

DESCRIPTION

TITLE OF INVENTION

PANTOGRAPH PERIPHERY OBSTRUCTION DETECTION DEVICE AND
DETECTION METHOD

TECHNICAL FIELD

[0001]

The present disclosure relates to a pantograph periphery obstruction detection device and detection method.

BACKGROUND

[0002]

In order to ensure the safety and stability of traveling railway vehicles, taking measures such as appropriately detecting pantograph obstructions is necessary. Here, pantograph obstructions are obstructions that contact the pantographs of a traveling railway vehicle and that interfere with the traveling of the railway vehicle. Conventionally, there have been exclusive measurement vehicles called inspection vehicles or vehicle clearance cars as a means of measuring obstructions, and these vehicles are operated at regular intervals between commercial operations (hereafter referred to as "measurement vehicles"). With these measurement vehicles, there are multiple measurement items such as the incline of the vehicle body and rail displacement, and obstructions are one of these measurement items.

[0003]

Obstruction measurement methods include contact sensor methods and laser sensor methods. With contact sensor methods, a rod-shaped elastic body is attached to the contact sensor, which is attached to a pantograph or a vehicle to detect contact with obstructions. With laser sensor methods, depending on the irradiation shape of the laser, there are spot-type lasers, scanning-type lasers, lens-type lasers (irradiating in a fan shape), and other types of lasers, and the absolute distance to an object to be measured is measured by the phase

difference of reflected waves and the deformation of the irradiated laser shape.

[0004]

However, with contact sensor methods, it is dangerous when the contact sensor collides with obstructions during high-speed travel, so detection work is normally carried out during low-speed operations, meaning contact sensor methods cannot be employed during high-speed travel. With laser sensor methods, while there are spot-type lasers, scanning-type lasers (for example, Patent Document 1), and lens-type lasers, the spot-type lasers and the scanning-type lasers are sensors that measure the distance to a measuring point at only one point, so it is not possible to measure the vicinity of the pantograph from a vehicle travelling at high speed over a wide range. In addition, since the lens-type laser usually uses a strong laser of CLASS-C or higher (JIS-C-6802 standard), it cannot be used for safety reasons in a place where people enter.

[0005]

In order to solve these problems, there is an image processing method using cameras. Two cameras installed on the left and right sides of the vehicle continuously take images of the pantograph periphery, and the captured images are image processed to detect obstructions in the pantograph periphery. Patent Document 2 discloses performing block extraction processing from the images from two cameras on the left and right, and a three-dimensional position is obtained by triangulation from the center of gravity position of the block.

CITATION LIST

PATENT LITERATURE

[0006]

Patent Document 1: WO 2014/024812 A

Patent Document 2: JP 2006-250775 A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007]

In the block extraction described in Patent Document 2, a mask image is created by binarization from the area excluding the pantograph and trolley wire. With this process, there is a problem that the mask image contains a large amount of noise and erroneous detections increase.

[0008]

The present disclosure has been made in view of the above-described circumstances, and an object of the present disclosure is to provide a pantograph periphery obstruction detection device and detection method whereby erroneous detection is reduced and good precision is obtained.

SOLUTION TO PROBLEM

[0009]

In order to solve the abovementioned problem, the present disclosure employs the following means.

That is, the pantograph periphery obstruction detection device according to the present disclosure is provided with: a reference camera and a first correction camera that capture images of the pantograph periphery; and an image processing device that processes images from the cameras, wherein the image processing device is provided with a stereo parallelization unit that corrects lens distortion and stereo parallelization and a data processing unit that processes the images corrected by the stereo parallelization unit, and the data processing unit is provided with a pantograph template setting unit that sets a template for the pantograph, a background removal unit that removes a background, a pantograph detection unit that detects the position of the pantograph, a parallax calculation unit that determines a parallax, which is an amount of deviation of a projection point of an object in each camera image, a three-dimensional coordinate calculation unit that calculates three-dimensional coordinates based on the parallax, an overhead wire detection unit that extracts lines such as overhead wires, an overhead wire support fitting detection unit that detects overhead wire support fittings, and an obstruction determination unit that determines obstructions based on the distance from the pantograph.

[0010]

According to the present disclosure, the stereo parallelization is corrected, and for the images, since the processes by the pantograph template setting unit, the background removal unit, the pantograph detection unit, the parallax calculation unit, the three-dimensional coordinate calculation unit, the overhead wire support fitting detection unit, and the obstruction determination unit are appropriately performed, it is possible to reliably detect obstructions.

