

DESCRIPTION

Title of Invention

MAP MATCHING DEVICE, ONBOARD DEVICE, MAP MATCHING METHOD,
AND PROGRAM

[Technical Field]

[0001]

The present disclosure relates to a map matching device, an onboard device, a map matching method, and a program.

[Background Art]

[0002]

It has been known that an onboard device mounted on a vehicle or the like receives a signal through an onboard antenna and identifies a current traveling route or the like from an actually measured positioning result.

[0003]

For example, Patent Document 1 discloses an onboard device that detects a traveling position of a vehicle having the onboard device.

[Citation List]

[Patent Document]

[0004]

[Patent Document 1] Japanese Unexamined Patent

Application Publication No. 2009-121847

[Summary of Invention]

[Technical Subject]

[0005]

By the way, some onboard devices apply a map matching processing to correct a traveling route on a road on a map, for example.

However, even in a case where such a technique is applied to the onboard device disclosed in Patent Document 1, a correct matching position may not be identified due to influence of surrounding environment.

[0006]

It is an object of the present disclosure to provide a map matching device, an onboard device, a map matching method, and a program that easily identify the correct matching position.

[Subject to be solved]

[0007]

A map matching device according to the present disclosure includes: a positioning result acquisition unit that acquires an actually measured positioning result including position information, the actually measured positioning result being a GNSS positioning result actually measured on the basis of a GNSS signal; a candidate identification unit that identifies a plurality

of candidate positions on a map relating to the actually measured positioning result; a statistical data identification unit that identifies statistical data of GNSS positioning results relating to the respective candidate positions; and a selection unit that selects a matching position from the plurality of candidate positions on the basis of a degree of matching between the statistical data and the actually measured positioning result.

[0008]

A map matching method according to the present disclosure includes a step of acquiring an actually measured positioning result including position information, the actually measured positioning result being a GNSS positioning result actually measured on the basis of a GNSS signal; a step of identifying a plurality of candidate positions on a map relating to the actually measured positioning result; a step of identifying statistical data of GNSS positioning results relating to the respective candidate positions; and a step of selecting a matching position from the plurality of candidate positions on the basis of a degree of matching between the statistical data and the actually measured positioning result.

[0009]

A program according to the present disclosure includes instructions for causing a computer of a map matching device to execute: a step of acquiring an actually measured positioning result including position information, the actually measured positioning result being a GNSS positioning result actually measured on the basis of a GNSS signal; a step of identifying a plurality of candidate positions on a map relating to the actually measured positioning result; a step of identifying statistical data of GNSS positioning results relating to the respective candidate positions; and a step of selecting a matching position from the plurality of candidate positions on the basis of a degree of matching between the statistical data and the actually measured positioning result.

[Advantageous Effects of Invention]

[0010]

By using the map matching device, the onboard device, the map matching method, and the program of the present disclosure, it is easy to identify the correct matching position.

[Brief Description of Drawings]

[0011]

Fig. 1 is a block diagram of a map matching device according to a first embodiment of the present disclosure.

Fig. 2 is an explanatory diagram of a positioning result estimation model according to the first embodiment of the present disclosure.

Fig. 3 is an explanatory diagram of position information according to the first embodiment of the present disclosure.

Fig. 4 is an enlarged view of the IV part of Fig. 3.

Fig. 5 is a diagram showing a function of a candidate identification unit according to the first embodiment of the present disclosure.

Fig. 6 is a diagram showing a probability distribution according to the first embodiment of the present disclosure.

Fig. 7 is a diagram showing a probability distribution according to the first embodiment of the present disclosure.

Fig. 8 is a flowchart of the map matching according to the first embodiment of the present disclosure.

Fig. 9 is an explanatory diagram of a positioning result estimation model according to a second embodiment of the present disclosure.

Fig. 10 is an explanatory diagram of a positioning result estimation model according to a third embodiment of the present disclosure.

Fig. 11 is a diagram showing an example of a computer hardware configuration included in the map matching device according to each embodiment of the present disclosure.

[Description of Embodiments]

[0012]

Embodiments according to the present disclosure will be hereinafter described with reference to the drawings. The same or corresponding configurations are represented by the same reference signs and numerals in all drawings, and common description is not repeated.

[0013]

<First Embodiment>

The first embodiment of the map matching device will be described with reference to Figs. 1 to 8.

[0014]

(Onboard System Configuration)

The onboard system 1 is a system that identifies a current position of a vehicle, a traveling route, and the like.

As shown in Fig. 1, the onboard system 1 includes an onboard antenna 2 and an onboard device 3.

The onboard system 1 is mounted on the vehicle.

For example, the onboard system 1 may acquire an actually measured positioning result PRO on the basis of

the global navigation satellite system (GNSS) signal SG received through the onboard antenna 2.

