CLAIMS

~~What is claimed is:~~

1. A method for retrieving an inventory item based on a handling robot, wherein:

the handling robot comprises:

a movable chassis ~~(10)~~, moving along a travelling direction;

a storage frame ~~(20)~~, installed on the movable chassis ~~(10)~~, and provided with a plurality of storage units ~~(23)~~ distributed in a vertical direction, each storage unit ~~(23)~~ being configured to place an inventory item;

a material handling device ~~(30)~~ for transporting the inventory item between a warehouse shelf and any one of the storage units ~~(23)~~, wherein the material handling device ~~(30)~~ has a preset horizontal reference line ~~(S6)~~, and comprises a telescopic arm ~~(36)~~ and a pusher assembly ~~(37)~~, the pusher assembly ~~(37)~~ comprises a manipulator ~~(371)~~ that is installed on the telescopic arm ~~(36)~~, and the telescopic arm ~~(36)~~, the pusher assembly ~~(37)~~ and the manipulator ~~(371)~~ move along the reference line ~~(S6)~~;

a lifting assembly ~~(40)~~ for driving the material handling device ~~(30)~~ to move in the vertical direction; and

a detection device for detecting position information of the material handling device ~~(30)~~ relative to the warehouse shelf, the storage units ~~(23)~~ and the inventory item by determining a positional relationship between the warehouse shelf, the storage units ~~(23)~~ and the inventory item and the reference line ~~(S6)~~;

the material handling device ~~(30)~~ further comprises:

a temporary storage unit ~~(35)~~ provided with the telescopic arm ~~(36)~~ and the detection device;

a fork ~~(32)~~, comprising the telescopic arm ~~(36)~~, the temporary storage unit ~~(35)~~, the detection device, and the manipulator ~~(371)~~;

a support bracket ~~(31)~~, installed on the lifting assembly ~~(40)~~; and

a rotation assembly ~~(33)~~, installed between the fork ~~(32)~~ and the support bracket ~~(31)~~;

the method for retrieving an inventory item comprises:

when a preset position of an inventory item on the warehouse shelf is on the reference line ~~(S6)~~, driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ to extend to the preset position along the reference line ~~(S6)~~;

loading, by the manipulator ~~(371)~~ that is remained on a horizontal plane where the reference line ~~(S6)~~ is located, the inventory item;

when one storage unit ~~(23)~~ is on the reference line ~~(S6)~~, driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ loaded with the inventory item to move to the storage frame ~~(20)~~ along the reference line ~~(S6)~~; and

unloading, by the manipulator ~~(371)~~ that is remained on the horizontal plane where the reference line ~~(S6)~~ is located, the inventory item to the storage frame ~~(20)~~;

the method for retrieving an inventory item further comprises:

causing the movable chassis ~~(10)~~ to move in the travelling direction according to the position information, driving, by the lifting assembly ~~(40)~~, the material handling device ~~(30)~~ to move in the vertical direction according to the position information, so that the preset position of the inventory item is located on the reference line ~~(S6)~~; and

after the manipulator ~~(371)~~ is loaded with the inventory item, driving, by the lifting assembly ~~(40)~~, the material handling device ~~(30)~~ to move along the vertical direction according to the position information, so that one storage unit ~~(23)~~ is located on the reference line ~~(S6)~~;

the position information of the material handling device ~~(30)~~ relative to the inventory item comprises a first position offset between the inventory item and the reference line ~~(S6)~~ in the travelling direction, and a second position offset between the inventory item and the reference line ~~(S6)~~ in the vertical direction, and a distance between the inventory item and the manipulator ~~(371)~~ along the reference line ~~(S6)~~;

the method for retrieving an inventory item further comprise:

causing the movable chassis ~~(10)~~ to move along the travelling direction according to the first position offset, so that the first position offset is smaller than a first error value; and

driving, by the lifting assembly ~~(40)~~, the material handling device ~~(30)~~ to move in the vertical direction according to the second position offset, so that the second position offset is smaller than a second error value; and

adjusting an extension amount of the telescopic arm ~~(36)~~ along the reference line ~~(S6)~~ according to the distance, so that the extension amount is larger than the distance;

the position information of the material handling device ~~(30)~~ relative to the inventory item further comprises: a deflection amount between the inventory item and the reference line ~~(S6)~~ in a horizontal direction;

the method for retrieving an inventory item further comprise:

driving, by the rotation assembly ~~(33)~~, the fork ~~(32)~~ to rotate around the vertical direction according to the deflection amount, so that the deflection amount is smaller than a third error value.