[0011]

In one embodiment of the present disclosure, in the overhead wire support fitting detection unit, abnormal coupling between the overhead wire support fittings and the overhead wires is detected.

In this embodiment, since abnormal coupling between the overhead wire support fittings and the overhead wires is detected, in addition to the detection of obstructions, abnormalities other than obstructions can also be properly detected.

[0012]

In one embodiment of the present disclosure, a second correction camera is provided, which second correction camera is arranged in a direction orthogonal to a line segment connecting the positions of the reference camera and the first correction camera when viewed from the reference camera.

In this embodiment, since the second correction camera is arranged at a position different from the first correction camera by 90 degrees when viewed from the reference camera, the accuracy of the three-dimensional coordinate calculation can be improved.

[0013]

The pantograph periphery obstruction detection method according to the present disclosure includes: capturing images of the pantograph periphery with a reference camera and a first correction camera; correcting lens distortion and stereo parallelization; setting a template of the pantograph; removing a background; detecting the position of the pantograph; determining a parallax,

which is an amount of deviation of a projection point of an object in each camera image; calculating three-dimensional coordinates based on the parallax; extracting lines such as overhead wires; detecting overhead wire support fittings; and determining obstructions based on the distance from the pantograph.

[0014]

According to the present disclosure, the stereo parallelization is corrected, and for the images, since the pantograph template setting, the background removing, the pantograph detecting, the parallax calculating, the three-dimensional coordinate calculating, the overhead wire support fitting detecting, and the obstruction determining are performed, it is possible to reliably detect obstructions.

[0015]

According to one embodiment of the present disclosure, detecting the overhead wire support fitting includes detecting abnormal coupling between the overhead wire support fittings and the overhead wires.

In this embodiment, since abnormal coupling between the overhead wire support fittings and the overhead wires is detected, in addition to the detection of obstructions, abnormalities other than obstructions can also be properly detected.

[0016]

In one embodiment of the present disclosure, capturing images of the pantograph periphery with a second correction camera is included, which second correction camera is arranged in a direction orthogonal to a line segment connecting the positions of the reference camera and the first correction camera when viewed from the reference camera.

In this embodiment, since the second correction camera is arranged at a position different from the first correction camera by 90 degrees when viewed from the reference camera, the accuracy of the three-dimensional coordinate calculation can be improved.

EFFECTS OF THE INVENTION

[0017]

According to the present disclosure, it is possible to provide a pantograph periphery obstruction detection device and detection method whereby erroneous detection is reduced and good precision is obtained.

BRIEF DESCRIPTION OF DRAWINGS

[0018]

Fig. 1 is a schematic diagram showing a configuration of the pantograph periphery obstruction detection device including installation of cameras for capturing images of the pantograph according to an embodiment of the present disclosure.

Fig. 2 is a schematic diagram showing a configuration of the pantograph periphery obstruction detection device including installation of cameras for capturing images of the pantograph according to an embodiment of the present disclosure.

Fig. 3 is a functional block diagram of the pantograph periphery obstruction detection device according to an embodiment of the present disclosure.

Fig. 4 is a flow chart showing the steps of the pantograph periphery obstruction detection according to an embodiment of the present disclosure.

Fig. 5 is an example of a reference camera image according to an embodiment of the present disclosure.

Fig. 6 illustrates the overhead wire detection process according to an embodiment of the present disclosure.

Fig. 7 is a drawing illustrating a foreground image obtained by the background removal process according to an embodiment of the present disclosure.

Fig. 8 is a drawing illustrating an overhead wire support fitting mask image according to an embodiment of the present disclosure.

Fig. 9 is a drawing illustrating an extracted overhead wire support fitting according to an embodiment of the present disclosure.

Fig. 10 is a drawing illustrating a determination gauge in the obstruction determination process according to an embodiment of the present disclosure.

Fig. 11 is a drawing in which a mask image area was added to a foreground image according to an embodiment of the present disclosure.

Fig. 12 is a drawing illustrating an image of Fig. 11 excluding a portion to be excluded from the obstruction determination.

Fig. 13 is a drawing illustrating a normal state of the overhead wire support fitting according to an embodiment of the present disclosure.

Fig. 14 is a drawing illustrating an abnormal state of the overhead wire support fitting according to an embodiment of the present disclosure.

Fig. 15 is a schematic diagram showing the relationship between data and data processing of the pantograph periphery obstruction detection device according to an embodiment of the present disclosure.

