another

10 endpoint of the road information and specify the road information connected to the road represented by the road information as the candidate for the next path; an estimated movement path information generation unit configured to specify the road information connected to the road information specified by the next path road information specification unit as the candidate for the next path from among the road information

15 specified by the road information specification unit as the candidate for a current movement path and separately generate the estimated movement path information in which the identification information of the road included in the road information and the identification information of the road included in the road information specified by the next path road information specification unit as the candidate for the next path are

20 associated for all the road information specified by the next path road information specification unit as the candidate for the next path; and an out-of-movement-path determination unit configured to determine the estimated movement path information in which possibility of the candidate for the movement path is low among generated estimated movement path information as the estimated movement path information

25 outside the movement path by setting the road information specified by the next path

road information specification unit as the candidate for the next path as the candidate for the current movement path and sequentially performing processes of the estimated movement location computation unit, the next path road information specification unit, and the estimated movement path information generation unit.

5 [0010]

According to the present invention, in the above-described movement path specification device, the estimated movement path information generation unit computes estimated likelihood of the road information specified as the candidate for a current movement path using at least a location and an extending direction in a real space of the road included in the road information specified as the candidate for the current movement path and the location and a traveling direction in the real space detected by its own device, and associates and records the computed estimated likelihood and the identification information of the road included in the road information specified as the candidate for the current movement path in the estimated movement path information, and the movement path output unit specifies one piece of the estimated movement path information based on the estimated likelihood from among the estimated movement path information other than that determined to be outside the movement path, and specifies and outputs the identification information of each road included in the estimated movement path information as the established past movement path.

20 [0011]

According to the present invention, in the above-described movement path specification device, the movement path output unit specifies the estimated movement path information in which the estimated likelihood having a highest value is recorded among the estimated likelihood recorded in association with the identification information of recently specified roads included in the estimated movement path

information other than that determined to be outside the movement path, and specifies and outputs the identification information of each road included in the estimated movement path information as the established past movement path.

[0012]

5 According to the present invention, in the above-described movement path specification device, the movement path output unit specifies the estimated movement path information in which the identification information of the road input from another device is recorded as the identification information of a recently specified road among the estimated movement path information other than that determined to be outside the
10 movement path, and specifies and outputs the identification information of each road included in the estimated movement path information as the established past movement path.

[0013]

 According to the present invention, in the above-described movement path
15 specification device, the movement path output unit specifies the estimated movement path information recording estimated likelihood having a highest value among the estimated likelihood recorded in association with the identification information of the road included in the road information specified as the candidate for the current movement path a predetermined number of times earlier among the estimated movement
20 path information other than that determined to be outside the movement path, and specifies and outputs the identification information of each road included in the estimated movement path information as the established past movement path.

[0014]

 According to the present invention, in the above-described movement path
25 specification device, after the identification information of roads specified as the

established past movement path is output, the movement path output unit determines to compute the output of the identification information of the road representing the established past movement path again when the identification information of the road recorded in most recently estimated movement path information among the output road
5 identification information is not consistent with the identification information of a connection road recorded in association with location information close to a current location among the identification information of connection roads included in newly specified road information.

[0015]

10 According to the present invention, there is provided a processing method of a movement path specification device, including: outputting, by a movement path output unit of the movement path specification device, identification information of a road included in any estimated movement path information other than that determined to be outside a movement path among the estimated movement path information including the
15 identification information of the road representing the movement path of past estimation as the identification information of the road representing an established past movement path.

[0016]

According to the present invention, in the above-described processing method,
20 the movement path output unit specifies the identification information of a continuously included common road as the established past movement path within the estimated movement path information other than that determined to be outside the movement path, and outputs the identification information of the road representing the past movement path.

25 [0017]

According to the present invention, the above-described processing method includes: specifying, by a road information specification unit of the movement path specification device, road information at a location within an error range from a current location of its own device as a candidate for a current movement path; sequentially

5 computing, by an estimated movement location computation unit of the movement path specification device, estimated movement locations from one endpoint closest to the current location on each road of the candidate for the current movement path specified by the road information specification unit according to passage of time based on a movement distance of a vehicle including its own device according to the passage of

10 time; specifying, by a next path road information specification unit of the movement path specification device, the road information in which the estimated movement location computed for the road information specified by the road information specification unit first approaches another endpoint of the road information and specifying the road information connected to the road represented by the road information as the candidate

15 for the next path; specifying, by an estimated movement path information generation unit of the movement path specification device, the road information connected to the road information specified by the next path road information specification unit as the candidate for the next path from among the road information specified by the road information specification unit as the candidate for a current movement path and

20 separately generating the estimated movement path information in which the identification information of the road included in the road information and the identification information of the road included in the road information specified by the next path road information specification unit as the candidate for the next path are associated for all the road information specified by the next path road information

25 specification unit as the candidate for the next path; and determining, by an

out-of-movement-path determination unit of the movement path specification device, the estimated movement path information in which possibility of the candidate for the movement path is low among generated estimated movement path information as the estimated movement path information outside the movement path by setting the road information specified by the next path road information specification unit as the candidate for the next path as the candidate for the current movement path and sequentially performing processes of the estimated movement location computation unit, the next path road information specification unit, and the estimated movement path information generation unit.

10 [0018]

According to the present invention, there is provided a program for causing a computer of a movement path specification device to function as: a movement path output means configured to output identification information of a road included in any estimated movement path information other than that determined to be outside a movement path among the estimated movement path information including the identification information of the road representing the movement path of past estimation as the identification information of the road representing an established past movement path.

[0019]

20 According to the present invention, in the above-described program, the movement path output means specifies the identification information of a continuously included common road as the established past movement path within the estimated movement path information other than that determined to be outside the movement path, and outputs the identification information of the road representing the past movement path.

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[0020]

According to the present invention, the above-described program causes the computer to function as: a road information specification means configured to specify road information at a location within an error range from a current location of its own device as a candidate for a current movement path; an estimated movement location computation means configured to sequentially compute estimated movement locations from one endpoint closest to the current location on each road of a candidate for the current movement path specified by the road information specification means according to passage of time based on a movement distance of a vehicle including its own device according to the passage of time; a next path road information specification means configured to specify the road information in which the estimated movement location computed for the road information specified by the road information specification means first approaches another endpoint of the road information and specify the road information connected to the road represented by the road information as the candidate for the next path; an estimated movement path information generation means configured to specify the road information connected to the road information specified by the next path road information specification means as the candidate for the next path from among the road information specified by the road information specification means as the candidate for a current movement path and separately generate the estimated movement path information in which the identification information of the road included in the road information and the identification information of the road included in the road information specified by the next path road information specification means as the candidate for the next path are associated for all the road information specified by the next path road information specification means as the candidate for the next path; and an out-of-movement-path determination means configured to determine the estimated

movement path information in which possibility of the candidate for the movement path is low among generated estimated movement path information as the estimated movement path information outside the movement path by setting the road information specified by the next path road information specification means as the candidate for the next path as the candidate for the current movement path and sequentially performing processes of the estimated movement location computation means, the next path road information specification means, and the estimated movement path information generation means.

10 EFFECTS OF THE INVENTION

[0021]

According to the present invention, a movement path on which a vehicle has previously traveled can be accurately computed.

15 BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Fig. 1 is a block diagram illustrating a configuration of a movement path specification device according to an embodiment of the present invention.

Fig. 2 is a diagram illustrating road information stored by a map data storage unit.

Fig. 3 is a first diagram illustrating an estimated movement path information data table.

Fig. 4 is a diagram illustrating a processing flow of the movement path specification device.

Fig. 5 is a first diagram illustrating a processing outline of a road information

specification unit.

Fig. 6A is a second diagram illustrating the processing outline of the road information specification unit.

