

DESCRIPTION

INVENTION TITLE: METHOD AND SYSTEM FOR CONTROLLING LOGISTICS
ROBOT

5

Technical Field

[1] The present disclosure relates to a method and a system for controlling a logistics robot, which enables efficient execution of processes in a factory in which a logistics
10 robot is used.

[2]

Background Art

[3] Recently, not only in general logistics warehouses and
15 factories, but also in operating areas where products with different specifications are manufactured by using various parts, a logistics robot has been introduced in order to flexibly and efficiently supply and transport parts.

[4] A logistics robot is a general term that encompasses an
20 autonomous mobile robot (AMR) and an automated guided vehicle (AGV), and such a logistics robot can perform movement and operations under the control of a control system.

[5] In an operating area to which the logistics robot and the control system are applied, each process can be performed
25 according to a logistics flow. However, it is difficult to

directly control the logistics flow, and it is not possible to flexibly respond to changes in the state of each process are not possible, thereby affecting an overall process rate or a product yield.

5 [6] Therefore, there is a need to propose a method for setting a logistics flow on the basis of process data and performing the processes of the operating area according to the set logistics flow.

[7]

10 [8] The matters described above as background art are provided only to enhance the understanding of the background of the present disclosure, and should not be construed as an acknowledgment that they correspond to the prior art already known to those skilled in the art.

15 [9]

Disclosure

Technical Problem

20 [10] The present disclosure has been proposed to solve these issues, and aims to provide a method and a system for controlling a logistics robot, in which processes can be efficiently executed according to a set logistics flow.

[11]

25 [12] The technical objectives intended to be achieved in the present disclosure are not limited to the technical

objectives mentioned above, and other technical objectives not mentioned will be clearly understood by those skilled in the art to which the present disclosure belongs from the description below.

5 [13]

Technical Solution

[14] In order to accomplish the above objectives, a method for controlling a logistics robot according to the present disclosure includes: setting one or more path pairs connecting at least one departure point and at least one destination; determining at least one candidate path pair related to a mission of a logistics robot among the set one or more path pairs on the basis of information related to product production; and performing transportation control of the logistics robot on the basis of the at least one determined candidate path pair.

[15]

[16] In addition, in order to accomplish the above objectives, a system for controlling a logistics robot according to the present disclosure includes: a path management device configured to set one or more path pairs connecting at least one departure point and at least one destination and to determine at least one candidate path pair related to a mission of a logistics robot among the set one

or more path pairs on the basis of information related to product production; and at least one control device configured to perform transportation control of the logistics robot on the basis of the at least one candidate path pair
5 determined by the path management device.

[17]

Advantageous Effects

[18] According to the method and system for controlling a
10 logistics robot of the present disclosure, when a problem occurs in a specific section of a logistics flow, the logistics flow is modified so that processes are executed normally according to the modified logistics flow, thereby enabling efficient management of an overall process.

15 **[19]** In addition, when processes are executed according to a logistics flow, various situations can be handled flexibly, thereby increasing a production output according to the cycle time of the overall process.

[20]

20 **[21]** Effects obtainable from the present disclosure are not limited to the effects mentioned above, and other effects not explicitly mentioned can be clearly understood by those skilled in the art to which the present disclosure pertains from the following description.

25 **[22]**

Description of Drawings

[23] FIG. 1 is a block diagram illustrating an example of the configuration of an operating area that may be applied to
5 embodiments of the present disclosure.

[24] FIG. 2 is a block diagram illustrating an example of the configuration of a control device that may be applied to embodiments of the present disclosure.

[25] FIG. 3 is a block diagram illustrating an example of
10 the configuration of a logistics robot that may be applied to embodiments of the present disclosure.

[26] FIG. 4 is a perspective view illustrating an example of the exterior of the logistics robot that may be applied to embodiments of the present disclosure.

[27] FIG. 5 is a flowchart illustrating an example of a
15 traveling process of the logistics robot that may be applied to embodiments of the present disclosure.

[28] FIG. 6 is a block diagram illustrating the configuration of a system for controlling a logistics robot
20 according to an embodiment of the present disclosure.