DESCRIPTION OF EMBODIMENTS

[0019]

Hereinafter, an embodiment according to the present disclosure is explained while making reference to the drawings.

(First Embodiment)

Fig. 1 is a schematic diagram showing a configuration of the pantograph periphery obstruction detection device including installation of cameras for capturing images of the pantograph according to the first embodiment of the present disclosure. As illustrated in Fig. 1, the pantograph periphery obstruction detection device 1 according to the present embodiment is provided with a reference camera 5 and a first correction camera 7 that capture images of the pantograph 3 periphery as well as an image processing device 11 that processes images from the cameras 5 and 7.

[0020]

The reference camera 5 and the first correction camera 7 are two area sensor cameras 5 and 7 installed on the roof of a vehicle. The installation positions of the two area sensor cameras 5 and 7 need to be at the same angle such that each camera 5 and 7 looks up at the pantograph 3 and such that the parallel stereo condition in the x direction (crosstie direction) is satisfied. The parallel stereo condition in the x-direction means the x-coordinate axes of the cameras 5 and 7 are on the same straight line and oriented in the same direction.

[0021]

Fig. 3 is a functional block diagram of the pantograph periphery obstruction detection device 1 according to the present embodiment. As illustrated in Fig. 3, the image processing device 11 is provided with a stereo parallelization unit 13 that corrects lens distortion and stereo parallelization and a data processing unit 15 that processes the images corrected by the stereo parallelization unit 13, and the data processing unit 15 is provided with a pantograph template setting unit 17 that sets a template of the pantograph, a background removal unit 19 that removes a background, a pantograph detection unit 21 that detects the position of the pantograph, a parallax calculation unit 23 that determines a parallax, which is an amount of deviation of a projection point of an object in each camera image from the cameras 5 and 7, a three-dimensional coordinate calculation unit 25 that calculates three-dimensional coordinates based on the parallax, an overhead wire detection unit 27 that extracts lines such as overhead wires, an overhead wire support fitting detection unit 29 that detects overhead wire support fittings, and an obstruction determination unit 31 that determines obstructions based on the distance from the pantograph 3.

[0022]

The image processing device 11 may be configured by hardware, and each of the functions thereof may be implemented with software. The image processing device 11 is an information processing device such as, for example, a personal computer. The respective functional blocks may be software or a program executed by the CPU or GPU in the information processing device. With such a configuration, it becomes possible to provide with a recording medium such as a CD-ROM or download via a network such as the internet. Alternatively, the

image processing device 11 may be software or a program provided on a cloud service.

[0023]

Fig. 4 is a flow chart showing the steps of the pantograph periphery obstruction detection by the pantograph periphery obstruction detection device 1 according to the present embodiment. Referring to Fig. 3 and Fig. 4, the operations of the pantograph periphery obstruction detection device 1 is explained.

[0024]

1. Stereo parallelization process (S01)

As illustrated in Fig. 1 and Fig. 3, videos of the pantograph 3 periphery captured by the reference camera 5 and the first correction camera 7 are transmitted to the image processing device 11. In the image processing device 11, the received videos are transmitted to the stereo parallelization unit 13 and lens distortion correction and stereo parallelization correction in the x-direction are performed. Here, stereo parallelization correction means performing correction so that the same object has the same v coordinates in the image coordinates (u, v) between the cameras 5 and 7. These corrections are performed using camera intrinsic and extrinsic parameters determined by calibration work performed in advance. In the subsequent processes, it is assumed that all image data are images that have undergone stereo parallelization correction. The images converted by performing lens distortion correction and stereo parallelization correction in the stereo parallelization unit 13 are sent to the data processing unit 15.

At the data processing unit 15, a template image of the pantograph 3 is created by the pantograph template setting unit 17 as preprocessing for obstruction detection. Fig. 5 illustrates an example of an image from the reference camera 5. A template image obtained by extracting the image portion of the pantograph 3 from the image from the reference camera 5 is created and registered.

[0025]

2. Background removal process (S02)

At the background removal unit 19, a foreground image is created by removing, from the image from the reference camera 5, the background and other backgrounds such as the pantograph and overhead wires 33 captured in each frame. As a background removal method, a background model is created for each pixel unit by a statistical background subtraction method, and a background determination is performed by comparing the background model with an input luminance value. By removing the background with the background removal unit 19, the foreground image illustrated in Fig. 7 is obtained.