Here, the actually measured positioning result PRO is a GNSS positioning result actually measured by the onboard system 1 on the basis of the GNSS signal SG, and includes position information IP indicating the actually measured position.

For example, the position information IP may indicate a reception position of the GNSS signal in the onboard antenna 2.

For example, the actually measured positioning result PRO may further include a position error actually measured by the onboard system 1, a reception intensity of the actually measured GNSS signal, an actually measured number of captured satellites, and the like.

Further, the information included in the actually measured positioning result PRO may be calculated from GNSS signals received from the plurality of satellites.

The onboard device 3 uses the acquired actually measured positioning result PRO to identify the traveling route of the vehicle and the like.

[0015]

(Configuration of Onboard Device)

The onboard device 3 includes a reception unit 4 and a map matching device 5.

The reception unit 4 receives the GNSS signal SG received by the onboard antenna 2 from the plurality of satellites.

For example, the onboard device 3 may be capable of measuring the current position of the vehicle and displaying the traveling route of the vehicle through processing in the map matching device 5.

[0016]

(Configuration of Map Matching Device)

The map matching device 5 is a device that performs the map matching processing on the current position of the vehicle acquired by the onboard device 3 and corrects the position of the vehicle on a road on the map as a matching position PM, for example.

The corrected position of the vehicle is displayed on the onboard device 3 or used for data processing in the onboard device 3.

The map matching device 5 includes a positioning result acquisition unit 52, a candidate identification unit 53, a statistical data identification unit 54, and a selection unit 55.

For example, the map matching device 5 may further include a statistical data acquisition unit 51 and an output unit 56.

[0017]

The statistical data acquisition unit 51 acquires the statistical data SDT of the GNSS positioning result PR1.

The statistical data SDT is associated with the position.

For example, the statistical data SDT may be associated with each position at a plurality of positions.

[0018]

For example, the statistical data SDT may be acquired in advance.

For example, the statistical data acquisition unit 51 may acquire the statistical data SDT by storing the statistical data SDT in the map matching device 5 at the time of shipment of the onboard device 3 in advance.

For example, the statistical data acquisition unit 51 may acquire the statistical data SDT stored inside the onboard device 3 at the time of activating the map matching device 5 in advance.

For example, the statistical data acquisition unit 51 may acquire the latest statistical data SDT from the outside of the onboard device 3 through communication in advance when the map matching device 5 is activated.

[0019]

For example, the GNSS positioning result PR1 indicated by the statistical data SDT may be a position, a

position error, a reception intensity of a GNSS signal, the number of captured satellites, or the like.

For example, the statistical data SDT may be a data set of probability distribution of the GNSS positioning result PR1.

[0020]

For example, the statistical data SDT may be statistical data including a plurality of parameters.

Thereby, in a case where each parameter is set, the statistical data of the GNSS positioning result PR1 relating to the set parameter is identified.

For example, the statistical data SDT may include 3D data, a traveling route, a camera image, a satellite orbit, and the like as the parameters.

[0021]

For example, the statistical data SDT may be statistical data calculated in advance by a positioning result estimation model.

For example, in a case where the statistical data SDT includes 3D data, traveling route, camera image, satellite orbit, and the like as the parameters, the statistical data SDT may be calculated by performing machine learning on the GNSS positioning result PR1 relating to each parameter using the positioning result estimation model as shown in Fig. 2.

[0022]

Here, the 3D data is map data having three-dimensional information about a road on which a vehicle is able to travel and surroundings of the road.

For example, the 3D data may include three-dimensional information about three-dimensional structures such as buildings, tunnels, walls, bridges, roads, mountains, trees, and signs around each position of the road.

[0023]

Further, the traveling route is a travel locus on the road on which the vehicle is able to travel, and includes position information IP1 at a position equivalent to the position indicated by the position information IP included in the actually measured positioning result PRO.

For example, as shown in Figs. 3 and 4, the position indicated by the actually measured position information IP includes an error. However, the position indicated by the position information IP1 does not have to include an error.

[0024]

The positioning result acquisition unit 52 acquires the actually measured positioning result PRO.

[0025]

The candidate identification unit 53 identifies a plurality of candidate positions PC on the map MAP relating to the actually measured positioning result PRO.

[0026]

For example, as shown in Fig. 5, it is assumed that the map MAP includes the 3D data TDD, a first road RD1, and a second road RD2 branching from the first road RD1. In that regard, it is assumed that the positioning result acquisition unit 52 acquires a result including the actually measured position PO as the actually measured positioning result PRO at a position after the branch between the first road RD1 and the second road RD2.

In such a case, for example, the candidate identification unit 53 may acquire a plurality of positions on the map MAP within a predetermined range RG from the position PO as the plurality of candidate positions PC. In that regard, the plurality of positions on the map MAP may be positions in the first road RD1 and the second road RD2.

