

DESCRIPTION

Title of Invention

ABNORMALITY DETECTION DEVICE, ON-BOARD UNIT, ABNORMALITY
DETECTION METHOD, AND PROGRAM

[Technical Field]

[0001]

The present disclosure relates to an abnormality detection device, an on-board unit, an abnormality detection method, and a program.

[Background Art]

[0002]

It is known that an on-board unit mounted on a vehicle or the like receives a signal via an on-board antenna and specifies a current traveling route or the like from an actually measured positioning result.

[0003]

Meanwhile, as a technique related to a communication terminal, for example, Patent Document 1 discloses a position information management system that manages a position of the communication terminal or the like.

[Citation List]

[Patent Document]

[0004]

[Patent Document 1] Japanese Unexamined Patent
Publication No. 2014-217015

[Summary of Invention]

[Technical Subject]

[0005]

The position information management system disclosed in Patent Document 1 collates movement history information with failure pattern information, and detects an abnormality in a distribution device that distributes position information to a communication terminal or the like.

However, in the abnormality detection method disclosed in Patent Document 1, an influence of a surrounding environment may be detected as an abnormality.

[0006]

It is an object of the present disclosure to provide an abnormality detection device, an on-board unit, an abnormality detection method, and a program in which the influence of the surrounding environment is hardly detected as an abnormality in the actually measured positioning result.

[Subject to be solved]

[0007]

An abnormality detection device according to the present disclosure includes a statistical data acquisition unit that acquires statistical data of a GNSS positioning

result associated with a position; a positioning result acquisition unit that acquires an actually measured positioning result which is the GNSS positioning result actually measured based on a GNSS signal and which includes position information; and a discrimination unit that discriminates an abnormality in the actually measured positioning result based on the statistical data.

[0008]

An abnormality detection method according to the present disclosure includes a step of acquiring statistical data of a GNSS positioning result associated with a position; a step of acquiring an actually measured positioning result which is the GNSS positioning result actually measured based on the GNSS signal and which includes position information; and a step of discriminating an abnormality in the actually measured positioning result based on the statistical data.

[0009]

A program according to the present disclosure causes a computer of an abnormality detection device to execute: a step of acquiring statistical data of a GNSS positioning result associated with a position; a step of acquiring an actually measured positioning result which is the GNSS positioning result actually measured based on the GNSS signal and which includes position information; and a step

of discriminating an abnormality in the actually measured positioning result based on the statistical data.

[Advantageous Effects of Invention]

[0010]

According to the abnormality detection device, the on-board unit, the abnormality detection method, and the program of the present disclosure, an influence of a surrounding environment is hardly detected as the abnormality in the actually measured positioning result.

[Brief Description of Drawings]

[0011]

Fig. 1 is a block diagram of an abnormality detection 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 probability distribution according to the first embodiment of the present disclosure.

Fig. 6 is a flowchart of an abnormality detection method according to the first embodiment of the present disclosure.

Fig. 7 is an explanatory diagram of a positioning result estimation model according to a second embodiment of the present disclosure.

Fig. 8 is an explanatory diagram of a positioning result estimation model according to a third embodiment of the present disclosure.

Fig. 9 is a block diagram of an abnormality detection device according to a modification example of the present disclosure.

Fig. 10 is a diagram showing an example of a hardware configuration of a computer provided in the abnormality detection device according to each embodiment of the present disclosure.

[Description of Embodiments]

[0012]

Hereinafter, embodiments according to the present disclosure will be described with reference to the drawings. The same or corresponding configurations are designated by the same reference numerals in all drawings, and common descriptions will be omitted.

[0013]

<First Embodiment>

A first embodiment of an abnormality detection device will be described with reference to Figs. 1 to 6.

[0014]

(On-board System Configuration)

An on-board system 1 is a system for specifying a current position, a traveling route, or the like of a vehicle.

As shown in Fig. 1, the on-board system 1 includes an on-board antenna 2 and an on-board unit 3.

The on-board system 1 is mounted on the vehicle.

For example, the on-board system 1 may acquire an actually measured positioning result PRO based on a global navigation satellite system (GNSS) signal SG received via the on-board antenna 2.

Here, the actually measured positioning result PRO is a GNSS positioning result actually measured by the on-board system 1 based on the GNSS signal SG, and includes position information IP indicating an actually measured position.

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

For example, the actually measured positioning result PRO may further include a position error actually measured by the on-board system 1, a reception intensity of the

actually measured GNSS signal, the actually measured number of captured satellites, and the like.

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

The acquired actually measured positioning result PRO is used in the on-board unit 3 to specify the traveling route of the vehicle and the like.

[0015]

(Configuration of On-board Unit)

The on-board unit 3 includes a reception unit 4 and an abnormality detection device 5.

The reception unit 4 receives the GNSS signal SG received by the on-board antenna 2 from a plurality of satellites.

For example, the on-board unit 3 may be able to acquire the current position of the vehicle from the actually measured positioning result PRO and display the traveling route of the vehicle through processing such as map matching.

[0016]

(Configuration of Abnormality Detection Device)

The abnormality detection device 5 is a device for detecting an abnormality in the actually measured positioning result PRO.

The abnormality detection device 5 includes a statistical data acquisition unit 51, a positioning result acquisition unit 52, and a discrimination unit 53.

For example, the abnormality detection device 5 may further include an output unit 54.

[0017]

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

The statistical data SDT is associated with a position.

For example, the statistical data SDT may be associated with each position of 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 abnormality detection device 5 in advance at the time of shipping the on-board unit 3.

For example, the statistical data acquisition unit 51 may acquire the statistical data SDT stored inside the on-board unit 3 in advance at the time of starting the abnormality detection device 5.

For example, the statistical data acquisition unit 51 may acquire the latest statistical data SDT from the outside

of the on-board unit 3 via communication in advance at the time of starting the abnormality detection device 5.

[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 a probability distribution of the GNSS positioning result PR1.

[0020]

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

As a result, when each parameter is set, the statistical data of the GNSS positioning result PR1 related to the set parameter is specified.

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

[0021]

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

For example, when the statistical data SDT includes 3D data, traveling route, a camera image, a satellite orbit,

and the like as parameters, the statistical data SDT may be calculated by performing machine learning on the GNSS positioning result PR1 related 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 on a road on which the vehicle can travel and surroundings thereof.

For example, the 3D data may include three-dimensional information on 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 movement trajectory on the road on which the vehicle can 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, whereas 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 discrimination unit 53 discriminates the abnormality in the actually measured positioning result PRO based on the statistical data SDT.

For example, the discrimination unit 53 may discriminate an abnormality in a reception intensity RI in the actually measured positioning result PRO.

For example, the discrimination unit 53 may include a comparison unit 531.

[0026]

The comparison unit 531 compares the actually measured positioning result PRO with the statistical data SDT related to the position information IP included in the actually measured positioning result PRO.

[0027]

For example, when a certain actually measured positioning result PRO is acquired, the discrimination unit 53 may specify statistical data SDO related to the actually measured positioning result PRO. At that time, the discrimination unit 53 may set each parameter based on the actually measured positioning result PRO, and from the statistical data SDT acquired by the statistical data acquisition unit 51, specify the statistical data SDO related to the actually measured positioning result PRO based on each parameter.

[0028]

For example, when a certain actually measured positioning result PRO is acquired, the discrimination unit 53 may specify, as the statistical data SDT related to the position information IP, the statistical data SDO in the position information IP1 equivalent to the position information IP out of the statistical data SDT with respect to the position information IP included in the actually measured positioning result PRO. At that time, the "position information IP1 equivalent to the position information IP" may be the position information IP1 indicating a position within an error range included in the position indicated by the position information IP.

For example, as shown in Figs. 3 and 4, the "error range included in the position indicated by the position information IP" may be a range of a circle having a radius corresponding to a magnitude of an error in the position indicated by the position information IP centering on the position indicated by the position information IP.

Then, the comparison unit 531 compares the actually measured positioning result PRO at the position indicated by the position information IP and the statistical data SDO at the position indicated by the position information IP1.