5 Fig. 6B is a second diagram illustrating the processing outline of the road information specification unit.

Fig. 7 is a second diagram illustrating the estimated movement path information data table.

Fig. 8 is a diagram illustrating a processing outline of an out-of-movement-path determination unit.

10 Fig. 9 is a third diagram illustrating the estimated movement path information data table.

Fig. 10 is a first diagram illustrating a processing outline of a movement path output unit.

15 Fig. 11 is a second diagram illustrating the processing outline of the movement path output unit.

Fig. 12 is a third diagram illustrating the processing outline of the movement path output unit.

Fig. 13 is a fourth diagram illustrating the processing outline of the movement path output unit.

20 Fig. 14A is a diagram illustrating an outline of an effect of the movement path specification device.

Fig. 14B is a diagram illustrating an outline of the effect of the movement path specification device.

25 Fig. 14C is a diagram illustrating an outline of the effect of the movement path specification device.

Fig. 15A is a fifth diagram illustrating the processing outline of the movement path output unit.

Fig. 15B is a fifth diagram illustrating the processing outline of the movement path output unit.

5 Fig. 16 is a diagram illustrating a processing outline during tunnel traveling.

PREFERRED EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0023]

Hereinafter, a movement path specification device according to an embodiment
10 of the present invention will be described with reference to the drawings.

Fig. 1 is a block diagram illustrating a configuration of the movement path specification device according to the embodiment.

In Fig. 1, reference sign 1 represents the movement path specification device. The movement path specification device 1, for example, is a device provided in a car
15 navigation device included in a vehicle or connected to the car navigation device via a communication cable within the vehicle. The movement path specification device 1 is a device configured to accurately determine a road on which the vehicle provided with its own device has previously travelled.

[0024]

20 The movement path specification device 1 is connected to a latitude-longitude measurement device 2, an acceleration sensor 3, a gyro sensor 4, and a vehicle velocity signal output device 5 provided in the vehicle via a communication cable. In the movement path specification device 1, information output from the latitude-longitude measurement device 2, the acceleration sensor 3, the gyro sensor 4, and the vehicle
25 velocity signal output device 5 is input by an input unit 10 of the movement path

specification device 1. In addition, the movement path specification device 1 includes processing units and storage units of a communication unit 11, a map data storage unit 12, a road information specification unit 13, an estimated movement location computation unit 14, a next path road information specification unit 15, an estimated movement path information generation unit 16, an estimated movement path information storage unit 17, an out-of-movement-path determination unit 18, a movement path output unit 19, an established movement path storage unit 20, a payment request response unit 21, and a control unit 100.

[0025]

10 The communication unit 11 is the processing unit configured to receive information from another device via a communication network such as a wireless link. In this embodiment, for example, a signal transmitted by a transmission device provided on a roadside or information transmitted by an information distribution server connected to a network via a wireless base station device is received.

15 The map data storage unit 12 is the storage unit configured to store map data including road information for roads included in a map. Although an example when the movement path specification device 1 according to this embodiment includes the map data storage unit 12 within its own device will be described, the map data storage unit 12 may be provided in an external device. In this case, the movement path specification
20 device 1 reads and processes information stored in the map data storage unit 12 via the communication cable or the communication network.

 In addition, the road information specification unit 13 is the processing unit configured to specify road information of an initial time of a movement start serving as a candidate for a movement path of the vehicle provided with its own device from among a
25 plurality of pieces of the road information stored in map data within the map data storage

unit 12 based on information input from the input unit 10.

[0026]

In addition, the estimated movement location computation unit 14 is the processing unit configured to compute a location in the specified road information based on traveling of the vehicle.

In addition, the next path road information specification unit 15 is the processing unit configured to specify the road information serving as the candidate for the next path.

In addition, the estimated movement path information generation unit 16 is the processing unit configured to generate the estimated movement path information in which road identification information (road IDs) represented by the road information is associated and held in order of movement path using road information specified as the candidate for the current movement path or road information specified as the candidate for the next path. Although details about the estimated movement path information will be described later, the estimated movement path information stores the road ID of the road on which the vehicle provided with the movement path specification device 1 has previously traveled or is currently traveling. For example, when it is estimated that the vehicle is likely to have sequentially traveled on roads A, B, C, and D, the estimated movement path information generation unit 16 generates the estimated movement path information associated and stored in order of road ID of the roads A, B, C, and D. In addition, the vehicle is likely to have sequentially traveled on the roads A, B, C, and E simultaneously when it is estimated that the vehicle is likely to have sequentially traveled on the roads A, B, C, and D. In this case, the estimated movement path information generation unit 16 further generates the estimated movement path information associated and stored in order of road ID of the roads A, B, C, and E.

The estimated movement path information storage unit 17 is the storage unit

configured to store the estimated movement path information generated by the estimated movement path information generation unit 16. More specifically, the estimated movement path information generation unit 16 writes the generated estimated movement path information to the estimated movement path information storage unit 17. Thereby,
5 the estimated movement path information storage unit 17 stores the estimated movement path information.

[0027]

In addition, the out-of-movement-path determination unit 18 is the processing unit configured to determine the estimated movement path information including
10 information about a road determined to be outside the movement path among the estimated movement path information recorded on the estimated movement path information storage unit 17.

In addition, the movement path output unit 19 is the processing unit configured to output information about the road established as that representing a past movement
15 path using the estimated movement path information other than that including the information about the road determined to be outside the movement path.

[0028]

In addition, the established movement path storage unit 20 is the storage unit configured to store the information about the road established as that representing the
20 past movement path output by the movement path output unit 19.

In addition, the payment request response unit 21 is the processing unit configured to issue a payment request response according to a payment request from an external device such as a charging device. The information recorded on the established movement path storage unit 20 is stored in the payment request response. That is, the
25 payment request response unit 21 is the processing unit configured to control a process of

reading information recorded on the established movement path storage unit 20 when a payment request has been input, generating the payment request response including the information, and transmitting the payment request response to a device of a payment request transmission source via the communication unit 11.

5 In addition, the control unit 100 is the processing unit configured to control the processing units of the input unit 10, the communication unit 11, the road information specification unit 13, the estimated movement location computation unit 14, the next path road information specification unit 15, the estimated movement path information generation unit 16, the out-of-movement-path determination unit 18, the movement path
10 output unit 19, and the payment request response unit 21. Also, a central processing unit (CPU) of a computer provided in the movement path specification device 1 executes a program and therefore these processing units are provided within the movement path specification device.

[0029]

15 Then, the movement path specification device 1 provided with the processing units and the storage units as described above estimates the road on the path on which the vehicle provided with its own device has previously traveled and outputs a road ID of the road representing the established past movement path.

 More specifically, the movement path specification device 1 specifies road
20 information at a location within the error range as a candidate for a current movement path based on at least a location in a real space of its own device from among the road information including at least a road ID, location information including an endpoint in the real space of the road, an extending direction, and an ID (connection road ID) of a connection road connected to the road as the road information about a plurality of roads
25 divided by an endpoint or the road, a branch point, or a connection point.

[0030]

In addition, the movement path specification device 1 specifies the location information of one endpoint closest to the current location in the real space of its own device for the specified road information among the location information included in the specified road information, and sequentially computes the estimated movement location
5 in the road represented by the specified road information according to the passage of time based on a movement distance of its own device according to the passage of time.

In addition, the movement path specification device 1 specifies the road information in which the estimated movement location computed for the specified road
10 information first approaches another endpoint of the road information, and specifies the road information representing the road connected to the other endpoint of the road information as a candidate for the next path.

