

DESCRIPTION

TITLE:

OBJECT TRANSPORTING METHOD AND CUBE STORAGE SYSTEM

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BACKGROUND

[Technical field]

[0001] The invention relates to a storage system, and in particular relates to an object transporting method and a cube storage system.

10 [Description of Related Art]

[0002] The rapid development of e-commerce has been accelerated during the epidemic period, driving the rise of B2C (business-to-consumer) logistics. In the post-pandemic era, people are increasingly reliant on e-commerce for shopping. However, in view of the increasingly serious problem of labor shortage, this has led to the vigorous development of smart logistics.

[0003] In order to improve transportation efficiency, many logistics and warehousing operators have begun to integrate software and hardware and come up with new solutions to simultaneously address the issues of abundant e-commerce products, fast delivery, and the difficulty in obtaining storage space.

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SUMMARY

[Problem to be Solved]

[0004] In view of this, an object transporting method and a cube storage system, which may be used to solve the aforementioned technical issues, are provided in the invention.

[Means for solving problems]

[0005] An object transporting method, which is adapted for a control system, is

5 provided in an embodiment of the invention. The method includes the following process.

In response to a first transporting task of a first target object stored in a first vertical storage structure, whether there is at least one blocking object stored in the first vertical storage structure relative to the first target object, in which the first transporting task indicates to transport the first target object from a current position to a first target position. The first

10 vertical storage structure includes multiple first object storage positions arranged vertically, and the current position of the first target object corresponds to one of the first object storage positions. In response to determining that there is at least one blocking object relative to the first target object stored in the first vertical storage structure, at least one assisting transporting robot is controlled to remove the at least one blocking object from the first
15 vertical storage structure. In response to determining that there is no blocking object relative to the first target object in the first vertical storage structure, controlling a first transporting robot to move to the current position to transport the first target object to the first target position.

[0006] A cube storage system, which includes a cube storage structure and a control

20 system, is provided in an embodiment of the invention. The cube storage structure includes a first vertical storage structure, and the first vertical storage structure includes multiple first object storage positions arranged vertically. The control system is

configured to execute the following process. In response to a first transporting task of a first target object stored in a first vertical storage structure, whether there is at least one blocking object stored in the first vertical storage structure relative to the first target object is determined, in which the first transporting task indicates to transport the first target object from a current position to a first target position, and the current position of the first target object corresponds to one of the first object storage positions. In response to determining that there is at least one blocking object stored in the first vertical storage structure relative to the first target object, at least one assisting transporting robot is controlled to remove the at least one blocking object from the first vertical storage structure. In response to determining that there is no blocking object in the first vertical storage structure relative to the first target object, a first transporting robot is controlled to move to the current position to transport the first target object to the first target position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a schematic diagram of a cube storage system according to an embodiment of the invention.

FIG. 2 is a schematic diagram of an object being transported according to an embodiment of the invention.

FIG. 3 is a flowchart of an object transporting method according to an embodiment of the invention.

FIG. 4 is an application scenario diagram according to an embodiment of the

invention.

FIG. 5 is a flowchart of executing a sorting task according to an embodiment of the invention.

FIG. 6 is a flowchart according to the return process shown in FIG. 5.

5 FIG. 7 is a flowchart of executing a loading task according to the seventh embodiment of the invention.

DESCRIPTION OF THE EMBODIMENTS

[0008] Referring to FIG. 1, FIG. 1 is a schematic diagram of a cube storage system
10 according to an embodiment of the invention. In FIG. 1, the cube storage system 10 includes a control system 11 and a cube storage structure 12.

[0009] In different embodiments, the control system 11 may be implemented as various smart devices and/or computer devices, but not limited thereto. In some embodiments, the control system 11 may include a storage circuit and a processor, the storage circuit is, for
15 example, any type of fixed or removable random access memory (RAM), read-only memory (ROM), a flash memory, a hard disk or other similar devices or a combination of these devices, and may be configured to record a plurality of codes or modules.

[0010] In addition, the processor is coupled to the storage circuit, and may be a general purpose processor, a special purpose processor, a conventional processor, a digital signal
20 processor, multiple microprocessors, one or more combined digital signal processing microprocessor, a controller, a microcontroller, an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), any other type of integrated circuit, state

machine, advanced RISC machine (ARM) based processor and the like.

[0011] In an embodiment of the invention, the processor of the control system 11 may implement various operations mentioned in the following embodiments by accessing the module/program code in the storage circuit. In some embodiments, the control system 11
5 may also include multiple subsystems (e.g., a micro-storage center, a storage management system, a storage control system, a storage execution system, a material transporting system, a vehicle dispatching system, etc.), and these subsystems may communicate and coordinate with each other to implement various operations mentioned below, but not limited thereto.