2. The method for retrieving an inventory item according to claim 1, further comprising:

before the lifting assembly ~~(40)~~ drives the material handling device ~~(30)~~ to move in the vertical direction so that the material handling device ~~(30)~~ horizontally faces to the preset position, causing the movable chassis ~~(10)~~ to move to a preset range in front of the warehouse shelf.

3. The method for retrieving an inventory item according to claim 1, wherein:

the detection device comprises a camera device ~~(340)~~, a laser guiding device or an infrared sensor for obtaining image information, wherein the camera device ~~(340)~~ is configured to collect a two-dimensional code label attached on a surface of the inventory item facing the handling robot, so as to obtain the position information of the material handling device ~~(30)~~ relative to the inventory item.

4. The method for retrieving an inventory item according to claim 1, wherein:

the method for retrieving an inventory item further comprises:

before the telescopic arm ~~(36)~~ drives the manipulator ~~(371)~~ loaded with the inventory item to move to the storage frame ~~(20)~~ along the reference line ~~(S6)~~, driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ loaded with the inventory item to retract to the temporary storage unit ~~(35)~~ along the reference line ~~(S6)~~;

unloading, by the manipulator ~~(371)~~ that is remained on the horizontal plane where the reference line ~~(S6)~~ is located, the inventory item to the temporary storage unit ~~(35)~~; and

pushing, by the pusher assembly ~~(37)~~, the inventory item located on the temporary storage unit ~~(35)~~ to the corresponding storage units ~~(23)~~ in the storage frame ~~(20)~~ along the reference line ~~(S6)~~.

5. The method for retrieving an inventory item according to claim 4, wherein:

the rotation assembly ~~(33)~~ comprises a first rotation member ~~(3300)~~ and a second rotation member ~~(3301)~~;

the first rotation member ~~(3300)~~ is installed to the support bracket ~~(31)~~;

the second rotation member ~~(3301)~~ is installed to the temporary storage unit ~~(35)~~, and rotates around a vertically set rotation axis ~~(S5)~~ relative to the first rotation member ~~(3300)~~, so that the fork ~~(32)~~ rotates around the rotation axis ~~(S5)~~ relative to the support bracket ~~(31)~~;

6. The method for retrieving an inventory item according to claim 4, wherein:

the handling robot further comprises:

a deflection detection device, connected between the fork ~~(32)~~ and the support bracket ~~(31)~~;

the driving, by the rotation assembly ~~(33)~~, the fork ~~(32)~~ to rotate around the vertical direction, comprises:

when the deflection detection device detects that the fork ~~(32)~~ has not yet rotated to the preset angle, driving, by the rotation assembly ~~(33)~~, the fork ~~(32)~~ to continue to rotate;

when the deflection detection device detects that the fork ~~(32)~~ has rotated over the preset angle, driving, by the rotation assembly ~~(33)~~, the fork ~~(32)~~ to rotate in a reverse direction; and

when the deflection detection device detects that the fork ~~(32)~~ rotates to the preset angle, causing the rotation assembly ~~(33)~~ to stop rotating.

7. The method for retrieving an inventory item according to claim 6, wherein:

the deflection detection device comprises:

a first sensor ~~(3330)~~, provided with a first detection range;

a second sensor ~~(3331)~~, provided with a second detection range;

when the first sensor ~~(3330)~~ detects the fork ~~(32)~~ in the first detection range, and the second sensor ~~(3331)~~ does not detect the fork ~~(32)~~ in the second detection range, the deflection detection device detects that the fork ~~(32)~~ has not yet rotated to the preset angle;

when the first sensor ~~(3330)~~ does not detect the fork ~~(32)~~ in the first detection range, and the second sensor ~~(3331)~~ detects the fork ~~(32)~~ in the second detection range, the deflection detection device detects that the fork ~~(32)~~ has rotated over the preset angle; and

when the first sensor ~~(3330)~~ detects the fork ~~(32)~~ in the first detection range, and the second sensor ~~(3331)~~ detects the fork ~~(32)~~ in the second detection range, the deflection detection device detects that the fork ~~(32)~~ rotates to the preset angle.

8. The method for retrieving an inventory item according to claim 1, wherein:

the inventory item comprises a first inventory item and a second inventory item;

the preset position comprises a first preset position and a second preset position, the first inventory item is located at the first preset position, and the second inventory item is located at the second preset position;

the storage frame ~~(20)~~ comprises a first storage unit and a second storage unit;

when there is the second inventory item back behind the first inventory item, the method for retrieving an inventory item further comprises:

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ to extend to the first preset position of the warehouse shelf along the reference line ~~(S6)~~;

loading, by the manipulator ~~(371)~~ that is remained on the horizontal plane where the reference line ~~(S6)~~ is located, the first inventory item located at the first preset position;

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ loaded with the first inventory item to move to the first storage unit along the reference line ~~(S6)~~;

unloading, by the manipulator ~~(371)~~ that is remained on the horizontal plane where the reference line ~~(S6)~~ is located, the first inventory item to the first storage unit;

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ to move to the second preset position of the warehouse shelf along the reference line;

loading, by the manipulator ~~(371)~~ that is remained on the horizontal plane where the reference line ~~(S6)~~ is located, the second inventory item located at the second preset position;

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ loaded with the second inventory item to move to the second storage unit along the reference line ~~(S6)~~; and

unloading, by the manipulator ~~(371)~~ that is remained on the horizontal plane where the reference line ~~(S6)~~ is located, the second inventory item to the second storage unit.

9. The method for retrieving an inventory item according to claim 8, further comprising:

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ to move to the first storage unit along the reference line ~~(S6)~~;

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ to be remained at the reference line ~~(S6)~~ and to load the first inventory item located at the first storage unit;

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ loaded with the first inventory item to move to the first preset position of the warehouse shelf along the reference line ~~(S6)~~; and

unloading, by the manipulator ~~(371)~~ that is remained on the horizontal plane where the reference line ~~(S6)~~ is located, the first inventory item to the first preset position of the warehouse shelf;

or

the method for retrieving an inventory item further comprises:

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ to move to the first storage unit along the reference line ~~(S6)~~;

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ to be remained on the horizontal plane where the reference line ~~(S6)~~ is located, to load the first inventory item located at the first storage unit;

driving, by the telescopic arm ~~(36)~~, the manipulator ~~(371)~~ loaded with the first inventory item to move to the second preset position of the warehouse shelf along the reference line ~~(S6)~~;

unloading, by the manipulator ~~(371)~~ that is remained on the horizontal plane where the reference line ~~(S6)~~ is located, the first inventory item to the second preset position of the warehouse shelf; and

uploading current position information of the first inventory item.

10. A handling robot ~~(100)~~, comprising:

a movable chassis ~~(10)~~, moving along a travelling direction;

a storage frame ~~(20)~~, installed on the movable chassis ~~(10)~~, and provided with a plurality of storage units ~~(23)~~ distributed in a vertical direction, each storage unit ~~(23)~~ being configured to place an inventory item;

a material handling device ~~(30)~~ for transporting the inventory item between a warehouse shelf and any one of the storage units ~~(23)~~, the material handling device ~~(30)~~ having a preset horizontal reference line ~~(S6)~~, and comprising a pusher assembly ~~(37)~~ that is movable along the reference line ~~(S6)~~;

a lifting assembly ~~(40)~~ for driving the material handling device ~~(30)~~ to move in the vertical direction, so that any one of the storage units ~~(23)~~ is located on the reference line ~~(S6)~~; and