In addition, the movement path specification device 1 specifies the road information including the location information of the endpoint included in the road
15 information specified as the candidate for the next path and the location information of a close endpoint within a predetermined distance from among the road information specified as the candidate for a current movement path, and generates the estimated movement 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 for the next path
20 are associated for all the road information specified as the candidate for the next path.

[0031]

In addition, the movement path specification device 1 determines the estimated movement path information in which possibility of the candidate for the movement path is low as the estimated movement path information outside the movement path among
25 generated estimated movement path information by setting the road information specified

as the candidate for the next path as the candidate for the current movement path and sequentially performing estimated movement location computation, next path road information specification, and estimated movement path information generation.

In addition, the movement path specification device 1 outputs the road ID
5 included in any estimated movement path information other than that determined to be outside the movement path as the road ID representing the established past movement path.

[0032]

Alternatively, for the output of the road ID representing the established past
10 movement path, the movement path specification device 1, for example, specifies a continuously included common road ID as the established past movement path within the estimated movement path information other than that determined to be outside the movement path, and outputs the road ID representing the past movement path.

Alternatively, for the output of the road ID representing the established past
15 movement path, the movement path specification device 1, for example, specifies one piece of estimated movement path information based on estimated likelihood from among the estimated movement path information other than that determined to be outside the movement path, and specifies and outputs each road ID included in the estimated movement path information as the established past movement path.

20 [0033]

Alternatively, for the output of the road ID representing the established past
movement path, the movement path specification device 1, for example, specifies the
estimated movement path information recording estimated likelihood having a highest
value among the estimated likelihood recorded in association with recently specified road
25 IDs included in the estimated movement path information other than that determined to

be outside the movement path, and specifies and outputs each road ID included in the estimated movement path information as the established past movement path.

Alternatively, for the output of the road ID representing the established past movement path, the movement path specification device 1, for example, specifies the
5 estimated movement path information in which the road ID input from another device is recorded as a recently specified road ID among the estimated movement path information other than that determined to be outside the movement path, and specifies and outputs each road ID included in the estimated movement path information as the established past movement path.

10 [0034]

Alternatively, for the output of the road ID representing the established past movement path, the movement path specification device 1, for example, specifies the estimated movement path information recording estimated likelihood having a highest value among the estimated likelihood recorded in association with the road ID included
15 in the road information specified as the candidate for the current movement path a predetermined number of times earlier among the estimated movement path information other than that determined to be outside the movement path, and specifies and outputs each road ID included in the estimated movement path information as the established past movement path.

20 Alternatively, for the output of the road ID representing the established past movement path, the movement path specification device 1, for example, computes the output of the road ID representing the established past movement path again when the road ID recorded in most recently estimated movement path information among output road IDs after the road ID specified as the established past movement path is output is
25 not consistent with a connection road ID recorded in association with location

information close to a current location among connection road IDs included in newly specified road information.

[0035]

Fig. 2 is a diagram illustrating road information stored by the map data storage
5 unit.

The road information stored by the map data storage unit 12 is information about roads represented in a map represented by map data, and information such as road IDs of the roads, a location (latitude and longitude) in a real space of the road, an extending direction, and a connection road ID representing another connected road is
10 stored. It is assumed that the road represented in the map represented by the map data is divided at a location such as a branch point, a starting point, or an end point of the road and a road ID is allocated to each division road. For example, the road on the map as illustrated in Fig. 2 is divided into 9 roads from a road of ID1 to a road of ID9 based on the starting point or the branch point of the road or a connection point of another road.

15 [0036]

In the road as illustrated in Fig. 2, road information about the 9 roads from the road of ID1 to the road of ID9 is recorded on the map data storage unit 12. Then, a plurality of pieces of location information such as location information of endpoints such as the starting point and the end point of the road in one division road represented by the
20 road ID and an intermediate point may be stored as a location in the real space of the road in one piece of road information. For example, for the road of ID1 in Fig. 2, location information of a connection point connected to the road of ID2, location information of a connection point connected to the road of ID3, location information of an intermediate point of the road of ID1, etc. are stored in the road information about the
25 road of ID1. Alternatively, location information of each point of a predetermined

spacing between endpoints such as the starting point and the end point may be stored in the road information.

[0037]

In addition, the extending direction stored in the road information is an angle
5 formed with a certain reference direction. For example, when the reference direction is true north, the extending direction corresponding to a location of a point on the road included in the road information is an angle of a straight line connecting the location of another point on the same road adjacent to the point formed with the reference direction. In addition, for example, in this embodiment, location information of a plurality of points
10 on the road and the extending direction represented by the angle from the reference direction for the location information of the plurality of points may be stored in the road information.

[0038]

In addition, because the road represented by the road ID1 is connected to the
15 road represented by the road ID2 and the road represented by the road ID3, the connection road ID2 and the connection road ID3 are stored as the connection road IDs in the road information including the road ID1. Here, the connection road IDs, for example, are registered in association with location information of an endpoint of a side to which the road represented by the connection road ID is connected among location
20 information of the endpoints included in the road information. That is, for example, for the road information of the road ID1, the road ID2 is connected to an endpoint A of the road and the road ID3 is connected to an endpoint B of the road. Accordingly, as the road information of the road ID1, the road ID1, the location information of the endpoint A, and the location information of the endpoint B are stored, the road ID2 is stored in
25 association with the location information of the endpoint A, and the road ID3 is stored in

association with the location information of the endpoint B. In addition, various information within the road information may be stored in other formats.

[0039]

Fig. 3 is a first diagram illustrating an estimated movement path information data table stored by the estimated movement path information storage unit.

The estimated movement path information storage unit 17 stores one or more pieces of estimated movement path information generated by the estimated movement path information generation unit 16 within the estimated movement path information data table. The example of Fig. 3 is an example when four pieces of road information estimated as roads on which the vehicle provided with its own device travels are specified from among the road information recorded on the map data storage unit 12 immediately after the movement path specification device 1 has started the process, and recorded within the estimated movement path information data table.

[0040]

The example of Fig. 3 is an example when the four pieces of road information including ID=1, 2, 4, and 5 are specified immediately after the movement path specification device 1 has started the process. An out-of-movement-path flag representing whether it is determined to be outside the movement path and the road information are stored in each of four pieces of corresponding estimated movement path information. In this embodiment, the out-of-movement-path flag is set to "0" in a situation in which it is not determined to be outside the movement path and is set to "1" in a situation in which it is determined to be outside the movement path. In addition, the road information stored in the estimated movement path information, for example, is a road ID and estimated likelihood. The estimated likelihood is a value representing a degree (likelihood) to which the road is estimated to be a road on which the vehicle

provided with the estimated path specification device travels, and is a value to be computed by the estimated movement path information generation unit 16.

[0041]

Fig. 4 is a diagram illustrating a processing flow of the movement path specification device.

Next, details of the process of the movement path specification device will be described in order using Fig. 4.

First, when the vehicle starts up, power is supplied from a battery of the vehicle to the movement path specification device 1 provided in the vehicle. Then, the control unit 100 of the movement path specification device 1 outputs a start request signal of the road information specification process to the road information specification unit 13. Then, the road information specification unit 13 starts the road information specification process (step S101). In addition, when the vehicle starts up, power is also supplied to the latitude-longitude measurement device 2, the acceleration sensor 3, the gyro sensor 4, and the vehicle velocity signal output device 5. Then, the latitude-longitude measurement device 2, the acceleration sensor 3, the gyro sensor 4, and the vehicle velocity signal output device 5 output detection signals to the movement path specification device 1.