[0012] In embodiments of the invention, the cube storage structure 12 may include
10 multiple vertical storage structures (e.g., vertical storage structures 121 and 122), and each vertical storage structure may include multiple object storage positions. Taking the vertical storage structure 121 as an example, it may include two object storage positions 121a and 121b, in which the object storage positions 121a and 121b are, for example, arranged in sequence in the vertical storage structure 121 from high to low. Taking the
15 vertical storage structure 122 as an example, it may include two object storage positions 122a and 122b, in which the object storage positions 122a and 122b are, for example, arranged in sequence in the vertical storage structure 122 from high to low.

[0013] In FIG. 1, each object storage position may be used to store an object OB, in which each object OB is, for example, a goods storage object (e.g., a box) that may be used
20 to store goods. In other embodiments, each object OB may also be implemented as other types of goods storage objects according to designer requirements, such as pallets, but not limited thereto.

[0014] In embodiments of the invention, each object storage position and object OB may be provided with corresponding locking mechanisms (such as latches, but not limited thereto), so that each object OB is fixedly stored in the corresponding object storage position.

5 **[0015]** In the embodiment of the invention, the control system 11 may arrange/control the transporting robot RB (which is, for example, an automatic guided vehicle (AGV)) to move in the cube storage structure 12 and transport the required object OB. In one embodiment, for the object OB that has been stored in a certain object storage position, the control system 11 may control the transporting robot RB to move to the corresponding
10 vertical storage structure, and the transporting robot RB may climb vertically upward/downward in this vertical storage structure to access and transport the required object OB. In different embodiments, the transporting robot RB may be designed with a climbing mechanism that may be used for vertical climbing upward/downward in a vertical storage structure, but not limited thereto.

15 **[0016]** For example, for the object OB that has been stored in the object storage position 122b, the control system 11 may arrange the transporting robot RB to move to the entry point E122 of the corresponding vertical storage structure 122 (which is, for example, located at the bottom of the vertical storage structure 122, or may be understood as the ground corresponding to the location of the vertical storage structure 122). After the
20 transporting robot RB arrives at the entry point E122, the transporting robot RB may climb vertically upward to below the object storage position 122b in the vertical storage structure 122. Then, the transporting robot RB may release the locking mechanism between the

object storage position 122b and the object OB, so that the object OB may be carried on the transporting robot RB.

[0017] Afterwards, the transporting robot RB carrying the object OB may climb vertically downward to the entry point E122 (e.g. the ground) in the vertical storage structure 122, and may transport the carried object OB to the required target position according to the instruction of the control system 11.

[0018] In the first embodiment, assuming that the above target position is the object storage position 121a in the vertical storage structure 121, the transporting robot RB located at the entry point E122 may move to the entry point E121 corresponding to the vertical storage structure 121 (which is, for example, located at the bottom of the vertical storage structure 121), and may climb vertically upward in the vertical storage structure 121 after arriving at the entry point E121, until the carried object OB enters the object storage position 121a. Then, the transporting robot 121 may trigger the locking mechanism between the object storage position 121a and the object OB, so that the object OB may be stored in the object storage position 121a, but not limited thereto.

[0019] In the second embodiment, assuming that the above target position is the outbound point of the cube storage structure 12, the transporting robot RB located at the entry point E122 may move to the outbound point to transport the carried object OB to the outbound point, but not limited thereto.

[0020] In one embodiment, if the object OB carried on the transporting robot RB is determined to be a blocking object that blocks other objects, the control system 11 may arrange the transporting robot RB to carry the object OB to other object storage positions in

the cube storage structure 12 in the manner of the first embodiment.

[0021] For example, if the control system 11 is required to access the object OB stored in the object storage position 122a (hereinafter referred to as the target object) in response to a certain task, then the object OB stored in the object storage position 122b in FIG. 1 may be understood as a blocking object relative to the target object because it blocks the path for the transporting robot RB to directly access the target object.

[0022] In this case, the control system 11 may arrange one or more transporting robots RB to move the object OB stored in the object storage position 122b to other object storage positions in the cube storage structure 12 for storage according to the above teachings, and the control system 11 may record these other object storage positions accordingly, so that these objects OB may be accessed when it is required, but not limited thereto.

[0023] In another embodiment, if the object OB carried on the transporting robot RB is an object that the relevant person wants to access, the control system 11 may arrange the transporting robot RB to carry the object OB to the outbound point of the cube storage structure 12 in the manner of the second embodiment, but not limited thereto.

[0024] Referring to FIG. 2, FIG. 2 is a schematic diagram of an object being transported according to an embodiment of the invention.

[0025] In FIG. 2, it is assumed that the cube storage structure 12 under consideration has the shown appearance (i.e., each vertical storage structure includes 7 object storage positions). In this embodiment, assuming that the transporting robot 299a is arranged to transport the object OB located at the object storage position 211a to the corresponding target position, the transporting robot 299a may climb vertically upward in the vertical

storage structure 211 to below the object storage position 211a after arriving at the entry point E211 (which is, for example, located at the bottom/ground of the vertical storage structure 211) of the vertical storage structure 211 to which the object storage position 211a belongs. Then, the transporting robot 299a may release the locking mechanism between
5 the object storage position 211a and the object OB, so that the object OB may be carried on the transporting robot 299a.