[29] FIG. 7 is a diagram illustrating a path pair according to an embodiment of the present disclosure.

[30] FIGS. 8 and 9 are diagrams illustrating changes in a path pair according to an embodiment of the present
25 disclosure.

[31] FIG. 10 is a diagram illustrating a method for controlling a logistics robot according to an embodiment of the present disclosure.

[32]

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Mode for Invention

[33] In describing embodiments disclosed in the present specification, if it is decided that the detailed description of known technologies related to the present disclosure makes the subject matter of the embodiments described herein unclear, the detailed description is omitted. Further, the accompanying drawings are provided only for easy understanding of embodiments disclosed in the specification, and the technical spirit disclosed in the specification is not limited by the accompanying drawings, and all changes, equivalents, and replacements should be understood as being included in the spirit and scope of the present disclosure.

[34] Terms including ordinal numbers such as "first" and "second", etc. may be used to describe various components, but the components are not to be construed as being limited to the terms. The terms are used only to distinguish one component from another component.

[35] It is to be understood that when one component is referred to as being "connected to" or "coupled to" another

component, it may be connected directly to or coupled directly to another component or be connected to or coupled to another component, but still another component may intervene therebetween. On the other hand, it should be understood that when one component is referred to as being "connected directly to" or "coupled directly to" another component, it is connected to or coupled to another component without still another component intervening therebetween.

10 **[36]** Singular forms are intended to include plural forms unless the context clearly indicates otherwise.

[37] It will be further understood that terms such as "comprise" or "have" used in this specification specify the presence of stated features, steps, operations, components, parts, or a combination thereof, but do not preclude the presence or addition of one or more other features, numerals, steps, operations, components, parts, or a combination thereof.

20 **[38]** Hereinafter, embodiments disclosed in the present specification will be described in detail with reference to the accompanying drawings, and identical or similar components are denoted by the same reference numerals regardless of the drawing numbers, and redundant descriptions thereof will be omitted.

[39] In addition, the term "unit" or "control unit" included in the names of internal components of a smart logistics vehicle or a control device is merely a term widely used to refer to a controller that controls specific
5 functions, and does not indicate a generic functional unit. For example, each controller may include a modem/transceiver for communication with other controllers or sensors to perform control of a corresponding function, a memory for storing an operating system, logic instructions, and
10 input/output information, and one or more processors configured to perform determinations, computations, and decisions necessary for controlling the corresponding function. Depending on the implementation, a single processor may perform computations for a plurality of
15 controllers.

[40]

[41] First, the configuration of an operating area in which a smart logistics vehicle is deployed and operated according to an embodiment will be described with reference to FIG. 1.

20 **[42]** FIG. 1 is a block diagram illustrating an example of the configuration of an operating area that may be applied to embodiments.

[43] Referring to FIG. 1, an operating area (100) may include a logistics robot (110), a production device (120),
25 a monitoring device (130), and a control device (140).

[44] The operating area (100) may be provided with a plurality of logistics robots (110), a plurality of production devices (120), and a plurality of monitoring devices (130) according to the production processes of products and target production rates. In addition, the operating area (100) may be implemented as a smart factory, but is not limited thereto. Each of the components will be described below.

[45] First, the logistics robot (110) may include an autonomous mobile robot (hereinafter referred to as "AMR") and an automated guided vehicle (hereinafter referred to as "AGV"). Depending on the operating policy of the logistics robot (110) in the operating area (100), only one type of AGV and AMR may be operated, or both AGV and AMR may be operated together within a single operating area (100).

