[0065] The present application provides an inspection apparatus 10 for a rail-transportation rolling stock. The inspection apparatus 10 for the rail-transportation rolling stock is used for detecting the rail-transportation rolling stock such as a bullet train, a high-speed railway, a train, and a subway. The rail-transportation rolling stock to be detected is hereinafter simply referred to as a vehicle to be detected.

[0066] Referring to FIG. 1, the inspection apparatus 10 for the rail-transportation rolling stock detects the vehicle to be detected at an inspection place. The inspection place comprises an inspection platform 200, a railway 100, and an inspection pit 300. The railway 100 is located on the inspection platform 200. The vehicle to be detected is parked on the railway 100. The inspection pit 300 is correspondingly formed in the inspection platform 200 along an extending direction of the railway 100.

[0067] 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.

[0068] 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.

[0069] 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.

[0070] 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 chain lift, or others. The specific selection can be made according to actual requirements and is not limited in the present application. The lift device 501 can be, but not exclusively, used to lower the inspection robot 400 or an operator into the inspection pit 300, or raise the inspection robot 400 or an operator to the inspection platform 200. The number of the lift devices 501 can be one or more. A plurality of lift devices 501 can be disposed at one side of the railway 100 and spaced along the railway 100, or can be distributed at both sides of the railway 100.

[0071] The control device 600 is communicatively connected to the inspection robot 400 to control an operation of the inspection robot 400. The control device 600 can be configured to control the inspection robot 400 to travel, perform detection, etc. The control device 600 can be, but is not limited to, a computer apparatus, a programmable logic controller (PLC), or other apparatus containing a processor. A specific structure, model, and the like of the control device 600 are not limited in the present application, as long as the function thereof can be realized.

[0072] An operation process of the inspection apparatus 10 for the rail-transportation rolling stock can comprise, but is not limited to, the following processes:

[0073] The control device 600 acquires an inspection task including the number of the vehicles to be detected, positions of the vehicles to be detected, items to be detected, etc. The control device 600 transmits the inspection task to the inspection robot 400 and issues an inspection instruction. The inspection robot 400 receives the inspection instruction, and autonomously travels to the position of the vehicle to be detected and detects the vehicle to be

[00133] The conductive rail is disposed adjacent to a side of the railway 100 where the inspection robot 400 travels on. The conductive rail is in the shape of a long strip. The conductive rail can be powered with a ground-to-ground safety voltage. The conductive rail can adopt a PVC profile, an aluminum profile, a copper strip composite structure, or the like. A number of conductive rails can be plural. A plurality of conductive rails are spaced along the railway 100. When the conductive brushes are disposed on both sides of the vehicle body 411, the plurality of conductive rails can be disposed at the inner sides of the two rails of the railway 100, respectively. The plurality of conductive rails can be controlled to be turned on and off separately.

[00134] In the entire operation of the inspection robot 400, when the inspection robot 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.

[00135] 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.

[00136] 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 mechanical arm 420 sometimes needs to be replaced in order to complete detection items. For convenience of explanation, the alternative detection device is named as the replacing detection device. The replaced detection device is named as the original detection device.

[00142] The auxiliary travelling device 910 is configured to travel to carry the devices thereon to move. The configuration, implementation principle, and control method of the auxiliary travelling device 910 are similar to those of the operation travelling device 410, and will not be described again herein.

[00143] The tool rack 920 can be disposed on top of the vehicle body of the auxiliary travelling device 910. The specific structure of the tool rack 920 is not limited and can be designed according to the structure, the size, and others of the tool to be placed thereon. 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.

[00144] 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.

[00145] 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.

[00146] 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.

[00147] In an embodiment, the inspection auxiliary device 900 further comprises an energy supply device 930. The energy supply device 930 is disposed on the auxiliary travelling device. The energy supply device is configured to supply energy to the inspection apparatus for the rail-transportation rolling stock. The inspection apparatus for the rail-transportation rolling stock comprises, but is not limited to, the inspection robot 400. The energy supply device 930 can comprise an electric power supply device 931, or a gas supply device 932, or any other device for supplying energy required for the inspection robot 400. In this example, the energy supply device 930 can supply and replenish energy to the inspection robot 400, thereby ensuring the energy supply of the inspection robot 400, and improving the stability and reliability of the operation of the inspection robot 400 and thus of the inspection apparatus 10 for the rail-transportation rolling stock.

[00148] In an embodiment, the energy supply device 930 comprises an electric power supply device 931. The electric power supply device 931 comprises an electric power source and a source interface. The electric power source is provided on the auxiliary travelling device 910. The source interface is electrically connected to the electric power source to electrically connect the electric power source and the inspection robot 400. That is, the electric power source supplies the electric power to the inspection robot 400 through the source interface. The specific structure, installation mode, and the like of the electric power source and the source interface are not limited as long as their functions can be realized. When the electric power of the inspection robot 400 is exhausted, the inspection auxiliary device 900 carrying the power supply device travels to

(1), M5 (2), M5 (3), and issues an operation control instruction. It is assumed that the inspection task is allocated such that the inspection robot M5 (1) completes the first inspection item at P150 in the figure; the inspection robot M5 (2) completes the second inspection item at P110 in the figure; and the inspection robot M5 (3) completes the third inspection item at P170 in the figure.

[00289] S2015, the inspection robots M5 (1), M5 (2), and M5 (3) respectively travel to P150, P110, and P170 according to the instructions of the scheduling device 20 and the control device 600.

[00290] S2016, the control device 600 sends an instruction “detecting position of the vehicle to be detected” to the inspection robot M5 (1) or M5 (2) or M5 (3), which then travels and performs a measurement along the direction “J4->J5->J6->J3->J2->J1” to obtain the parking deviation ΔX of the vehicle to be detected and the height deviation ΔYn of the components.

[00291] S202, the inspection robots M5 (1), M5 (2), and M5 (3) feed back information to the control device 600 after being in position.

[00292] 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.

[00293] 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.

[00294] 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.

[00295] S206, the same as steps S114 to S115.

[00296] 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:

[00297] S211, the same as the step S201.

[00298] 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.

[00299] 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.

[00300] S214, the control device 600 sends an instruction “detecting the vehicle side L-J2 of the vehicle to be detected” to the inspection robot M5(3), which then travels along the direction “P116->P117” to detect the item at the vehicle side L-J2.

[00301] S215, the control device 600 sends an instruction “detecting the vehicle side L-J3 of the vehicle to be detected” to the inspection robot M5(4), which then travels along the direction “P118->P119” to detect the item at the vehicle side L-J3.

[00302] S216, the control device 600 sends an instruction “detecting the vehicle side L-J4 of the vehicle to be detected” to the inspection robot M5(1), which then travels along the direction “P121->P122” to detect the item at the vehicle side L-J4.

[00303] S217, the control device 600 sends an instruction “detecting the vehicle side L-J5 of the vehicle to be detected” to the inspection robot M5(5), which then travels along the direction “P123->P124” to detect the item at the vehicle side L-J5.

[00304] S218, the control device 600 sends an instruction “detecting the vehicle side L-J6 of the vehicle to be detected” to the inspection robot M5(6), which then travels along the direction “P125->P126” to detect the item at the vehicle side L-J6.

[00305] S219, the same as steps S114 to S115.

[00306] In an embodiment, the inspection robots M5 (1) and M5 (2) are engaged with each other by means of the engaging device 440 and cooperatively operated at the P122 and P123 positions as follows: