

DESCRIPTION

TITLE OF THE INVENTION: INSULATOR DETECTION DEVICE AND
INSULATOR DETECTION METHOD

TECHNICAL FIELD

[0001]

The present invention relates to an insulator detection device and an insulator detection method.

BACKGROUND ART

[0002]

An overhead line (hereinafter, trolley wire) and a track (hereinafter, rail) are the main facilities of the electric railroad. These are both the important maintenance facilities for operating the railroad.

[0003]

While running an electric railroad vehicle, the trolley wire contacts power collectors every time the electric railroad vehicle passes. The trolley wire is thus gradually worn, and if not replaced, the trolley wire may be eventually broken and may cause an accident. In addition, the rail may be wound due to the train running and may be deformed, flawed, or worn, and if the progression of the degradation is ignored, an accident such as derailment of the electric railroad vehicle may occur.

[0004]

Given this, quick identification of a portion that needs caution because of the wear and the like of the trolley wire and rail and specification of information on the location of the caution-needed portion of the trolley wire and rail (e.g., the location at which the caution-needed portion exists is how many kilometers of running distance away from a predetermined point) to deal with the caution-needed portion are important

in terms of the maintenance management.

[0005]

Vehicles such as a maintenance utility vehicle and a road-rail vehicle are used for performing maintenance of the facilities including the trolley wire and rail. When the caution-needed portion is detected as a result of inspection, the location of the caution-needed portion is estimated based on the location of the vehicle acquiring the data.

[0006]

The location of the vehicle can be identified by detecting the location of a supporting object disposed on the ground, and in this case, the detection of the supporting object is quite important. The supporting objects have different shapes in a tunnel section and a lighting section, and the supporting object in the tunnel section is provided with an insulator for insulation between the supporting object and the overhead line. That is, in the tunnel section, it is possible to indirectly detect the supporting object by detecting the insulator.

[0007]

A rigid overhead line supporting insulator detection device has been known as a conventional technique of the insulator detection, which detects an insulator by disposing a laser light source and a video camera on the top of the roof of an inspection vehicle, capturing images of slit images acquired by generating light fluxes from the laser light source having a width covering the trolley wire, a rigid trolley wire, and the insulator, and performing image processing (e.g., see Patent Document 1 listed below).

[0008]

On the other hand, also a trolley wire inspection device

has been known, which measures the trolley wire using an area measurement sensor disposed on the roof of the vehicle and calculates a height, a deviation, and the like of the trolley wire using a calculation device based on the acquired measurement result (e.g., see Patent Document 2 listed below).

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0009]

Patent Document 1: Japanese Patent Application Publication No. 2005-147879

Patent Document 2: Japanese Patent Application Publication No. 2010-243416

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0010]

The conventional insulator detection device has a problem of the high cost because it requires the laser light source, a highly sensitive camera, and the calculation device.

[0011]

Thus, an object of the present invention is to provide an insulator detection device and an insulator detection method capable of detecting an insulator using a simple configuration while reducing cost.

MEANS FOR SOLVING THE PROBLEMS

[0012]

An insulator detection device according to the first invention for solving the abovementioned problems, comprises:

an area measurement sensor, which is a uniaxial-scanning-type, that is disposed on a roof of a vehicle and acquires at least data of a distance and an angle to an

overhead line; and

a calculation device that includes an overhead line position calculation unit, which detects a height and a deviation of the overhead line based on the data acquired by the area measurement sensor, characterized in that

the calculation device includes an insulator detection unit, which acquires the number of data points from the data acquired by the area measurement sensor and detects an insulator based on the acquired number of the data points.

[0013]

An insulator detection device according to the second invention is characterized in that

the insulator detection unit includes

an overhead line periphery data point measurement unit, which determines an insulator detection region as a region in which the detection of the insulator is executed based on position data of the overhead line calculated by the overhead line position calculation unit and acquires the number of the data points within the insulator detection region, and

an insulator determination processing unit, which determines whether the insulator exists based on the number of the data points.

[0014]

An insulator detection device according to the third invention is characterized in that

when the number of the data points is greater than a predetermined value, which is determined based on a median and a standard deviation of the number of the data points within the insulator detection region of a predetermined number of lines, the insulator detection processing unit determines that

the insulator exists.