[0026] Afterwards, the transporting robot 299a carrying the object OB may climb vertically downward to the entry point E211 in the vertical storage structure 211, and transport the object OB to the corresponding target position.

10 **[0027]** In addition, assuming that the control system 11 is required to access the target object located at the object storage position 212a in response to a certain task, the control system 11 may regard all objects OB between the entry point E212 of the corresponding vertical storage structure 212 and the target object as blocking objects (i.e., the object OB located at object storage positions 212b to 212d). In this case, the control system 11 may
15 arrange one or more transporting robots (e.g., the transporting robot 299b) to transport the objects OB located in the object storage positions 212b to 212d to other object storage positions in the cube storage structure 12. In embodiments of the invention, the transporting robot used to carry blocked objects may be referred to as an assisting transporting robot, but not be limited thereto.

20 **[0028]** Referring to FIG. 3, FIG. 3 is a flowchart of an object transporting method according to an embodiment of the invention. The method of this embodiment may be executed by the control system 11 in FIG. 1, and the details of each step in FIG. 3 will be

described below with reference to the elements shown in FIG. 1.

[0029] First, in step S310, in response to a first transporting task for a first target object stored in a first vertical storage structure, the control system 11 determines whether there is a blocking object stored in the first vertical storage structure relative to the first target object.

5 The first transporting task indicates to transport the first target object from a current position to a first target position. Furthermore, the first vertical storage structure includes multiple first object storage positions arranged vertically, and the current position of the first target object corresponds to one of the first object storage positions.

[0030] In one embodiment, the first vertical storage structure is, for example, one of
10 multiple vertical storage structures of the cube storage structure 12, but not limited thereto.

[0031] In one embodiment, the control system 11 may determine whether at least one object is stored in the first object storage position between the current position of the first target object and the first entry point of the first vertical storage structure.

[0032] In response to determining that at least one object is stored in the first object
15 storage position between the current position of the first target object and the first entry point, the control system 11 may determine the at least one object as the at least one blocking object relative to the first target object. On the other hand, in response to determining that no object is stored in the first object storage position between the current position of the first target object and the first entry point, the control system 11 may determine that there is no
20 blocking object relative to the first target object in the first vertical storage structure.

[0033] In the third embodiment, assuming that the first target object is the object OB stored in the object storage position 211a in FIG. 2, the corresponding first vertical storage

structure is, for example, the vertical storage structure 211. Then, the control system 11 may determine whether at least one object is stored in the object storage position between the current position (i.e., the object storage position 211a) of the first target object and the entry point E211 of the vertical storage structure 211.

5 **[0034]** It may be seen from FIG. 2 that since no object is stored in the object storage position between the entry point E211 and the object storage position 211a, the control system 11 may determine that there is no blocking object relative to the first target object in the first vertical storage structure.

10 **[0035]** In the fourth embodiment, assuming that the first target object is the object OB stored in the object storage position 212a in FIG. 2, the corresponding first vertical storage structure is, for example, the vertical storage structure 212. Then, the control system 11 may determine whether at least one object is stored in the object storage position between the current position (i.e., the object storage position 212a) of the first target object and the entry point E212 of the vertical storage structure 212.

15 **[0036]** It may be seen from FIG. 2 that since other objects OB are stored in the object storage positions 212b to 212d between the entry point E212 and the object storage position 212a, the control system 11 may determine the objects OB stored in the object storage positions 212b to 212d as blocking objects relative to the first target object, but not limited thereto.

20 **[0037]** In one embodiment, in response to determining that no blocking object relative to the first target object is stored in the first vertical storage structure, the control system 11 may continue to execute step S330 after step S310.

[0038] On the other hand, in response to determining that the blocking object relative to the first target object is stored in the first vertical storage structure, the control system 11 may continue to execute step S320 after step S310 to control the assisting transporting robot to remove blocked objects from the first vertical storage structure. For example, if the first target object is an object OB stored in the object storage position 212a, the control system 11 may arrange the assisting transporting robot to remove the objects OB stored in the object storage positions 212b to 212d from the vertical storage structure 212.

[0039] In one embodiment, during the execution of step S320, the control system 11 may execute the following steps in sequence: (a) finding a specific blocking object closest to the first entry point among at least one blocking object; (b) controlling a transporting robot as one of at least one assisting transporting robot to move to the first entry point (which is, for example, located at the bottom of the first vertical storage structure), and controlling the transporting robot to climb vertically upward in the first vertical storage structure to access a specific blocked object; (c) controlling the transporting robot to move the specific blocked object to the second object storage position of the cube storage structure 12, in which the second object storage position belongs to the second vertical storage structure of the cube storage structure 12; (d) repeating steps (a) to (c) until there is no blocking object relative to the first target object in the first vertical storage structure.

