

GOODS DISTRIBUTION SCHEDULING METHOD, APPARATUS, DEVICE, AND STORAGE MEDIUM

[0001] The present disclosure claims priority of a Chinese patent application
5 submitted to State Intellectual Property Office of China on August 06, 2021, with
an application No. 202110902043.9 and a title of “GOODS DISTRIBUTION
SCHEDULING METHOD, APPARATUS, COMPUTER DEVICE, AND
STORAGE MEDIUM”, and priority of a Chinese patent application submitted to
State Intellectual Property Office of China on February 18, 2022, with an
10 application No. 202210153563.9 and a title of “ROBOT TASK DISTRIBUTION
METHOD, APPARATUS, COMPUTER DEVICE, AND STORAGE MEDIUM”;
the entire content of which is incorporated in the present disclosure by reference.

TECHNICAL FIELD

15 [0002] The present disclosure relates to the technical field of smart devices, and
in particular, to a goods distribution scheduling method, apparatus, device, and
storage medium.

BACKGROUND

20 [0003] With development of infrastructure and technologies such as
communications, the Internet of Things, big data, and so on, many scenes involve
more requirements of collaboration. For example, in a scene of distributing
goods in a building including a robot assembly station and several distribution
robots, how should an order for a distribution task be distributed, which robot
25 should distribute it, when it should be distributed (by an elevator), and the order of
taking an elevator, and so on, are all issues that need to be considered at the group
level.

[0004] At present, distribution of goods for buildings is often assigning tasks
according to preset rules and then distributing according to a result of task
30 assignment. When the number of orders is large (the load is large), a large
number of order delays often occur, operations of distribution robots, robot

assembly stations, and elevators may conflict, and the efficiency of goods distribution will be low.

[0005] In view of this, it is necessary to provide a new goods distribution scheduling method, apparatus, device, and storage medium to overcome the
5 above-mentioned defects.

SUMMARY OF THE DISCLOSURE

[0006] Based on this, aiming at the above technical problems, it is necessary to provide a goods distribution scheduling method, apparatus, device, and storage
10 medium, which realize cloud scheduling for cooperative distribution among distribution robots, robot assembly stations, and building elevators, improve accuracy of assigning goods distribution tasks, and is conducive to improve goods distribution efficiency.

[0007] In order to realize the above purpose, in a first aspect, the present
15 disclosure provides a goods distribution scheduling method, which is applicable to a scene of package distribution in a building and includes the following steps executed by a cloud server:

[0008] acquiring state information of a distribution robot and of a robot assembly station, and acquiring order information of a package distribution task
20 and operation data of a building elevator;

[0009] calculating a current load of the robot assembly station and remaining capacity of the distribution robot based on the state information of the robot assembly station and the state information of the distribution robot;

[0010] determining a distribution capacity requirement of a distribution task in
25 a next cycle based on the order information of the distribution task and the operation data of the building elevator;

[0011] assigning the distribution task in the next cycle according to the distribution capacity requirement, the current load, and the remaining capacity to obtain an assigning result; and

30 [0012] generating a scheduling instruction according to the assigning result, and sending the scheduling instruction to the distribution robot, the robot

assembly station, and the building elevator, such that the distribution robot, the robot assembly station, and the building elevator operate based on the scheduling instruction.

[0013] In a preferred embodiment, the step of calculating a current load of the robot assembly station and remaining capacity of the distribution robot based on the state information of the robot assembly station and the state information of the distribution robot includes:

[0014] acquiring storage space information of the robot assembly station, and determining a current load of the robot assembly station based on the storage space information;

[0015] acquiring load information of the distribution robot, and determining current capacity of the distribution robot based on the load information; and

[0016] determining the remaining capacity based on the current load and the current capacity.

[0017] In a preferred embodiment, the step of acquiring load information of the distribution robot, and determining current capacity of the distribution robot based on the load information includes:

[0018] calculating capacity of one distribution robot using the following formula:

$$M = \left\lfloor m * \frac{\min(e, w1) - w2}{e - w2} \right\rfloor$$

[0019] wherein M is capacity of one distribution robot, m is the maximum load, e is electric power that suffices to complete maximum-loaded tasks, w1 is current electric power, and w2 is reserve electric power; and

[0020] determining the current capacity based on the capacity of one distribution robot.

[0021] In a preferred embodiment, the order information of the distribution task includes historical order information and current order information, and the operation data of the building elevator includes historical elevator operation data and current elevator operation data; the step of determining a distribution capacity

requirement of a distribution task in a next cycle based on the order information of the distribution task and the operation data of the building elevator includes:

[0022] acquiring the historical order information and the historical elevator operation data, and estimating an initial capacity requirement of each floor in the next cycle based on the historical order information and the historical elevator operation data;

[0023] acquiring the current order information and the current elevator operation data, and determining a current capacity requirement based on the current order information and the current elevator operation data; and

[0024] determining the distribution capacity requirement based on the initial capacity requirement and the current capacity requirement.

[0025] In a preferred embodiment, the step of assigning the distribution task in the next cycle according to the distribution capacity requirement, the current load, and the remaining capacity to obtain an assigning result includes:

[0026] calculating additional cost of executing a distribution task by the distribution robot according to the distribution capacity requirement and the remaining capacity;

[0027] acquiring a cost threshold preset by the distribution robot executing the distribution task;

[0028] assigning a package of the distribution task to the distribution robot to distribute when the additional cost is less than the cost threshold; and

[0029] assigning a package of the distribution task to the robot assembly station for temporary storage based on the current load when the additional cost is larger than or equal to the cost threshold.

[0030] In a preferred embodiment, the step of assigning a package of the distribution task to the distribution robot to distribute when the additional cost is less than the cost threshold includes:

[0031] calculating task revenue of executing each distribution task by each robot according to state information of a plurality of distribution robots and order information of a plurality of distribution tasks;

[0032] generating a revenue matrix with an index (robot, task) based on the

task revenue; and

[0033] performing task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty.

[0034] In a preferred embodiment, the step of calculating task revenue of
5 executing each distribution task by each robot according to state information of a plurality of distribution robots and order information of the distribution tasks includes:

[0035] acquiring launch time and current time of each distribution task according to the order information of the distribution tasks, and acquiring a type
10 basic value and a type time multiplier preset for each distribution task;

[0036] calculating ideal cost and additional cost of executing each distribution task by each robot according to the order information of the distribution tasks and the state information; and

[0037] calculating the task revenue based on the type basic value, the ideal cost,
15 the current time, the launch time, the type time multiplier, and the additional cost.

[0038] In a preferred embodiment, the ideal cost is a sum of ideal horizontal movement time, ideal longitudinal movement time, and ideal interaction time of performing each task in a preset condition by a robot, and the additional cost is a sum of additional horizontal movement time, additional longitudinal moving time,
20 and additional interaction time of adding a new task on the basis of an existing task by a robot.

[0039] In a preferred embodiment, the step of performing task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty includes:

[0040] searching a coordinate (i, j) where the maximum value in the revenue
25 matrix is located;

[0041] assigning a distribution task in a j-th column to a distribution robot in an i-th row; and

[0042] deleting the distribution task in the j-th column of the revenue matrix.

[0043] In a preferred embodiment, after the step of assigning a distribution task
30 in a j-th column to a distribution robot in an i-th row, the method further includes:

[0044] acquiring current state information of the distribution robot after accepting the distribution task in the j-th column;

[0045] determining whether the distribution robot is capable of continuously accepting distribution tasks according to the current state information;

5 [0046] deleting the distribution robot in the i-th row of the revenue matrix when the distribution robot is incapable of continuously accepting distribution tasks; and

[0047] re-calculating task revenue of executing each distribution task in the distribution revenue matrix by the distribution robot when the distribution robot is

10 capable of continuously accepting distribution tasks, and updating the re-calculated task revenue into the revenue matrix.