[0029]

For example, a case where the discrimination unit 53 discriminates the abnormality in the reception intensity RI in the actually measured positioning result PRO will be described.

In this case, the comparison unit 531 uses the statistical data SDO regarding the reception intensity in the position information IP1 in the statistical data SDT as a comparison reference. At that time, as shown in Fig. 5, the statistical data SDO regarding the reception intensity may be, for example, a probability distribution of the reception intensity in the position information IP1.

[0030]

For example, as shown in Fig. 5, the probability distribution of the reception intensity shows a distribution in which the reception intensity decreases from a peak between an upper limit and a lower limit of the reception intensity toward the lower limit and the upper limit.

When the reception intensity RI corresponds to the reception intensity showing a peak in the probability distribution of the reception intensity, the on-board system 1 receives a plausible reception intensity RI at the position indicated by the position information IP.

On the contrary, when the reception intensity RI corresponds to the reception intensity that does not show a peak in the probability distribution of the reception

intensity, the on-board system 1 receives an implausible reception intensity RI at the position indicated by the position information IP.

Therefore, in the probability distribution of the reception intensity, when the reception intensity RI that does not show a peak includes the reception intensity RI, there is a high possibility that the reception intensity RI is abnormal.

Therefore, for example, as shown in Fig. 5, when the reception intensity RI at the position indicated by the position information IP is included in a reception intensity in a distribution of 0.01% from the lower limit or a distribution of 0.01% from the upper limit of the probability distribution of the reception intensity, the discrimination unit 53 may discriminate the reception intensity RI as an abnormality.

[0031]

When the discrimination unit 53 discriminates that the actually measured positioning result PRO is abnormal, the output unit 54 outputs that the abnormality is detected.

For example, in order to notify a user of the abnormality, the output unit 54 may output an alarm, a message, or the like.

For example, in order to review after detecting the abnormality, the output unit 54 outputs and stores various

data and the like including the fact that the abnormality is detected and a time and a position at which the abnormality is detected, on a recording medium or the like.

[0032]

(Operation)

An operation of the abnormality detection device 5 of this embodiment will be described.

The operation of the abnormality detection device 5 corresponds to an embodiment of the abnormality detection method.

The abnormality detection device 5 executes each step shown in Fig. 6.

[0033]

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

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

[0034]

Following the execution of step ST01, the positioning result acquisition unit 52 acquires the actually measured positioning result PRO which is the GNSS positioning result actually measured based on the GNSS signal SG and which includes the position information IP (step ST02).

[0035]

Following the execution of step ST02, the discrimination unit 53 discriminates the abnormality in the actually measured positioning result PRO based on the acquired statistical data SDT (step ST03).

[0036]

If the discrimination unit 53 does not discriminate the abnormality (step ST03: No), step ST02 is executed again.

When the discrimination unit 53 discriminates the abnormality (step ST03: Yes), the output unit 54 outputs that the abnormality is detected by display or data output (step ST04).

[0037]

(Action and Effect)

According to this embodiment, the abnormality detection device 5 detects the abnormality in the actually measured positioning result based on the statistical data SDT of the GNSS positioning result associated with the position.

Since the statistical data SDT of the GNSS positioning result includes the influence of the surrounding environment, the abnormality detection device 5 can suppress the influence of the surrounding environment at each position and detect the abnormality in the actually measured positioning result.

Therefore, according to the abnormality detection device 5, the influence of the surrounding environment is hardly detected as the abnormality in the actually measured positioning result.

[0038]

For example, a communication status of radio waves may differ depending on an influence of three-dimensional structures such as buildings, tunnels, walls, bridges, roads, mountains, trees, and signs around each position of the road.

Meanwhile, since the statistical data SDT is statistical data acquired from the GNSS positioning result related to each position, the statistical data SDT is, for example, statistical data including the influence of the three-dimensional structure related to each position.

Therefore, since the abnormality detection device 5 can detect the abnormality based on the statistical data including the influence of the three-dimensional structure, the abnormality detection device 5 can suppress the influence of the three-dimensional structure and can detect the abnormality in the actually measured positioning result regardless of the presence or absence of the three-dimensional structure.

