supports the messenger wire 103, and the like, all of which define the overhead wire together with the trolley wire 102.

[0074] FIG. 26 is a block diagram illustrating a configuration example of a trolley-wire measurement device 1b according to the fourth embodiment. The trolley-wire measurement device 1b is configured by adding a support-point detection unit 70 to the configuration of the trolley-wire measurement device 1.

[0075] The support-point detection unit 70 detects from the point-group data 11 stored in the storage unit 10 a point on the messenger wire 103, a point on the hanger wire, and a point on the fitting, the messenger wire 103, the hanger wire, and the fitting being arranged to support the trolley wire 102. Within the target extraction area 112 illustrated in FIG. 9, the support-point detection unit 70 can detect, for example, the point above the trolley wire 102 as the messenger wire 103, and the point between the trolley wire 102 and the messenger wire 103 as the hanger wire, as with the process of detecting the trolley wire 102 in the trolley-wire detection unit 30. Further, the support-point detection unit 70 can further detect the fitting by, for example, performing matching between the detected points and a template expressing the shape of the fitting, as with the manner of detecting the rails 101 in the rail detection unit 21. The process of detecting the messenger wire 103, the hanger wire, and the fitting in the support-point detection unit 70 described above is merely an example, and the process is not limited thereto.

[0076] In the trolley-wire measurement device 1b, the height and displacement measurement unit 40 uses the respective positions of the messenger wire 103, the hanger wire, and the fitting which have been detected by the support-point detection unit 70. As a result, the

CLAIMS

1. A trolley-wire measurement device comprising:

a rail detection unit to detect rails from point-group data that is an aggregate of points obtained by measuring a target object three-dimensionally, the rails defining a railway on which a train runs;

a reference setting unit to set a reference for measuring a height and a displacement of a point on a trolley wire on a basis of the rails detected from the point-group data in the rail detection unit;

a trolley-wire detection unit to detect the point on the trolley wire from the point-group data;

a height and displacement measurement unit to measure the height and the displacement of the point on the trolley wire by using the reference; and

a data input unit to obtain latest point-group data from a measuring device to measure the target object three-dimensionally, wherein

the rail detection unit detects the rails by using the latest point-group data obtained, and updates a rail position,

the reference setting unit sets the reference for measuring the height and the displacement of the point on the trolley wire on a basis of rails detected from the latest point-group data and previous point-group data,

the trolley-wire detection unit detects the point on the trolley wire from the latest point-group data obtained, and

the height and displacement measurement unit measures the height and the displacement of the point on the trolley wire detected from the latest point-group data, by using the reference set on the basis of the rails detected from

the latest point-group data and the previous point-group data.

2. The trolley-wire measurement device according to claim 1, wherein the trolley-wire detection unit detects the point on the trolley wire from the point-group data within an area set on the basis of the reference set by the reference setting unit.

3. The trolley-wire measurement device according to claim 1 or 2, wherein the rails are two in number, and

the reference setting unit derives a rail plane including surfaces through which the two rails contact the train, a railway center line positioned at a center between the two rails on the rail plane, and a railway center plane orthogonal to the rail plane on the railway center line, and outputs the rail plane as a first reference and the railway center plane as a second reference, to the height and displacement measurement unit, and

the height and displacement measurement unit measures a distance between the first reference and the point on the trolley wire, as the height of the point on the trolley wire, and measures a distance between the second reference and the point on the trolley wire, as the displacement of the point on the trolley wire.

4. The trolley-wire measurement device according to claim 3, wherein

when the point-group data includes points regarding a plurality of railways,

the rail detection unit detects the rails on a railway-by-railway basis,

the reference setting unit derives the rail plane, the

railway center line, and the railway center plane on the railway-by-railway basis, and outputs the first reference and the second reference for each railway, to the height and displacement measurement unit,

the trolley-wire detection unit detects a point on the trolley wire on the railway-by-railway basis, and

the height and displacement measurement unit measures a height and a displacement of the point on the trolley wire on a railway-by-railway basis.

5. The trolley-wire measurement device according to claim 1 or 2, wherein the rails are two in number, and

the reference setting unit derives a rail plane including surfaces through which the two rails contact the train, and a railway center line positioned at a center between the two rails on the rail plane, and outputs the rail plane as a first reference and the railway center line as a second reference, to the height and displacement measurement unit, and

the height and displacement measurement unit measures a distance between the first reference and the point on the trolley wire, as the height of the point on the trolley wire, and measures a distance between the second reference and a foot of a perpendicular extending from the point on the trolley wire to the first reference, as the displacement of the point on the trolley wire.

6. The trolley-wire measurement device according to claim 5, wherein

when the point-group data includes points regarding a plurality of railways,

the rail detection unit detects the rails on a railway-by-railway basis,

the reference setting unit derives the rail plane and the railway center line on the railway-by-railway basis, and outputs the first reference and the second reference for each railway, to the height and displacement measurement unit,

the trolley-wire detection unit detects a point on the trolley wire on the railway-by-railway basis, and

the height and displacement measurement unit measures a height and a displacement of the point on the trolley wire on the railway-by-railway basis.

7. The trolley-wire measurement device according to any one of claims 1 to 6, comprising a storage unit to store therein the point-group data.

8. The trolley-wire measurement device according to any one of claims 1 to 7, comprising a measurement-result output unit to output a measurement result of the height and the displacement of the point on the trolley wire which have been measured by the height and displacement measurement unit.

9. The trolley-wire measurement device according to any one of claims 1 to 8, comprising a support-point detection unit to detect from the point-group data a point on a messenger wire, a point on a hanger wire, and a point on a fitting, the messenger wire, the hanger wire, and the fitting being arranged to support the trolley wire.