[0048] In a preferred embodiment, a formula for calculating the task revenue is:

[0049] Task revenue = Type basic value + (Current time-Launch time) × Type time multiplier - Additional cost, wherein the type basic value, the type time multiplier, the current time, and the launch time are acquired according to order

15 information of the distribution task, and the additional cost is a sum of additional horizontal movement time, additional longitudinal movement time, and additional interaction time of adding a new distribution task on the basis of an existing distribution task by a robot.

20 [0050] In a preferred embodiment, in the step of performing task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty, that the revenue matrix is empty includes that: state information of distribution robots in all rows of the revenue matrix is incapable of accepting any distribution task, and distribution tasks in all columns of the revenue matrix have

25 been assigned completely.

[0051] In a second aspect, the present disclosure provides a goods distribution scheduling apparatus, which is applicable to a scene of package distribution in a building and includes:

[0052] an acquiring module configured to acquire state information of a

30 distribution robot and of a robot assembly station, and acquire order information of a package distribution task and operation data of a building elevator;

- [0053] a calculating module configured to calculate a current load of the robot assembly station and remaining capacity of the distribution robot based on the state information of the robot assembly station and the state information of the distribution robot;
- 5 [0054] a determining module configured to determine a distribution capacity requirement of a distribution task in a next cycle based on the order information of the distribution task and the operation data of the building elevator;
- [0055] an assigning module configured to assign the distribution task in the next cycle according to the distribution capacity requirement, the current load, and
- 10 the remaining capacity to obtain an assigning result; and
- [0056] a scheduling module configured to generate a scheduling instruction according to the assigning result, and send the scheduling instruction to the distribution robot, the robot assembly station, and the building elevator, such that the distribution robot, the robot assembly station, and the building elevator
- 15 operate based on the scheduling instruction.
- [0057] In a preferred embodiment, the calculating module includes:
- [0058] a current load determining unit configured to acquire storage space information of the robot assembly station, and determine a current load of the robot assembly station based on the storage space information;
- 20 [0059] a current capacity determining unit configured to acquire load information of the distribution robot, and determine current capacity of the distribution robot based on the load information; and
- [0060] a remaining capacity determining unit configured to determine the remaining capacity based on the current load and the current capacity.
- 25 [0061] In a preferred embodiment, the order information of the distribution task includes historical order information and current order information, and the operation data of the building elevator includes historical elevator operation data and current elevator operation data; the determining module includes:
- [0062] an initial requirement acquiring unit configured to acquire the historical
- 30 order information and the historical elevator operation data, and estimate an initial capacity requirement of each floor in the next cycle based on the historical order

information and the historical elevator operation data;

[0063] a current requirement acquiring unit configured to acquire the current order information and the current elevator operation data, and determine a current capacity requirement based on the current order information and the current elevator operation data; and

[0064] a distribution requirement determining unit configured to determine the distribution capacity requirement based on the initial capacity requirement and the current capacity requirement.

[0065] In a preferred embodiment, the assigning module includes:

10 [0066] an additional cost calculating unit configured to calculate additional cost of executing a distribution task by the distribution robot according to the distribution capacity requirement and the remaining capacity;

[0067] a cost threshold acquiring unit configured to acquire a cost threshold preset by the distribution robot executing the distribution task;

15 [0068] a first assigning unit configured to assign a package of the distribution task to the distribution robot to distribute when the additional cost is less than the cost threshold; and

[0069] a second assigning unit configured to assign a package of the distribution task to the robot assembly station for temporary storage based on the current load when the additional cost is larger than or equal to the cost threshold.

[0070] In a preferred embodiment, the first assigning unit includes:

[0071] a task revenue calculating unit configured to calculate task revenue of executing each distribution task by each robot according to state information of a plurality of distribution robots and order information of a plurality of distribution tasks;

[0072] a revenue matrix generating unit configured to generate a revenue matrix with an index (robot, task) based on the task revenue; and

[0073] a distribution task assigning unit configured to perform task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty.

[0074] In a preferred embodiment, the distribution task assigning unit includes:

[0075] a searching unit configured to search a coordinate (i, j) where the maximum value in the revenue matrix is located;

[0076] an assigning sub-unit configured to assign a distribution task in a j-th column to a distribution robot in an i-th row; and

5 [0077] a deleting unit configured to delete the distribution task in the j-th column of the revenue matrix.

[0078] In a third aspect, the present disclosure further provides a computer device including a memory, a processor, and a computer program stored in the memory and being executable in the processor; the processor, when executing the
10 computer program, implements the goods distribution scheduling method according to any one of the above embodiments.

[0079] In a fourth aspect, the present disclosure further provides a computer storage medium, the computer storage medium stores a computer program therein, and the computer program, when being executed by a processor, implements the
15 goods distribution scheduling method according to any one of the above embodiments.

[0080] In comparison with the prior art, in the goods distribution scheduling method, apparatus, device, and storage medium provided by the present disclosure, a cloud server can: acquire state information of a distribution robot and of a robot
20 assembly station, and acquire order information of a package distribution task and operation data of a building elevator; calculate a current load and remaining capacity based on the state information of the robot assembly station and the state information of the distribution robot; determine a distribution capacity requirement of a distribution task in a next cycle based on the order information of
25 the distribution task and the operation data of the building elevator; assign the distribution task in the next cycle according to the distribution capacity requirement, the current load, and the remaining capacity to obtain an assigning result; and according to the assigning result, generate a scheduling instruction sent to the distribution robot, the robot assembly station, and the building elevator,
30 such that the distribution robot, the robot assembly station, and the building elevator operate based on the scheduling instruction. Cloud scheduling for

cooperative distribution among the distribution robot, the robot assembly station, and the building elevator is realized, collaboration among the distribution robot, the robot assembly station, and the building elevator is strong, and conflict and confusion can be avoided; accuracy of assigning goods distribution tasks is improved, and it is conducive to improve goods distribution efficiency.

[0081] Other features and advantages of the present disclosure will be set forth in the following description, and, in part, will become apparent from the description, or will be learned by practice of the present disclosure. The objectives and other advantages of the present disclosure will be realized and obtained by the structures particularly pointed out in the description, claims and drawings, and the details of one or more embodiments of the present disclosure will be set forth in the following drawings and the description.

[0082] In order to make the above purposes, features and advantages of the present disclosure be more obvious and easier to understand, optional embodiments are exemplified below, and are described in detail as follows in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0083] In order to describe technical solutions in embodiments of the present application or in the prior art more clearly, drawings required being used in description of the embodiments or of the prior art will be simply introduced below. Obviously, for one of ordinary skill in the art, it is also possible to acquire other drawings according to these drawings without paying any creative work.

[0084] FIG. 1 is a principle block diagram of a goods distribution scheduling apparatus provided by one or more embodiments of the present disclosure.

[0085] FIG. 2 is a flow chart of a goods distribution scheduling method provided by one or more embodiments of the present disclosure.

[0086] FIG. 3 is a schematic diagram of application of distribution task assignment in one or more embodiments of the present disclosure.

[0087] FIG. 4 is a principle block diagram of a computer device provided by one or more embodiments of the present disclosure.

DETAILED DESCRIPTION

[0088] In order that the above-mentioned purposes, features and advantages of the present disclosure can be understood more clearly, the solutions of the present disclosure will be further described below. It should be noted that the embodiments of the present disclosure and the features in the embodiments may be combined with each other under the condition of no conflict.

[0089] In the following description, many specific details are set forth in order to facilitate fully understanding the present disclosure, but the present disclosure can also be implemented in other ways different from those described here; obviously, the embodiments in the specification are only some embodiments of the present disclosure examples, but not all embodiments.