[0042]

Specifically, the latitude-longitude measurement device 2 outputs a current location (latitude and longitude) of the vehicle provided with the movement path specification device 1 to the movement path specification device 1 at predetermined intervals. In addition, the acceleration sensor 3 outputs current acceleration of the vehicle to the movement path specification device 1 at predetermined intervals. In addition, the gyro sensor 4 outputs an angle of the vehicle based on a predetermined

direction or an angular velocity of the vehicle to the movement path specification device 1 at predetermined intervals. In addition, the vehicle velocity signal output device 5 outputs a pulse signal (vehicle velocity signal) proportional to the number of rotations of an axle to the movement path specification device 1 at predetermined intervals. Then, the road information specification unit 13 of the movement path specification device 1 first specifies road information of an initial time of a movement start within an error range of a current location using the current location among input information (step S102).

[0043]

Fig. 5 is a first diagram illustrating a processing outline of the road information specification unit.

The process of step S102 will be described in further detail. The road information specification unit 13 reads a distance of the error range from a memory, etc. In addition, the road information specification unit 13 reads road information storing a certain road IDx from the map data storage unit 12, reads location information in which a distance from the current location is closest among the location information stored along with the road IDx from the road information, and determines whether the distance between a location represented by the location information and the current location is less than the distance of the error range. Then, when the determination is Yes, the road information specification unit 13 estimates and specifies the road information including the road IDx as a candidate for a road which is likely to be on a movement path at an initial time of movement. Then, the road information specification unit 13 similarly determines whether the road is within the error range using road information about each road stored in the map data storage unit 12, and estimates and specifies the road information representing the road within the error range as the road information

representing the candidate for the road which is likely to be on the movement path.

[0044]

In Fig. 5, an example when the current location of the vehicle is in the vicinity of a connection point between the road of the road ID1 and the road of the road ID2 is illustrated. In this case, a distance between a location of a point (endpoint or the like) on the road included in each of four pieces of road information including road IDs of the road ID1, the road ID2, the road ID4, and the road ID5 and the current location is assumed to be within the error range. Then, the four pieces of road information including the road IDs of the road ID1, the road ID2, the road ID4, and the road ID5 are estimated and specified to be road information representing the candidate for the road which is likely to be on the movement path.

Thus, the road information specification unit 13 reads the four pieces of specified road information including the road IDs of the road ID1, the road ID2, the road ID4, and the road ID5 from the map data storage unit 12 and outputs the read four pieces of specified road information to the estimated movement location computation unit 14. In addition, the road information specification unit 13 outputs the four pieces of specified road information as the road information of the initial time of the movement start to the estimated movement path information generation unit 16.

[0045]

When the road information of the initial time of the movement start is input, the estimated movement path information generation unit 16 determines whether the estimated movement path information is already recorded within the estimated movement path information data table of the estimated movement path information storage unit 17. Here, power is supplied to the movement path specification device 1 and no estimated movement path information is recorded within the estimated movement

path information data table of the estimated movement path information storage unit 17 in an initial state. The estimated movement path information generation unit 16 reads a road ID from the road information of the initial time of the movement start specified by the road information specification unit 13 and generates estimated movement path information equal in number to the number of pieces of the road information of the initial time of the movement start individually including the road ID (step S103). That is, the estimated movement path information generation unit 16 generates estimated movement path information 1 including the road ID1, estimated movement path information 2 including the road ID2, estimated movement path information 3 including the road ID4, and estimated movement path information 4 including the road ID5. Then, the estimated movement path information generation unit 16 registers the information of the estimated movement path information 1 to 4 in the estimated movement path information data table.

[0046]

At this time, the estimated movement path information generation unit 16 records the estimated movement path information 1 by associating and recording an out-of-movement-path flag representing “0” of the situation in which it is not determined to be outside the movement path and the road ID1 serving as the road information in the estimated movement path information data table within the estimated movement path information storage unit 17.

In addition, the estimated movement path information generation unit 16 records the estimated movement path information 2 by associating and recording the out-of-movement-path flag representing “0” of the situation in which it is not determined to be outside the movement path and the road ID2 serving as the road information in the estimated movement path information data table within the estimated movement path

information storage unit 17.

In addition, the estimated movement path information generation unit 16 records the estimated movement path information 3 by associating and recording the out-of-movement-path flag representing “0” of the situation in which it is not determined to be outside the movement path and the road ID4 serving as the road information in the
5 estimated movement path information data table within the estimated movement path information storage unit 17.

In addition, the estimated movement path information generation unit 16 records the estimated movement path information 4 by associating and recording the
10 out-of-movement-path flag representing “0” of the situation in which it is not determined to be outside the movement path and the road ID5 serving as the road information in the estimated movement path information data table within the estimated movement path information storage unit 17.

Thereby, the estimated movement path information generation unit 16 generates
15 the estimated movement path information data table as illustrated in Fig. 3.

[0047]

Figs. 6A and 6B are second diagrams each illustrating the processing outline of the road information specification unit.

On the other hand, when the specified road information of the initial time of the
20 movement start is input from the road information specification unit 13, the estimated movement location computation unit 14 specifies location information of one endpoint close to the current location in a real space of its own device from among endpoints of the location information included in the road information. For example, location information of one endpoint close to the current location is read from the four pieces of
25 road information including the road ID1, the road ID2, the road ID4, and the road ID5.

Then, movement distances are sequentially computed using a vehicle velocity signal, acceleration, each velocity, latitude/longitude, etc. input from the input unit 10 according to passage of time. The estimated movement location computation unit 14 sequentially computes estimated movement locations (see Fig. 6A) according to the movement distances from one endpoints specified in the four pieces of specified road information (step S104), and outputs the road information specified by the road information specification unit 13 and the estimated movement location iteratively computed according to the passage of time for the specified road information to the next path road information specification unit 15.

10 [0048]

The next path road information specification unit 15 sequentially receives the road information specified by the road information specification unit 13 and estimated movement locations for the specified road information input from the estimated movement location computation unit 14. Then, the next path road information specification unit 15 iteratively computes a distance between the location information of another endpoint different from the one endpoint included in the road information and the estimated movement location, and determines whether the computed distance is within a predetermined distance for the road information (step S105). Then, the first road information for which the computed distance is within the predetermined distance is specified (step S106). Thereby, when it is estimated that movement according to the movement distance represented by the estimated movement location has been performed on the road represented by the road information specified by the road information specification unit 13, the road that first reaches the branch point or the connection point with another road is specified.

25 [0049]

Then, the next path road information specification unit 15 specifies the road information about the connection road connected to the other endpoint among the road information in which the current location of the vehicle is specified to be closest to the location of the other endpoint in the specified road information as the road information
5 (see Fig. 6B) about the road representing the candidate for the next path (step S107).

For example, a connection road ID included within the specified road information in association with the other endpoint of the road information in which the current location of the vehicle is specified to be closest to the location of the other endpoint in the specified road information is detected. Then, the road information including the road

10 ID which is the same as the connection road ID is read from the map data storage unit 12 and the road information is specified to be the road information representing the road of the candidate for the next path. In the example of Fig. 6B, the road information of the road ID4 and the road information of the road ID5 are specified to be the road information serving as the candidate for the next path. Then, the next path road
15 information specification unit 15 outputs the road information serving as the candidate for the current movement path specified by the road information specification unit 13 and the road information serving as the candidate for the next path specified by the next path road information specification unit 15 to the estimated movement path information generation unit 16.

20 [0050]

When the road information serving as the candidate for the current movement path specified by the road information specification unit 13 and the road information serving as the candidate for the next path specified by the next path road information specification unit 15 are input from the next path road information specification unit 15,

25 the estimated movement path information generation unit 16 calculates estimated

likelihood of each of the roads represented by the road information serving as the candidates for the current movement path. The estimated likelihood is a value representing the degree (likelihood) to which the vehicle is likely to travel on the road represented by the road information serving as the candidate for the current movement
5 path.