[46] An AGV generally performs operations (such as movement, direction change, and stop) required within the operating area (100) by recognizing and following guidance facilities disposed on the floor for guiding AGV. Here, the guidance facilities may include optically recognizable markers (spots, 2D codes, etc.), tags that can be contactlessly recognized at close range (for example, NFC tags, RFID tags, etc.), magnetic strips, wires, etc., but these are merely examples and are not intended to be limiting. The guide facilities may be arranged continuously

on the floor or discontinuously to be spaced apart from each other. Since the AGV performs operations primarily by recognizing and following the guide facilities, the guide facilities are required to be installed in advance before
5 operation. Therefore, when it is necessary to move the AGV to a new path or modify an existing path, the installation or modification of the guide facilities must be physically performed. In addition, since the AGV does not deviate from a path set through the guide facilities, the AGV generally
10 stops when an obstacle is detected on or near the path until the detected obstacle disappears or separate control is provided. In the operation of the AGV, since the control device (140) must control the AGV on the basis of the guide facilities, the control device (140) may transmit to the AGV
15 commands such as "travel until a third marker is recognized" or "turn a heading direction by 90 degrees when the third marker is recognized," either as individual command units or as mission units including a plurality of commands (for example, retrieval, supply, charging, patrol, etc.).

20 **[47]** An AMR may determine its current position (i.e., positioning) by sensing a surrounding environment, and, by using positioning and a map, the AMR may perform its own path planning, which is a main distinction from an AGV. Accordingly, when a map with coordinate compatibility is
25 shared between the AMR and the control device (140), the

control device (140) may control the AMR by instructing it on a coordinate-based path. In addition, when an obstacle is detected during travel, the AMR may independently set an avoidance path to bypass the obstacle and then return to an original path thereof. The function of the control device (140) in setting one or more intermediate coordinates for the path of the AMR may be referred to as global path planning, and the function of the AMR in setting a travel path or an avoidance path between the intermediate coordinates according to global path planning may be referred to as local path planning.

[48] A more detailed configuration of the logistics robot (110) will be described with reference to FIGS. 3 and 4, and the traveling control process of the AMR will be described with reference to FIG. 5.

[49] Next, the production device (120) may refer to a device that performs a production process of a product within the operating area (100) (for example, a robot arm, a conveyor belt, etc.), and, in a broader sense, may refer to a device deployed to assist the logistics robot (110) in performing missions such as access when the production process is carried out by a human. The device deployed to assist in performing missions may include, but is not limited to, a device that detects the status of a designated location where the logistics robot (110) may place or pick

up a pallet within an area where a specific production process is performed, a device that determines the progress of the process, and means for restricting entry into the area.

5 **[50]** For example, the production device (120) may be controlled through a programmable logic controller (PLC) and may communicate with the control device (140) regarding the progress of the process.

10 **[51]** The monitoring device (130) may perform the function of acquiring information to assess a situation within the operating area (100) and transmitting the information to the control device (140). For example, the monitoring device (130) may include a camera, a proximity sensor, or the like, but is not limited thereto.

15 **[52]** The control device (140) may communicate with the aforementioned components (110, 120, 130) to acquire information necessary for operating the operating area (100) or to control each of the components. For example, the control device (140) may perform operations such as
20 dispatching the logistics robot (110), setting its path, assigning missions, managing processes for each product, and managing materials.

[53] In an implementation, the control device (140) may include an AMR/AGV control system (ACS) that controls
25 surrounding process equipment on the basis of the position

of an AGV or AMR and performs mission-based control of the AGV/AMR, and a mobile robot integrated monitoring system (MoRIMS) that integrates and monitors two or more ACSs. The MoRIMS may monitor the status and paths of all logistics robots (110) within the operating area (100) as well as perform logistics flow settings and traffic control on the basis of information from each of the ACSs. For example, when the ACSs are provided for smart logistics robots of the same manufacturer or model, the MoRIMS may perform integrated control to prevent collisions, such as analyzing bottleneck levels in intersecting or overlapping areas, controlling acceleration and deceleration during travel, and regenerating avoidance paths, through traffic distribution control between heterogeneous systems on the basis of information acquired from the plurality of ACSs.

[54] In addition, the MoRIMS may also have, as its upper-level control entity, a manufacturing execution system (MES), and the manufacturing execution system (MES) may in turn be linked with an advanced planning & scheduling (APS) system.