[0090] The terms “first”, “second”, and the like in the description and claims of the present disclosure are used to distinguish different objects, rather than to describe a specific order of the objects. For example, a first camera and a second camera are used to distinguish different cameras, rather than to describe a specific order of the cameras.

[0091] In the embodiments of the present disclosure, words such as “exemplary” or “such as” are used to mean serving as an example, illustration, or description. Any embodiment or design solution in the embodiments of the present disclosure described as “exemplary” or “such as” should not be construed as being preferred or advantageous over other embodiments or design solutions. In particular, the use of words such as “exemplary” or “such as” is intended to present the relevant concepts in a specific manner, and further, in the description of the embodiments of the present disclosure, unless otherwise stated, the meaning of “plurality” refers to two or more than two.

[0092] Referring to FIG. 1, which is a principle block diagram of a goods distribution scheduling apparatus provided by the present disclosure. The goods distribution scheduling apparatus 100 provided by the present disclosure includes an acquiring module 10, a calculating module 20, a determining module 30, an assigning module 40, and a scheduling module 50.

[0093] Specifically, the acquiring module 10 is configured to acquire state information of a distribution robot and of a robot assembly station, and acquire order information of a package distribution task and operation data of a building elevator; the calculating module 20 is configured to calculate a current load of the robot assembly station and remaining capacity of the distribution robot based on the state information of the robot assembly station and the state information of the distribution robot; the determining module 30 is configured to determine a distribution capacity requirement of a distribution task in a next cycle based on the order information of the distribution task and the operation data of the building elevator; the assigning module 40 is configured to assign the distribution task in the next cycle according to the distribution capacity requirement, the current load, and the remaining capacity to obtain an assigning result; and the scheduling module 50 is configured to generate a scheduling instruction according to the assigning result, and send the scheduling instruction to the distribution robot, the robot assembly station, and the building elevator, such that the distribution robot, the robot assembly station, and the building elevator operate based on the scheduling instruction.

[0094] Furthermore, the calculating module includes: a current load determining unit, a current capacity determining unit, and a remaining capacity determining unit.

[0095] Specifically, the current load determining unit is configured to acquire storage space information of the robot assembly station, and determine a current load of the robot assembly station based on the storage space information; the current capacity determining unit configured to acquire load information of the distribution robot, and determine current capacity of the distribution robot based on the load information; and the remaining capacity determining unit is configured to determine the remaining capacity based on the current load and the current capacity.

[0096] In this embodiment, when acquiring load information of the distribution robot, and determining current capacity of the distribution robot based on the load information, the following steps are specifically executed:

[0097] calculating capacity of one distribution robot using the following formula:

$$M=\left\lfloor m * \frac{\min(e,w1)-w2}{e-w2} \right\rfloor$$

[0098] wherein M is capacity of one distribution robot, m is the maximum load, e is electric power that suffices to complete maximum-loaded tasks, w1 is current electric power, and w2 is reserve electric power; and

[0099] determining the current capacity based on the capacity of one distribution robot.

[00100] Furthermore, the order information of the distribution task includes historical order information and current order information, and the operation data of the building elevator includes historical elevator operation data and current elevator operation data; the determining module includes: an initial requirement acquiring unit, a current requirement acquiring unit, and a distribution requirement determining unit.

[00101] Specifically, the initial requirement acquiring unit is configured to acquire the historical order information and the historical elevator operation data, and estimate an initial capacity requirement of each floor in the next cycle based on the historical order information and the historical elevator operation data; the current requirement acquiring unit is configured to acquire the current order information and the current elevator operation data, and determine a current capacity requirement based on the current order information and the current elevator operation data; and the distribution requirement determining unit is configured to determine the distribution capacity requirement based on the initial capacity requirement and the current capacity requirement.

[00102] Furthermore, the assigning module includes: an additional cost calculating unit, a cost threshold acquiring unit, a first assigning unit, and a second assigning unit.

[00103] Specifically, the additional cost calculating unit is configured to calculate additional cost of executing a distribution task by the distribution robot according to the distribution capacity requirement and the remaining capacity; the

cost threshold acquiring unit is configured to acquire a cost threshold preset by the distribution robot executing the distribution task; the first assigning unit is configured to assign a package of the distribution task to the distribution robot to distribute when the additional cost is less than the cost threshold; and the second
5 assigning unit is configured to assign a package of the distribution task to the robot assembly station for temporary storage based on the current load when the additional cost is larger than or equal to the cost threshold.

[00104] Furthermore, the first assigning unit includes: a task revenue calculating unit, a revenue matrix generating unit, and a distribution task assigning unit.

10 [00105] Specifically, the task revenue calculating unit is configured to calculate task revenue of executing each distribution task by each robot according to state information of a plurality of distribution robots and order information of a plurality of distribution tasks; the revenue matrix generating unit is configured to generate a revenue matrix with an index (robot, task) based on the task revenue;
15 and the distribution task assigning unit is configured to perform task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty. Understandably, that the revenue matrix is empty includes that: state information of distribution robots in all rows of the revenue matrix is incapable of accepting any distribution task, and distribution tasks in all columns
20 of the revenue matrix have been assigned completely.

[00106] In this embodiment, when calculating task revenue of executing each distribution task by each robot according to state information of a plurality of distribution robots and order information of distribution tasks, the following steps are specifically executed:

25 [00107] acquiring launch time and current time of each distribution task according to the order information of the distribution tasks, and acquiring a type basic value and a type time multiplier preset for each distribution task;

[00108] calculating ideal cost and additional cost of executing each distribution task by each robot according to the order information of the distribution tasks and
30 the state information; and

[00109] calculating the task revenue based on the type basic value, the ideal cost,

the current time, the launch time, the type time multiplier, and the additional cost.

[00110] Understandably, the ideal cost is a sum of ideal horizontal movement time, ideal longitudinal movement time, and ideal interaction time of performing each task in a preset condition by a robot, and the additional cost is a sum of
5 additional horizontal movement time, additional longitudinal moving time, and additional interaction time of adding a new task on the basis of an existing task by a robot.

[00111] Specifically, a formula for calculating the task revenue is as follows:

[00112] Task revenue = Task basic value + (Current time-Launch time) × Type
10 time multiplier - Additional cost, wherein Task basic value = Type basic value + Ideal cost.

[00113] As an embodiment, under the condition that the meanings of other calculation parameters remain unchanged, the ideal cost may also not be considered when calculating the task revenue. When the ideal cost is not
15 considered, the method of calculating the task revenue is:

[00114] Task revenue = Type basic value + (Current time-Launch time) × Type
time multiplier - Additional cost, wherein the type basic value, the type time multiplier, the current time, and the launch time are acquired according to information of the task, and the additional cost is a sum of additional horizontal
20 movement time, additional longitudinal movement time, and additional interaction time of adding a new task on the basis of an existing task by a robot.

[00115] Furthermore, the distribution task assigning unit includes: a searching unit, an assigning sub-unit, and a deleting unit.

[00116] Specifically, the searching unit is configured to search a coordinate (i, j)
25 where the maximum value in the revenue matrix is located; the assigning sub-unit is configured to assign a distribution task in a j-th column to a distribution robot in an i-th row; and the deleting unit is configured to delete the distribution task in the j-th column of the revenue matrix.

[00117] Furthermore, after the step of assigning a distribution task in a j-th
30 column to a distribution robot in an i-th row, the following steps are further executed:

[00118] acquiring current state information of the distribution robot after accepting the distribution task in the j-th column;

[00119] determining whether the distribution robot is capable of continuously accepting distribution tasks according to the current state information;

5 [00120] deleting the distribution robot in the i-th row of the revenue matrix when the distribution robot is incapable of continuously accepting distribution tasks; and

[00121] re-calculating task revenue of executing each distribution task in the distribution revenue matrix by the distribution robot when the distribution robot is
10 capable of continuously accepting distribution tasks, and updating the re-calculated task revenue into the revenue matrix.