[0051]

In a specific computation technique, for example, location information P1, a movement distance L1, and a traveling direction D1 of the vehicle are first computed according to passage of time from the time at which the road information serving as the
10 candidate for the current movement path is specified to the time at which the road information serving as the candidate for the next path is specified. In addition, the estimated movement path information generation unit 16 reads location information P2, an extending distance L2 between endpoints of the road, and an extending direction D2 included in the road information serving as the candidate for the current movement path.
15 Then, a difference between the location information P1 and the location information P2, a difference between the movement distance L1 and the extending distance L2, and a difference between an angle (an angle from a reference azimuth such as true north) represented by the traveling direction D1 and an angle (an angle from a reference azimuth such as true north) represented by the extending direction D2 are computed
20 according to the passage of time and a sum of values obtained by weighting the differences is computed as the estimated likelihood. Then, the estimated movement path information generation unit 16 associates the estimated likelihood computed for the road information serving as the candidate of the current movement path with the road ID of the road information and records the associated estimated likelihood and road ID
25 within the estimated movement path information data table illustrated in Fig. 3 (step

S108). The computation of the estimated likelihood and the recording within the estimated movement path information data table are performed for the road information serving as the candidates for all current movement paths.

[0052]

5 After the above-described process of step S106, the next path road information specification unit 15 sets the road information specified as the candidate for the next path as the candidate for the current movement path, and outputs the road information representing the candidate for the current movement path to the estimated movement location computation unit 14. Then, the estimated movement location computation unit
10 14 computes the estimated movement location as described above using the road information serving as the candidate for the current movement path input from the next path road information specification unit 15. In addition, based on the estimated movement location, the next path road information specification unit 15 specifies specific information serving as the candidate for the next path. Then, the similar process is
15 iterated at intervals of predetermined timings T1, T2, ... in the estimated movement location computation unit 14 and the next path road information specification unit 15, and the next path road information specification unit 15 outputs the road information serving as the candidate for the current movement path and the road information serving as the candidate for the next path to the estimated movement path information generation
20 unit 16 at predetermined intervals.

[0053]

 The estimated movement path information generation unit 16 receives the road information serving as the candidate for the current movement path and the road information serving as the candidate for the next path input from the next path road
25 information specification unit 15 at predetermined intervals. Then, every time there is

an input, the estimated movement path information is updated or generated (step S109).

More specifically, the estimated movement path information generation unit 16

determines whether the estimated movement path information is already recorded within the estimated movement path information data table of the estimated movement path

5 information storage unit 17. Here, the estimated movement path information including the road ID of the road information of the initial time of the movement start is already recorded within the estimated movement path information data table according to the above-described process. Then, the estimated movement path information generation unit 16 specifies the road information for holding the same road ID as the connection

10 road ID in association with the location information of the endpoint included in the road information specified as the candidate for the next path from among the road information specified as the candidate for the current movement path. Then, the estimated movement path information in which the road ID included in the road information is associated with the road ID included in the road information specified as the candidate for the next path is separately generated for all the road information specified as the

15 candidate for the next path.

[0054]

That is, in the description using the examples of Figs. 5, 6A, and 6B, the road information specified as the candidate for the current movement path is the road

20 information including each of the road ID1, the road ID2, the road ID4, and the road ID5.

In addition, the road information specified as the candidate for the next path is the road ID4 and the road ID5. Then, the estimated movement path information generation unit

16 reads each of connection road IDs associated with location information of an endpoint from the road information of the road ID4 and the road ID5 specified as the candidate for

25 the next path. The connection road ID2 is included in the connection road IDs. Then,

the estimated movement path information generation unit 16 specifies the road information in which the same road IDs as the read connection road IDs are held from the road information including the road ID1, the road ID2, the road ID4, and the road ID5. That is, the road information including the road ID2 is specified.

5 [0055]

Then, the estimated movement path information generation unit 16 copies the estimated movement path information (the estimated movement path information 2 of Fig. 3) including the connection road ID2 as the road ID of the previously specified road information, and generates new estimated movement path information 2-2 recording the
10 road ID4 of the road information specified as the candidate for the next path by associating the copied estimated movement path information with the road ID2 within the estimated movement path information. In addition, likewise, the estimated movement path information generation unit 16 copies the estimated movement path information (the estimated movement path information 2 of Fig. 3) including the
15 connection road ID2 as the road ID of the previously specified road information, and generates new estimated movement path information 2-3 recording the road ID5 of the road information specified as the candidate for the next path by associating the copied estimated movement path information with the road ID2 within the estimated movement path information.

20 [0056]

In addition, the estimated movement path information generation unit 16 updates the estimated movement path information 1 to 4 already recorded on the estimated movement path information storage unit 17 by reading each road ID and associating the read road ID with the same road ID within the estimated movement path
25 information. That is, the estimated movement path information 1 is updated by

associating the road ID1 and the road ID1. In addition, likewise, the estimated movement path information 2 is updated by associating the road ID2 and the road ID2. In addition, likewise, the estimated movement path information 3 is updated by associating the road ID4 and the road ID4. In addition, likewise, the estimated movement path information 4 is updated by associating the road ID5 and the road ID5.

[0057]

Fig. 7 is a second diagram illustrating the estimated movement path information data table stored by the estimated movement path information storage unit.

According to the above-described process of the estimated movement path information generation unit 16, the estimated movement path information data table stores estimated movement path information 1, estimated movement path information 2, estimated movement path information 2-2, estimated movement path information 2-3, estimated movement path information 3, and estimated movement path information 4 as illustrated in Fig. 7. Also, in the end step of the above-described process, the road ID of the road information (road information 1) specified at the initial time (timing T1) of the movement start and its estimated likelihood are recorded in the estimated movement path information, and the road ID of the road information (road information 2) specified by the next path road information specification unit as the candidate for the next path at a timing T2 is further recorded in association with its road ID. At a time point of this process, the estimated likelihood associated with each road ID represented by the road information 2 is not yet registered.

[0058]

Then, the estimated movement path information generation unit 16 performs a similar process of the above-described estimated likelihood computation technique when the road information serving as the candidate for the current movement path specified by

the road information specification unit 13 and the road information serving as the candidate for the next path specified by the next path road information specification unit 15 are input from the next path road information specification unit 15 the next time.

Then, the estimated movement path information generation unit 16 computes the

5 estimated likelihood for the road of each road ID represented by the road information 2, and records the estimated likelihood computed for the road information serving as the candidate of the current movement path in association with the road ID of corresponding road information within the estimated movement path information data table. Thereby, the estimated likelihood is recorded in association with each road ID recorded as the road
10 information 2 of the estimated movement path information of Fig. 7.

[0059]

Next, the out-of-movement-path determination unit 18 performs a process of excluding the estimated movement path information recorded as the road ID of the road information in which the road ID of the road considered as the movement path having
15 low possibility has recently been specified from among the estimated movement path information recorded on the estimated movement path information storage unit 17 from the candidate (step S110).

In this process, for example, when a road information notification signal (beacon) storing the road ID is received from an external device via the communication
20 unit 11 during the above-described process, the estimated movement path information in which the road ID other than that read from the road information notification signal is recorded as the road ID of the road information most recently specified is excluded as a candidate.

Alternatively, for example, the estimated movement path information recording
25 estimated likelihood less than or equal to a threshold value among estimated likelihood

recorded within the estimated movement path information in association with the road ID of the most recently specified road information is excluded as a candidate.

[0060]

Fig. 8 is a diagram illustrating a processing outline of the out-of-movement-path determination unit.

