[0007] An inspection apparatus for a rail-transportation rolling stock is provided. The inspection apparatus for a rail-transportation rolling stock is used to detect a vehicle to be detected which is parked on a railway. The railway is located on an inspection platform. An inspection pit is formed in the inspection platform along an extending direction of the railway. The inspection apparatus for the rail-transportation rolling stock comprises:

an inspection robot;

a lift device group comprising at least one lift device disposed at a side of the railway, the lift device has a liftable structure, and the lift device is able to be engaged with the inspection pit and be flush with a surface of the inspection platform by descending and ascending;

a control device communicatively connected to the inspection robot and configured to control an operation of the inspection robot.

[0008] In one of embodiments, the lift device group comprises at least two lift devices respectively disposed at two sides of the railway. The at least two lift devices are able to be engaged and communicated with inspection pit to form at least one passage.

[0009] In one of embodiments, the number of the railways is at least 2. The number of the inspection pits is at least 2. The number of the lift device groups is at least 2.

Each inspection pit is corresponding to one railway.

Each railway is corresponding to one lift device group.

A plurality of lift devices of the at least two lift device groups are able to be engaged and communicated with the at least two inspection pits to form at least one passage across the railways.

[0010] In one of embodiments, the inspection apparatus for the rail-transportation rolling stock further comprises an on-site working-condition detection device for detecting a working condition of an inspection place, disposed at the railway, the inspection platform, and/or the inspection pit, and communicatively connected to the control device.

[0011] In one of embodiments, the on-site working-condition detection device comprises at least one of a stagnant liquid detection mechanism, a to-be-detected vehicle in-position

stock further comprises an inspection auxiliary device comprising:

an auxiliary travelling device;

a tool rack disposed on the auxiliary travelling device and configured to place a replacing detection device thereon.

[0018] In one of embodiments, the inspection auxiliary device further comprises:

a mechanical emergency device disposed on the auxiliary travelling device, having a matched structure with the engaging device, and configured to be mechanically engaged with the inspection apparatus.

[0019] In one of embodiments, the detection device is connected to the end of the mechanical arm via a quick-coupling device.

The quick-coupling device comprises a mechanical arm segment connected to the mechanical arm and a tool segment connected to the detection device. The mechanical arm segment and the tool segment are able to be electrically and mechanically connected to each other in a plug-in manner.

The tool rack of the inspection auxiliary device places the replacing detection device. One end of the replacing detection device is connected with an additional tool segment. The additional tool segment is configured to be connected to the mechanical arm segment, so that the replacing detection device is connected to the mechanical arm.

[0020] In one of embodiments, the inspection apparatus for the rail-transportation rolling stock further comprises:

a reference datum disposed at a side of the railway along the extending direction of the railway;

a pose detection device disposed on the inspection robot and configured to detect distance information of the inspection robot with respect to the reference datum;

a processing device communicatively connected to the pose detection device and configured to calculate a pose deviation of the inspection robot with respect to a datum coordinate on basis of the distance information of the inspection robot with respect to the reference datum.

[0021] In one of embodiments, the processing device is communicatively connected to the control device. The control device is further configured to control the travelling of the inspection

direction of the railway 100.

[0055] The inspection platform 200 can be a plane flush with the ground, or a plane higher than or lower than the ground. The inspection platform 200 is configured to dispose a required apparatus for inspection and allow the required apparatus for inspection and the staff to travel thereon. The railway 100 comprises two parallel rails which can be disposed on the inspection platform 200 directly or via spaced support columns or other means. The number of railways 100 can be one or more. Each railway 100 is correspondingly provided with the inspection fit 300. The inspection pit 300 is a pit recessed in the inspection platform 200 and having a groove structure. The inspection pit 300 is formed between the two rails of the railway 100 and extends in the extending direction of the railway 100. A size and recessed size of the inspection pit 300 can be set according to actual requirements and are not specifically limited in the present application. The vehicle to be detected is parked on the railway 100. The detection for sides of the vehicle to be detected can be performed on the inspection platform 200. The detection for a bottom of the vehicle to be detected can be performed in the inspection pit 300.

[0056] In an embodiment, the inspection apparatus 10 for the rail-transportation rolling stock comprises an inspection robot 400, a lift device group 500, and a control device 600.

[0057] The inspection robot 400 is a robot for inspecting the rail-transportation rolling stock, and is hereinafter referred to as the inspection robot 400. The inspection robot 400 is configured to detect relevant parameters of the vehicle to be detected, such as appearance, size, position and pose, temperature, air leakage, and others. A specific structure and function of the inspection robot 400 are not limited in the present application, and can be selected according to actual requirements.