[0027]

For example, the candidate identification unit 53 may further narrow down the plurality of candidate positions PC on the basis of the score calculated for each candidate position PC.

The scores calculated by the candidate identification unit 53 may include a distance between each candidate position PC and the position PO.

The scores calculated by the candidate identification unit 53 may further include a degree of matching between the traveling direction of the road to which each candidate position PC belongs and a direction of speed of the vehicle equipped with the onboard system 1 at the position PO.

The scores calculated by the candidate identification unit 53 may further include an evaluation value of map matching at a position before the position PO.

[0028]

The statistical data identification unit 54 identifies the statistical data SDC of the GNSS positioning result relating to each candidate position PC on the map MAP.

For example, the statistical data identification unit 54 may identify the statistical data of the reception intensities as each statistical data SDC.

[0029]

For example, in a case where a certain actually measured positioning result PRO is acquired, the statistical data identification unit 54 may set each parameter on the basis of each candidate position PC so as

to identify the statistical data SDC relating to each candidate position PC on the basis of each parameter from statistical data SDT acquired by the statistical data acquisition unit 51.

In that regard, the statistical data identification unit 54 may set 3D data, a traveling route, a camera image, a satellite orbit, and the like in each candidate position PC as the parameters.

[0030]

The selection unit 55 selects the matching position PM from the plurality of candidate positions PC on the basis of the degree of matching between the statistical data SDC relating to each candidate position PC and the actually measured positioning result PRO.

For example, the selection unit 55 may select the matching position PM for the reception intensity RI from the actually measured positioning result PRO.

For example, the selection unit 55 may include a comparison unit 551.

[0031]

The comparison unit 551 compares the actually measured positioning result PRO with the statistical data SDC relating to each candidate position PC.

[0032]

For example, the selection unit 55 describes a case where the matching position PM is selected for the reception intensity RI from the actually measured positioning result PRO.

In such a case, the comparison unit 551 uses the statistical data SDC about the reception intensities at each candidate position PC as a reference among the statistical data pieces SDC. In that regard, the statistical data SDC about the reception intensities may be, for example, a probability distribution of the reception intensities at the respective candidate positions PC.

For example, the probability distribution of the reception intensities may show a distribution that decreases from a peak between the upper limit and the lower limit of the reception intensities toward the lower limit and the upper limit.

[0033]

A description will be given of a case where the first candidate position PC1 and the second candidate position PC2 are acquired as the plurality of candidate positions PC and the statistical data of the reception intensities is identified as each statistical data SDC.

It is assumed that the statistical data SDC about the reception intensities at the first candidate position

PC1 is the probability distribution about the reception intensities as shown in Fig. 6.

Further, it is assumed that the statistical data SDC about the reception intensities at the second candidate position PC2 is a probability distribution about the reception intensities as shown in Fig. 7.

Comparing the probability distribution shown in Fig. 6 with the reception intensity RI, the position of the reception intensity RI in the probability distribution shown in Fig. 6 corresponds to a position of the peak of the profile of the probability distribution about the reception intensities.

On the other hand, in a case where the probability distribution shown in Fig. 7 and the reception intensity RI are compared, the position of the reception intensity RI in the probability distribution shown in Fig. 7 corresponds to a position near the tail of the profile of the probability distribution about the reception intensities.

[0034]

In such a case, the probability that the reception intensity RI appears is higher in the first candidate position PC1 than in the second candidate position PC2.

Therefore, the selection unit 55 may select the first candidate position PC1 having a high probability

that the reception intensity RI appears as the matching position PM, among the first candidate position PC1 and the second candidate position PC2.

For example, the selection unit 55 may calculate a probability of occurrence of the reception intensity RI in the probability distribution (statistical data SDC) of each candidate position PC as the degree of matching so as to select the candidate position PC having the highest calculated degree of matching as the matching position PM.

[0035]

The output unit 56 outputs the matching position PM.

For example, the onboard device 3 may accumulate the matching position PM output from the output unit 56 and display the traveling route of the vehicle.

[0036]

(Operations)

The operations of the map matching device 5 of the present embodiment will be described.

The operations of the map matching device 5 corresponds to the embodiment of the map matching method.

The map matching device 5 implements each step shown in Fig. 8.

[0037]

First, the statistical data acquisition unit 51 acquires the statistical data SDT associated with a position (ST01).

For example, the statistical data acquisition unit 51 may acquire the statistical data SDT in advance.

[0038]

Subsequently to the implementation of ST01, the positioning result acquisition unit 52 acquires the actually measured positioning result PRO including the position information IP, which is the GNSS positioning result actually measured on the basis of the GNSS signal SG (ST02).

[0039]

Subsequently to the implementation of ST02, the candidate identification unit 53 identifies the plurality of candidate positions PC on the map MAP relating to the actually measured positioning result PRO (ST03).