[00122] It can be understood that the above-mentioned functional modules and units can be stored in a memory in the form of software programs and executed by a processor. In alternative embodiments, the above-mentioned functional
15 modules and units may also be hardware with specific functions, for example, chips programmed with specific software programs.

[00123] The above-mentioned functional modules and units are introduced in detail in conjunction with FIG. 2 below.

[00124] As shown in FIG. 2, which is a flowchart of a goods distribution
20 scheduling method provided by the present disclosure. It should be noted that the method of the present disclosure is not limited to the sequence of the following steps, and in other embodiments, the method of the present disclosure may only include some of the steps described below, or some of the steps may be deleted. In implementation, the goods distribution scheduling method can be
25 implemented by the above-mentioned goods distribution scheduling apparatus.

[00125] The goods distribution scheduling method provided by the present disclosure is applicable to a scene of package distribution in a building and includes the following steps executed by a cloud server:

[00126] S10: acquiring state information of a distribution robot and of a robot
30 assembly station, and acquiring order information of a package distribution task and operation data of a building elevator.

[00127] Specifically, the robot assembly station, the distribution robot, and the building elevator can communicate with the cloud server through 4G data link; the acquiring module 10 of the cloud server acquires the state information of robot assembly station and the state information of the distribution robot through this communication, and at the same time, acquires the operation data of the building elevator; moreover, when a user needs to carry out package distribution, order information of the distribution task can be acquired.

[00128] Understandably, the robot assembly station (Station) is a facility that has storage space and can use a mechanical arm to refit a robot. Under the building distribution scene, refitting the robot is assembling the robot, at this time, the robot assembly station can be regarded as a courier cabinet with an assembly function, and the state information of the robot assembly station includes but is not limited to storage space information, etc.

[00129] The state information of the distribution robot includes but is not limited to: a floor where the robot is currently located, coordinates and an angle of map where it is located, a load, and power information; wherein, the load is specific to occupancy of each Cabinet under each Box and corresponding order information, Cabinet is storage space corresponding to a package, and Box is the smallest unit for the robot assembly station to assemble the distribution robot. At present, one Box corresponds to two Cabinets, and a single distribution robot has a maximum load of two Boxes. When the robot assembly station assembles the distribution robot, it is possible to switch only one Box.

[00130] Package is a basic unit used to describe space required for distribution of goods, order is a distribution task under a user's perspective, and basic information of an order is composed of launch time, a starting point, a destination point, package quantity, sender information, recipient information, etc. Among them, the points are physical locations that are marked when implementing in a building and can be perceived by many robots. Basic information of a point is composed of location information and description information, wherein the location information is a floor where it is located and coordinates in a corresponding map.

[00131] Operation data of an elevator refers to data information of elevator in an operation process, including but not limited to: operation states (stop, ascending and descending), elevator events (door opening events, start events), and position information in an operation process (a current stop floor, passing floors), etc.

- 5 [00132] Step S20: calculating a current load of the robot assembly station and remaining capacity of the distribution robot based on the state information of the robot assembly station and the state information of the distribution robot.

[00133] Specifically, the calculating module 20 can calculate the current load according to the acquired state information of the robot assembly station, and can
10 calculate the remaining capacity according to the acquired state information of the distribution robot. It can be understood that the capacity is used to describe the capacity (quantity) of packages that need to be distributed by the robot, and the remaining capacity is the remaining capacity of distributing packages of the robot after accepting one or more tasks.

- 15 [00134] Step S30, determining a distribution capacity requirement of a distribution task in a next cycle based on the order information of the distribution task and the operation data of the building elevator.

[00135] Specifically, the capacity requirement is used to characterize the scale of required robot load. It is possible to preset a capacity estimation model, that is,
20 perform machine learning through historical order information and historical elevator operation data, the obtained result is used to estimate the capacity requirement of the next cycle and thereby obtain the initial capacity requirement. Moreover, the current capacity requirement can be determined based on the current order information and the current elevator operation data, and the
25 determining module 30 determines the final distribution capacity requirement according to the initial capacity requirement and the current capacity requirement.

[00136] Step S40: assigning the distribution task in the next cycle according to the distribution capacity requirement, the current load, and the remaining capacity to obtain an assigning result.

- 30 [00137] Specifically, the assigning module 40 adopts an optimization algorithm to perform the capacity assignment for distribution tasks, and the target of

optimization is to maximize revenue (i.e., revenue-extra cost), and at the same time, the cloud calculates in conjunction with historical data to obtain a cost threshold of using robot distribution at a current time point, which is used to decide whether a package should be distributed directly by the distribution robot or temporarily stored in the robot assembly station. When the decision is assigned to the robot, the condition that waiting time of the rider is less than 1 minute needs to be additionally considered. Among distribution robots that meet the assignment conditions, the most profitable one is selected as the final assigning result, and packages that do not meet conditions of assignment to the robot will be instructed to be put into the robot assembly station, thereby obtaining the capacity assigning result.

[00138] Step S50: generating a scheduling instruction according to the assigning result, and sending the scheduling instruction to the distribution robot, the robot assembly station, and an elevator control system of a building, such that the distribution robot, the robot assembly station, and the elevator control system operate based on the scheduling instruction.

[00139] Specifically, the scheduling module 50 of the cloud server generates a scheduling instruction according to the capacity assigning result, sends the scheduling instruction to a control center of the robot assembly station and the distribution robot, such that the control center of the robot assembly station and the distribution robot performing goods distribution according to the scheduling instruction; and an elevator instruction is sent to an elevator control system of a building, such that the elevator control system schedules operation of an elevator based on the elevator scheduling instruction.

[00140] Therefore, in the goods distribution scheduling method provided by the present disclosure, a cloud server can: acquire state information of a distribution robot and of a robot assembly station, and acquire order information of a package distribution task and operation data of a building elevator; calculate a current load and remaining capacity of the distribution robot based on the state information of the robot assembly station and the state information of the distribution robot; determine a distribution capacity requirement of a distribution task in a next cycle

based on the order information of the distribution task and the operation data of the building elevator; assign the distribution task in the next cycle according to the distribution capacity requirement, the current load, and the remaining capacity to obtain an assigning result; and according to the assigning result, generate a scheduling instruction sent to the distribution robot, the robot assembly station, and the building elevator, such that the distribution robot, the robot assembly station, and the building elevator operate based on the scheduling instruction. Cloud scheduling for cooperative distribution among the distribution robot, the robot assembly station, and the building elevator is realized, collaboration among the distribution robot, the robot assembly station, and the building elevator is strong, and conflict and confusion can be avoided; accuracy of assigning goods distribution tasks is improved, and it is conducive to improve goods distribution efficiency.

[00141] Furthermore, the step S20 includes the following steps:

[00142] Acquiring storage space information of the robot assembly station, and determining a current load of the robot assembly station based on the storage space information. Specifically, the storage space information includes the number of storage spaces and using states of the storage spaces; each package corresponds to a storage space, and the using state of each storage space is divided into “occupied” and “idle” according to whether a package is stored therein; based on the number of storage spaces of which the storage space using state is “occupied”, the current load of the robot assembly station can be determined.

[00143] Acquiring load information of the distribution robot, and determining current capacity of the distribution robot based on the load information. Specifically, based on the state information of the distribution robot, its load information can be acquired, and thus the current capacity of the robot can be acquired.

[00144] Determining the remaining capacity based on the current load and the current capacity. Specifically, according to the current load of the robot assembly station and the current capacity of the distribution robot, the remaining capacity of the robot can be obtained.