[0040] During the execution of step (c), the control system 11 may execute the following: controlling the transporting robot to climb vertically downward in the first vertical storage structure to the first entry point of the first vertical storage structure; controlling the transporting robot to move from the first entry point of the first vertical

storage structure to the second entry point of the second vertical storage structure; and controlling the transporting robot to climb vertically upward to the second object storage position in the second vertical storage structure, and fixing the specific blocking object to the second object storage position.

5 **[0041]** In one embodiment, before controlling the transporting robot to move from the first entry point of the first vertical storage structure to the second entry point of the second vertical storage structure, the control system 11 may also determine whether the second vertical storage structure is locked. In response to determining that the second vertical storage structure is not locked, the control system 11 may lock the second vertical storage
10 structure and control the transporting robot to move from the first entry point of the first vertical storage structure to the second entry point of the second vertical storage structure. On the other hand, in response to determining that the second vertical storage structure has been locked, the control system 11 may control the transporting robot to move from the first entry point of the first vertical storage structure to the second entry point of the second
15 vertical storage structure.

[0042] Based on this, in the fourth embodiment, the control system 11 may first determine that the object OB stored in the object storage position 212d is a specific blocking object, arrange the transporting robot 299b as the assisting transporting robot to move to the entry point E212, and control the transporting robot 299b to climb upward in the vertical
20 storage structure 212 to access the object OB stored in the object storage position 212d.

[0043] Afterwards, the control system 11 may control the transporting robot 299b to climb vertically downward to the entry point E212 in the vertical storage structure 212, and

determine whether the second vertical storage structure is locked. If it is not locked, the control system 11 may control the transporting robot 299b to move from the entry point E212 to the second entry point of the second vertical storage structure after locking the second vertical storage structure; if it is locked, the control system 11 may directly control the transporting robot 299b to move from the entry point E212 to the second entry point of the second vertical storage structure, but not limited thereto. Then, the control system 11 may control the transporting robot 299b to climb vertically upward to the second object storage position in the second vertical storage structure, and fix the specific blocking object to the second object storage position.

[0044] The above concept may be used again to move the objects OB stored in the object storage positions 212c and 212b to other object storage positions in the cube storage structure 12, and the details are not repeated herein.

[0045] After step S320 is completed, the control system 11 may execute step S310 again. At this time, since there is no blocking object relative to the first target object, the control system 11 may continue to execute step S330. In another embodiment, after step S320 is completed, the control system 11 may also directly execute step S330, but not limited thereto.

[0046] In step S330, the control system 11 controls the first transporting robot to move to the current position to transport the first target object to the first target position.

[0047] During the execution of step S330, the control system 11 may control the first transporting robot to move to the first entry point, and control the first transporting robot to climb vertically upward to the current position of a target object in the first vertical storage

structure to access the first target object.

[0048] Afterwards, the control system 11 may control the first transporting robot to move the first target object from the current position to the first target position. For example, the control system 11 may control the first transporting robot to climb vertically
5 downward from the current position of the first target object to the first entry point of the first vertical storage structure, and control the first transporting robot to move from the first entry point of the first vertical storage structure to the first target position (e.g., the entry point of the cube storage structure 12).

[0049] In the embodiment of the invention, the first transporting task may be a sorting
10 task or a stock taking task.

[0050] In the fifth embodiment, when the control system 11 determines that one or more of the goods stored in the first target object is required to be obtained in a certain order (e.g., an e-commerce shopping order), the control system 11 may accordingly determine a sorting task as the first transporting task, and accordingly set the first target position corresponding
15 to the first transporting task as the outbound point of the cube storage structure 12. Based on this, the control system 11 may accordingly execute the operations in the previous embodiment to arrange for the first transporting robot to transport the first target object to the outbound point of the cube storage structure 12 to facilitate subsequent sorting.

[0051] For ease of understanding, the following embodiments will be further described
20 with reference to the scenario shown in FIG. 4, which is an application scenario diagram according to an embodiment of the invention.

[0052] In FIG. 4, the control system 11 may arrange the first transporting robot to

transport the first target object to the outbound point OUTB1 of the cube storage structure 12 in response to the sorting task. Afterwards, the control system 11 may execute the method shown in FIG. 5 accordingly.

[0053] Referring to FIG. 5, FIG. 5 is a flowchart of executing a sorting task according to an embodiment of the invention.

[0054] In step S510, in response to determining that the first target object has been transported to the first target position (e.g., the outbound point OUTB1 of the cube storage structure 12), the control system 11 determines whether the sorting workstation 411 is available. In one embodiment, if there is space on the sorting workstation 411 for placing the first target object, the control system 11 may determine that the sorting workstation 411 is available, otherwise it may determine that the sorting workstation 411 is unavailable, but not limited thereto.