[0040]

Subsequently to the implementation of ST03, the statistical data identification unit 54 identifies the statistical data SDC of the GNSS positioning result relating to each candidate position PC on the map MAP (ST04).

[0041]

Subsequently to the implementation of ST04, the selection unit 55 selects the matching position PM from the plurality of candidate positions PC on the basis of the degree of matching between the statistical data SDC relating to each candidate position PC and the actually measured positioning result PRO (ST05).

[0042]

Subsequently to the implementation of ST05, the output unit 56 outputs the matching position PM (ST06).

[0043]

(Action and Effect)

According to the present embodiment, the map matching device 5 selects the matching position PM on the basis of the degree of matching between the statistical data SDC and the actually measured positioning result.

Since the statistical data SDC of each candidate position PC includes the influence of the surrounding environment, the map matching device 5 is able to suppress the influence of the surrounding environment at each position and select the matching position PM.

Consequently, according to the map matching device 5, it is easy to identify the correct matching position.

[0044]

For example, a communication status of radio waves may differ due to influence of three-dimensional

structures such as buildings, tunnels, walls, bridges, roads, mountains, trees, and signs around each position of the road.

On the other hand, the statistical data SDC is identified from the statistical data SDT acquired from the GNSS positioning result relating to each position, and is thus statistical data including, for example, the influence of the three-dimensional structure relating to each position.

Therefore, the map matching device 5 is able to identify the matching position PM on the basis of each statistical data SDC including the influence of the three-dimensional structure. Thus, the map matching device 5 is able to suppress the influence of the three-dimensional structure, and is able to identify the matching position PM regardless of presence or absence of the three-dimensional structure.

[0045]

Further, according to an example of the present embodiment, since the statistical data SDC and the actually measured positioning result PRO are compared, it is easy to evaluate the degree of matching between the statistical data SDC and the actually measured positioning result PRO.

[0046]

Further, according to an example of the present embodiment, the selection unit 55 is able to select the matching position PM on the basis of the reception intensity RI including the influence of the surrounding environment and the statistical data SDC of the reception intensity including the influence of the surrounding environment.

Consequently, the map matching device 5 is able to identify the matching position PM in which the influence of the surrounding environment on the reception intensity RI is suppressed.

[0047]

According to the present embodiment, since the plurality of candidate positions PC can be narrowed down on the basis of the score calculated for each candidate position PC, the selection unit 55 is able to identify the matching position PM from the narrowed down candidates.

Consequently, the map matching device 5 is able to easily identify the matching position PM.

[0048]

<Second Embodiment>

A second embodiment of the map matching device will be described with reference to Figs. 1, 8, and 9.

[0049]

(Constitution)

In a similar manner to the first embodiment, the map matching device 5 is configured as shown in Fig. 1.

[0050]

In the present embodiment, for example, in the statistical data acquisition unit 51, the statistical data SDT, which is associated with the position, may be further associated with the time.

For example, the statistical data SDT may include the time as the parameter in addition to 3D data, a traveling route, a camera image, a satellite orbit, and the like.

[0051]

For example, in a case where the statistical data SDT includes the time as the parameter in addition to the 3D data, the traveling route, the camera image, the satellite orbit, and the like, the statistical data SDT may be calculated by performing machine learning on the GNSS positioning result PR1 relating to each parameter using the positioning result estimation model as shown in Fig. 9.

[0052]

For example, the positioning result acquisition unit 52 may include the time at which the actually measured positioning result PRO is actually measured in the actually measured positioning result PRO.

[0053]

For example, the statistical data identification unit 54 may identify statistical data relating to the time at which the actually measured positioning result PRO is actually measured as the statistical data SDC of the GNSS positioning result relating to each candidate position.

[0054]

(Operations)

The operations of the map matching device 5 of the present embodiment will be described.

The operations of the map matching device 5 corresponds to the embodiment of the map matching method.

The map matching device 5 implements each step shown in Fig. 8 in a similar manner to the first embodiment.

[0055]

First, the statistical data acquisition unit 51 acquires the statistical data SDT associated with a position (ST01). In that regard, for example, the statistical data SDT may be further associated with the time.

[0056]

Subsequently to the implementation of ST01, the positioning result acquisition unit 52 acquires the actually measured positioning result PRO including the position information IP, which is the GNSS positioning

result actually measured on the basis of the GNSS signal SG (ST02). In that regard, for example, the positioning result acquisition unit 52 may include the time at which the actually measured positioning result PRO is actually measured in the actually measured positioning result PRO.

[0057]

Subsequently to the implementation of ST02, the candidate identification unit 53 identifies a plurality of candidate positions on the map relating to the actually measured positioning result PRO (ST03).