Fig. 8 is a tree diagram illustrating the estimated movement path information illustrated in Fig. 7. Road information specified at each of timings T1 and T2 is stored in the estimated movement path information. In this state, an example in which the out-of-movement-path determination unit 18 has excluded the estimated movement path information 1, the estimated movement path information 3, and the estimated movement path information 4 recorded by associating the estimated likelihood less than or equal to the threshold value with the latest (timing T2) road information based on the estimated likelihood as candidates is illustrated.

[0061]

Fig. 9 is a third diagram illustrating the estimated movement path information data table stored by the estimated movement path information storage unit.

When the estimated movement path information in which the road ID of the road considered as the movement path having low possibility is recorded as the road ID of the road information most recently specified (timing T2) is excluded from among the estimated movement path information recorded on the estimated movement path information storage unit 17, the out-of-movement-path determination unit 18 rewrites the out-of-movement-path flag stored in the estimated movement path information determined to be excluded from “0” to “1” as illustrated in Fig. 9. Then, the out-of-movement-path determination unit 18 outputs a movement path establishment request to the movement path output unit 19.

[0062]

Next, when the movement path establishment request is input from the out-of-movement-path determination unit 18, the movement path output unit 19 specifies the road ID established as the movement path from among road IDs representing roads estimated as past movement paths using the road ID included in the estimated movement path information including the out-of-movement-path flag “0” recorded on the estimated movement path information storage unit 17 (step S111). Specifically, for example, the movement path output unit 19 compares the road IDs in sequence from the first recorded road ID among all the estimated movement path information including the out-of-movement-path flag “0” recorded on the estimated movement path information storage unit 17, and extracts a continuously common road ID. Then, the movement path output unit 19 specifies the road represented by the extracted road ID continuously common from the first road ID as the established past movement path, and records the “road ID continuously common from the first road ID” representing the established movement path on the established movement path storage unit 20.

[0063]

Fig. 10 is a first diagram illustrating a processing outline of the movement path output unit.

In Fig. 10, the estimated movement path information including road information specified at timings T1, T2, T3, and T4 is illustrated in a tree diagram. An example in which the road represented by the road ID continuously common from the first road ID specified at the timing T1 is specified as the established past movement path based on the estimated movement path information is illustrated. The example of Fig. 10 is an example in which the number of pieces of the estimated movement path information including the out-of-movement-path flag “0” recorded on the estimated movement path

information storage unit 17 is 3. Thus, an example in which the movement path output unit 19 records the road ID2 specified at the timing T1 and the road ID4 specified at the timing T2 as the road ID continuously common from the first road ID on the established movement path storage unit 20 using the three pieces of estimated movement path information is illustrated.

[0064]

Here, in addition to the above-described process, the movement path specification device 1 may be configured to perform a map matching process of plotting and displaying a current location on a map displayed on the display unit such as a monitor as in the related art (step S112). Then, the control unit 100 of the movement path specification device 1 determines whether to perform an end operation based on an input of power OFF, a processing pause request signal included in a wireless signal received from an external device when the vehicle enters a parking lot, a payment request signal from outside, or the like (step S113), and iterates the process from the above-described process of step S104 when there is no end. Thereby, a process of recording new estimated movement path information, updating the estimated movement path information, or excluding the estimated movement path information as a candidate is performed on the estimated movement path information data table of the estimated movement path information storage unit 17. The movement path output unit 19 records the road ID representing the past movement path sequentially established by iterating the process on the established movement path storage unit 20 after step S111. Then, for example, when a payment request is input (step S114), the payment request response unit 21 outputs a payment request response storing the road ID recorded on the established movement path storage unit 20 to the request source (step S115).

[0065]

Here, the request source of the payment request, for example, is a charging processing device connected via a wireless communication network, a car navigation device connected via the communication cable, or the like. Then, when the device of the request source inputs the payment request response, a charging process is performed
5 based on the road ID stored in the payment request response.

[0066]

Also, the road ID continuously common from the first road ID is not likely to be extracted using the estimated movement path information including the out-of-movement-path flag “0” recorded on the estimated movement path information
10 storage unit 17. For example, it is assumed that there is a region in which computation is difficult because a road branch, etc. is complex. In this case, a transmission device configured to transmit a road information notification signal in which the road ID is stored may be installed on the road, the movement path specification device 1 may receive a road information communication signal via the communication unit 11, and the
15 movement path output unit 19 may specify the road ID established as the movement path based on the road ID included in the road information communication signal. In this case, the movement path output unit 19 specifies the estimated movement path information in which the road ID read from the road information communication signal is held as the latest recorded road ID from among all the estimated movement path
20 information including the out-of-movement-path flag “0,” specifies the road represented by each road ID included in the estimated movement path information as the established past movement path, and records the road ID representing the established movement path on the established movement path storage unit 20.

[0067]

25 Alternatively, when the vehicle is in a certain specific region, a road ID having

high reliability is read from a reliability database within its own device when it is determined that the vehicle travels on a road within the region by storing the road ID having the high reliability for a final movement path. Thus, the estimated movement path information in which the road ID is recorded as the road ID of the recently specified road information may be specified, the road represented by each road ID included in the estimated movement path information may be specified as the established past movement path, and the road ID representing the established movement path may be recorded on the established movement path storage unit 20.

[0068]

Alternatively, the movement path output unit 19 may use other techniques in the above-described process of specifying the estimated movement path information as the established past movement path. For example, when a movement path establishment request has been input from the out-of-movement-path determination unit 18, the movement path output unit 19 may specify one piece of estimated movement path information based on estimated likelihood from among the estimated movement path information including the out-of-movement-path flag “0” recorded on the estimated movement path information storage unit 17, and specify and output each road ID included in the estimated movement path information as the road ID representing the established past movement path. In this case, the movement path output unit 19 reads latest estimated likelihood recorded in the estimated movement path information from among the estimated movement path information including the out-of-movement-path flag “0” recorded on the estimated movement path information storage unit 17, and specifies the road represented by each road ID included in the estimated movement path information in which the estimated likelihood representing a highest value is recorded as the established past movement path.

[0069]

Fig. 11 is a second diagram illustrating the processing outline of the movement path output unit.

Fig. 11 is an example in which the movement path output unit 19 specifies the
 5 estimated movement path information in which the estimated likelihood having the
 highest value for the road information specified at a latest timing is recorded from among
 the estimated movement path information including the out-of-movement-path flag “0,”
 and specifies and outputs each road ID included in the estimated movement path
 information as the road ID representing the established past movement path. In the
 10 example of Fig. 11, estimated likelihood of the road ID4 among the road information
 specified at the latest timing T4 is highest. Accordingly, the estimated movement path
 information including the road ID4 at the timing T4 is specified. Then, the movement
 path output unit 19 specifies the road ID2, the road ID4, the road ID5, and the road ID4
 included in the estimated movement path information as the road ID representing the
 15 established past movement path and records the specified road ID2, road ID4, road ID5,
 and road ID4 on the established movement path storage unit 20.

[0070]

Alternatively, the movement path output unit 19 may specify the estimated
 movement path information in which the estimated likelihood having the highest value is
 20 recorded among the estimated likelihood recorded in association with the road ID of the
 road information specified as the candidate for the current movement path at a timing a
 predetermined number of times earlier from among the estimated movement path
 information including the out-of-movement-path flag “0” recorded on the estimated
 movement path information storage unit 17, and specify and output each road ID
 25 included in the estimated movement path information as the road ID representing the

established past movement path.

[0071]

Fig. 12 is a third diagram illustrating the processing outline of the movement path output unit.