[55] In addition to the aforementioned components (110, 120, 130, 140) of the operating area (100), devices for communication between components, such as beacons, repeaters, and access points (APs), chargers for charging the logistics robot (110), loading spaces for storing or

loading parts, spaces for storing finished or intermediate products, traffic lights, barriers, and standby spaces for idle logistics robots (110) may be appropriately arranged within the operating area (100).

5 **[56]** Hereinafter, with reference to FIG. 2, the configuration of the control device (140) that may be applied to embodiments of the present disclosure will be described.

10 **[57]** FIG. 2 is a block diagram illustrating an example of the configuration of the control device that may be applied to embodiments of the present disclosure. Components shown in FIG. 2 mainly represent components related to the embodiments of the present disclosure, and, in actual implementation of the control device (140), more or fewer
15 components may be included.

20 **[58]** Referring to FIG. 2, the control device (140) may include a firmware management unit (141), a traffic control unit (142), a process management unit (143), a production/logistics management unit (144), an inventory management unit (145), a communication unit (146), a vehicle monitoring unit (147), and a map management unit (148).

[59] The firmware management unit (141) may obtain the latest firmware of the logistics robot (110) through the communication unit (146) and transmit it to the logistics

robot (110), thereby performing a firmware update to keep the firmware of the logistics robot (110) up to date.

[60] The traffic control unit (142) controls traffic lights and barriers on the basis of the paths of the logistics robot (110), and may recalculate the paths of the logistics robot (110) according to traffic conditions.

[61] The process management unit (143) may define processes for each product and may manage missions such as process progress and execution positions.

10 **[62]** The production/logistics management unit (144) may dispatch the logistics robot (110) on the basis of missions.

[63] The inventory management unit (145) manages the location and quantity of each material, and such information may be useful for more efficient process operation, such as
15 dispatching the logistics robot (110) to a destination for pallet pickup or retrieval in advance of the actual detection of assembly or consumption of the material.

[64] The communication unit (146) may communicate not only with the internal components of the operating area (100),
20 such as the logistics robot (110), the production device (120), and the monitoring device (130), but also with external entities, such as a firmware update server.

[65] The vehicle monitoring unit (147) may monitor the location, path, battery status, communication status, and
25 powertrain status of each logistics robot (110). Here, the

path refers to a concept including a waypoint-based global path and a real-time local path. In addition, the battery status may include information such as voltage, current, temperature, peak values of voltage and current, state of charge (SOC), and state of health (SOH). The communication status may include information on a currently active communication protocol (e.g., Wi-Fi), a connected access point (AP), a distance to the AP, and a channel in use. Furthermore, the powertrain status may include load, temperature, and RPM of a drivetrain.

[66] In addition, the vehicle monitoring unit (147) may check a mission, operation mode, firmware version, etc. currently assigned to each logistics robot (110).

[67]

[68] *The map management unit (148) acquires grid map-type map data generated by the AMR among the logistics robots (110) as the AMR travels inside the operating area (100) and may provide a tool that allows a factory administrator to edit the acquired map data. Through editing of the map data, zones in which one or more preset operations are performed when the logistics robot (110) enters, virtual lanes, intersections, and no-entry areas may be set, but these are merely examples and not limiting. In addition, the map management unit (148) may distribute an initially generated grid map obtained through the actual travel of a

specific logistics robot (110) to other logistics robots (110) via the communication unit (146).

[69] Next, the logistics robot (110) will be described with reference to FIGS. 3 and 4.

5 **[70]** FIG. 3 is a block diagram illustrating an example of the configuration of the logistics robot that may be applied to embodiments of the present disclosure.

[71] Referring to FIG. 3, the logistics robot (110) may include a traveling unit (111), a sensing unit (112), a
10 loading unit (113), a communication unit (114), and a control unit (115). Each of the components will be described below.

[72] The traveling unit (111) may include a driving source, wheels, suspension, etc. involved in the movement, steering,
15 and stopping of the logistics robot (110). The driving source may be implemented by using an electric motor powered by a built-in battery (not shown). The wheels may include one or more drive wheels that receive driving force from the driving source and non-drive wheels that rotate as a vehicle
20 body moves without receiving driving force. Depending on the implementation, when a plurality of drive wheels are provided, a driving source may be matched to each drive wheel so that the rotation of each drive wheel may be independently controlled. In this case, steering may be
25 achieved by making the rotational directions of different

drive wheels different to rotate the vehicle body without the need for separate steering means. At least some of the non-drive wheels may be configured as caster-type wheels, but this is merely illustrative and is not limited thereto.