[0058]

Subsequently to the implementation of ST03, the statistical data identification unit 54 identifies the statistical data SDC of the GNSS positioning result relating to each candidate position PC on the map MAP (ST04). In that regard, for example, in ST03, the statistical data identification unit 54 may identify statistical data relating to the time at which the actually measured positioning result PRO is actually measured as the statistical data SDC.

[0059]

Subsequent operations are the same as the operations in the first embodiment.

[0060]

(Action and Effect)

According to an example of the present embodiment, the selection unit 55 is able to select the matching position PM on the basis of the statistical data SDC relating to each time.

Since the statistical data SDC includes the influence of the surrounding environment at each time, the selection unit 55 is able to select the matching position PM on the basis of the actually measured positioning result PRO including the influence of the surrounding environment at each time and the statistical data SDC including the influence of the surrounding environment at each time.

Therefore, the selection unit 55 is able to select the matching position PM by suppressing the influence of the surrounding environment at each time.

Consequently, the map matching device 5 is able to identify the matching position PM in which the influence of the surrounding environment is suppressed at each time.

[0061]

For example, the communication status of radio waves may differ between night and day even at the same position. On the other hand, according to an example of the present embodiment, the map matching device 5 is able to suppress the difference in communication status of the radio wave due to the difference in time. Therefore, it is possible

to identify the matching position PM regardless of the difference in time between night and day, for example.

[0062]

<Third Embodiment>

A third embodiment of the map matching device will be described with reference to Figs. 1, 8, and 10.

[0063]

(Constitution)

In a similar manner to the first embodiment, the map matching device 5 is configured as shown in Fig. 1.

[0064]

In the present embodiment, for example, in the statistical data acquisition unit 51, the statistical data SDT associated with the position may be further associated with a vehicle.

For example, the statistical data SDT may include the vehicle in addition to the 3D data, the traveling route, the camera image, the satellite orbit, and the like as the parameters.

[0065]

For example, in a case where the statistical data SDT includes the vehicle as the parameter in addition to the 3D data, the traveling route, the camera image, the satellite orbit, and the like, the statistical data SDT may be calculated by performing machine learning on the

GNSS positioning result PR1 relating to each parameter using the positioning result estimation model as shown in Fig. 10.

[0066]

For example, the positioning result acquisition unit 52 may include the vehicle type information indicating a vehicle type of the vehicle, on which the positioning result acquisition unit 52 is mounted, in the actually measured positioning result PRO, which is preset vehicle type information.

[0067]

For example, the statistical data identification unit 54 may identify statistical data relating to the vehicle type of the vehicle of which the actually measured positioning result PRO is actually measured as the statistical data SDC of the GNSS positioning result relating to each candidate position.

[0068]

(Operations)

The operations of the map matching device 5 of the present embodiment will be described.

The operations of the map matching device 5 corresponds to the embodiment of the map matching method.

The map matching device 5 implements each step shown in Fig. 8 in a similar manner to the first embodiment.

[0069]

First, the statistical data acquisition unit 51 acquires the statistical data SDT associated with a position (ST01). In that regard, for example, the statistical data SDT may be further associated with the vehicle type.

[0070]

Subsequently to the implementation of ST01, the positioning result acquisition unit 52 acquires the actually measured positioning result PRO including the position information IP, which is the GNSS positioning result actually measured on the basis of the GNSS signal SG (ST02). In that regard, for example, the positioning result acquisition unit 52 may include the vehicle type information indicating a vehicle type of the vehicle, on which the positioning result acquisition unit 52 is mounted, in the actually measured positioning result PRO, which is preset vehicle type information.

[0071]

Subsequently to the implementation of ST02, the candidate identification unit 53 identifies a plurality of candidate positions on the map relating to the actually measured positioning result PRO (ST03).

[0072]

Subsequently to the implementation of ST03, the statistical data identification unit 54 identifies the statistical data SDC of the GNSS positioning result relating to each candidate position PC on the map MAP (ST04). In that regard, for example, in ST03, the statistical data identification unit 54 may identify statistical data relating to the vehicle type of the vehicle of which the actually measured positioning result PRO is actually measured as the statistical data SDC.

[0073]

Subsequent operations are the same as the operations in the first embodiment.

[0074]

(Action and Effect)

According to the present embodiment, the selection unit 55 is able to select the matching position PM on the basis of the statistical data SDC relating to each vehicle type.

Since the statistical data SDC includes the influence of the surrounding environment in each vehicle type, the selection unit 55 is able to select the matching position PM, on the basis of the actually measured positioning result PRO including the influence of the surrounding environment in each vehicle type and the

statistical data SDC including the influence of the surrounding environment in each vehicle type.

Therefore, the selection unit 55 is able to select the matching position PM by suppressing the influence of the surrounding environment on each vehicle type.

Consequently, the map matching device 5 is able to identify the matching position PM in which the influence of the surrounding environment is suppressed in each vehicle type.