[0055] In one embodiment, the sorting workstation 411 may be used to allow relevant personnel and/or robotic arms to sort (e.g., load into logistics containers) or stock-take the goods in the order in response to the aforementioned order, but not limited thereto.

[0056] In one embodiment, in response to determining that the sorting workstation 411 is unavailable, the control system 11 may repeatedly execute step S510 until the sorting workstation 411 is determined to be available, but not limited thereto.

[0057] In one embodiment, in response to determining that the sorting workstation 411 is available, the control system 11 may control the object moving robot (e.g., a robotic arm) to move the first target object carried by the first transporting robot from the first target position (e.g., the outbound point OUTB1 of the cube storage structure 12) to the sorting

workstation 411, to facilitate relevant personnel and/or robotic arms to perform the required sorting.

[0058] Next, in step S530, after the sorting task of the first target object is completed, the control system 11 may determine whether the first target object located at the sorting workstation 411 is empty (i.e., determine whether all the goods in the first target object have been removed from the first target object). If not, this means that there are still goods stored in the first target object, and the control system 11 may continue to execute step S540 to control the second transporting robot to store the first target object in the cube storage structure 12 through a return process. The return process is explained separately with FIG.

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[0059] On the other hand, if the first target object of the sorting workstation 411 is empty, it means that no goods are stored in the first target object, that is, the first target object may be used to load other goods. In this case, the control system 11 may continue to execute step S550 to control the object moving robot to move the first target object to the third transporting robot, and control the third transporting robot to transport the first target object to the empty object station 412.

[0060] During the execution of step S550, the control system 11 may, for example, arrange the third transporting robot to the storage point INB1 of the cube storage structure 12, and control the object moving robot to move the first target object located at the sorting workstation 411 to the third transporting robot. Afterwards, the third transporting robot carrying the first target object may move to the outbound point OUTB2 of the cube storage structure 12, and the first target object may be moved to the empty object station 412 by

relevant personnel and/or robotic arms.

[0061] In an embodiment of the invention, the empty object station 412 may store multiple empty objects without any goods, these empty objects may be loaded with corresponding goods by relevant personnel and/or robotic arms in response to corresponding loading tasks, and then transported by corresponding transporting robots to a certain object storage position in the cube storage structure 12 for storage, but not limited thereto. The content related to the loading task is explained separately with FIG. 7.

[0062] Referring to FIG. 6, FIG. 6 is a flowchart according to the return process shown in FIG. 5. First, in step S610, the control system 11 determines that the first target object is in the third object storage position in the cube storage structure 12, in which the third object storage position belongs to the third vertical storage structure in the cube storage structure 12, and a third entry point is at the bottom of the third vertical storage structure. In different embodiments, the third vertical storage structure may be the same as or different from the first and second vertical storage structures mentioned previously, but not limited thereto.

[0063] Afterwards, in step S620, the control system 11 controls the second transporting robot to move to the inbound point INB1 of the cube storage structure 12, and controls the object moving robot to move the first target object (which is not empty) from the sorting workstation 411 to the second transporting robot located at the inbound point INB1.

[0064] In step S630, the control system 11 determines whether the third vertical storage structure is locked. If it is locked, the control system 11 may execute step S640 to lock the third vertical storage structure, and then execute step S650; if not, the control system 11

may directly execute step S650, but not limited thereto.

[0065] In step S650, the control system 11 controls the second transporting robot to move from the inbound point INB1 of the cube storage structure 12 to the third entry point of the third vertical storage structure.

5 **[0066]** In step S660, the control system 11 controls the second transporting robot to climb vertically upward to the third object storage position in the third vertical storage structure, and fix the first target object to the third object storage position.

[0067] In step S670, the control system 11 controls the second transporting robot to climb vertically downward to the third entry point of the third vertical storage structure, and
10 unlock the third vertical storage structure.

[0068] In the sixth embodiment, when the control system 11 determines that it is necessary to confirm whether the quantity of goods stored in the first target object is correct for certain reasons, the control system 11 may accordingly determine a stock taking task as the first transporting task, and accordingly set the first target position corresponding to the
15 first transporting task as the outbound point of the cube storage structure 12. Based on this, the control system 11 may accordingly execute the operations in the previous embodiment to arrange for the first transporting robot to transport the first target object to the outbound point of the cube storage structure 12 to facilitate subsequent stock taking.

[0069] In the sixth embodiment, the control system 11 may also execute steps S510 to
20 S520 to move the first target object to the sorting workstation 411 to facilitate relevant personnel to confirm the quantity of goods in the first target object.

[0070] In response to determining that the goods in the first target object are correct

after stock-taking, the control system 11 may execute step S540 accordingly to control the second transporting robot to store the first target object in the cube storage structure through the return process. For relevant details, reference may be made to the descriptions in previous embodiments and are not repeated herein.

