

DESCRIPTION**Title of Invention: ROBOT SYSTEM****Technical Field**

[0001]

The present invention relates to a self-propelled robot system that can move to any working location and perform tasks using a robot arm.

Background Art

[0002]

Robot arms that can automatically perform intended tasks are widely used in various industrial fields. When a robot arm is fixed at a working location in a factory and operated, a base for supporting the robot arm is fixed with respect to a horizontal plane serving as a control reference for the robot arm, which makes it easy to continue to stably execute high-precision control.

[0003]

Furthermore, there have been recently developed robot systems in which an automatic traveling robot called an automatic guided vehicle (AGV) or an autonomous mobile robot (AMR) moves to any desired working location while a robot arm is mounted on the automatic traveling robot, and the robot arm executes an intended task, and the need for such systems is increasing day by day.

[0004]

Patent Literature 1 discloses a prior art of this type of robot system. The robot system disclosed in this Patent Literature 1 is configured such that a robot cell can be placed on an automatic guided vehicle and transported, and the automatic guided vehicle can move alone with the robot cell being left at a workplace. The robot system configured in this way has an advantage that the automatic guided vehicle can transport another robot cell while the robot cell installed at the workplace is performing a task, so that overall work efficiency can be improved.

[0005]

However, the robot system of Patent Literature 1 is designed such that each of batteries (reference numerals 17 and 42 in Fig. 4 and Fig. 9 in Patent Literature 1) incorporated in the robot cell and the automatic guided vehicle is connected to an external power source (also reference numeral 9) to be supplied with power. Therefore, when there occurs a situation that it is required to charge the batteries of robot cells installed at workplaces, an external power source must be prepared at each of the workplaces, which causes problems that it is cumbersome to handle the external power sources and increases the equipment costs.

Citation List

Patent Literature

[0006]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2021-84178

Disclosure of Invention

Technical Problem

[0007]

The present invention has been made in consideration of the above-mentioned problems of the prior art, and has an object to provide a robot system that can efficiently supply power to a storage battery in an apparatus main body via an unmanned carrier.

Solution to Problem

[0008]

A robot system according to the present invention includes an apparatus main body having a robot arm mounted thereon and an unmanned carrier, and is configured such that the unmanned carrier is capable of moving integrally with the apparatus main body while the apparatus main body is carried on the unmanned carrier, and is also capable of separating from the apparatus main body and moving alone, the robot system comprising: a wireless power

supply/charging unit including an electric power transmission coil, an electric power reception coil, and a storage battery, the electric power reception coil being incorporated in the apparatus main body, and the electric power transmission coil and the storage battery being incorporated in the unmanned carrier; and a positioning mechanism for connecting the unmanned carrier and the apparatus main body to each other, wherein the electric power transmission coil and the electric power reception coil are arranged on the same axis by the positioning mechanism.

[0009]

With this configuration, the electric power transmission coil and the electric power reception coil of the wireless power supply/charging unit can be arranged on the same axis, which makes it possible to efficiently supply electric power to the storage battery of the apparatus main body via the unmanned carrier.

[0010]

Furthermore, in the robot system according to the present invention, the unmanned carrier may have, on a top surface thereof, a supporting surface movable freely upward and downward, while the apparatus main body has a supported surface formed on a bottom surface thereof, the unmanned carrier and the apparatus main body may be configured such that the unmanned carrier and the apparatus main body are connected to each other by moving the supporting surface upward to bring the supporting surface into contact with the supported surface in a state where the unmanned carrier is placed below the apparatus main body, and the apparatus main body is lifted up by further moving the supporting surface upward, and the positioning mechanism may be configured such that a convex portion provided on one of the supporting surface and the supported surface is fitted to a concave portion provided on the other to align a central axis of the electric power reception coil with a central axis of the electric power transmission coil.

[0011]

Here, it is preferable that the convex portion is formed in a tapered shape in which an outer circumferential surface of the convex portion decreases in diameter toward a tip thereof, and the concave portion is formed in a cone shape in which an inner circumferential surface of the concave portion is fitted to the outer circumferential surface of the convex portion.