[0075]

For example, even at the same position, the radio wave communication statuses of trucks and mini-vehicles having significantly different vehicle heights may differ. On the other hand, according to an example of the present embodiment, the map matching device 5 is able to suppress the difference in communication status of the radio wave due to the difference in vehicle type. Therefore, it is possible to identify the matching position PM regardless of the difference in vehicle type between the truck and the mini-vehicle.

[0076]

As a modification example, in the statistical data acquisition unit 51, the statistical data SDT associated with the position may be associated with the time and the vehicle type.

For example, the statistical data SDT may include the time and the vehicle type as the parameters in addition to the 3D data, the traveling route, the camera image, the satellite orbit, and the like.

In that regard, the statistical data identification unit 54 may identify statistical data relating to the time actually measured by the actually measured positioning result PRO and the vehicle type as the statistical data SDC of the GNSS positioning result relating to each candidate position.

[0077]

<Other Modification Example>

In each of the above-described embodiments, the statistical data SDT is calculated by the positioning result estimation model, but any method may be used as long as the statistical data SDT is calculated.

For example, various parameters acquired from a test vehicle or an actual traveling vehicle and actually measured GNSS positioning results are accumulated, and the statistical data SDT may be calculated by the positioning result estimation model from the accumulated various parameters and the actually measured GNSS positioning results.

[0078]

In each of the above-described embodiments, ST02 is implemented following the implementation of ST01, but as a modification example, ST01 may be implemented after ST02 is implemented.

[0079]

In each of the above-described embodiments, a program for implementing various functions of the map matching device 5 is stored on a computer-readable storage medium, and various kinds of processing are performed by reading and executing the program stored on the storage medium in a computer system such as a microcomputer. Here, the processes of various kinds of processing of the CPU of the computer system are stored in a computer-readable storage medium in the form of a program, and the various kinds of processing are performed by the computer reading and executing the program. The computer-readable storage medium refers to a magnetic disk, a magneto-optical disk, a CD-ROM, a DVD-ROM, a semiconductor memory, or the like. Further, this computer program may be transferred to a computer through a communication line, and the computer receiving the transfer may execute the program.

[0080]

In each of the above-described embodiments, an example of a hardware configuration of a computer for

executing a program for implementing various functions of the map matching device 5 will be described.

[0081]

As shown in Fig. 11, a computer 59 provided in the map matching device 5 includes a CPU 591, a memory 592, a storage reproduction device 593, an input output interface (hereinafter referred to as "IO I/F") 594, and a communication interface (hereinafter referred to as "communication I/F") 595.

[0082]

The memory 592 is a medium such as a random access memory (hereinafter referred to as "RAM") that temporarily stores data or the like used in a program executed by the map matching device 5.

For example, the memory 592 may store the statistical data SDT, the actually measured positioning result PRO, the candidate position PC, the statistical data SDC, the matching position PM, and the like.

[0083]

The storage reproduction device 593 is a device that stores data or the like in an external medium such as a CD-ROM, a DVD, or a flash memory, or reproducing data or the like in the external media.

[0084]

The IO I/F 594 is an interface that inputs and outputs information and the like between the map matching device 5 and other devices.

[0085]

The communication I/F 595 is an interface that communicates with other devices through a communication line such as the Internet or a dedicated communication line.

[0086]

<Other Embodiment>

Although the embodiments of the present disclosure have been described above, the embodiments are presented as examples and are not intended to limit the scope of the disclosure. The embodiments can be implemented in various other embodiments, and various omissions, replacements, and changes can be made without departing from the spirit of the disclosure. These embodiments and variations thereof are included in the scope and spirit of the disclosure.

[0087]

<Additional Notes>

The map matching device, the onboard device, the map matching method, and the program described in the above-described embodiment are grasped as follows, for example.

[0088]

(1) A map matching device 5 according to a first aspect includes: a positioning result acquisition unit 52 that acquires an actually measured positioning result PRO including position information IP, the actually measured positioning result PRO being a GNSS positioning result actually measured on the basis of a GNSS signal SG; a candidate identification unit 53 that identifies a plurality of candidate positions PC on a map MAP relating to the actually measured positioning result PRO; a statistical data identification unit 54 that identifies statistical data SDC of GNSS positioning results relating to the respective candidate positions PC; and a selection unit 55 that selects a matching position PM from the plurality of candidate positions PC on the basis of a degree of matching between the statistical data SDC and the actually measured positioning result PRO.

[0089]

According to this aspect, the map matching device 5 selects the matching position PM on the basis of the degree of matching between the statistical data SDC and the actually measured positioning result PRO.

Since the statistical data SDC of each candidate position PC includes the influence of the surrounding environment, the map matching device 5 is able to suppress

the influence of the surrounding environment at each position and select the matching position PM.

Consequently, according to the map matching device 5, it is easy to identify the correct matching position.