10. The trolley-wire measurement device according to any one of claims 1 to 9, wherein the reference setting unit sets the reference on a basis of positions on inner sides

of top portions of two, left and right ones of the rails detected in the rail detection unit.

11. The trolley-wire measurement device according to any one of claims 1 to 10, wherein when a plurality of target objects are detected in an area of an extracted point group, the trolley-wire detection unit detects a target object positioned on a lower side of the detected target objects, as a trolley wire.

12. A trolley-wire measurement method comprising:

a rail detecting step of, by a rail detection unit, detecting rails from point-group data that is an aggregate of points obtained by measuring a target object three-dimensionally, the rails defining a railway on which a train runs;

a reference setting step of, by a reference setting unit, setting a reference for measuring a height and a displacement of a point on a trolley wire on a basis of the rails detected from the point-group data in the rail detection unit;

a trolley-wire detecting step of, by a trolley-wire detection unit, detecting the point on the trolley wire from the point-group data;

a height and displacement measuring step of, by a height and displacement measurement unit, measuring the height and the displacement of the point on the trolley wire by using the reference;

a data input step of, by a data input unit, obtaining latest point-group data from a measuring device to measure the target object three-dimensionally, wherein

at the rail detecting step, the rail detection unit detects the rails by using the latest point-group data obtained, and updates a rail position,

at the reference setting step, the reference setting unit sets the reference for measuring the height and the displacement of the point on the trolley wire on a basis of rails detected from the latest point-group data and previous point-group data,

at the trolley-wire detecting step, the trolley-wire detection unit detects the point on the trolley wire from the latest point-group data obtained, and

at the height and displacement measuring step, the height and displacement measurement unit measures the height and the displacement of the point on the trolley wire detected from the latest point-group data, by using the reference set on the basis of the rails detected from the latest point-group data and the previous point-group data.

13. The trolley-wire measurement method according to claim 12, wherein at the trolley-wire detecting step, the trolley-wire detection unit detects the point on the trolley wire from the point-group data within an area set on a basis of the reference set by the reference setting unit.

14. The trolley-wire measurement method according to claim 12 or 13, wherein the rails are two in number, and

at the reference setting step, the reference setting unit derives a rail plane including surfaces through which the two rails contact the train, a railway center line positioned at a center between the two rails on the rail plane, and a railway center plane orthogonal to the rail

plane on the railway center line, and outputs the rail plane as a first reference and the railway center plane as a second reference, to the height and displacement measurement unit, and

at the height and displacement measuring step, the height and displacement measurement unit measures a distance between the first reference and the point on the trolley wire, as the height of the point on the trolley wire, and measures a distance between the second reference and the point on the trolley wire, as the displacement of the point on the trolley wire.

15. The trolley-wire measurement method according to claim 14, wherein

when the point-group data includes points regarding a plurality of railways,

at the rail detecting step, the rail detection unit detects the rails on a railway-by-railway basis,

at the reference setting step, the reference setting unit derives the rail plane, the railway center line, and the railway center plane on the railway-by-railway basis, and outputs the first reference and the second reference for each railway, to the height and displacement measurement unit,

at the trolley-wire detecting step, the trolley-wire detection unit detects a point on the trolley wire on the railway-by-railway basis, and

at the height and displacement measuring step, the height and displacement measurement unit measures a height and a displacement of the point on the trolley wire on the railway-by-railway basis.

16. The trolley-wire measurement method according to claim

12 or 13, wherein the rails are two in number, and

at the reference setting step, the reference setting unit derives a rail plane including surfaces through which the two rails contact the train, and a railway center line positioned at a center between the two rails on the rail plane, and outputs the rail plane as a first reference and the railway center line as a second reference, to the height and displacement measurement unit, and

at the height and displacement measuring step, the height and displacement measurement unit measures a distance between the first reference and the point on the trolley wire, as the height of the point on the trolley wire, and measures a distance between the second reference and a foot of a perpendicular extending from the point on the trolley wire to the first reference, as the displacement of the point on the trolley wire.

17. The trolley-wire measurement method according to claim 16, wherein

when the point-group data includes points regarding a plurality of railways,

at the rail detecting step, the rail detection unit detects the rails on a railway-by-railway basis,

at the reference setting step, the reference setting unit derives the rail plane and the railway center line on the railway-by-railway basis, and outputs the first reference and the second reference for each railway, to the height and displacement measurement unit,

at the trolley-wire detecting step, the trolley-wire detection unit detects a point on the trolley wire on the railway-by-railway basis, and

at the height and displacement measuring step, the height and displacement measurement unit measures a height

and a displacement of the point on the trolley wire on the railway-by-railway basis.

18. The trolley-wire measurement method according to any one of claims 12 to 17, comprising a measurement-result output step of, by a measurement-result output unit, outputting a measurement result of the height and the displacement of the point on the trolley wire which have been measured at the height and displacement measuring step.

19. The trolley-wire measurement method according to any one of claims 12 to 18, comprising a support-point detecting step of, by a support-point detection unit, detecting a point on a messenger wire, a point on a hanger wire, and a point on a fitting, the messenger wire, the hanger wire, and the fitting being arranged to support the trolley wire.

20. The trolley-wire measurement device according to any one of claims 12 to 19, wherein at the reference setting step, the reference setting unit sets the reference on a basis of positions on inner sides of top portions of two, left and right ones of the rails detected in the rail detection unit.

21. The trolley-wire measurement device according to any one of claims 12 to 20, wherein at the trolley-wire detecting step, when a plurality of target objects are detected in an area of an extracted point group, the trolley-wire detection unit detects a target object positioned on a lower side of the detected target objects, as a trolley wire.