5 **[0071]** On the other hand, in response to determining that the goods in the first target object are incorrect after stock-taking, the relevant personnel may input the correct quantity of goods, and then the control system 11 executes step S540 accordingly, but not limited thereto.

10 **[0072]** Referring to FIG. 7, FIG. 7 is a flowchart of executing a loading task according to the seventh embodiment of the invention. In the seventh embodiment, relevant personnel and/or robotic arms may take an empty object from the empty object station 412 at the loading workstation 413 in response to a certain loading task, and load the empty object (hereinafter referred to as the second target object).

15 **[0073]** Based on this, in step S710, the control system 11 may obtain the loading task and associate the loading task with the second target object. In one embodiment, the body of the second target object may be provided with an indicator (e.g., a barcode and/or a QR code) corresponding to the identity of the second target object, and the relevant personnel may, for example, read the indicator through a corresponding reader when processing the loading task, and then associate the loading task with the second target object, but not
20 limited thereto.

[0074] Afterwards, the relevant personnel may load the corresponding goods into the second target object according to the loading task. For example, assuming that the loading

task indicates to load 10 dolls into the second target object, the relevant personnel and/or robotic arms may load 10 dolls into the second target object accordingly, but not limited thereto.

[0075] Next, in step S720, during the process of loading the goods into the second target object, the control system 11 determines whether the weight of the second target object is about to exceed the weight threshold.

[0076] If it is about to exceed the weight threshold (e.g., loading one more goods causes the weight of the second target object to exceed the weight threshold), the control system 11 may accordingly execute step S730 to control the second transporting robot to store the second target object in the cube storage structure 12 through the return process, and introduce the third target object to support the aforementioned loading task. On the other hand, in response to determining that the weight of the second target object is not about to exceed the weight threshold, the control system 11 may execute step S740 to allow the goods to continue to be loaded into the second target object, and return to step S720, but not limited thereto.

[0077] In FIG. 4, during the process of transporting the second target object to the cube storage structure 12, the object moving robot may first move the second target object located at the loading workstation 413 to the inbound point INB2 of the cube storage structure 12. The second transporting robot then transports the second target object to the corresponding object storage position, but not limited thereto.

[0078] For example, in the case where the second target object has 6 dolls stored, if the control system 11 determines that adding another doll causes the weight of the second target

object to exceed the weight threshold, the control system 11 may transport the second target object to the cube storage structure 12 for storage through the aforementioned return process, and then introduce a new empty object (e.g., the aforementioned third target object) to store the remaining 4 dolls, but not limited thereto.

5 **[0079]** In summary, embodiments of the invention provide a technical solution for moving target objects and/or blocking objects in a cube storage structure. Since embodiments of the invention allow the transporting robot to access and transport objects (e.g., boxes and/or pallets) in a cube storage structure by climbing vertically upward/downward, therefore, compared with conventional large-scale automated storage, 10 the method of the embodiments of the invention is highly flexible. In this case, the cube storage structure may be disposed closer to the end consumer, which may greatly shorten the pickup time.

[0080] Although the disclosure has been described in detail with reference to the above embodiments, they are not intended to limit the disclosure. Those skilled in the art should 15 understand that it is possible to make changes and modifications without departing from the spirit and scope of the disclosure. Therefore, the protection scope of the disclosure shall be defined by the following claims.

[Description of Symbols]

[0081]

20 10: Cube storage system
 11: Control system
 12: Cube storage structure

121, 122, 211, 212: Vertical storage structure

121a, 121b, 122a, 122b, 211a, 212a -212d: Object storage position

E121, E122, E211, E212: Entry point

RB, 299a, 299b: Transporting robot

5 411: Sorting workstation

412: Empty object station

413: Loading workstation

INB1, INB2: inbound point

OUTB1, OUTB2: outbound point

10 OB: object

S310~S330, S510~S550, S610~S670, S710~S740: steps

CLAIMS

Claim 1:

An object transporting method, adapted for a cube storage system including a control system and a cube storage structure, the cube storage structure including a first vertical storage structure, the object transporting method comprising performing following steps using the control system:

in response to a first transporting task of a first target object stored in the first vertical storage structure, determining whether there is a blocking object stored in the first vertical storage structure relative to the first target object, wherein a first transporting task indicates to transport the first target object from a current position to a first target position, the first vertical storage structure comprises a plurality of first object storage positions arranged vertically, and the current position of the first target object corresponds to one of the first object storage positions;

in response to determining that there is the blocking object stored in the first vertical storage structure relative to the first target object, controlling at least one assisting transporting robot to move along a bottom of the cube storage structure to a bottom of the first vertical storage structure, then to climb vertically upward to below the blocking object in the first vertical storage structure, such that after the at least one auxiliary handling robot accesses the blocking object, the at least one assisting transporting robot climbs vertically downward to the bottom of the first vertical storage structure in the first vertical storage structure, thereby removing the blocking object from the first vertical storage structure;

in response to determining that there is no blocking object in the first vertical storage structure relative to the first target object, controlling a first transporting robot to move along the bottom of the cube storage structure to the bottom of the first vertical storage structure, then to climb vertically upward to the current position, such that after the first transporting

robot accesses the first target object, the first transporting robot climbs vertically downward to the bottom of the first vertical storage structure in the first vertical storage structure, thereby transporting the first target object to the first target position.

5 Claim 2:

The object transporting method as claimed in claim 1, wherein the first vertical storage structure comprises a first entry point located at the bottom of the first vertical storage structure, and the object transporting method comprises:

10 in response to determining that at least one object is stored in the first object storage positions between the current position of the first target object and the first entry point, determining each object as the at least one blocking object relative to the first target object.

Claim 3:

15 The object transporting method as claimed in claim 1, wherein the first vertical storage structure comprises a first entry point located at the bottom of the first vertical storage structure, and in response to determining that there are a plurality of blocking objects stored in the first vertical storage structure relative to the first target object, controlling the at least one assisting transporting robot to remove the plurality of blocking objects from the first vertical storage structure comprises:

20 (a) finding a specific blocking object closest to the first entry point among the plurality of blocking objects;

(b) controlling a transporting robot as one of the at least one assisting transporting robot to move along the bottom of the cube storage structure to the first entry point, and controlling the transporting robot to climb vertically upward to below the specific blocking
25 object from the first entry point in the first vertical storage structure, such that after the

transporting robot accesses the specific blocked object, the transporting robot climbs vertically downward to the bottom of the first entry point in the first vertical storage structure, thereby removing the specific blocking object from the first vertical storage structure;

5 (c) controlling the transporting robot to move the specific blocked object to a second object storage position of the cube storage structure, wherein the second object storage position belongs to a second vertical storage structure of the cube storage structure;

(d) repeating steps (a) to (c) until there is no blocking object in the first vertical storage structure relative to the first target object.

10

Claim 4:

The object transporting method as claimed in claim 3, wherein the second vertical storage structure comprises a second entry point located at bottom of the second vertical storage structure, and the step (c) comprises:

15 controlling the transporting robot to move along the bottom of the cube storage structure from the first entry point of the first vertical storage structure to the second entry point of the second vertical storage structure;

controlling the transporting robot to climb vertically upward to the second object storage position from the second entry point in the second vertical storage structure, and

20 fixing the specific blocking object to the second object storage position.

Claim 5:

The object transporting method as claimed in claim 4, wherein before controlling the transporting robot to move along the bottom of the cube storage structure from the first entry point of the first vertical storage structure to the second entry point of the second

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vertical storage structure, the object transporting method further comprises:

determining whether the second vertical storage structure is locked;

in response to determining that the second vertical storage structure is not locked, locking the second vertical storage structure, and controlling the transporting robot to move from the first entry point of the first vertical storage structure to the second entry point of the second vertical storage structure;

in response to determining that the second vertical storage structure has been locked, controlling the transporting robot to move from the first entry point of the first vertical storage structure to the second entry point of the second vertical storage structure.

Claim 6:

The object transporting method as claimed in claim 1, wherein the first vertical storage structure comprises a first entry point located at bottom of the first vertical storage structure, and controlling the first transporting robot to move to the current position to transport the first target object to the first target position comprises:

controlling the first transporting robot to move along the bottom of the cube storage structure to the first entry point, and controlling the first transporting robot to climb vertically upward to the current position of the first target object from the first entry point in the first vertical storage structure, such that the first transporting robot accesses the first target object;

controlling the first transporting robot to move the first target object from the current position to the first target position.

Claim 7:

The object transporting method as claimed in claim 6, wherein controlling the first transporting robot to move the first target object from the current position to the first target position comprises:

controlling the first transporting robot to climb vertically downward from the current
5 position of the first target object to the first entry point of the first vertical storage structure,
and controlling the first transporting robot to move from the first entry point of the first
vertical storage structure to the first target position.

Claim 8:

10 The object transporting method as claimed in claim 1, wherein the first target
position is an outbound point of the cube storage structure.

Claim 9:

The object transporting method as claimed in claim 8, wherein the first transporting
15 task corresponds to a sorting task, and after controlling the first transporting robot to move
along the bottom of the cube storage structure to the bottom of the first vertical storage
structure, then to climb vertically upward to the current position, such that after the first
transporting robot accesses the first target object, the first transporting robot climbs
vertically downward to the bottom of the first vertical storage structure in the first vertical
20 storage structure, thereby transporting the first target object to the first target position, the
object transporting method further comprises:

in response to determining that the first target object has been transported to the first
target position, determining whether a sorting workstation is available;

in response to determining that the sorting workstation is available, controlling an
25 object moving robot to move the first target object from the first target position to the sorting

workstation.

Claim 10:

The object transporting method as claimed in claim 9, wherein the first target object
5 is a goods storage object that stores at least one goods, and the object transporting method
further comprises:

determining whether the first target object located at the sorting workstation is empty
after the sorting task is completed;

in response to determining that the first target object is not empty, controlling
10 a second transporting robot to store the first target object in the cube storage structure
through a return process.

Claim 11:

The object transporting method as claimed in claim 10, wherein the return process
15 comprises:

determining that the first target object is in a third object storage position in the cube
storage structure, wherein the third object storage position belongs to a third vertical storage
structure in the cube storage structure, and a third entry point is at bottom of the third vertical
storage structure;

20 controlling the second transporting robot to move to an inbound point of the cube
storage structure, and controlling the object moving robot to move the first target object
from the sorting workstation to the second transporting robot located at the inbound point;

controlling the second transporting robot to move from the inbound point of the cube
storage structure to the third entry point of the third vertical storage structure;

25 controlling the second transporting robot to climb vertically upward to the third

object storage position in the third vertical storage structure, and fixing the first target object to the third object storage position.

Claim 12:

5 The object transporting method as claimed in claim 11, wherein before controlling the second transporting robot to move from the inbound point of the cube storage structure to the third entry point of the third vertical storage structure, the object transporting method further comprises:

 determining whether the third vertical storage structure is locked;

10 in response to determining that the third vertical storage structure is not locked, locking the third vertical storage structure, and controlling the second transporting robot to move from the inbound point of the cube storage structure to the third entry point of the third vertical storage structure;

 in response to determining that the third vertical storage structure has been
15 locked, controlling the second transporting robot to move from the inbound point of the cube storage structure to the third entry point of the third vertical storage structure.

Claim 13:

20 The object transporting method as claimed in claim 11, wherein after fixing the first target object to the third object storage position, the object transporting method further comprises:

 controlling the second transporting robot to climb vertically downward to the third entry point of the third vertical storage structure, and unlocking the third vertical storage
25 structure.

Claim 14:

The object transporting method as claimed in claim 10, further comprising:

in response to determining that the first target object is empty, controlling the object
5 moving robot to move the first target object to a third transporting robot, and controlling the
third transporting robot to transport the first target object to an empty object station.

Claim 15:

The object transporting method as claimed in claim 9, wherein the first target object
10 is a goods storage object that stores at least one goods, the first transporting task corresponds
to a stock taking task, and the object transporting method further comprises:

in response to determining that the at least one goods stored in the first target object
is correct after stock-taking, controlling a second transporting robot to store the first target
object in the cube storage structure through a return process.

Claim 16:

The object transporting method as claimed in claim 1, further comprising:

obtaining a loading task, and associating the loading task with a second target object,
wherein the second target object is a goods storage object and is initialized to be empty, and
20 the loading task indicates to load at least one goods into the second target object;

determining whether a weight of the second target object is about to exceed a weight
threshold during a process of loading the at least one goods into the second target object;

in response to determining that the weight of the second target object is not about to
exceed the weight threshold, allowing the at least one goods to continue to be loaded into
25 the second target object;

in response to determining that the weight of the second target object is about to exceed the weight threshold, controlling a second transporting robot to store the second target object in a third object storage position in the cube storage structure through a return process, and introducing a third target object to support the loading task, wherein the third
5 object storage position belongs to a third vertical storage structure in the cube storage structure,

the return process comprises:

controlling the second transporting robot to climb vertically upward to the third object storage position in the third vertical storage structure, and fixing the second target
10 object to the third object storage position.

Claim 17:

A cube storage system, comprising:

a cube storage structure, comprising a first vertical storage structure, the first vertical
15 storage structure comprising a plurality of first object storage positions arranged vertically;
and

a control system, configured to execute:

in response to a first transporting task of a first target object storing in the first vertical storage structure, determining whether there is a blocking object stored
20 in the first vertical storage structure relative to the first target object, wherein the first transporting task indicates to transport the first target object from a current position to a first target position, and the current position of the first target object corresponds to one of the first object storage positions;

in response to determining that there is the blocking object stored in the first
25 vertical storage structure relative to the first target object, controlling at least one

assisting transporting robot to move along a bottom of the cube storage structure to a bottom of the first vertical storage structure, then to climb vertically upward to below the blocking object in the first vertical storage structure, such that after the at least one auxiliary handling robot accesses the blocking object, the at least one assisting transporting robot climbs vertically downward to the bottom of the first vertical storage structure in the first vertical storage structure, thereby removing the blocking object from the first vertical storage structure;

in response to determining that there is no blocking object in the first vertical storage structure relative to the first target object, controlling a first transporting robot to move along the bottom of the cube storage structure to the bottom of the first vertical storage structure, then to climb vertically upward to the current position, such that after the first transporting robot accesses the first target object, the first transporting robot climbs vertically downward to the bottom of the first vertical storage structure in the first vertical storage structure, thereby transporting the first target object to the first target position.