With this configuration, even when there is a slight misalignment between the unmanned carrier and the apparatus main body, the concave portion and the convex portion can be fitted together to achieve accurate positioning.

[0012]

Furthermore, it is preferable that a combination of the convex portion and the concave portion is provided at least at two opposing positions on the supporting surface and the supported surface.

With this configuration, the supported surface can be positioned two-dimensionally with respect to the supporting surface, and the central axis of the electric power reception coil can be more accurately aligned with the central axis of the electric power transmission coil.

[0013]

As described above, according to the present invention, it is possible to implement a robot system that is capable of efficiently supplying electric power to a storage battery of the apparatus main body via an unmanned carrier.

Brief Description of Drawings

[0014]

Fig. 1A to Fig. 1C are diagrams showing an overview of a robot system according to an embodiment of the present invention, where Fig. 1A is a perspective view of an apparatus main body having a robot arm installed therein, and Figs. 1B and 1C are perspective views of an unmanned carrier.

Figs. 2A and 2B are perspective views showing a basic

operation of the robot system according to the embodiment of the present invention.

Fig. 3 is a configuration diagram showing an overview of a wireless power supply/charging unit.

Fig. 4 is a partially notched front view showing a positioning mechanism.

Reference Signs List

[0015]

10: apparatus main body, 10a: supported surface, 11: robot arm, 12: leg portion, 20: unmanned carrier, 21: support board (supporting surface), 22: lifting mechanism, 30: wireless power supply/charging unit, 31: storage battery, 32: electric power transmission circuit, 33: electric power transmission coil, 34: storage battery, 35: electric power reception circuit, 36: electric power reception coil, 37: power source, 41: convex portion, 42: concave portion

Best Mode for carrying out the Invention

[0016]

An embodiment of the present invention will be described in detail hereunder with reference to the drawings.

As shown in Fig. 1A to Fig. 1C, Fig. 2A and Fig. 2B, a robot system according to the present embodiment includes an apparatus main body 10 having a robot arm 11 mounted thereon, and an unmanned carrier 20.

The robot arm 11 is automatically controlled by a robot control circuit (not shown), and has a function of performing various tasks including a product assembling task. The apparatus main body 10 has a function as a base for supporting the robot arm 11, and the robot arm 11 is mounted on the upper surface of this apparatus main body 10.

The apparatus main body 10 shown in the figures has four leg portions 12, and is configured such that the lower ends of these leg portions 12 are arranged on the floor surface. Note that the arrangement configuration of the apparatus main body 10 on the floor surface is not limited to the configuration using a plurality of leg portions 12.

[0017]

The unmanned carrier 20 is automatically controlled by a transport control circuit (not shown) to travel autonomously. The unmanned carrier 20 has a function of moving integrally with the apparatus main body 10 while carrying the apparatus main body 10 thereon, and separating from the apparatus main body 10 and moving independently.

[0018]

The unmanned carrier 20 has a support board 21 (supporting surface) on a top surface thereof, and is freely movable upward and downward. The support board 21 can be moved upward and downward by a lifting mechanism 22 incorporated in the unmanned carrier 20. Furthermore, a bottom surface of the apparatus main body 10 forms a supported surface 10a, and the support board 21 is brought into contact with the supported surface 10a, whereby the unmanned carrier 20 and the apparatus main body 10 are connected to each other. The apparatus main body 10 is lifted up by further moving the support board 21 upward.

[0019]

Specifically, as shown in Fig. 2A, the unmanned carrier 20 is placed below the apparatus main body 10. By moving the support board 21 upward under this state, the support board 21 comes into contact with the supported surface 10a (the bottom surface of the apparatus main body 10), whereby a connection state between the unmanned carrier 20 and the apparatus main body 10 is formed.