[0015]

An insulator detection method according to the fourth invention is characterized in that the insulator detection method comprises:

acquiring data of a distance and an angle to a structure above a vehicle acquired by an area measurement sensor disposed on a roof of the vehicle;

acquiring the number of data points based on the data;
and

detecting an insulator based on the acquired number of the data points.

[0016]

The insulator detection method according to the fifth invention is characterized in that the insulator detection method further comprises:

determining an insulator detection region as a region in which the detection of the insulator is executed based on the data;

acquiring the number of the data points within the insulator detection region; and

determining whether the insulator exists based on the number of the data points.

[0017]

The insulator detection method according to the sixth invention is characterized in that the insulator detection method further comprises:

when the number of the data points is greater than a predetermined value, which is determined based on a median and a standard deviation of the number of the data points within

the insulator detection region of a predetermined number of lines, determining that the insulator exists.

EFFECT OF THE INVENTION

[0018]

According to an insulator detection device and an insulator detection method of the present invention, it is possible to detect an insulator using a simple configuration while reducing cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

[Fig. 1A] A front view that schematically illustrates an application example of an insulator detection device according to an embodiment of the present invention.

[Fig. 1B] A side view that schematically illustrates the application example of the insulator detection device according to the embodiment of the present invention.

[Fig. 2] A perspective view that illustrates an example of an insulator.

[Fig. 3] A block diagram that illustrates a configuration of an insulator detection device according to Embodiment 1 of the present invention.

[Fig. 4] An explanatory diagram that illustrates an example in which a rigid overhead line is viewed from directly below.

[Fig. 5] An explanatory diagram that illustrates an example of the insulator detection illustrated in Fig. 4.

[Fig. 6] An explanatory diagram that illustrates an example in which a portion including an insulator is viewed from directly below.

[Fig. 7] An explanatory diagram that illustrates an example of the insulator detection illustrated in Fig. 6.

[Fig. 8] A flowchart that illustrates a flow of an insulator detection processing according to Embodiment 1 of the present invention.

MODE FOR CARRYING OUT THE INVENTION

[0020]

Hereinafter, an insulator detection device and an insulator detection method according to the present invention are described using the drawings.

Note that the terms in this specification are defined as follows.

"deviation" = A technical term of the railroad that means a distance from the center of a pantograph that is a position at which the pantograph contacts the trolley wire.

"line" = A measured surface acquired from scanning in the railroad tie direction by an area measurement sensor. For example, when the area measurement sensor performs the measurement at 25 Hz, the number of the lines acquired in one second is 25 lines.

EMBODIMENT

[0021]

Hereinafter, details of the insulator detection device and the insulator detection method according to an embodiment of the present invention are described using Fig. 1A to Fig. 8.

[0022]

As illustrated in Figs. 1A and 1B, the insulator detection device according to this embodiment includes an area measurement sensor 2, which is disposed on the roof of a vehicle 1 so as to be capable of measuring a trolley wire 4, and a

calculation device 3 disposed in the vehicle 1.

Fig. 2 illustrates an example of the insulator. In Fig. 2, 5 denotes a supporting object, 6 denotes an insulator, 7 denotes a supporting saddle, and 8 denotes a rigid overhead line.

[0023]

The area measurement sensor 2 radially emits laser light about an axis parallel to the traveling direction of the vehicle 1 and receives the reflected light to measure a distance to a measurement target. In this embodiment, the area measurement sensor 2 scans a measurement area A (scanning angle of 270°) illustrated in Figs. 1A and 1B in 1080 steps, and thus an angle resolution ω is 0.25° .

[0024]

The calculation device 3 calculates a height D_H , a deviation D_B , and the like of the trolley wire 4 based on the measurement result acquired by the area measurement sensor 2. As illustrated in Fig. 3, the calculation device 3 includes an overhead line position calculation unit 3a, an overhead line periphery data point measurement unit 3b, an insulator determination processing unit 3c, and a memory 3d.