[0058] The lift device group 500 comprises at least one lift device 501 disposed at a side of the railway 100. The lift device 501 has a liftable structure, that is, the lift device 501 is capable of ascending and descending. Specifically, a lifting pit can be formed in the inspection platform 200 located at a side of the railway 100. The lift device 501 is disposed in the lifting pit and capable of ascending and descending in the lifting pit. The lift device 501 can be engaged with the inspection pit 300 and be flush with a surface of the inspection platform 200 by ascending and descending. The lift device 501 can be a rail lift, a crank lift, a scissor lift, a

400 stops at the target position and performs the detection, the mechanical arm 420 has a heavy workload for a long work time, therefore, the power consumption is maximum in the detection process. Consequently, the inspection robot 400 often needs to be charged in the detection process. In this embodiment, when the inspection robot 400 travels and stops at the target position to perform the detection, the conductive brush of the inspection robot 400 is extended by means of the extendable cantilever to be in contact with the conductive rail. When the conductive rail is powered, the inspection robot 400 can be charged via the conductive rail. When the detection task of the inspection robot 400 is to be completed and the inspection robot 400 is to move towards next detection position, the conductive rail is de-energized, the charging of the conductive brush is stopped, and the conductive brush is retracted by means of the extendable cantilever. Then the inspection robot 400 travels to the next detection position.

[00123] In another embodiment, the auxiliary charging terminal 450 is a conductive rail and the auxiliary charging device 800 is a conductive brush. The arrangement of the conductive brush and the conductive rail is just opposite to that of the previous embodiment. The implementation methods, principles, and arrangements are similar. Details will not described again herein.

[00124] In the above two embodiments, the auxiliary charging of the inspection robot 400 is realized by the cooperation of the conductive brush and the conductive rail, so that the working electric quantity of the inspection robot 400 is ensured, and the reliability and stability of the inspection apparatus 10 for the rail-transportation rolling stock are improved. Moreover, the conductive rail is in the shape of a long strip, and thus when the inspection robot 400 or the vehicle to be detected stops with a position deviation, it is still possible to cooperate with the conductive brush to complete charging of the inspection auxiliary device 900, thereby reducing a charging error.

[00125] Referring to FIGS. 8 and 9, in an embodiment, the quick-coupling device 431 comprises two parts: a mechanical arm segment 433 and a tool segment 435. The mechanical arm segment 433 is corresponding to and matched with the tool segment 435. The mechanical arm segment 433 is electrically and mechanically connected to the mechanical arm 420. The tool segment 435 is electrically and mechanically connected to the detection device 430. The

replacing detection device is placed on the tool rack 920. When the original detection device needs to be replaced, the auxiliary travelling device 910 is controlled to travel to the inspection robot 400, and then the original detection device is replaced with the replacing detection device placed on the tool rack 920. The replacement method can be automatic or manual, and is not limited herein.

[00132] In this embodiment, the inspection apparatus 10 for the rail-transportation rolling stock comprises the inspection auxiliary device 900. The inspection auxiliary device 900 is provided with the tool rack 920, so that the replacing detection device can be transported to the inspection robot 400, thereby realizing the replacement of the detection device 430. The inspection auxiliary device 900 provided in this embodiment improves the comprehensiveness of the function of the inspection apparatus 10 for the rail-transportation rolling stock, and improves the intelligence thereof.

[00133] In an embodiment, the tool rack 920 has a shape and size which is matched with the shape and size of the replacing detection device. That is, the tool rack 920 mimics the shape design of the replacing detection device, so that the replacing detection device can be more securely and more fitly placed on the tool rack 920.

[00134] In an embodiment, the replacing detection device is disposed on the tool rack 920 of the inspection auxiliary device 900. One end of the replacing detection device is connected with an additional tool segment 435. The replacing detection device is electrically and mechanically connected to the additional tool segment 435. The additional tool segment 435 is configured to be connected to the mechanical arm segment 433, so that the replacing detection device is connected to the end of the mechanical arm 420. In the replacement of the detection device 430, the original detection device 430 and the tool segment 435 connected thereto are removed, the additional tool segment 435 of the replacing detection device is connected to the mechanical arm segment 433 at the end of the mechanical arm 420, so that the replacing detection device is electrically and mechanically connected to the mechanical arm 420. In this embodiment, by providing the additional tool segment 435 on the replacing detection device, the quick replacement of the detection device is achieved, thereby improving the working efficiency.