[0039]

Further, according to an example of this embodiment, by comparing the actually measured positioning result PRO

and the statistical data SDT related to the position information IP, the abnormality detection device 5 can detect the abnormality in the actually measured positioning result based on the statistical data SDT including the influence of the surrounding environment of the position where the actually measured positioning result PRO is acquired.

[0040]

Further, according to an example of this embodiment, the abnormality detection device 5 can detect the abnormality in the actually measured reception intensity RI based on the statistical data SDT of the reception intensity including the influence of the surrounding environment.

Therefore, according to the abnormality detection device 5, the influence of the surrounding environment on the reception intensity RI is hardly detected as the abnormality in the actually measured positioning result.

[0041]

<Second Embodiment>

A second embodiment of the abnormality detection device will be described with reference to Figs. 1, 6, and 7.

[0042]

(Configuration)

The abnormality detection device 5 is configured as shown in Fig. 1 in the same manner as in the first embodiment.

In this embodiment, for example, the statistical data SDT may be further associated with a time.

[0043]

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

[0044]

For example, when the statistical data SDT includes a time as a parameter, in addition to 3D data, a traveling route, a camera image, a satellite orbit, and the like, the statistical data SDT may be calculated by performing machine learning on the GNSS positioning result PR1 related to each parameter using the positioning result estimation model as shown in Fig. 7.

[0045]

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

[0046]

For example, the discrimination unit 53 may specify the statistical data related to the time at which the actually measured positioning result PRO is actually

measured as the statistical data SDO related to the actually measured positioning result PRO.

[0047]

(Operation)

An operation of the abnormality detection device 5 of this embodiment will be described.

The operation of the abnormality detection device 5 corresponds to an embodiment of the abnormality detection method.

The abnormality detection device 5 executes each step shown in Fig. 6 in the same manner as in the first embodiment.

First, the statistical data acquisition unit 51 acquires the statistical data SDT associated with each position of a plurality of positions (step ST01). At that time, for example, the statistical data SDT may be further associated with the time.

[0048]

Following the execution of step ST01, the positioning result acquisition unit 52 acquires the actually measured positioning result PRO which is the GNSS positioning result actually measured based on the GNSS signal SG and which includes the position information IP (step ST02). At that time, 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.

[0049]

Following the execution of step ST02, the discrimination unit 53 discriminates the abnormality in the actually measured positioning result PRO based on the acquired statistical data SDT (step ST03). At that time, for example, the discrimination unit 53 may specify the statistical data related to the time at which the actually measured positioning result PRO is actually measured as the statistical data SDO related to the actually measured positioning result PRO.

[0050]

Subsequent operations are the same as in the first embodiment.

[0051]

(Action and Effect)

According to an example of this embodiment, the abnormality detection device 5 detects the abnormality in the actually measured positioning result based on the statistical data SDT of the GNSS positioning result associated with each time.

Since the statistical data SDT of the GNSS positioning result includes the influence of the surrounding environment at each time, the abnormality detection device 5 can

suppress the influence of the surrounding environment at each time and detect the abnormality in the actually measured positioning result.

[0052]

For example, the communication status of the radio waves may differ between night and day even at the same position. On the other hand, according to an example of this embodiment, since the abnormality detection device 5 can suppress the difference in the communication status of the radio waves due to the difference in time, for example, the abnormality in the actually measured positioning result can be detected regardless of the difference in time between night and day.

[0053]

<Third Embodiment>

A third embodiment of the abnormality detection device will be described with reference to Figs. 1, 6, and 8.

[0054]

(Configuration)

The abnormality detection device 5 is configured as shown in Fig. 1 in the same manner as in the first embodiment.

In this embodiment, for example, the statistical data SDT may be further associated with a vehicle type.

[0055]

For example, in the statistical data acquisition unit 51, the statistical data SDT may include a vehicle type in addition to 3D data, a traveling route, a camera image, a satellite orbit, and the like, as parameters.

[0056]

For example, when the statistical data SDT includes the vehicle type as the parameter, in addition to the 3D data, the traveling route, the camera image, the satellite orbit, and the like, as shown in Fig. 8, the statistical data SDT may be calculated by performing machine learning on the GNSS positioning result PR1 related to each parameter using the positioning result estimation model.