[0026]

3. Pantograph detection process (S03)

At the pantograph detection unit 21, the pantograph position (u, v) [pix] is detected by template matching with the pantograph template image registered in advance in step S01 with respect to the image from the reference camera 5.

[0027]

4. Parallax calculation process (S04)

At the parallax calculation unit 23, the amount of deviation (parallax) of a projection point of an object in images from the reference camera 5 and the first correction camera 7 is determined. As the method for determining the parallax, semi-global block matching is used. In the semi-global block matching, a small area (block) centered on a pixel of interest in the image is used as a template, and areas similar to the template are searched for from images from other cameras. Note that there are cases where the texture on the image, such as the walls of a building or the ground, does not have features, and corresponding points cannot be determined uniquely when matching is performed. In this case, the corresponding points are determined by taking into account that the parallax of the surrounding pixels does not fluctuate abruptly. This method is called a global optimization method.

[0028]

5. Three-dimensional coordinate calculation process (S05)

In the three-dimensional coordinate calculation unit 25, the three-dimensional coordinates (x, y, z) are calculated by the following formula using the parallax obtained in step S04. Note that b is the distance between the cameras, and f is the focal length. These b and f are constants and numerical values unique to the camera installation conditions and the camera lens.

[0029]

[Formula 1]

$$\begin{aligned} x &= \frac{bu}{u - u'} \\ y &= \frac{bv}{u - u'} \\ z &= \frac{bf}{u - u'} \end{aligned}$$

[0030]

Since the calculated three-dimensional coordinates are calculated in the coordinate system of the reference camera 5, they are calculated in the coordinate system tilted by the tilt angle of the camera. In order to make the coordinate system horizontal, the tilt angle θ of the camera is corrected by the following formula.

[0031]

[Formula 2]

$$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \theta & -\sin \theta \\ 0 & \sin \theta & \cos \theta \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

[0032]

6. Overhead wire detection process (S06)

In the overhead wire detection unit 27, an overhead wire mask image is created in which lines such as overhead wires 33 and trolley wires 34 are extracted from the image from the reference camera 5 as illustrated in Fig. 5 so that overhead

wires 33 are not detected as obstructions 39. As steps thereof, a gray scale-top-hat processing (JP 5811637 B) and binarization are performed on the image from the reference camera 5 in the horizontal direction of the image, and as illustrated in Fig. 6, an object thin in the horizontal direction of the image is extracted. Even if there is noise at this stage, an image as illustrated in Fig. 6 is obtained because a labeling process is performed and the noise is removed according to the size of the label area.

[0033]

7. Overhead wire support fitting detection process (S07)

In the overhead wire support fitting detection unit 29, an overhead wire support fitting mask image is created from the foreground image obtained in the background removal process in step S02 illustrated in Fig. 7 such that overhead wire support fittings 35 such as curved pull-off arms and straight pull-off arms are not detected as obstructions 39. As steps thereof, by performing top-hat processing on the foreground image in the vertical direction of the image, an object that is thin in the vertical direction of the image is extracted as illustrated in Fig. 8. Since the overhead wire support fittings 35 have a certain size in the horizontal direction, the overhead wire support fittings can be extracted as illustrated in Fig. 9 by removing, by the labeling process, the noise according to the size of the label area.

[0034]

8. Obstruction determination process (S08)

In the obstruction determination unit 31, the determination of obstructions 39 is performed from the distance (separation) (mm) from the pantograph 3. The range for calculating the separation from the pantograph 3 is performed from the pantograph 3 to the cameras 5 and 7. The reason is that if the z-coordinate is separated from the pantograph 3, the pantograph 3 will shield the object, and the object will not be captured accurately. An obstruction determination gauge G (dynamic gauge), as illustrated in Fig. 10, the positions of which are variable according to the dynamically moving pantograph is set, and an object that is present in a position closer to the pantograph than the dynamic gauge G is determined to be an obstruction 39. The area for calculating the separation from

the pantograph 3 is only a foreground area obtained in the background removal process in step S02. Further, permanent railroad facilities such as overhead wires 33, curved pull-off arms, and overhead wire fittings 36 such as hangars must not be determined as obstructions. For this reason, objects corresponding to the following conditions are excluded from the obstruction determination.