5 Fig. 12 illustrates an example in which the movement path output unit 19 specifies the estimated movement path information in which the estimated likelihood having the highest value is recorded among the estimated likelihood recorded in association with the road ID of the road information specified at a timing a predetermined number of times earlier as the candidate for the current movement path
10 from among the estimated movement path information including the out-of-movement-path flag “0,” and specifies and outputs each road ID included in the estimated movement path information as the road ID representing the established past movement path. In the example of Fig. 12, the estimated likelihood recorded in association with the road ID recorded at a timing T3 previous to the road ID recorded at
15 the latest timing T4 for the currently generated estimated movement path information is read from among the estimated movement path information including the out-of-movement-path flag “0,” the road ID1, the road ID4, and the road ID4 included in the estimated movement path information recording an estimated likelihood of “0.7” which is the highest value are specified as the road ID representing the established past
20 movement path and recorded on the established movement path storage unit 20.

[0072]

Fig. 13 is a fourth diagram illustrating the processing outline of the movement path output unit.

25 The movement path output unit 19 may be configured to compute an output of the road ID representing the established past movement path again when the road ID

most recently recorded in the estimated movement path information among the output road IDs after the road ID representing the established past movement path is output to the established movement path storage unit 20 is not consistent with the connection road ID recorded in association with the location information closest to the current location among the connection road IDs included in the road information in association with the road ID representing the movement path newly established after the output of the road ID.

[0073]

That is, as illustrated in (a) of Fig. 13, the movement path output unit 19 is assumed to sequentially output the road ID2, the road ID4, and the road ID4 as the established past movement paths at the timings T1, T2, and T3. In this situation, the movement path output unit 19 compares the road ID4 recorded in the estimated movement path information most recently (timing T3) among the already output road IDs to the connection road ID included in information about the road ID6 having the highest estimated likelihood value representing the newly established movement path thereafter (timing T4). Here, the connection road IDs included in the road information of the road ID6 are only the connection road ID5 and the connection road ID7, and the connection road ID4 is not included. Accordingly, it can be determined that the road represented by the road ID4 and the road represented by the road ID6 are not connected. Thereby, the movement path output unit 19 determines to compute the established past movement path again when the road ID4 recorded in the estimated movement path information most recently (timing T3) among the already output road IDs is not consistent with the connection road ID included in information about the road ID6 having the highest estimated likelihood value representing the newly established movement path thereafter (timing T4). Then, in this case, the movement path output unit 19 computes the road ID

serving as the established past movement path again as illustrated in (b) of Fig. 13.

[0074]

Here, in general map matching technology, it may be determined and displayed that the vehicle travels on a road different from a road on which the vehicle actually

5 travels according to accuracy of map matching. However, according to the above-described process of the movement path specification device, a highly reliable road estimated as a traveling road is established based on estimated likelihood, a road ID obtained according to communication from another device, or the like, and the road ID of the established road is output as the past movement path. Accordingly, it is also
10 possible to specify the road representing a highly accurate past movement path from road specification using map matching of the related art.

[0075]

Figs. 14A, 14B, and 14C are diagrams each illustrating an outline of an effect of the movement path specification device.

15 Fig. 14A illustrates the general map matching technology. In the map matching technology, a location is specified based on a reception signal from a GPS satellite and a current traveling road is specified. However, in the map matching technology, accuracy is degraded and sudden transition from a situation in which traveling on a certain road is determined to a situation in which traveling on another road
20 not connected to the road is determined may occur. In such a case, it is difficult to determine a road on which the vehicle has actually traveled and determine whether the vehicle has reached a road specified for current traveling by traveling through the determined road. However, when the road of the previously established road ID2 is connected to the road of the road ID4 and the road of the road ID5 as illustrated in Fig.
25 14B, the movement path specification device 1 of this embodiment determines which of

the road of the road ID4 and the road of the road ID5 is a road on which the vehicle has traveled according to estimated likelihood at the end of traveling of the road of the road ID4 or the road of the road ID5 (at the end of traveling up to an endpoint) or a road ID read from a signal from another device. Accordingly, as illustrated in Fig. 14C, each continuous road included in the movement path can be accurately specified.

[0076]

Figs. 15A and 15B are fifth diagrams each illustrating the processing outline of the movement path output unit.

The situation illustrated in Fig. 15A is an example in which the number of roads capable of being established by the movement path output unit 19 as the past movement path is two or more. For example, when the movement path according to roads of Road ID2→Road ID5→Road ID6→Road ID8 and the movement path according to roads of Road ID2→Road ID4→Road ID7→Road ID8 are considered as illustrated in Fig. 15A, the movement paths are compared, a different road is specified, and a sum of distances of the roads is computed for each movement path. Then, the movement path having a smallest distance sum may be established as the past movement path (Fig. 15B).

Thereby, it is possible to perform a cheapest charging process in consideration of a merit for a user when charging is performed according to a movement distance. Alternatively, a different road is specified by comparing the movement paths and a sum of payment money of the road is computed for each movement path. Then, a movement path of a smallest sum of payment money may be established as the past movement path.

[0077]

Fig. 16 is a diagram illustrating a processing outline during tunnel traveling.

The movement path specification device 1 may be configured to stop a process of establishing the past movement path from the entry of a tunnel to the exit of the tunnel.

In this case, the next path road information specification unit 15 detects a road ID representing a tunnel input according to communication or the like at the tunnel entry and a road ID representing the tunnel input according to communication or the like at the tunnel exit, and outputs road information including the road ID (tunnel) as the road information serving as the candidate for the next path to the estimated movement path information generation unit 16 by detecting the two road IDs. In addition, the out-of-movement-path determination unit 18 excludes estimated movement path information in which a road ID other than that of the tunnel is most recently recorded, and the movement path output unit 19 establishes the road ID representing the past movement path from among the estimated movement path information in which the road ID of the tunnel is most recently recorded.

[0078]

Also, the above-described movement path specification device internally includes a computer system. The steps of each of the above-described processes may be stored in a computer-readable recording medium in the form of a program, and the above-described processes are performed by causing a computer to read and execute the program. Here, "computer-readable recording medium" denotes a magnetic disk, a magneto-optical disc, a compact disc-read only memory (CD-ROM), a digital versatile disc (DVD)-ROM, a semiconductor memory, etc. The computer program may be distributed to a computer via a communication line, and executed by the computer receiving the distributed program.

[0079]

The program may implement some of the functions described above. The program may also be a so-called differential file (differential program) capable of implementing the above-described functions in combination with a program already

recorded on the computer system.

INDUSTRIAL APPLICABILITY

[0080]

- 5 The present invention can be widely applied to a movement path specification device, which is disposed in a vehicle, etc. and specifies a movement path of the vehicle, and a movement path specification method, and a movement path through which the vehicle has previously traveled can be accurately computed.

10 DESCRIPTION OF THE REFERENCE SYMBOLS

[0081]

- 1 Movement path specification device
- 2 Movement longitude measurement device
- 3 Acceleration sensor
- 15 4 Gyro sensor
- 5 Vehicle velocity signal output device
- 10 Input unit
- 11 Communication unit
- 12 Map data storage unit
- 20 13 Road information specification unit
- 14 Estimated movement location computation unit
- 15 Next path road information specification unit
- 16 Estimated movement path information generation unit
- 17 Estimated movement path information storage unit
- 25 18 Out-of-movement-path determination unit

19 Movement path output unit

20 Established movement path storage unit

21 Payment request response unit

100 Control unit

CLAIMS

[Claim 1]

A movement path specification device comprising:

5 a movement path output unit configured to output identification information of a road included in any estimated movement path information other than that determined to be outside a movement path among the estimated movement path information including the identification information of the road representing the movement path of past estimation as the identification information of the road representing an established past movement path.

10 [Claim 2]

The movement path specification device according to claim 1, wherein the movement path output unit specifies the identification information of a continuously included common road as the established past movement path within the estimated movement path information other than that determined to be outside the movement path, 15 and outputs the identification information of the road representing the past movement path.