[00145] In a specific alternative embodiment, the state information of the distribution robot includes the maximum battery capacity, the maximum load, and electricity that can meet the maximum load; the step of acquiring load information of the distribution robot, and determining current capacity of the distribution robot based on the load information includes:

[00146] calculating capacity of one distribution robot using the following formula:

$$M = \left\lfloor m * \frac{\min(e, w1) - w2}{e - w2} \right\rfloor$$

[00147] wherein M is capacity of one distribution robot, m is the maximum load, e is electric power that suffices to complete maximum-loaded tasks, w1 is current electric power, and w2 is reserve electric power; and

[00148] determining the current capacity based on the capacity of one distribution robot.

[00149] Understandably, when calculating the remaining capacity, considering electricity levels of robots, and through calculating capacity of each distribution robot, the current capacity is obtained; a rate and accuracy of acquiring the capacity are improved, and the remaining capacity calculated in combination with the electricity and load of the robots is more accurate.

[00150] Furthermore, the order information of the distribution task includes historical order information and current order information, and the operation data of the building elevator includes historical elevator operation data and current elevator operation data. The step S30 includes the following steps:

[00151] acquiring the historical order information and the historical elevator operation data, and estimating an initial capacity requirement of each floor in the next cycle based on the historical order information and the historical elevator operation data;

[00152] acquiring the current order information and the current elevator operation data, and determining a current capacity requirement based on the current order information and the current elevator operation data; and

[00153] determining the distribution capacity requirement based on the initial

capacity requirement and the current capacity requirement.

[00154] Specifically, an initial capacity requirement and a current capacity requirement are summarized, and a distribution capacity requirement to be assigned can be obtained. Among them, regarding the initial capacity

5 requirement, it is possible to predict, based on the historical order information and the historical elevator operation data, how many packages' capacity requirement will occur on each floor during each time slice (such as 3 minutes) in a future period of time (such as 30 minutes), and expected waiting time of the elevator going up and down to each floor. It is understandable that although the
10 prediction is performed according to time slices, any two slices may be linearly connected in the specific implementation. For example, it is expected that a certain floor of a building will have n_1 and n_2 packages at t_1 and t_2 ($t_2 > t_1$) time respectively, and the two time points are connected linearly, then there will be $n_1 * [(t_2 - t) / (t_2 - t_1)] + n_2 * [(t - t_1) / (t_2 - t_1)]$ packages when $t \in [t_1, t_2]$, thus in fact,
15 expectation at any time point can be obtained.

[00155] Furthermore, the step S40 includes the following steps:

[00156] calculating additional cost of executing a distribution task by the distribution robot according to the distribution capacity requirement and the remaining capacity;

20 [00157] acquiring a cost threshold preset by the distribution robot executing the distribution task;

[00158] assigning a package of the distribution task to the distribution robot to distribute when the additional cost is less than the cost threshold; and

[00159] assigning a package of the distribution task to the robot assembly station
25 for temporary storage based on the current load when the additional cost is larger than or equal to the cost threshold.

[00160] Specifically, the expectation is adjusted according to actual order information, and capacity assignment for the next stage is preformed for not assigned packages (just received orders) and an expected quantity of packages.

30 The capacity assignment adopts an optimization algorithm, and an object of

optimization is maximizing revenue. At the same time, the cloud can calculate in combination with historical data to obtain a cost threshold of distribution using robots at the current time point, which is used to decide whether a package should be directly distributed by a robot or temporarily stored in Station.

- 5 [00161] Furthermore, the step of assigning a package of the distribution task to the distribution robot to distribute when the additional cost is less than the cost threshold includes:

[00162] calculating task revenue of executing each distribution task by each robot according to state information of a plurality of distribution robots and order
10 information of a plurality of distribution tasks;

[00163] generating a revenue matrix with an index (robot, task) based on the task revenue; and

[00164] performing task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty.

- 15 [00165] Specifically, task revenue of executing each distribution task by each robot is calculated according to acquired state information and order information. A larger the task revenue value represents that a robot is more beneficial to accept the task, for example, according to a task type, a load requirement, and supplementary information, etc., it is determined whether a robot meets task
20 acceptance conditions. If not, the task revenue is 0, which means that the robot cannot accept the task. Then a revenue matrix is generate based on the task revenue obtained by calculation, the revenue matrix is a matrix formed by arranging the task revenue obtained by calculation in a manner that rows correspond to a plurality of robots and columns correspond to a plurality of tasks.
25 Finally, task assignment is performed for the robots based on the revenue matrix until the revenue matrix is empty, which realizes task assignment for multiple robots in a building according to the task revenue. By appropriate task arrangement and distribution, a robot cluster can better utilize respective advantages of internal members and complete tasks efficiently. Understandably,
30 that the revenue matrix is empty includes that: state information of distribution robots in all rows of the revenue matrix is incapable of accepting any distribution

task, and distribution tasks in all columns of the revenue matrix have been assigned completely.

[00166] Furthermore, the step of calculating task revenue of executing each distribution task by each robot according to state information of a plurality of
5 distribution robots and order information of the distribution tasks includes:

[00167] acquiring launch time and current time of each distribution task according to the order information of the distribution tasks, and acquiring a type basic value and a type time multiplier preset for each distribution task;

[00168] calculating ideal cost and additional cost of executing each distribution
10 task by each robot according to the order information of the distribution tasks and the state information; and

[00169] calculating the task revenue based on the type basic value, the ideal cost, the current time, the launch time, the type time multiplier, and the additional cost.

[00170] Specifically, the launch time and the current time are obtained in the
15 order information, and the type basic value and the type time multiplier are obtained according to the task type in the order information. Understandably, depending on difference of urgency of the tasks, different types basic values and type time multipliers are correspondingly preset for different types of tasks in the task revenue. For example, basic values and time multipliers of takeaway tasks are
20 higher than those of express delivery tasks. Moreover, according to the “first come, first served” principle, the longer the task waiting time, that is, the greater the difference between the current time and the launch time, the higher the task revenue.

[00171] Understandably, task cost refers to time cost required for a robot to
25 perform a task, although links corresponding to different tasks are different, it can be basically divided into horizontal movement time, longitudinal movement time and interaction time. Among them, the horizontal movement time can be obtained by a sum of distances between nodes obtained by the robot’s plane pathfinding divided by a horizontal movement speed; the longitudinal movement
30 time is estimated according to a state of an elevator group, for example, estimated according to historical data of the elevator group; the interaction time is calculated

according to specific tasks, for example: a takeout task reserves 30 seconds and 90 seconds for riders to deliver goods and for users to pick up meals, respectively, and a patrol task reserves corresponding observation time for each observation point.

5 [00172] The ideal cost is the sum of ideal horizontal movement time, ideal longitudinal movement time and ideal interaction time for a robot to perform each task under preset conditions, that is, pre-estimation completed under preset conditions, for example: a robot's movement speed, time for waiting an elevator, and so on, are all estimated based on historical averages, such as historical actual
10 cost when the robot performed this type of task last time, such as historical average spent time when the robot performed this type of task; in some embodiments, the ideal cost can also be a preset numerical threshold, which is different from actual cost in that a real-time scene can be estimated more accurately according to current situations such as population, elevators, etc. The
15 additional cost is the sum of additional horizontal movement time, additional longitudinal movement time, and additional interaction time for the robot to add a new task on the basis of the existing task. For example: the same starting point means that the robot may be able to merge paths of two tasks, the same target floor has no additional longitudinal movement time for the robot, etc.

20 [00173] Specifically, a formula for calculating the task revenue is as follows:

[00174] Task revenue = Task basic value + (Current time-Launch time) × Type time multiplier - Additional cost, wherein Task basic value = Type basic value + Ideal cost.

[00175] As an embodiment, under the condition that the meanings of other
25 calculation parameters remain unchanged, the ideal cost may also not be considered when calculating the task revenue. When the ideal cost is not considered, the method of calculating the task revenue is:

[00176] Task revenue = Type basic value + (Current time-Launch time) × Type time multiplier - Additional cost, wherein the type basic value, the type time
30 multiplier, the current time, and the launch time are acquired according to information of the task, and the additional cost is a sum of additional horizontal

movement time, additional longitudinal movement time, and additional interaction time of adding a new task on the basis of an existing task by a robot; specific obtaining methods or calculating methods of the type basic value, the current time, the launch time, the type time multiplier, and the additional cost refer to the

5 above-mentioned embodiments.

[00177] Understandably, adding the ideal cost in the process of calculating the task revenue is intended to avoid the problem that a long-distance task causes a priority level to be lowered due to cost.

[00178] Furthermore, the step of performing task assignment for the distribution

10 robots according to the revenue matrix until the revenue matrix is empty includes the following steps:

[00179] searching a coordinate (i, j) where the maximum value in the revenue matrix is located;

[00180] assigning a distribution task in a j-th column to a distribution robot in an

15 i-th row; and

[00181] deleting the distribution task in the j-th column of the revenue matrix.

[00182] By such design, first, the searching unit can search the coordinate (i, j) where the maximum value in the revenue matrix is located, the assigning sub-unit assigns a task in the j-th column to a robot in the i-th row, and the first deleting

20 unit deletes the j-th column of the revenue matrix; that is, after task assignment for the j-th column has been completed, this column is deleted, thereby completing the step of assigning the distribution task in the j-th column to the distribution robot in the i-th row.

[00183] Furthermore, after the step of assigning a distribution task in a j-th

25 column to a distribution robot in an i-th row, the following steps are further included:

[00184] acquiring current state information of the distribution robot after accepting the distribution task in the j-th column;

[00185] determining whether the distribution robot is capable of continuously

30 accepting distribution tasks according to the current state information;

[00186] deleting the distribution robot in the i-th row of the revenue matrix

when the distribution robot is incapable of continuously accepting distribution tasks; and

[00187] re-calculating task revenue of executing each distribution task in the distribution revenue matrix by the distribution robot when the distribution robot is
5 capable of continuously accepting distribution tasks, and updating the re-calculated task revenue into the revenue matrix.

[00188] Specifically, after assigning the task in the j-th column to the robot in the i-th row, it is possible to acquire current state information of the robot after accepting the task in the j-th column, for example, load after accepting the task,
10 remaining electricity after completing the task, and other information, and then determine whether the robot can continuously accept tasks according to the current state information; when the robot does not meet conditions of continuously accepting new tasks, that is, cannot continuously accept tasks, the i-th row of the revenue matrix can be deleted. Understandably, when the
15 distribution robot can continuously accept tasks, task revenue of executing each task in the revenue matrix by the robot is re-calculated, and the updating unit can update the re-calculated task revenue into the revenue matrix, thereby facilitating re-performing task assignment according to the updated revenue matrix.

[00189] As embodiments, the ideal cost, the additional cost, and the task revenue
20 in the above embodiments can also be calculated by a calculating unit; in implementation, according to differences of requirements, calculation of the ideal cost, the additional cost, and the task revenue can be completed by one or more calculating units.

[00190] Referring to FIG. 3, which is a schematic diagram of application of
25 distribution task assignment in the present disclosure. In FIG. 3, taking a scene including four robots and four tasks as an example, a revenue matrix is first obtained by calculation. Since the robot 1 only remains load 1, the task 1 and the task 4 are unacceptable for the robot 1, and task revenue is 0; then it is found that the maximum value in the revenue matrix occurs in (1, 2), therefore the task 2 is
30 assigned to the robot 1; after the robot 1 accepting the task 2, its load reaches an upper limit, therefore the revenue matrix deletes the second column and the first

row synchronously; since states of other robots are unchanged, there is no need for re-calculation, the maximum value in the revenue matrix occurs in (3, 1), and thus the task 1 is assigned to the robot 4; task assignment is performed according to the above process, until all tasks are assigned or all robots reach upper limits.

5 It is realized that task assignment is performed for a robot cluster according to task revenue, not only can tasks of the same type be assigned reasonably, but also executing sequences of tasks of different types can be arranged properly; by appropriate task arrangement and distribution, the robot cluster can better utilize respective advantages of internal members and complete tasks efficiently.

10 [00191] Furthermore, in the step S50, the cloud server shares planning arrangement with Station and robots according to the assigning result, and makes mobile scheduling for idle elevators; and in other embodiments, can also send instruction of riders' package placement to a user mobile phone terminal, so as to further improve the efficiency of goods distribution.

15 [00192] The robot assembly station, after receiving the scheduling instruction of the cloud server, deploys packages based on the scheduling instruction, and feedbacks to the cloud server after the assignment is successful, wherein assigning methods include a same-floor-priority method and a time-priority method. Specifically, since the distribution time is not known at this time, the time cost

20 cannot be accurately calculated; the same floor means no additional time cost, and the same-floor-priority method means that packages on the same floor are distributed together first; the time-priority method means that in the same target floor, the earlier the task is initiated, the higher the profit. In this embodiment, when there is no target Box on the same floor (or all of them are full), empty

25 Boxes are preferentially selected, and then Boxes on the target floor in the same section (there may be partitions on the floor) are preferentially selected according to an elevator group. It should be noted that a robot assembly station control center can control the robot assembly station to perform package deployment. The robot assembly station control center, while assigning packages, will calculate

30 expected arrival time of each robot that has received an assembly task, and adjust Box positions according to a sequence to save assembly time.

[00193] A distribution robot, after acquiring the scheduling instruction of the cloud server, chooses to accept or temporarily not accept the task according to its own real load situation, and the robot that accepts the task adjusts the order of executing the task according to the priority of the task and the task revenue.

5 Specifically, a task that is being executed has the highest priority, and the priority of a charging task will be directly increased when a power level drops below a certain threshold. Understandably, since errors may exist in communication, the robot has the right of near field priority in the process of performing tasks. For example, during a distribution process, the robot will re-calculate cost of

10 executing each task according to elevator states obtained in the near field, and the distribution robot will update the latest states to the cloud server.

[00194] If a building elevator is still in an idle state when receiving the scheduling instruction of the cloud server, it will move according to the instruction of the cloud. Specifically, the elevator can be controlled to operate by

15 an elevator control center.

[00195] Optionally, after the step S50, the goods distribution scheduling method further includes:

[00196] after receiving state updating success messages of the robot assembly station, the distribution robot, and the building elevator, generating a scheduling

20 task in the next cycle based on the updated states.

[00197] In this embodiment, after state updating success messages of a robot assembly station control center, a distribution robot, and an elevator control system are received, a scheduling task in the next cycle is generated based on the updated states, thereby realizing updating the scheduling task in real time;

25 timeliness and precision of scheduling is conducive to improve goods distribution efficiency.

[00198] Referring to FIG. 4, the present disclosure further provides a computer device 4, the computer device 4 includes a memory 41, a processor 42, and a network interface 43 which are connected in communication by a system bus. It

30 should be pointed out that the figure only shows the computer device 4 having components connected to the memory 41, the processor 42, and the network

interface 43, but it should be understood that it is not required to implement all the shown components, and more or fewer components may be alternatively implemented. Among them, those skilled in the art can understand that the computer device here is a device that can automatically perform numerical calculation and/or information processing according to instructions set or stored in advance, and its hardware includes but is not limited to microprocessors, special-purpose Integrated circuit (Application Specific Integrated Circuit, ASIC), Programmable Gate Array (Field-Programmable Gate Array, FPGA), digital signal processors (Digital Signal Processor, DSP), embedded devices, etc.

[00199] The computer device can be a desktop computer, a notebook, a palmtop computer, a cloud server, and other computing devices. The computer device can perform human-computer interaction with users through a keyboard, a mouse, a remote controller, a touch pad, a voice control device, or other methods.

[00200] The memory 41 includes at least one type of readable storage medium, the readable storage medium includes a flash memory, a hard disk, a multimedia card, a card type memory (for example, SD or D interface display memory or the like), a random access memory (RAM), a static random access memory (SRAM), a read only memory (ROM), an electrically erasable programmable read only memory (EEPROM), a programmable read only memory (PROM), a magnetic memory, a magnetic disk, an optical disk, etc. In some embodiments, the memory 41 may be an internal storage unit of the computer device 4, such as a hard disk or a memory of the computer device 4. In other embodiments, the memory 41 may also be an external storage device of the computer device 4, such as a plug-in hard disk, a smart memory card (Smart Media Card, SMC), a secure digital (Secure Digital, SD) card, a flash memory card (Flash Card), and the like equipped for the computer device 4. Of course, the memory 41 may also include both the internal storage unit of the computer device 4 and its external storage device. In this embodiment, the memory 41 is generally used to store an operating system and various application software installed on the computer device 4, such as program codes compressed in an Android installation package. In addition, the memory 41 can also be used to temporarily store various types of

data that have been output or will be output.

[00201] In some embodiments, the processor 42 may be a central processing unit (Central Processing Unit, CPU), a controller, a microcontroller, a microprocessor, or other data processing chips. This processor 42 is usually used to control the
5 overall operation of the computer device 4. In this embodiment, the processor 42 is configured to run program codes or process data stored in the memory 41, for example, run program codes for controlling electronic files.

[00202] The network interface 43 can include a wireless network interface or a wired network interface. The network interface 43 is usually configured to
10 establish a communication connection between the computer device 4 and other electronic devices.

[00203] The present disclosure further provides a computer storage medium, the computer storage medium stores a computer program therein, and the computer program, when being executed by a processor, implements the goods distribution
15 scheduling method according to any one of the above embodiments.

[00204] Through the description of the above embodiments, those skilled in the art can clearly understand that the methods of the above embodiments can be realized by means of software and necessary general hardware platform, and of course can also be by hardware, but in many cases the former is a better
20 implementation. Based on this understanding, essence or parts that make contributions to the prior art of the technical solutions of the present application can be embodied in the form of a software product, and the computer software product is stored in a storage medium (such as ROM/RAM, magnetic disk, optical disk), and includes several instructions to make a terminal device (which may be a
25 mobile phone, a computer, a server, an air conditioner, or a network device, etc.) execute the methods described in the various embodiments of the present application.

[00205] The present application may be used in numerous general-purpose or special-purpose computer system environments or configurations. For example:
30 personal computers, server computers, handheld devices or portable devices, tablet devices, multiprocessor systems, microprocessor-based systems, set-top

boxes, programmable consumer electronic devices, network PCs, minicomputers, mainframe computers, distributed computing environments including any of the above systems or devices, and the like. The present application may be described in general context of computer-executable instructions executed by a computer, such as program modules. Generally, a program module includes routines, programs, objects, components, data structures, and others that perform particular tasks or implement particular abstract data types. The present application may also be practiced in distributed computing environments; in these distributed computing environments, tasks are performed by remote processing devices connected through a communications network. In a distributed computing environment, program modules may be located in local and remote computer storage media including storage devices.

[00206] It should be noted that all embodiments of the goods distribution scheduling method provided by the present disclosure are applicable to the goods distribution scheduling device 100, the computer device, and the computer storage medium provided by the present disclosure, and all can achieve the same or similar beneficial effect.

[00207] Various technical features of the above embodiments can be combined arbitrarily. In order to make the description be concise, possible combinations of the various technical features in the above-described embodiments are not all described, however, as long as there is no contradiction in the combinations of these technical features, they should be all considered as being within the scope of this specification.

[00208] The above embodiments only express several implementations of the present disclosure, their description is relatively specific and detailed, but cannot therefore be interpreted as limitation to the scope of the invention patent. It should be noted that, for those skilled in the art, several modifications and improvements can be made without departing from the concept of the present disclosure, these all belong to the protection scope of the present disclosure. Accordingly, the patent protection scope of the present disclosure should be determined by the appended claims.

Industrial Applicability

[00209] In the goods distribution scheduling method, apparatus, computer device, and computer storage medium provided by the present disclosure, a cloud server can: acquire state information of a distribution robot and of a robot assembly station, and acquire order information of a package distribution task and operation data of a building elevator; calculate a current load and remaining capacity based on the state information of the robot assembly station and the state information of the distribution robot; determine a distribution capacity requirement of a distribution task in a next cycle based on the order information of the distribution task and the operation data of the building elevator; assign the distribution task in the next cycle according to the distribution capacity requirement, the current load, and the remaining capacity to obtain an assigning result; and according to the assigning result, generate a scheduling instruction sent to the distribution robot, the robot assembly station, and the building elevator, such that the distribution robot, the robot assembly station, and the building elevator operate based on the scheduling instruction. Cloud scheduling for cooperative distribution among the distribution robot, the robot assembly station, and the building elevator is realized, collaboration among the distribution robot, the robot assembly station, and the building elevator is strong, and conflict and confusion can be avoided; accuracy of assigning goods distribution tasks is improved, and it is conducive to improve goods distribution efficiency, there is strong industrial applicability.

What is claimed is:

1. A goods distribution scheduling method, which is applicable to a scene of package distribution in a building and comprises the following steps executed by a cloud server:

5 acquiring state information of a distribution robot and of a robot assembly station, and acquiring order information of a package distribution task and operation data of a building elevator;

 calculating a current load of the robot assembly station and remaining capacity of the distribution robot based on the state information of the robot
10 assembly station and the state information of the distribution robot;

 determining a distribution capacity requirement of a distribution task in a next cycle based on the order information of the distribution task and the operation data of the building elevator;

 assigning the distribution task in the next cycle according to the distribution
15 capacity requirement, the current load, and the remaining capacity to obtain an assigning result; and

 generating a scheduling instruction according to the assigning result, and sending the scheduling instruction to the distribution robot, the robot assembly station, and the building elevator, such that the distribution robot, the robot
20 assembly station, and the building elevator operate based on the scheduling instruction.

2. The goods distribution scheduling method according to claim 1, wherein the step of calculating a current load of the robot assembly station and remaining capacity of the distribution robot based on the state information of the robot
25 assembly station and the state information of the distribution robot comprises:

 acquiring storage space information of the robot assembly station, and determining a current load of the robot assembly station based on the storage space information;

 acquiring load information of the distribution robot, and determining current
30 capacity of the distribution robot based on the load information; and

 determining the remaining capacity based on the current load and the current

capacity.

3. The goods distribution scheduling method according to claim 2, wherein the step of acquiring load information of the distribution robot, and determining current capacity of the distribution robot based on the load information comprises:
5 calculating capacity of one distribution robot using the following formula:

$$M = \left\lfloor m * \frac{\min(e, w1) - w2}{e - w2} \right\rfloor$$

wherein M is capacity of one distribution robot, m is the maximum load, e is electric power that suffices to complete maximum-loaded tasks, w1 is current electric power, and w2 is reserve electric power; and

10 determining the current capacity based on the capacity of one distribution robot.

4. The goods distribution scheduling method according to claim 1, wherein the order information of the distribution task comprises historical order information and current order information, and the operation data of the building
15 elevator comprises historical elevator operation data and current elevator operation data; the step of determining a distribution capacity requirement of a distribution task in a next cycle based on the order information of the distribution task and the operation data of the building elevator comprises:

acquiring the historical order information and the historical elevator operation
20 data, and estimating an initial capacity requirement of each floor in the next cycle based on the historical order information and the historical elevator operation data;

acquiring the current order information and the current elevator operation data, and determining a current capacity requirement based on the current order
25 information and the current elevator operation data; and

determining the distribution capacity requirement based on the initial capacity requirement and the current capacity requirement.

5. The goods distribution scheduling method according to claim 1, wherein the step of assigning the distribution task in the next cycle according to the
30 distribution capacity requirement, the current load, and the remaining capacity to

obtain an assigning result comprises:

calculating additional cost of executing a distribution task by the distribution robot according to the distribution capacity requirement and the remaining capacity;

5 acquiring a cost threshold preset by the distribution robot executing the distribution task;

assigning a package of the distribution task to the distribution robot to distribute when the additional cost is less than the cost threshold; and

10 assigning a package of the distribution task to the robot assembly station for temporary storage based on the current load when the additional cost is larger than or equal to the cost threshold.

6. The goods distribution scheduling method according to claim 5, wherein the step of assigning a package of the distribution task to the distribution robot to distribute when the additional cost is less than the cost threshold comprises:

15 calculating task revenue of executing each distribution task by each robot according to state information of a plurality of distribution robots and order information of a plurality of distribution tasks;

generating a revenue matrix with an index (robot, task) based on the task revenue; and

20 performing task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty.

7. The goods distribution scheduling method according to claim 6, wherein the step of calculating task revenue of executing each distribution task by each robot according to state information of a plurality of distribution robots and order
25 information of the distribution tasks comprises:

acquiring launch time and current time of each distribution task according to the order information of the distribution tasks, and acquiring a type basic value and a type time multiplier preset for each distribution task;

30 calculating ideal cost and additional cost of executing each distribution task by each robot according to the order information of the distribution tasks and the state information; and

calculating the task revenue based on the type basic value, the ideal cost, the current time, the launch time, the type time multiplier, and the additional cost.

8. The goods distribution scheduling method according to claim 7, wherein the ideal cost is a sum of ideal horizontal movement time, ideal longitudinal movement time, and ideal interaction time of performing each task in a preset condition by a robot, and the additional cost is a sum of additional horizontal movement time, additional longitudinal moving time, and additional interaction time of adding a new task on the basis of an existing task by a robot.

9. The goods distribution scheduling method according to claim 6, wherein the step of performing task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty includes:

searching a coordinate (i, j) where the maximum value in the revenue matrix is located;

assigning a distribution task in a j-th column to a distribution robot in an i-th row; and

deleting the distribution task in the j-th column of the revenue matrix.

10. The goods distribution scheduling method according to claim 6, after the step of assigning a distribution task in a j-th column to a distribution robot in an i-th row, further comprising:

acquiring current state information of the distribution robot after accepting the distribution task in the j-th column;

determining whether the distribution robot is capable of continuously accepting distribution tasks according to the current state information;

deleting the distribution robot in the i-th row of the revenue matrix when the distribution robot is incapable of continuously accepting distribution tasks; and

re-calculating task revenue of executing each distribution task in the distribution revenue matrix by the distribution robot when the distribution robot is capable of continuously accepting distribution tasks, and updating the re-calculated task revenue into the revenue matrix.

11. The goods distribution scheduling method according to claim 6, wherein a formula for calculating the task revenue is:

Task revenue = Type basic value + (Current time-Launch time) × Type time multiplier - Additional cost, wherein the type basic value, the type time multiplier, the current time, and the launch time are acquired according to order information of the distribution task, and the additional cost is a sum of additional horizontal movement time, additional longitudinal movement time, and additional interaction time of adding a new distribution task on the basis of an existing distribution task by a robot.

12. The goods distribution scheduling method according to claim 6, wherein in the step of performing task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty, that the revenue matrix is empty comprises that: state information of distribution robots in all rows of the revenue matrix is incapable of accepting any distribution task, and distribution tasks in all columns of the revenue matrix have been assigned completely.

13. A goods distribution scheduling apparatus, which is applicable to a scene of package distribution in a building and comprises:

an acquiring module configured to acquire state information of a distribution robot and of a robot assembly station, and acquire order information of a package distribution task and operation data of a building elevator;

a calculating module configured to calculate a current load of the robot assembly station and remaining capacity of the distribution robot based on the state information of the robot assembly station and the state information of the distribution robot;

a determining module configured to determine a distribution capacity requirement of a distribution task in a next cycle based on the order information of the distribution task and the operation data of the building elevator;

an assigning module configured to assign the distribution task in the next cycle according to the distribution capacity requirement, the current load, and the remaining capacity to obtain an assigning result; and

a scheduling module configured to generate a scheduling instruction according to the assigning result, and send the scheduling instruction to the distribution robot, the robot assembly station, and the building elevator, such that

the distribution robot, the robot assembly station, and the building elevator operate based on the scheduling instruction.

14. The goods distribution scheduling apparatus according to claim 13, wherein the calculating module comprises:

5 a current load determining unit configured to acquire storage space information of the robot assembly station, and determine a current load of the robot assembly station based on the storage space information;

 a current capacity determining unit configured to acquire load information of the distribution robot, and determine current capacity of the distribution robot
10 based on the load information; and

 a remaining capacity determining unit configured to determine the remaining capacity based on the current load and the current capacity.

15 15. The goods distribution scheduling apparatus according to claim 13, wherein the order information of the distribution task includes historical order information and current order information, and the operation data of the building elevator includes historical elevator operation data and current elevator operation data; the determining module comprises:

 an initial requirement acquiring unit configured to acquire the historical order information and the historical elevator operation data, and estimate an initial
20 capacity requirement of each floor in the next cycle based on the historical order information and the historical elevator operation data;

 a current requirement acquiring unit configured to acquire the current order information and the current elevator operation data, and determine a current capacity requirement based on the current order information and the current
25 elevator operation data; and

 a distribution requirement determining unit configured to determine the distribution capacity requirement based on the initial capacity requirement and the current capacity requirement.

30 16. The goods distribution scheduling apparatus according to claim 13, wherein the assigning module comprises:

 an additional cost calculating unit configured to calculate additional cost of

executing a distribution task by the distribution robot according to the distribution capacity requirement and the remaining capacity;

a cost threshold acquiring unit configured to acquire a cost threshold preset by the distribution robot executing the distribution task;

5 a first assigning unit configured to assign a package of the distribution task to the distribution robot to distribute when the additional cost is less than the cost threshold; and

a second assigning unit configured to assign a package of the distribution task to the robot assembly station for temporary storage based on the current load
10 when the additional cost is larger than or equal to the cost threshold.

17. The goods distribution scheduling apparatus according to claim 16, wherein the first assigning unit comprises:

a task revenue calculating unit configured to calculate task revenue of executing each distribution task by each robot according to state information of a
15 plurality of distribution robots and order information of a plurality of distribution tasks;

a revenue matrix generating unit configured to generate a revenue matrix with an index (robot, task) based on the task revenue; and

a distribution task assigning unit configured to perform task assignment for
20 the distribution robots according to the revenue matrix until the revenue matrix is empty.

18. The goods distribution scheduling apparatus according to claim 16, wherein the distribution task assigning unit includes:

a searching unit configured to search a coordinate (i, j) where the maximum
25 value in the revenue matrix is located;

an assigning sub-unit configured to assign a distribution task in a j-th column to a distribution robot in an i-th row; and

a deleting unit configured to delete the distribution task in the j-th column of the revenue matrix.

30 19. A computer device, comprising a memory, a processor, and a computer program stored in the memory and being executable in the processor; wherein the

processor, when executing the computer program, implements the goods distribution scheduling method according to any one of claims 1-12.

20. A computer storage medium, wherein the computer storage medium stores a computer program therein, and the computer program, when being executed by
- 5 a processor, implements the goods distribution scheduling method according to any one of claims 1-12.