[0025]

The overhead line position calculation unit 3a acquires data (angle and distance; hereinafter called area measurement sensor data) acquired by the area measurement sensor 2 scanning the measurement area A and calculates an overhead line position (height D_H , deviation D_B , and the like) based on the area measurement sensor data. A reference numeral B illustrated in Figs. 1A and 1B denotes an overhead line detection region, which is set within the measurement area A based on the deviation in

the height direction and the horizontal direction of the trolley wire 4 when calculating the overhead line position. Note that the measurement of the overhead line position is performed using a known method (e.g., see paragraphs 0032 to 0056 in Patent Document 2 mentioned above), and detailed descriptions are omitted herein.

[0026]

The overhead line periphery data point measurement unit 3b determines an insulator detection region C (see Fig. 2) by designating an area of the height and the deviation based on the overhead line position acquired by the overhead line position calculation unit 3a, measures the number of pieces of laser data (hereinafter called the number of data points) within the insulator detection region C based on the overhead line position data, and acquires the number of the data points in an area including the rigid overhead line 8 as illustrated in Fig. 5 or 7. This processing is performed on scanned data of a predetermined number of lines (e.g., thousands of lines) at one time.

The insulator detection region C is determined by, for example, designating an origin (x_0 , y_0) to be relative to the position of the trolley wire 4 (0 , 0) and setting a width W and a height H depending on the position, shape, and distance to the ceiling of the rigid overhead line 8. x_0 and the width W are set such that at least the insulator 6 is included within an area in the deviation direction of the insulator detection region C, and y_0 and the height H are set such that an area in the vertical direction of the insulator detection region C is an area from a position lower than the trolley wire 4 to a position higher than the insulator 6 and lower than the ceiling.

[0027]

The insulator determination processing unit 3c detects the insulator 6 based on the number of the data points acquired by the overhead line periphery data point measurement unit 3b. That is, the number of the data points in the insulator detection region C has a tendency that the number of the data points, which is acquired from the periphery of the trolley wire 4 when the insulator 6 exists as illustrated in Figs. 6 and 7, is greater than the number of the data points, which is acquired from the periphery of the trolley wire 4 when only the rigid overhead line 8 exists (no insulator 6 exists) as illustrated in Figs. 4 and 5. The insulator determination processing unit 3c uses this tendency to detect the insulator 6.

In specific, a median m and a standard deviation s of the number of the data points in the insulator detection region C of the predetermined number of lines are acquired. When the determined line is an i -th line and the number of the data points of the i -th line is D_i and once the following expression (1) is satisfied, it is determined that the i -th line includes the insulator 6:

$$D_i > m + (\text{decision coefficient}) \times s \dots (1),$$

where decision coefficient is a coefficient used for the insulator determination.

In addition, L in Figs. 4 and 6 denotes the line.

[0028]

The memory 3d stores various kinds of data.

[0029]

Next, processing by the insulator detection device according to this embodiment is simply described using Fig. 8.

As illustrated in Fig. 8, when the insulator 6 is detected

in this embodiment, distance data acquired by the area measurement sensor 2 is firstly collected (step S1), and the position of the trolley wire 4 is calculated based on the distance data collected by the overhead line position calculation unit 3a (step S2). Then, the number of the data points in the periphery of the trolley wire 4 is measured by the overhead line periphery data point measurement unit 3b based on the position of the trolley wire 4 calculated by the overhead line position calculation unit 3a (step S3), and the insulator 6 is detected by the insulator determination processing unit 3c based on the measured number of the data points of the predetermined number of lines (step S4).

[0030]

According to the insulator detection device and the insulator detection method of this embodiment having the abovementioned configuration, the number of the data points in the periphery of the trolley wire 4 is measured based on the deviation and the height of the trolley wire 4 acquired by a simple device using the area measurement sensor 2, which is an uniaxial-scanning-type, and when the measured value is greater than the number of the data points of another line, it is determined that the line includes the insulator 6, and thus the insulator 6 is detected. Accordingly, it is possible to indirectly detect the supporting object 5.

[0031]

In the conventional method, the idea of a so-called light-section method in which laser slit light radiates and a shape of an insulator irradiated with the laser light is measured with a camera has been used. However, this method has a problem that it requires a configuration including the two

devices, the camera and the laser, and this increases the cost and makes the device configuration complicated.