- (1) Objects having a small object area in the image (noise that could not be removed in the background removal)
- (2) Objects having an overlapping rate with the overhead wire mask area that is equal to or higher than a threshold value (overhead wire fittings)
- (3) Curved wire fittings mask areas

With the addition of the mask image area to the foreground image, the illustration in Fig. 11 is obtained and with the removal of areas corresponding to the above conditions, the illustration in Fig. 12 is obtained. When the obstruction determination is performed on the area in Fig. 12, obstructions such as trees are determined to be obstructions 39.

[0035]

Fig. 15 is a schematic diagram showing the relationship between data and data processing of the pantograph periphery obstruction detection device 1 according to the present embodiment. With reference to Fig. 15, the relationship between data and data processing of the pantograph periphery obstruction detection device 1 is explained in detail. In Fig. 15, the data are shown as rectangles and data processing are shown as circles.

- (1) Stereo parallelization p1 is performed on the reference camera image d1 obtained from the reference camera 5 and the first correction camera image d2 obtained from the first correction camera 7, and a parallelization reference camera image d3 and a parallelization first correction camera image d4 are generated.
- (2) Overhead wire detection p2 is performed on the parallelization reference camera image d3 and an overhead wire mask image d5 is generated.
- (3) Pantograph detection p3 is performed on the parallelization reference

camera image d3 and a template image d7 to be explained later and a pantograph position d6 is obtained.

- (4) Template setting p4 is performed on the parallelization reference camera image d3 and the template image d7 is generated.
- (5) Background removal p5 is performed on the parallelization reference camera image d3 and a foreground image d8 is generated.
- (6) The parallax calculation p6 is performed on the parallelization reference camera image d3 and the parallelization first correction camera image d4 and a parallax d9 is obtained.
- (7) The overhead wire support fitting detection p8 is performed on the foreground image d8 and an overhead wire fitting mask image d10 is generated.
- (8) With the parallax d9 as input, the three-dimensional coordinate calculation p9 is performed, and the three-dimensional coordinate d11 is obtained.
- (9) The obstruction determination p7 is performed on the overhead wire mask image d5, the pantograph position d6, the foreground image d8, the overhead wire fitting mask image d10, and the three-dimensional coordinate d11 that were generated in the previous processes, and an obstruction determination result d12 is outputted.

As explained above, using the reference camera image d1 and the first correction camera image d2 as input data as starting points, various data processing is performed, and finally the obstruction determination result is outputted.

[0036]

As explained above, in the present embodiment, the reference camera 5 and the first correction camera 7 that capture images of the pantograph 3 periphery are provided, and by using the videos of these cameras 5 and 7, stereo parallelization correction is performed, so the three-dimensional position of an object in the images can be accurately ascertained. The overhead wires 33 and the trolley wires 34 are detected by the gray scale-top hat processing, so mask

images can be created by appropriately detecting the overhead wires 33 and the trolley wires 34. Since labeling processing is performed when various mask images are created, it is possible to create highly accurate mask images from which noise has been removed. Accordingly, erroneous detections of the overhead wires 33 and the trolley wires 34 as obstructions 39 can be prevented. Further, the dynamic gauge G in which the positions are variable in accordance with the pantograph 3 is set, and an object present closer to the pantograph 3 than the dynamic gauge 3 is determined as an obstruction 39, so erroneous detections can be prevented and obstructions 39 can be detected with high accuracy. Accordingly, it is possible to provide a pantograph periphery obstruction detection device 1 and a detection method whereby erroneous detection is reduced and good precision is obtained.

[0037]

(Second embodiment)

The difference between the present embodiment and the first embodiment is that, in the overhead wire support fitting detection process of step S07 in Fig. 4, the overhead wire support fitting detection unit 29 is further provided with a process that can determine abnormalities when there is an abnormality in the overhead wire support fittings 35. The other configurations are the same as the first embodiment. The following cases can be considered abnormalities of the overhead wire support fittings 35 in the present embodiment.

- (1) Cases when the connecting part with the overhead wire 33 comes loose.
- (2) Cases when the utility pole 37 side of the overhead wire support fitting 35 is damaged, and is connected only to the overhead wire 33.

As a condition of (1) above, the overhead wire 33 hangs down, so the distance from the pantograph 3 increases. For this reason, it is possible to distinguish the distance from the pantograph 3 with a threshold value.

In the case of (2) above, the overhead wire support fitting 35 enters the abnormal state illustrated in Fig. 14 from the normal state illustrated in Fig. 13. Thus, determination is possible using the area information (angle when linearly approximated, center of gravity position, and positional relationship with the

pantograph 3) of the overhead wire support fitting 35. In the present embodiment, in addition to the operational effects of the first embodiment, it is possible to detect abnormalities in the overhead wire support fitting 35, so it is possible to secure the normal state of the overhead wire support fitting.