[00135] In an embodiment, the inspection auxiliary device 900 further comprises an

deviation ΔX of the vehicle to be detected and the height deviation ΔYn of the components.

[00279] S202, the inspection robots M5 (1), M5 (2), and M5 (3) feed back information to the control device 600 after being in position.

[00280] S203, the control device 600 sends an instruction “detecting the bottom of the vehicle to be detected” to the inspection robot M5(1), which then travels along the direction “P140->P150->P160” and detect the item at the vehicle bottom.

[00281] S204, the control device 600 sends an instruction “detecting the side L of the vehicle to be detected” to the inspection robot M5(2), which then travels along the direction “P110->P120->P130” to detect the item at the vehicle side L.

[00282] S205, the control device 600 sends an instruction “detecting the vehicle side R of the vehicle to be detected” to the inspection robot M5(3), which then travels along the direction “P170->P180->P190” to detect the item at the vehicle side R.

[00283] S206, the same as steps S114 to S115.

[00284] In an embodiment, the scheduling device 20 schedules six inspection robots M5(1) to M5(6) to perform inspection operations at the side L of the vehicle to be detected at the same time, the steps are as follows:

[00285] S211, the same as the step S201.

[00286] S212, in the above S2014, the scheduling device 20 sends "P001->P110" to the inspection robot M5(1); the scheduling device 20 sends “P002->P114” to the inspection robot M5(2); the scheduling device 20 sends "P003->P116" to the inspection robot M5(3); the scheduling device 20 sends “P004->P118” to the inspection robot M5(4); the scheduling device 20 sends "P005->P123" to the inspection robot M5(5); the scheduling device 20 sends “P006->P125” to the inspection robot M5(6); and the scheduling device 20 sends "P144->P125" to the inspection robot M5 (6). The travelling process of the inspection robots is similar to that of S110. The inspection robots feed back information to the control device 600 when they are in position.

[00287] S213, the control device 600 sends an instruction “detecting the vehicle side L-J1 of the vehicle to be detected” to the inspection robot M5(2), which then travels along the direction “P114->P115” to detect the item at the vehicle side L-J1.

CLAIMS

What is claimed is:

1. An inspection apparatus for a rail-transportation rolling stock, characterized in that the inspection apparatus is used to detect a vehicle to be detected which is parked on a railway (100), the railway is located on an inspection platform (200), an inspection pit (300) is formed in the inspection platform (200) along an extending direction of the railway (100), the inspection apparatus comprises:

an inspection robot (400);

a lift device group (500) comprising at least one lift device (501) disposed at a side of the railway (100), the lift device (501) has a liftable structure, and the lift device (501) is able to be engaged with the inspection pit (300) and be flush with a surface of the inspection platform (200) by descending and ascending;

a control device (600) communicatively connected to the inspection robot (400) and configured to control an operation of the inspection robot (400).

2. The inspection apparatus for the rail-transportation rolling stock of claim 1, characterized in that the lift device group (500) comprises at least two lift devices (501) respectively disposed at two sides of the railway (100), the at least two lift devices (501) are able to be engaged and communicated with inspection pit (300) to form at least one passage.

3. The inspection apparatus for the rail-transportation rolling stock of claim 2, characterized in that the number of the railways (100) is at least 2, the number of the inspection pits (300) is at least 2, the number of the lift device groups (500) is at least 2;

each inspection pit (300) is corresponding to one railway (100);

each railway (100) is corresponding to one lift device group (500);

a plurality of lift devices (501) of the at least two lift device groups (500) are able to be engaged and communicated with the at least two inspection pits (300) to form at least one passage across the railways.

4. The inspection apparatus for the rail-transportation rolling stock of claim 1, characterized by further comprising an on-site working-condition detection device (700) for detecting a working condition of an inspection place, disposed at the railway (100), the inspection platform (200), and/or the inspection pit (300), and communicatively connected to the control device (600).

5. The inspection apparatus for the rail-transportation rolling stock of claim 4, characterized in that the on-site working-condition detection device (700) comprises at least one of a stagnant liquid detection mechanism (710), a to-be-detected vehicle in-position detection assembly (720), and an intrusion detection assembly (730);

the stagnant liquid detection mechanism (710) is disposed in the inspection pit (300), communicatively connected to the control device (600), and configured to detect a stagnant liquid condition in the inspection pit (300);

the to-be-detected vehicle in-position detection assembly (720) is disposed at the railway (100), communicatively connected to the control device (600), and configured to detect whether the vehicle to be detected is parked in position;

the intrusion detection assembly (730) is disposed at the railway (100), the inspection platform (200), and/or the inspection pit (300), communicatively connected to the control device (600), and configured to detect the presence of an intrusion in the inspection place.

6. The inspection apparatus for the rail-transportation rolling stock of claim 1, characterized in that the inspection robot (400) comprises:

an operation travelling device (410) comprising a vehicle body (411) having a receiving chamber (413) and a vehicle wheel (412) disposed at a bottom of the vehicle body (411);

a mechanical arm (420) disposed on the vehicle body (411) and communicatively connected to the control device (600), the mechanical arm (420) has a foldable structure and is able to be received in the receiving chamber (413).

7. The inspection apparatus for the rail-transportation rolling stock of claim 6, characterized in that the inspection robot (400) further comprises:

a detection device (430) disposed at an end of the mechanical arm (420) and communicatively connected to the control device (600).

8. The inspection apparatus for the rail-transportation rolling stock of claim 7, characterized in that the inspection robot (400) further comprises:

an engaging device (440) disposed on the vehicle body (411) and configured to be engaged with other devices.

9. The inspection apparatus for the rail-transportation rolling stock of claim 7, characterized in that the inspection robot (400) further comprises:

auxiliary charging terminal (450) disposed on the vehicle body (411).

10. The inspection apparatus for the rail-transportation rolling stock of claim 9, characterized by further comprising:

an auxiliary charging device (800) disposed at the railway (100), having a matched structure with the auxiliary charging terminal (450), and configured to provide electric power for the auxiliary charging terminal (450).

11. The inspection apparatus for the rail-transportation rolling stock of claim 8, characterized by further comprising an inspection auxiliary device (900) comprising:

auxiliary travelling device (910);

a tool rack (920) disposed on the auxiliary travelling device (910) and configured to place a replacing detection device thereon.

12. The inspection apparatus for the rail-transportation rolling stock of claim 11, characterized in that the inspection auxiliary device (900) further comprises:

a mechanical emergency device (941) disposed on the auxiliary travelling device (910), matched with the engaging device (440), and configured to be mechanically engaged with the

inspection apparatus (400).

13. The inspection apparatus for the rail-transportation rolling stock of claim 12, characterized in that the detection device (430) is connected to the end of the mechanical arm (420) via a quick-coupling device (431);

the quick-coupling device (431) comprises a mechanical arm segment (433) connected to the mechanical arm (420) and a tool segment (435) connected to the detection device (430), the mechanical arm segment (433) and the tool segment (435) are able to be electrically and mechanically connected to each other in a plug-in manner;

the tool rack (920) of the inspection auxiliary device (900) places the replacing detection device, one end of the replacing detection device is connected with an additional tool segment (435), the additional tool segment (435) is configured to be connected to the mechanical arm segment (433), so that the replacing detection device is connected to the mechanical arm (420).

14. The inspection apparatus for the rail-transportation rolling stock of claim 1, characterized by further comprising:

a reference datum (310) disposed at a side of the railway (100) along the extending direction of the railway (100);

a pose detection device (320) disposed on the inspection robot (400) and configured to detect distance information of the inspection robot (400) with respect to the reference datum (310);

a processing device (330) communicatively connected to the pose detection device (320) and configured to calculate a pose deviation of the inspection robot (400) with respect to a datum coordinate on basis of the distance information of the inspection robot (400) with respect to the reference datum (310).

15. The inspection apparatus for the rail-transportation rolling stock of claim 14, characterized in that the processing device (330) is communicatively connected to the control device (600), the control device (600) is further configured to control the travelling of the inspection robot (400) according to the pose deviation of the inspection robot (400) with respect to the datum

coordinate.

16. An inspection system for a rail-transportation rolling stock, characterized by comprising:

the inspection apparatus (100) for the rail-transportation rolling stock of any one of claims 1-15, wherein the number of the inspection robots (400) is at least 2;

a scheduling device (20) communicatively connected to the inspection robots (400) to schedule the inspection robots (400).

17. The inspection system for the rail-transportation rolling stock of claim 16, characterized in that the at least two inspection robots (400) are respectively provided with different detection devices (430), and the scheduling device (20) is configured to control each of the inspection robots (400) to separately implement one detection item for a plurality of vehicles to be detected.