[0032]

However, the insulator detection device and the insulator detection method according to this embodiment have an advantage that it is possible to detect the insulator 6 using a simple configuration including a single scanning laser (the area measurement sensor 2) while reducing cost. Also, there is an additional advantage that it is possible to measure the height of the trolley wire 4 by the area measurement sensor 2 used for detecting the insulator 6.

[0033]

The present invention can be applied to an insulator detection device and an insulator detection method.

INDUSTRIAL APPLICABILITY

[0034]

1...vehicle, 2...area measurement sensor, 3...calculation device, 3a...overhead line position calculation unit, 3b...overhead line periphery data point measurement unit, 3c...insulator determination processing unit, 3d...memory, 4...trolley wire, 5...supporting object, 6...insulator, 7...supporting saddle, 8...rigid overhead line, A...measurement area, B...detection area, C...insulator detection region, D_B ...deviation of trolley wire, D_H ...height of trolley wire, L...line, H...height of insulator detection region, W...width of insulator detection region

CLAIMS

[Claim 1]

An insulator detection device characterized in that the insulator detection device comprises:

a single area measurement sensor, which is a uniaxial-scanning-type, that is disposed on a roof of a vehicle and acquires at least data of a distance and an angle to an overhead line; and

a calculation device that includes an overhead line position calculation unit, which detects a height and a deviation of the overhead line based on the data acquired by the area measurement sensor, wherein

the area measurement sensor radially emits laser light about an axis parallel to a traveling direction of the vehicle and receives reflected light to measure a distance to a measurement target, and

the calculation device includes an insulator detection unit, which acquires the number of data points from the data acquired by the area measurement sensor and detects an insulator based on the acquired number of the data points.

[Claim 2]

An insulator detection device comprising:

an area measurement sensor, which is a uniaxial-scanning-type, that is disposed on a roof of a vehicle and acquires at least data of a distance and an angle to an overhead line; and

a calculation device that includes an overhead line position calculation unit, which detects a height and a deviation of the overhead line based on the data acquired by the area measurement sensor, wherein

the calculation device includes an insulator detection unit, which acquires the number of data points from the data acquired by the area measurement sensor and detects an insulator based on the acquired number of the data points, characterized in that

the insulator detection unit includes

an overhead line periphery data point measurement unit, which determines an insulator detection region as a region in which the detection of the insulator is executed based on position data of the overhead line calculated by the overhead line position calculation unit and acquires the number of the data points within the insulator detection region, and

an insulator determination processing unit, which determines whether the insulator exists based on the number of the data points.

[Claim 3]

The insulator detection device according to claim 2, characterized in that

when the number of the data points is greater than a predetermined value, which is determined based on a median and a standard deviation of the number of the data points within the insulator detection region of a predetermined number of lines, the insulator detection processing unit determines that the insulator exists.

[Claim 4]

An insulator detection method characterized in that the insulator detection method comprises:

acquiring data of a distance and an angle to a structure above a vehicle acquired by an area measurement sensor that is disposed on a roof of the vehicle and radially emits laser light about an axis parallel to a traveling direction of the vehicle;

acquiring the number of data points based on the data;
and

detecting an insulator based on the acquired number of the data points.

[Claim 5]

The insulator detection method according to claim 4, characterized in that the insulator detection method further comprises:

calculating position data of an overhead line based on the data;

determining an insulator detection region as a region in which the detection of the insulator is executed based on the position data;

acquiring the number of the data points within the insulator detection region; and

determining whether the insulator exists based on the number of the data points.

[Claim 6]

The insulator detection method including:

acquiring data of a distance and an angle to a structure above a vehicle acquired by an area measurement sensor disposed on a roof of the vehicle;

acquiring the number of data points based on the data;
and

detecting an insulator based on the acquired number of the data points, characterized in that the insulator detection method further comprises:

calculating position data of an overhead line based on the data;

determining an insulator detection region as a region in which the detection of the insulator is executed based on the

position data and acquires the number of the data points within the insulator detection region; and

determining whether the insulator exists based on the number of the data points by, when the number of the data points is greater than a predetermined value, which is determined based on a median and a standard deviation of the number of the data points within the insulator detection region of a predetermined number of lines, determining that the insulator exists.