[Claim 3]

The movement path specification device according to claim 1 or 2, comprising:

20 a road information specification unit configured to specify road information at a location within an error range from a current location of its own device as a candidate for a current movement path;

an estimated movement location computation unit configured to sequentially compute estimated movement locations from one endpoint closest to the current location on each road of a candidate for the current movement path specified by the road 25 information specification unit according to passage of time based on a movement

distance of a vehicle including its own device according to the passage of time;

a next path road information specification unit configured to specify the road information in which the estimated movement location computed for the road information specified by the road information specification unit first approaches another
5 endpoint of the road information and specify the road information connected to the road represented by the road information as the candidate for the next path;

an estimated movement path information generation unit configured to specify the road information connected to the road information specified by the next path road information specification unit as the candidate for the next path from among the road
10 information specified by the road information specification unit as the candidate for a current movement path and separately generate the estimated movement path information in which the identification information of the road included in the road information and the identification information of the road included in the road information specified by the next path road information specification unit as the candidate for the next path are
15 associated for all the road information specified by the next path road information specification unit as the candidate for the next path; and

an out-of-movement-path determination unit configured to determine the estimated movement path information in which possibility of the candidate for the movement path is low among generated estimated movement path information as the
20 estimated movement path information outside the movement path by setting the road information specified by the next path road information specification unit as the candidate for the next path as the candidate for the current movement path and sequentially performing processes of the estimated movement location computation unit, the next path road information specification unit, and the estimated movement path
25 information generation unit.

[Claim 4]

The movement path specification device according to claim 3,
wherein the estimated movement path information generation unit computes
estimated likelihood of the road information specified as the candidate for a current
5 movement path using at least a location and an extending direction in a real space of the
road included in the road information specified as the candidate for the current
movement path and the location and a traveling direction in the real space detected by its
own device, and associates and records the computed estimated likelihood and the
identification information of the road included in the road information specified as the
10 candidate for the current movement path in the estimated movement path information,
and

wherein the movement path output unit specifies one piece of the estimated
movement path information based on the estimated likelihood from among the estimated
movement path information other than that determined to be outside the movement path,
15 and specifies and outputs the identification information of each road included in the
estimated movement path information as the established past movement path.

[Claim 5]

The movement path specification device according to claim 4, wherein the
movement path output unit specifies the estimated movement path information in which
20 the estimated likelihood having a highest value is recorded among the estimated
likelihood recorded in association with the identification information of recently
specified roads included in the estimated movement path information other than that
determined to be outside the movement path, and specifies and outputs the identification
information of each road included in the estimated movement path information as the
25 established past movement path.

[Claim 6]

The movement path specification device according to any of claims 1 to 3, wherein the movement path output unit specifies the estimated movement path information in which the identification information of the road input from another device is recorded as the identification information of a recently specified road among the estimated movement path information other than that determined to be outside the movement path, and specifies and outputs the identification information of each road included in the estimated movement path information as the established past movement path.

10 [Claim 7]

The movement path specification device according to claim 4, wherein the movement path output unit specifies the estimated movement path information recording estimated likelihood having a highest value among the estimated likelihood recorded in association with the identification information of the road included in the road information specified as the candidate for the current movement path a predetermined number of times earlier among the estimated movement path information other than that determined to be outside the movement path, and specifies and outputs the identification information of each road included in the estimated movement path information as the established past movement path.

20 [Claim 8]

The movement path specification device according to any one of claims 1 to 7, wherein, after the identification information of roads specified as the established past movement path is output, the movement path output unit determines to compute the output of the identification information of the road representing the established past movement path again when the identification information of the road recorded in most

recently estimated movement path information among the output road identification information is not consistent with the identification information of a connection road recorded in association with location information close to a current location among the identification information of connection roads included in newly specified road information.

[Claim 9]

A processing method of a movement path specification device, comprising:
outputting, by a movement path output unit of the movement path specification device, identification information of a road included in any estimated movement path information other than that determined to be outside a movement path among the estimated movement path information including the identification information of the road representing the movement path of past estimation as the identification information of the road representing an established past movement path.

[Claim 10]

The processing method according to claim 9, wherein the movement path output unit specifies the identification information of a continuously included common road as the established past movement path within the estimated movement path information other than that determined to be outside the movement path, and outputs the identification information of the road representing the past movement path.

[Claim 11]

The processing method according to claim 9 or 10, comprising:
specifying, by a road information specification unit of the movement path specification device, road information at a location within an error range from a current location of its own device as a candidate for a current movement path;
sequentially computing, by an estimated movement location computation unit of

the movement path specification device, estimated movement locations from one endpoint closest to the current location on each road of the candidate for the current movement path specified by the road information specification unit according to passage of time based on a movement distance of a vehicle including its own device according to the passage of time;

specifying, by a next path road information specification unit of the movement path specification device, the road information in which the estimated movement location computed for the road information specified by the road information specification unit first approaches another endpoint of the road information and specifying the road information connected to the road represented by the road information as the candidate for the next path;

specifying, by an estimated movement path information generation unit of the movement path specification device, the road information connected to the road information specified by the next path road information specification unit as the candidate for the next path from among the road information specified by the road information specification unit as the candidate for a current movement path and separately generating the estimated movement path information in which the identification information of the road included in the road information and the identification information of the road included in the road information specified by the next path road information specification unit as the candidate for the next path are associated for all the road information specified by the next path road information specification unit as the candidate for the next path; and

determining, by an out-of-movement-path determination unit of the movement path specification device, the estimated movement path information in which possibility of the candidate for the movement path is low among generated estimated movement

path information as the estimated movement path information outside the movement path by setting the road information specified by the next path road information specification unit as the candidate for the next path as the candidate for the current movement path and sequentially performing processes of the estimated movement location computation unit, 5 the next path road information specification unit, and the estimated movement path information generation unit.

[Claim 12]

A program for causing a computer of a movement path specification device to function as:

10 a movement path output means configured to output identification information of a road included in any estimated movement path information other than that determined to be outside a movement path among the estimated movement path information including the identification information of the road representing the movement path of past estimation as the identification information of the road 15 representing an established past movement path.

[Claim 13]

The program according to claim 12, wherein the movement path output means specifies the identification information of a continuously included common road as the established past movement path within the estimated movement path information other 20 than that determined to be outside the movement path, and outputs the identification information of the road representing the past movement path.

[Claim 14]

The program according to claim 12 or 13, wherein the program causes the computer to further function as:

25 a road information specification means configured to specify road information at

a location within an error range from a current location of its own device as a candidate for a current movement path;

an estimated movement location computation means configured to sequentially compute estimated movement locations from one endpoint closest to the current location on each road of a candidate for the current movement path specified by the road information specification means according to passage of time based on a movement distance of a vehicle including its own device according to the passage of time;

a next path road information specification means configured to specify the road information in which the estimated movement location computed for the road information specified by the road information specification means first approaches another endpoint of the road information and specify the road information connected to the road represented by the road information as the candidate for the next path;

an estimated movement path information generation means configured to specify the road information connected to the road information specified by the next path road information specification means as the candidate for the next path from among the road information specified by the road information specification means as the candidate for a current movement path and separately generate the estimated movement path information in which the identification information of the road included in the road information and the identification information of the road included in the road information specified by the next path road information specification means as the candidate for the next path are associated for all the road information specified by the next path road information specification means as the candidate for the next path; and

an out-of-movement-path determination means configured to determine the estimated movement path information in which possibility of the candidate for the movement path is low among generated estimated movement path information as the

estimated movement path information outside the movement path by setting the road information specified by the next path road information specification means as the candidate for the next path as the candidate for the current movement path and sequentially performing processes of the estimated movement location computation means, the next path road information specification means, and the estimated movement path information generation means.