[0057]

For example, the positioning result acquisition unit 52 may include vehicle type information which is set in advance and indicates the vehicle type of the vehicle on which the abnormality detection device is mounted, in the actually measured positioning result PRO.

[0058]

For example, the discrimination unit 53 may specify statistical data related to the vehicle type of the vehicle for which the actually measured positioning result PRO is actually measured as the statistical data SDO related to the actually measured positioning result PRO.

[0059]

(Operation)

An operation of the abnormality detection device 5 of this embodiment will be described.

The operation of the abnormality detection device 5 corresponds to an embodiment of the abnormality detection method.

The abnormality detection device 5 executes each step shown in Fig. 6 in the same manner as in the first embodiment.

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

[0060]

Following the execution of step ST01, the positioning result acquisition unit 52 acquires the actually measured positioning result PRO which is the GNSS positioning result actually measured based on the GNSS signal SG and which includes the position information IP (step ST02). At that time, for example, the positioning result acquisition unit 52 may include vehicle type information which is set in advance and indicates the vehicle type of the vehicle on which the abnormality detection device 5 is mounted, in the actually measured positioning result PRO.

[0061]

Following the execution of step ST02, the discrimination unit 53 discriminates the abnormality in the actually measured positioning result PRO based on the acquired statistical data SDT (step ST03). At that time, for example, the discrimination unit 53 may specify statistical data related to the vehicle type of the vehicle for which the actually measured positioning result PRO is actually measured, as the statistical data SDO related to the actually measured positioning result PRO.

[0062]

Subsequent operations are the same as in the first embodiment.

[0063]

(Action and Effect)

According to this embodiment, the abnormality detection device 5 detects the abnormality in the actually measured positioning result based on the statistical data SDT of the GNSS positioning result PR1 associated with each vehicle type.

Since the statistical data SDT of the GNSS positioning result PR1 includes the influence of the surrounding environment in each vehicle type, the abnormality detection device 5 can suppress the influence of the surrounding environment in each vehicle type and detect the abnormality in the actually measured positioning result.

[0064]

For example, the communication status of the radio waves may differ between a truck and a minicar, which are significantly different in vehicle height, even at the same position. On the other hand, according to an example of this embodiment, since the abnormality detection device 5 can suppress the difference in the communication status of the radio waves due to the difference in the vehicle type, the abnormality in the actually measured positioning result can be detected regardless of the difference in the vehicle type between the truck and the minicar.

[0065]

As a modification example, the statistical data SDT may be associated with the time and vehicle type.

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

At that time, the discrimination unit 53 may specify the statistical data related to the time at which the actually measured positioning result PRO is actually measured and the vehicle type of the vehicle as the statistical data SDO related to the actually measured positioning result PRO.

[0066]

<Other Modification Example>

In each of the above-described embodiments, the abnormality detection device 5 detects the abnormality in the actually measured positioning result PRO, but an abnormality mode may be further specified for the detected abnormality.

As a modification example, as shown in Fig. 9, the abnormality detection device 5 may further include an abnormality mode specifying unit 55 for specifying an abnormality mode of the actually measured positioning result PRO based on the statistical data SDT.

As described above, since the actually measured positioning result PRO may include various positioning results such as the actually measured position, the position error, the reception intensity, the number of captured satellites, and the like, the abnormality mode specifying unit 55 can specify the abnormality mode based on a pattern of combinations of the positioning results.

For example, the abnormality mode specifying unit 55 may perform machine-learning on each pattern of the combinations of the GNSS positioning results PR1 to specify the abnormality mode to which the actually measured positioning result PRO belongs from among abnormality modes such as an on-board antenna drop, a software bug, interfering radio waves inside or outside the vehicle in

communication, and interfering structures inside or outside the vehicle in communication, poor connection of various cables, and the like.

According to this modification example, the abnormality detection device 5 can specify the abnormality mode of the actually measured positioning result PRO.

Therefore, the abnormality mode of the actually measured positioning result PRO can be understood.