[0038]

(Third Embodiment)

Fig. 2 is a schematic diagram showing a configuration of the pantograph periphery obstruction detection device 100 including the installation of cameras for capturing images of the pantograph according to the present embodiment. The difference between this embodiment and the first embodiment and the second embodiment is that, in addition to the reference camera 5 and the first correction camera 7, a second correction camera 9 is provided. The second correction camera 9 is arranged on the y-axis in a direction orthogonal to the x-axis including the line segment connecting the positions of the reference camera 5 and the first correction camera 7 when viewed from the reference camera 5. In the first embodiment and the second embodiment, parallel stereo in the x-direction is used, so an object that is elongated in the horizontal direction on the image and that has no features in the texture tends to have large three-dimensional measurement errors. In addition to the operational effects of the first embodiment and the second embodiment, the present embodiment adds a parallel stereo configuration in the y direction, each process is performed with the respective stereo configuration, and erroneous detections can be further reduced by determining the determination results with AND when determining obstructions.

REFERENCE SIGNS LIST

[0039]

1, 100	Pantograph periphery obstruction detection device
3	Pantograph
5	Reference camera
7	First correction camera
9	Second correction camera
11	Image processing device

13	Stereo parallelization unit
15	Data processing unit
17	Pantograph template setting unit
19	Background removal unit
21	Pantograph detection unit
23	Parallax calculation unit
25	Three-dimensional coordinate calculation unit
27	Overhead wire detection unit
29	Overhead wire support fitting detection unit
31	Obstruction determination unit
33	Overhead wires
35	Overhead wire support fittings

CLAIMS

1. A pantograph periphery obstruction detection device comprising:
a reference camera and a first correction camera that capture images of the pantograph periphery; and
an image processing device that processes images from the cameras, wherein the image processing device comprises
a stereo parallelization unit that corrects lens distortion and stereo parallelization, and
a data processing unit that processes the images corrected by the stereo parallelization unit, and
the data processing unit comprises
a pantograph template setting unit that sets a template of the pantograph,
a background removal unit that creates a foreground image from which a background has been removed,
a pantograph detection unit that detects the position of the pantograph,
a parallax calculation unit that determines a parallax, which is an amount of deviation of a projection point of an object in each camera image,
a three-dimensional coordinate calculation unit that calculates three-dimensional coordinates based on the parallax,
an overhead wire detection unit that extracts lines such as overhead wires and creates an overhead wire mask image,
an overhead wire support fitting detection unit that detects overhead wire support fittings from the foreground image and creates an overhead wire support fitting mask image, and
an obstruction determination unit that applies the overhead wire mask image and the overhead wire support fitting mask image to the foreground image and determines obstructions based on the distance from the pantograph.
2. The pantograph periphery obstruction detection device of claim 1, wherein in the overhead wire support fitting detection unit, abnormal coupling between the overhead wire support fittings and the overhead wires is detected.
3. The pantograph periphery obstruction detection device of claim 1 or 2,

comprising a second correction camera, which second correction camera is arranged in a direction orthogonal to a line segment connecting the positions of the reference camera and the first correction camera when viewed from the reference camera.

4. A pantograph periphery obstruction detection method comprising:
 - capturing images of a pantograph periphery with a reference camera and a first correction camera;
 - correcting lens distortion and stereo parallelization;
 - setting a template of the pantograph;
 - creating a foreground image from which a background has been removed;
 - detecting the position of the pantograph;
 - determining a parallax, which is an amount of deviation of a projection point of an object in each camera image;
 - calculating three-dimensional coordinates based on the parallax;
 - extracting lines such as overhead wires and creating an overhead wire mask image;
 - detecting overhead wire support fittings from the foreground image and creating an overhead wire support fitting mask image; and
 - applying the overhead wire mask image and the overhead wire support fitting mask image to the foreground image and determining obstructions based on the distance from the pantograph.

5. The pantograph periphery obstruction detection method of claim 4, wherein detecting the overhead wire support fittings includes detecting abnormal coupling between the overhead wire support fittings and the overhead wires.

6. The pantograph periphery obstruction detection method of claim 4 or 5 comprising capturing images of the pantograph periphery with a second correction camera, which second correction camera is arranged in a direction orthogonal to a line segment connecting the positions of the reference camera and the first correction camera when viewed from the reference camera.