

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:

acquiring state information of a distribution robot and of a robot assembly station, and

5 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 assembly station and the state information of the distribution robot;

10 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 capacity requirement, the current load, and the remaining capacity to obtain an assigning result; and

15 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, 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 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;

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

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

the step of acquiring load information of the distribution robot, and determining current capacity of the distribution robot based on the load information comprises:

calculating capacity of one distribution robot using the following formula:

30
$$M = \left\lfloor m * \frac{\min(e, w1) - w2}{e - w2} \right\rfloor$$

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

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

2. 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 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 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 information and the current elevator operation data; and

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

3. The goods distribution scheduling method according to claim 1, wherein 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 comprises:

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

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

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.

4. The goods distribution scheduling method according to claim 3, 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:

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

5 5. The goods distribution scheduling method according to claim 4, 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 information of the distribution tasks comprises:

10 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;

 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

15 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.

 6. The goods distribution scheduling method according to claim 5, 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.

 7. The goods distribution scheduling method according to claim 4, wherein the step of performing task assignment for the distribution robots according to the revenue matrix until the revenue matrix is empty includes:

25 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.

 8. The goods distribution scheduling method according to claim 4, after the step of assigning a distribution task in a j-th column to a distribution robot in an i-th row, further comprising:

30 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.

9. The goods distribution scheduling method according to claim 4, 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.

10. The goods distribution scheduling method according to claim 4, 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.

11. 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;

5 the calculating module comprises:

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;

10 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

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

15 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:

20 an initial requirement acquiring unit 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;

25 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

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

the assigning module comprises:

30 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;

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 when the additional
5 cost is larger than or equal to the cost threshold;

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 plurality of distribution robots and order information of a plurality of distribution tasks;

10 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 the distribution robots according to the revenue matrix until the revenue matrix is empty.

12. The goods distribution scheduling apparatus according to claim 11, wherein the
15 distribution task assigning unit includes:

a searching unit configured to search a coordinate (i, j) where the maximum 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

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

13. 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
25 according to any one of claims 1-10.

14. A computer storage medium, wherein the computer storage medium stores a computer program therein, and the computer program, when being executed by a processor, implements the goods distribution scheduling method according to any one of claims 1-10.