[0067]

In each of the above-described embodiments, the comparison unit 531 compares the actually measured positioning result PRO at the position indicated by the position information IP with the statistical data SDT at the position indicated by the position information IP1 information, but the comparison may be made in any way if the actually measured positioning result PRO is compared with the statistical data SDT.

As a modification example, the comparison unit 531 may calculate a degree of abnormality as a comparison result.

For example, the comparison unit 531 may calculate, as the degree of abnormality, what percentage of the distribution from the upper limit or the lower limit the actually measured positioning result PRO belongs to, in the statistical data SDT as a reference. At that time, the discrimination unit 53 may discriminate the actually

measured positioning result PRO as an abnormality when the calculated degree of abnormality is smaller than a predetermined value.

For example, when comparing the reception intensity RI and the probability distribution, the comparison unit 531 may calculate, as the degree of abnormality, what percentage of the distribution from the upper limit or the lower limit the reception intensity RI belongs to, in the probability distribution of the reception intensity as a reference. At that time, the discrimination unit 53 may discriminate the reception intensity RI as an abnormality when the calculated degree of abnormality is smaller than a predetermined value (for example, 0.01%).

[0068]

In each of the above-described embodiments, the statistical data SDT is calculated by using 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 using the positioning result estimation model from the accumulated various parameters and actually measured GNSS positioning results.

[0069]

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

[0070]

In each of the above-described embodiments, a program for realizing various functions of the abnormality detection device 5 is recorded on a computer-readable recording medium, and the program recorded on the recording medium is loaded onto a computer system such as a microcomputer and executed to perform various kinds of processing. Here, processes of the various kinds of processing of a CPU of the computer system are stored in a computer-readable recording 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 recording medium refers to a magnetic disk, a magneto-optical disk, a CD-ROM, a DVD-ROM, a semiconductor memory, or the like. Further, the computer program may be distributed to the computer via a communication line, and the computer receiving the distribution may execute the program.

[0071]

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

program for realizing various functions of the abnormality detection device 5 will be described.

[0072]

As shown in Fig. 10, a computer 59 included in the abnormality detection device 5 includes a CPU 591, a memory 592, a storage/reproduction device 593, and an input/output interface (hereinafter referred to as "IO I/F") 594, and a communication interface (hereinafter referred to as "communication I/F") 595.

[0073]

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 abnormality detection device 5.

For example, the memory 592 may store the statistical data SDT, the actually measured positioning result PRO, and the like.

[0074]

The storage/reproduction device 593 is a device for storing 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 stored in the external media.

[0075]

The IO I/F 594 is an interface for inputting/outputting information and the like between the abnormality detection device 5 and other devices.

[0076]

The communication I/F 595 is an interface for communicating with other devices via a communication line such as the Internet or a dedicated communication line.

[0077]

<Other Embodiments>

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

[0078]

<Additional Notes>

The abnormality detection device, the on-board unit, the abnormality detection method, and the program described in the above-described embodiment are understood as follows, for example.

[0079]

(1) The abnormality detection device 5 according to a first aspect includes the statistical data acquisition unit 51 that acquires the statistical data SDT of the GNSS positioning result PR1 associated with the position, the positioning result acquisition unit 52 that acquires the actually measured positioning result PRO which is the GNSS positioning result actually measured based on the GNSS signal SG and which includes the position information IP, and a discrimination unit 53 that discriminates the abnormality in the actually measured positioning result PRO based on the statistical data SDT.

[0080]

According to this aspect, the abnormality detection device 5 detects the abnormality in the actually measured positioning result based on the statistical data SDT of the GNSS positioning result PR1 associated with the position.

Since the statistical data SDT of the GNSS positioning result PR1 includes the influence of the surrounding environment, the abnormality detection device 5 can suppress the influence of the surrounding environment at each position and detect the abnormality in the actually measured positioning result.

Therefore, according to the abnormality detection device 5, the influence of the surrounding environment is

hardly detected as the abnormality in the actually measured positioning result.

[0081]

(2) The abnormality detection device 5 according to a second aspect is the abnormality detection device 5 according to (1), in which the discrimination unit 53 includes the comparison unit 531 that compares the actually measured positioning result PRO with the statistical data SDT related to the position information IP.