a detection device for detecting position information of the material handling device ~~(30)~~ relative to the warehouse shelf, the storage units ~~(23)~~ and the inventory item by determining a positional relationship between the warehouse shelf, the storage units ~~(23)~~ and the inventory item and the reference line ~~(S6)~~;

the material handling device ~~(30)~~ comprises a support bracket ~~(31)~~, a fork ~~(32)~~, and a rotation assembly ~~(33)~~;

when one of the storage units ~~(23)~~ is located on the reference line ~~(S6)~~, the pusher assembly ~~(37)~~ pushes the inventory item to a corresponding storage unit ~~(23)~~ along the reference line ~~(S6)~~, or the pusher assembly ~~(37)~~ pulls the inventory item located at the corresponding storage unit ~~(23)~~ away therefrom;

the movable chassis ~~(10)~~ is configured to move in the travelling direction according to the position information, and the lifting assembly ~~(40)~~ is configured to drive the material handling device ~~(30)~~ to move in the vertical direction according to the position information;

the position information of the material handling device ~~(30)~~ relative to the inventory items comprises a first position offset between the inventory item and the reference line ~~(S6)~~ in the travelling direction of the movable chassis ~~(10)~~, and a second position offset between the inventory item and the reference line ~~(S6)~~ in the vertical direction;

the movable chassis ~~(10)~~ is configured to move along the travelling direction according to the first position offset so that the first position offset is less than a first error value; and

the lifting assembly ~~(40)~~ is configured to drive the material handling device ~~(30)~~ to move in the vertical direction according to the second position offset so that the second position offset is smaller than a second error value;

the position information of the material handling device ~~(30)~~ relative to the

inventory item further comprises: a deflection amount between the inventory item and the reference line ~~(S6)~~ in a horizontal direction;

the rotation assembly ~~(33)~~ is configured to drive the fork ~~(32)~~ to rotate around the vertical direction according to the deflection amount, so that the deflection amount is smaller than a third error value.

11. The handling robot ~~(100)~~ according to claim 10, wherein the material handling device ~~(30)~~ further comprises a temporary storage unit ~~(35)~~;

the temporary storage unit ~~(35)~~ is configured to temporarily store an inventory item that is to be transported between the warehouse shelf and any one of the storage units ~~(23)~~, and the temporary storage unit ~~(35)~~ has the reference line ~~(S6)~~;

when one of the storage units ~~(23)~~ is located on the reference line ~~(S6)~~, the pusher assembly ~~(37)~~ pushes an inventory item located on the temporary storage unit ~~(35)~~ to a corresponding storage unit ~~(23)~~ along the reference line ~~(S6)~~, or the pusher assembly ~~(37)~~ pulls an inventory item on a corresponding storage unit ~~(23)~~ to the temporary storage unit ~~(35)~~.

12. The handling robot ~~(100)~~ according to claim 11, wherein the material handling device ~~(30)~~ further comprises a telescopic arm ~~(36)~~;

the telescopic arm ~~(36)~~ comprises an outer arm section ~~(360)~~, a middle arm section ~~(361)~~ and an inner arm section ~~(362)~~, the outer arm section ~~(360)~~ is fixedly installed to the temporary storage unit ~~(35)~~, the middle arm section ~~(361)~~ is installed on the outer arm section ~~(360)~~, and the inner arm section ~~(362)~~ is installed to the middle arm section ~~(361)~~, the middle arm section ~~(361)~~ moves relative to the outer arm section ~~(360)~~ along the reference line ~~(S6)~~, the inner arm section ~~(362)~~ moves relative to the middle arm section ~~(361)~~ along the reference line ~~(S6)~~;

the pusher assembly ~~(37)~~ is installed to the inner arm section ~~(362)~~;

the inner arm section ~~(362)~~ moves relative to the outer arm section ~~(360)~~ along the reference line ~~(S6)~~, so that the pusher assembly ~~(37)~~ moves relative to the storage frame ~~(20)~~ along the reference line ~~(S6)~~.