By further moving the support board 21 upward, the apparatus main body 10 is lifted up as shown in Fig. 2B. At this time, the leg portions 12 are floated from the floor surface. This makes it possible to move the unmanned carrier 20 integrally with the apparatus main body 10 while the apparatus main body 10 is carried on the unmanned carrier 20.

[0020]

The unmanned carrier 20 transports the apparatus main

body 10 to a preset workplace, and moves the support board 21 downward to place the apparatus main body 10 at the workplace. In connection with the downward movement of the support board 21, the connection state between the unmanned carrier 20 and the apparatus main body 10 is released.

The apparatus main body 10 having the robot arm 11 installed thereon performs a required task at the workplace where it is placed. Meanwhile, the unmanned carrier 20 can be separated from the apparatus main body 10, and move independently, so that the unmanned carrier 20 is allowed to perform a transport work anew while targeting another apparatus main body 10.

[0021]

The robot system of the present embodiment includes a wireless power supply/charging unit 30 as shown in Fig. 3, and is configured to be capable of supplying power to a storage battery 34 incorporated in the apparatus main body 10 via the unmanned carrier 20, thereby charging the storage battery 34.

The wireless power supply/charging unit 30 is configured by a storage battery 31, an electric power transmission circuit 32, and an electric power transmission coil 33 which are incorporated in the unmanned carrier 20, and a storage battery 34, an electric power reception circuit 35, and an electric power reception coil 36 which are incorporated in the apparatus main body 10.

[0022]

The storage battery 31 incorporated in the unmanned carrier 20 can be connected to an external power source 37 to be charged. This storage battery 31 is used as driving power for the unmanned carrier 20, and used to supply electric power to the storage battery 34 incorporated in the apparatus main body 10.

[0023]

The storage battery 34 incorporated in the apparatus main body 10 is used as driving power for the robot arm 11.

In order to supply electric power to this storage battery 34, the storage battery 31, the electric power transmission circuit 32, and the electric power transmission coil 33 are incorporated in the unmanned carrier 20, and further the electric power reception circuit 35 and the electric power reception coil 36 are incorporated in the apparatus main body 10.

Here, the incorporation positions of the electric power transmission coil 33 and the electric power reception coil 36 are adjusted such that they are arranged on the same axis in a state where the unmanned carrier 20 and the apparatus main body 10 are connected to each other.

[0024]

When the unmanned carrier 20 and the apparatus main body 10 are connected to each other, the electric power transmission circuit 32 is activated to convert the current from the storage battery 31 to an alternating current and supply the alternating current to the electric power transmission coil 33. The passage of current through the electric power transmission coil 33 generates a magnetic flux, which causes an induced current (alternating current) to flow through the electric power reception coil 36 according to the principle of electromagnetic induction. This induced current is converted to direct current by the electric power reception circuit 35, and the direct current is supplied to the storage battery 34 in the apparatus main body 10. In this way, the storage battery 34 in the apparatus main body 10 can be charged.

Therefore, there is no need to provide an external power source for charging the storage battery 34 at each workplace where the apparatus main body 10 is installed, which makes it possible to simplify the facilities.

[0025]

In a wireless power supply method using electromagnetic induction, it is preferable to arrange the electric power transmission coil 33 and the electric power

reception coil 36 on the same axis. When a misalignment occurs between the central axis of the electric power transmission coil 33 and the central axis of the electric power reception coil 36, the induced current to be generated in the electric power reception coil 36 decreases, so that there is a risk that the storage battery 34 cannot be charged efficiently.

[0026]

Therefore, the robot system according to the present embodiment includes a positioning mechanism configured by a combination of convex portions 41 and concave portions 42 as shown in Fig. 4. In Fig. 4, the convex portions 41 are provided at two locations on the top surface of the support board 21 of the unmanned carrier 20, and the concave portions 42 are provided at two opposing locations on the supported surface 10a of the apparatus main body 10.

The support board 21 moves upward so that the convex portions 41 are fit into the concave portions 42, whereby it is possible to connect the support board 21 and the supported surface 10a to each other in the same positional relation at all times. The positions where the electric power transmission coil 33 and the electric power reception coil 36 are incorporated are adjusted so that they are arranged on the same axis in the above connection state.