[0082]

According to this aspect, the abnormality detection device 5 can detect the abnormality in the actually measured positioning result based on the statistical data SDT including the influence of the surrounding environment at the position at which the actually measured positioning result PRO is acquired.

[0083]

(3) The abnormality detection device 5 according to a third aspect is the abnormality detection device 5 according to (1) or (2), in which the actually measured positioning result PRO includes the reception intensity RI, and the discrimination unit 53 discriminates the abnormality with respect to the reception intensity RI.

[0084]

According to this aspect, the abnormality detection device 5 can detect the abnormality in the actually measured reception intensity RI based on the statistical data SDT of the reception intensity including the influence of the surrounding environment.

Therefore, according to the abnormality detection device 5, the influence of the surrounding environment on the reception intensity RI is hardly detected as the abnormality in the actually measured positioning result.

[0085]

(4) The abnormality detection device 5 according to a fourth aspect is the abnormality detection devices 5 according to any one of (1) to (3), in which the statistical data SDT is further associated with the time.

[0086]

According to this aspect, the abnormality detection device 5 detects the abnormality in the actually measured positioning result based on the statistical data SDT of the GNSS positioning result PR1 associated with each time.

Since the statistical data SDT of the GNSS positioning result PR1 includes the influence of the surrounding environment at each time, the abnormality detection device 5 can suppress the influence of the surrounding environment at each time and detect the abnormality in the actually measured positioning result.

Therefore, according to the abnormality detection device 5, the influence of the surrounding environment at each time is hardly detected as the abnormality in the actually measured positioning result.

[0087]

(5) The abnormality detection device 5 according to a fifth aspect is the abnormality detection devices 5 according to any one of (1) to (4), in which the statistical data SDT is further associated with the vehicle type.

[0088]

According to this aspect, the abnormality detection device 5 detects the abnormality in the actually measured positioning result based on the statistical data SDT of the GNSS positioning result PR1 associated with each vehicle type.

Since the statistical data of the GNSS positioning result PR1 includes the influence of the surrounding environment in each vehicle type, the abnormality detection device 5 can detect the abnormality in the actually measured positioning result based on the statistical data including the influence of the surrounding environment in each vehicle type.

Therefore, according to the abnormality detection device 5, the influence of the surrounding environment in

each vehicle type is hardly detected as the abnormality in the actually measured positioning result.

[0089]

(6) The abnormality detection device 5 according to a sixth aspect is the abnormality detection device 5 according to any one of (1) to (5), further including the abnormality mode specifying unit 55 that specifies the abnormality mode of the actually measured positioning result PRO based on the statistical data SDT.

[0090]

According to this aspect, the abnormality detection device 5 can specify the abnormality mode of the actually measured positioning result PRO.

Therefore, the abnormality mode of the actually measured positioning result PRO can be understood.

[0091]

(7) The on-board unit according to a seventh aspect includes the abnormality detection device 5 according to any one of (1) to (6), and the reception unit 4 that receives the GNSS signal SG received by the on-board antenna 2 from a plurality of satellites.

[0092]

According to this aspect, the on-board unit 3 detects the abnormality in the actually measured positioning result

based on the statistical data SDT of the GNSS positioning result PR1 associated with the position.

Since the statistical data SDT of the GNSS positioning result PR1 includes the influence of the surrounding environment, the on-board unit 3 can suppress the influence of the surrounding environment at each position and detect the abnormality in the actually measured positioning result.

Therefore, according to the on-board unit 3, the influence of the surrounding environment is hardly detected as the abnormality in the actually measured positioning result.

[0093]

(8) The abnormality detection method according to an eighth aspect includes a step of acquiring the statistical data SDT of the GNSS positioning result PR1 associated with the position, a step of acquiring the actually measured positioning result PRO which is the GNSS positioning result actually measured based on the GNSS signal SG and which includes the position information IP, and a step of discriminating the abnormality in the actually measured positioning result PRO based on the statistical data SDT.

[0094]

According to this aspect, the abnormality detection method detects an abnormality in the actually measured

positioning result based on the statistical data SDT of the GNSS positioning result PR1 associated with the position.