[0090]

(2) The map matching device 5 according to a second aspect is the map matching device 5 of (1) in which the selection unit 55 includes a comparison unit 551 that compares the statistical data SDC with the actually measured positioning result PRO.

[0091]

According to this aspect, since the statistical data SDC and the actually measured positioning result PRO are compared, it is easy to evaluate the degree of matching between the statistical data SDC and the actually measured positioning result PRO.

[0092]

(3) The map matching device 5 according to a third aspect is the map matching device 5 of (1) or (2) in which the actually measured positioning result PRO includes a reception intensity RI, and the statistical data identification unit 54 identifies statistical data of the reception intensities as the statistical data SDC.

[0093]

According to this aspect, the selection unit 55 is able to select the matching position PM on the basis of the reception intensity RI including the influence of the surrounding environment and the statistical data SDC of the reception intensity including the influence of the surrounding environment.

Consequently, the map matching device 5 is able to identify the matching position PM in which the influence of the surrounding environment on the reception intensity RI is suppressed.

[0094]

(4) In the map matching device 5 according to a fourth aspect, the statistical data identification unit 54 is one of the map matching devices 5 that identifies statistical data relating to the time at which the actually measured positioning result PRO is actually measured as the statistical data SDC (1) to (3).

[0095]

According to this aspect, the selection unit 55 is able to select the matching position PM on the basis of the statistical data SDC relating to each time.

Since the statistical data SDC includes the influence of the surrounding environment at each time, the selection unit 55 is able to select the matching position PM on the basis of the actually measured positioning

result PRO including the influence of the surrounding environment at each time and the statistical data SDC including the influence of the surrounding environment at each time.

Therefore, the selection unit 55 is able to select the matching position PM by suppressing the influence of the surrounding environment at each time.

Consequently, the map matching device 5 is able to identify the matching position PM in which the influence of the surrounding environment is suppressed at each time.

[0096]

(5) The map matching device 5 according to a fifth aspect is the map matching device 5 of any one of (1) to (4) in which the statistical data identification unit 54 identifies the statistical data relating to a vehicle type of a vehicle of which the actually measured positioning result PRO is actually measured as the statistical data SDC.

[0097]

According to this aspect, the selection unit 55 is able to select the matching position PM on the basis of the statistical data SDC relating to each vehicle type.

Since the statistical data SDC includes the influence of the surrounding environment in each vehicle type, the selection unit 55 is able to select the matching

position PM, on the basis of the actually measured positioning result PRO including the influence of the surrounding environment in each vehicle type and the statistical data SDC including the influence of the surrounding environment in each vehicle.

Therefore, the selection unit 55 is able to select the matching position PM by suppressing the influence of the surrounding environment on each vehicle type.

Consequently, the map matching device 5 is able to identify the matching position PM in which the influence of the surrounding environment is suppressed in each vehicle type.

[0098]

(6) The map matching device 5 according to a sixth aspect is the map matching device 5 of any one of (1) to (5) in which the candidate identification unit 53 further narrows down the plurality of candidate positions PC on the basis of scores calculated for the respective candidate positions PC.

[0099]

According to this aspect, since the plurality of candidate positions PC can be narrowed down, the selection unit 55 is able to identify the matching position PM from the narrowed down candidates.

Consequently, the map matching device 5 is able to easily identify the matching position PM.

[0100]

(7) An onboard device 3 according to a seventh aspect includes: the map matching device 5 of any one of (1) to (6); and a reception unit 4 that receives the GNSS signal SG received by an onboard antenna 2 from a plurality of satellites.

[0101]

According to this aspect, the onboard device 3 selects the matching position PM on the basis of the degree of matching between the statistical data SDC and the actually measured positioning result.

Since the statistical data SDC of each candidate position PC includes the influence of the surrounding environment, the onboard device 3 is able to suppress the influence of the surrounding environment at each position and select the matching position PM.

Consequently, according to the onboard device 3, it is easy to identify the correct matching position.

[0102]

(8) A map matching method according to an eighth aspect includes: a step of acquiring an actually measured positioning result PRO including position information IP, the actually measured positioning result PRO being a GNSS

positioning result actually measured on the basis of a GNSS signal SG; a step of identifying a plurality of candidate positions PC on a map MAP relating to the actually measured positioning result PRO; a step of identifying statistical data SDC of GNSS positioning results relating to the respective candidate positions PC; and a step of selecting a matching position PM from the plurality of candidate positions PC on the basis of a degree of matching between the statistical data SDC and the actually measured positioning result PRO.

[0103]

According to this aspect, the map matching method selects the matching position PM on the basis of the degree of matching between the statistical data SDC and the actually measured positioning result.

Since the statistical data SDC of each candidate position PC includes the influence of the surrounding environment, the map matching method is able to suppress the influence of the surrounding environment at each position and select the matching position PM.