[0027]

In the present embodiment, as described above, the combination of the convex portion 41 and the concave portion 42 is provided at two opposing positions on the support board 21 and the supported surface 10a, so that two-dimensional positional deviations within the planes of the support board 21 and the supported surface 10a can be eliminated, and the electric power transmission coil 33 and the electric power reception coil 36 can be accurately arranged on the same axis.

[0028]

Furthermore, the convex portion 41 is formed in a

tapered shape in which the outer circumferential surface thereof decreases in diameter as it goes to the tip of the convex portion 41, and the concave portion 42 is formed in a cone shape in which the inner circumferential surface thereof is fitted to the outer circumferential surface of the convex portion 41.

By forming the convex portions 41 and the concave portions 42 in such shapes, even if there is a slight positional deviation between the support board 21 and the supported surface 10a when the support board 21 is moved upward and connected to the supported surface 10a, the convex portion 41 can enter an opening of the concave portion 42 which is formed to be wider than the tip of the convex portion 41, so that the convex portion 41 and the concave portion 42 can be fitted to each other to eliminate the positional deviation.

[0029]

The present invention is not limited to the above-described embodiment, and various modifications and applications are possible as necessary.

For example, the robot arm 11, the apparatus main body 10, and the unmanned carrier 20 shown in Figs. 1A to 1C, Fig. 2A, and Fig. 2B are illustrated to show schematic structures, and the components thereof are not limited to those in the structures shown in Figures.

Furthermore, the positioning mechanism shown in Fig. 4 is configured such that the convex portion 41 is provided on the support board 21 and the concave portion 42 is provided on the supported surface 10a, but it may be configured such that the concave portion 42 is provided on the support board 21 and the convex portion 41 is provided on the supported surface 10a.

Still furthermore, the combination of the convex portion 41 and the concave portion 42 may be provided at each of three or more opposing positions on the support board 21 (supporting surface) and the supported surface 10a.

Claims

[Claim 1]

A robot system that includes an apparatus main body having a robot arm mounted thereon and an unmanned carrier, and is configured such that the unmanned carrier is capable of moving integrally with the apparatus main body while the apparatus main body is carried on the unmanned carrier, and is also capable of separating from the apparatus main body and moving alone, the robot system comprising:

a wireless power supply/charging unit including an electric power transmission coil, an electric power reception coil, and a storage battery, the electric power reception coil being incorporated in the apparatus main body, and the electric power transmission coil and the storage battery being incorporated in the unmanned carrier; and

a positioning mechanism for connecting the unmanned carrier and the apparatus main body to each other, wherein the electric power transmission coil and the electric power reception coil are arranged on the same axis by the positioning mechanism.

[Claim 2]

The robot system according to claim 1, wherein:

the unmanned carrier has, on a top surface thereof, a supporting surface movable freely upward and downward, while the apparatus main body has a supported surface formed on a bottom surface thereof;

the unmanned carrier and the apparatus main body are configured such that the unmanned carrier and the apparatus main body are connected to each other by moving the supporting surface upward to bring the supporting surface into contact with the supported surface in a state where the unmanned carrier is placed below the apparatus main body, and the apparatus main body is lifted up by further moving the supporting surface upward; and

the positioning mechanism is configured such that a convex portion provided on one of the supporting surface and the supported surface is fitted to a concave portion provided on the other to align a central axis of the electric power reception coil with a central axis of the electric power transmission coil.

[Claim 3]

The robot system according to claim 2, wherein the convex portion is formed in a tapered shape in which an outer circumferential surface of the convex portion decreases in diameter toward a tip thereof, and the concave portion is formed in a cone shape in which an inner circumferential surface of the concave portion is fitted to the outer circumferential surface of the convex portion.

[Claim 4]

The robot system according to claim 2 or 3, wherein a combination of the convex portion and the concave portion is provided at least at two opposing positions on the supporting surface and the supported surface.