Since the statistical data SDT of the GNSS positioning result includes the influence of the surrounding environment, the abnormality detection method can suppress the influence of the surrounding environment at each position and detect the abnormality in the actually measured positioning result.

Therefore, according to the abnormality detection method, it is difficult to detect the influence of the surrounding environment as an abnormality in the actually measured positioning result.

[0095]

(9) The program according to a ninth aspect causes the computer 59 of the abnormality detection device 5 to execute a step of acquiring the statistical data SDT of the GNSS positioning result associated with the position, a step of acquiring the actually measured positioning result PRO which is the GNSS positioning result actually measured based on the GNSS signal SG and which includes the position information IP, and a step of discriminating the abnormality in the actually measured positioning result PRO based on the statistical data SDT.

[0096]

According to this aspect, the abnormality detection device 5 detects the abnormality in the actually measured

positioning result based on the statistical data SDT of the GNSS positioning result PR1 associated with the position.

Since the statistical data SDT of the GNSS positioning result PR1 includes the influence of the surrounding environment, the abnormality detection device can suppress the influence of the surrounding environment at each position and detect the abnormality in the actually measured positioning result.

Therefore, according to the program, the influence of the surrounding environment is hardly detected as the abnormality in the actually measured positioning result.

[Industrial Applicability]

[0097]

According to the abnormality detection device, the on-board unit, the abnormality detection method, and the program of the present disclosure, the influence of the surrounding environment is hardly detected as the abnormality in the actually measured positioning result.

[Reference Signs List]

[0098]

- 1: On-board system
- 2: On-board antenna
- 3: On-board unit
- 4: Reception unit
- 5: Abnormality detection device

51: Statistical data acquisition unit
52: Positioning result acquisition unit
53: Discrimination unit
54: Output unit
55: Abnormality mode specifying unit
59: Computer
531: Comparison unit
591: CPU
592: Memory
593: Storage/reproduction device
594: IO I/F
595: Communication I/F
IP: Position information
IP1: Position information
PRO: Actually measured positioning result
PR1: GNSS positioning result
RI: Reception intensity
SDO: Statistical data
SDT: Statistical data
SG: GNSS signal

Claims

[Claim 1]

An abnormality detection device comprising:

a statistical data acquisition unit that acquires statistical data of a GNSS positioning result associated with a position;

a positioning result acquisition unit that acquires an actually measured positioning result which is the GNSS positioning result actually measured based on a GNSS signal and which includes position information; and

a discrimination unit that discriminates an abnormality in the actually measured positioning result based on the statistical data.

[Claim 2]

The abnormality detection device according to claim 1, wherein the discrimination unit includes a comparison unit that compares the actually measured positioning result with the statistical data related to the position information.

[Claim 3]

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

the discrimination unit discriminates the abnormality with respect to the reception intensity.

[Claim 4]

The abnormality detection device according to any one of claims 1 to 3, wherein the statistical data is further associated with a time.

[Claim 5]

The abnormality detection device according to any one of claims 1 to 4, wherein the statistical data is further associated with a vehicle type.

[Claim 6]

The abnormality detection device according to any one of claims 1 to 5, further comprising an abnormality mode specifying unit that specifies an abnormality mode of the actually measured positioning result based on the statistical data.

[Claim 7]

An on-board unit comprising:

the abnormality detection device according to any one of claims 1 to 6; and

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

[Claim 8]

An abnormality detection method comprising:

a step of acquiring statistical data of a GNSS positioning result associated with a position;

a step of acquiring an actually measured positioning result which is the GNSS positioning result actually measured based on the GNSS signal and which includes position information; and

a step of discriminating an abnormality in the actually measured positioning result based on the statistical data.

[Claim 9]

A program for causing a computer of an abnormality detection device to execute:

a step of acquiring statistical data of a GNSS positioning result associated with a position;

a step of acquiring an actually measured positioning result which is the GNSS positioning result actually measured based on the GNSS signal and which includes position information; and

a step of discriminating an abnormality in the actually measured positioning result based on the statistical data.