13. The handling robot ~~(100)~~ according to claim 12, wherein the pusher assembly ~~(37)~~ comprises a manipulator ~~(371)~~ and a fixed push rod ~~(370)~~;

the manipulator ~~(371)~~ is installed at an end of the inner arm section ~~(362)~~, so that the manipulator ~~(371)~~ moves relative to the storage frame ~~(20)~~ along the reference line ~~(S6)~~, and the manipulator ~~(371)~~ unfolds or fold relative to the inner arm section ~~(362)~~;

when the manipulator ~~(371)~~ folds relative to the inner arm section ~~(362)~~, an end of the inner arm section ~~(362)~~ installed with the manipulator ~~(371)~~ moves to another side from one side of the inventory item on the storage unit ~~(23)~~ or the warehouse shelf that is located on the reference line ~~(S6)~~, so that when the manipulator ~~(371)~~ folds is unfolded relative to the inner arm section ~~(362)~~, the manipulator ~~(371)~~ pulls a corresponding inventory item to the temporary storage unit ~~(35)~~;

the fixed push rod ~~(370)~~ is installed on an end of the inner arm section ~~(362)~~ away from the manipulator ~~(371)~~, so that the fixed push rod ~~(370)~~ moves relative to the storage frame ~~(20)~~ along the reference line ~~(S6)~~;

the fixed push rod ~~(370))~~ is configured to push the inventory item placed on the temporary storage unit ~~(35)~~ to the storage unit ~~(23)~~ located on the reference line ~~(S6)~~, or to push the inventory item placed in the temporary storage unit ~~(35)~~ to an empty position of the warehouse shelf,

14. The handling robot ~~(100)~~ according to claim 13, wherein the pusher assembly ~~(37)~~ further comprises a push rod driving device ~~(372)~~;

the push rod driving device ~~(372)~~ is connected to the manipulator ~~(371)~~, and is configured to drive the manipulator ~~(371)~~ to rotate relative to the inner arm section ~~(362)~~, so that the manipulator ~~(371)~~ folds or unfolds relative to the inner arm section ~~(362)~~.

15. The handling robot ~~(100)~~ according to claim 12, wherein the telescopic arm ~~(36)~~ further comprises an ~~outer~~inner arm section driving assembly ~~(364)~~;

the inner~~outer~~ arm section driving assembly ~~(364)~~ comprises a movable pulley ~~(3640)~~ and a sliding chain ~~(3641)~~, the movable pulley ~~(3640)~~ is a flat belt pulley and the sliding chain ~~(3641)~~ is an open-loop flat belt;

the movable pulley ~~(3640)~~ is installed on the middle arm section ~~(361)~~;

a middle part of the sliding chain ~~(3641)~~ is arranged to be bent and sleeved over the movable pulley ~~(3640)~~, so that both ends of the sliding chain ~~(3641)~~ are oppositely arranged, one end being fixedly connected to the outer arm section ~~(360)~~, and the other end being fixedly connected to the inner arm section ~~(362)~~;

when the middle arm section ~~(361)~~ moves at a first speed relative to the outer arm section ~~(360)~~ along the reference line ~~(S6)~~, the inner arm section ~~(362)~~ moves at a second speed relative to the outer arm section ~~(360)~~ along the reference line ~~(S6)~~, and the second speed is twice the first speed.

16. The handling robot ~~(100)~~ according to claim 11, wherein the support bracket ~~(31)~~ is installed on the lifting assembly ~~(40)~~, and the lifting assembly ~~(40)~~ is configured to drive the support bracket ~~(31)~~ to move in the vertical direction;

the fork ~~(32)~~ comprises the temporary storage unit ~~(35)~~, the telescopic arm ~~(36)~~, and the pusher assembly ~~(37)~~;

the rotation assembly ~~(33)~~ comprises a first rotation member ~~(3300)~~ and a second rotation member ~~(3301)~~;

the first rotation member ~~(3300)~~ is installed to the support bracket ~~(31)~~;

the second rotation member ~~(3301)~~ is installed to the temporary storage unit ~~(35)~~, and rotates around a vertically set rotation axis ~~(S5)~~ relative to the first rotation member ~~(3300)~~, so that the fork ~~(32)~~ rotates around the rotation axis ~~(S5)~~ relative to the support bracket ~~(31)~~.