Consequently, according to the map matching method, it is easy to identify the correct matching position.

[0104]

(9) A program according to a ninth aspect causes a computer 59 of the map matching device 5 to execute: a

step of acquiring an actually measured positioning result PRO including position information IP, the actually measured positioning result PRO being a GNSS positioning result actually measured on the basis of a GNSS signal SG; a step of identifying a plurality of candidate positions PC on a map MAP relating to the actually measured positioning result PRO; a step of identifying statistical data SDC of GNSS positioning results relating to the respective candidate positions PC; and a step of selecting a matching position PM from the plurality of candidate positions PC on the basis of a degree of matching between the statistical data SDC and the actually measured positioning result PRO.

[0105]

According to this aspect, the map matching device 5 selects the matching position PM on the basis of the degree of matching between the statistical data SDC and the actually measured positioning result.

Since the statistical data SDC of each candidate position PC includes the influence of the surrounding environment, the map matching device 5 is able to suppress the influence of the surrounding environment at each position and select the matching position PM.

Consequently, according to the program, it is easy to identify the correct matching position.

[Industrial Applicability]

[0106]

By using the map matching device, the onboard device, the map matching method, and the program of the present disclosure, it is easy to identify the correct matching position.

[Reference Signs List]

[0107]

- 1: onboard system
- 2: onboard antenna
- 3: onboard device
- 4: reception unit
- 5: map matching device
- 51: statistical data acquisition unit
- 52: positioning result acquisition unit
- 53: candidate identification unit
- 54: statistical data identification unit
- 55: selection unit
- 56: output unit
- 59: computer
- 551: comparison unit
- 591: CPU
- 592: memory
- 593: storage reproduction device
- 594: IO I/F

595: communication I/F
IP: position information
IP1: position information
MAP: map
PC: candidate position
PC1: first candidate position
PC2: second candidate position
PM: matching position
PO: position
PR1: GNSS positioning result
PRO: actually measured positioning result
RD1: first road
RD2: second road
RG: predetermined range
RI: reception intensity
SDC: statistical data
SDT: statistical data
SG: GNSS signal
TDD: 3D data

Claims

[Claim 1]

A map matching device comprising:

a positioning result acquisition unit that acquires an actually measured positioning result including position information, the actually measured positioning result being a GNSS positioning result actually measured on the basis of a GNSS signal;

a candidate identification unit that identifies a plurality of candidate positions on a map relating to the actually measured positioning result;

a statistical data identification unit that identifies statistical data of GNSS positioning results relating to the respective candidate positions; and

a selection unit that selects a matching position from the plurality of candidate positions on the basis of a degree of matching between the statistical data and the actually measured positioning result.

[Claim 2]

The map matching device according to claim 1, wherein the selection unit includes a comparison unit that compares the statistical data with the actually measured positioning result.

[Claim 3]

The map matching device according to claim 1 or 2,
wherein the actually measured positioning result
includes a reception intensity, and

the statistical data identification unit identifies
statistical data of the reception intensities as the
statistical data.

[Claim 4]

The map matching device according to any one of
claims 1 to 3, wherein the statistical data identification
unit identifies the statistical data relating to a time at
which the actually measured positioning result is actually
measured as the statistical data.

[Claim 5]

The map matching device according to any one of
claims 1 to 4, wherein the statistical data identification
unit identifies the statistical data relating to a vehicle
type of a vehicle of which the actually measured
positioning result is actually measured as the statistical
data.

[Claim 6]

The map matching device according to any one of claims 1 to 5, wherein the candidate identification unit further narrows down the plurality of candidate positions on the basis of scores calculated for the respective candidate positions.

[Claim 7]

An onboard device comprising:

the map matching device according to any one of claims 1 to 6; and

a reception unit that receives the GNSS signal received by an onboard antenna from a plurality of satellites.

[Claim 8]

A map matching method comprising:

a step of acquiring an actually measured positioning result including position information, the actually measured positioning result being a GNSS positioning result actually measured on the basis of a GNSS signal;

a step of identifying a plurality of candidate positions on a map relating to the actually measured positioning result;

a step of identifying statistical data of GNSS positioning results relating to the respective candidate positions; and

a step of selecting a matching position from the plurality of candidate positions on the basis of a degree of matching between the statistical data and the actually measured positioning result.

[Claim 9]

A program comprising instructions for causing a computer of a map matching device to execute:

a step of acquiring an actually measured positioning result including position information, the actually measured positioning result being a GNSS positioning result actually measured on the basis of a GNSS signal;

a step of identifying a plurality of candidate positions on a map relating to the actually measured positioning result;

a step of identifying statistical data of GNSS positioning results relating to the respective candidate positions; and

a step of selecting a matching position from the plurality of candidate positions on the basis of a degree of matching between the statistical data and the actually measured positioning result.