5 **[73]** The sensing unit (112) is configured to detect the surrounding environment or the operational state of the logistics robot (110), and may include at least one of a 2D laser scanner (e.g., LiDAR), a 3D vision (stereo) camera, a multi-axis gyro sensor, an acceleration sensor, a wheel
10 encoder, and a proximity sensor.

[74] The encoder may output information for determining how much a wheel has rotated by using light emitted from a light-emitting element (e.g., a light-emitting diode). For example, the encoder may count the number of slits arranged
15 along the circumferential direction of a wheel or of a disk that rotates together with the wheel during a unit time. The control unit (115) may perform odometry, which estimates displacement by analyzing the amount of positional change over time on the basis of data acquired through the encoder
20 and the gyro sensor. However, due to the slip or wear of the wheel (such as a change in the effective radius of the wheel), the displacement estimated on the basis of the encoder data may differ from actual displacement. Therefore, when performing odometry, the control unit (115)
25 may correct noise and errors by applying a predetermined

algorithm (for example, an extended Kalman filter (EKF)) to information collected from the wheel and gyro sensor, thereby outputting results that tend to be closer to actual values. This odometry may be particularly useful when
5 localization by using a 2D laser scanner to be described later is unavailable.

[75] The 2D laser scanner may scan the surrounding environment by emitting laser beams through a rotating mirror and detecting reflected signals. In this case, by
10 analyzing the intensity of the reflected signals and time difference between emission and reception, detection results in the form of a point cloud may be output.

[76] The 3D vision camera may calculate a distance to an object on the basis of disparity between two cameras spaced
15 apart from each other by a predetermined distance, that is, pixel disparity between images captured by each of the cameras. In this case, a texture projector that projects a predetermined pattern of infrared light may be provided to enable detection even on uniformly colored planar surfaces
20 (for example, a white wall).

[77] Generally, a 2D laser scanner is used for mapping, navigation, and object recognition, while a 3D camera may be utilized especially for avoiding an obstacle during navigation, but this is merely illustrative and is not
25 necessarily limited thereto.

[78] The loading unit (113) serves as a means for loading products to be transported and may take the form of the upper plate itself on the vehicle body, a table arranged on the upper plate, a lift, a turntable rotating along a vertical axis, a forklift, a conveyor, or a combination thereof. The forklift may support telescopic and tilting functions similar to those of a forklift truck.

[79] The communication unit (114) may communicate with other components within the operating area (100), such as the production device (120) and the control device (140), support communication between the logistics robots (110), and communicate with a charger during execution of a charging mission.

[80] The control unit (115) acts as an entity performing overall control of the aforementioned components (111, 112, 113, 114), and may perform functions such as managing a current mission, determining a current location and a destination, planning a path, and controlling the loading unit on the basis of information acquired from the control device (140) through the communication unit (114).

[81] FIG. 4 is a perspective view illustrating an example of the exterior of the logistics robot that may be applied to embodiments of the present disclosure.

[82] Referring to FIG. 4, an example of an AMR as the logistics robot (110) is illustrated. The vehicle body may

have a track-type flat shape with a long axis extending along a first axis direction. One drive wheel (111-1) is arranged at the center of the vehicle body along the first axis direction and may be arranged on a first side in a second axis direction, while another drive wheel (not shown) may be arranged on a second side in the second axis direction to face the one drive wheel (111-1). This arrangement of the drive wheels may be referred to as a "differential drive (DD)" configuration. Although not shown in FIG. 4, two or more non-drive wheels may be disposed at the lower portion of the vehicle body. In this case, when the two drive wheels rotate at the same speed in the same direction, the robot may move forward or backward along the first axis direction, and when they rotate at the same speed in opposite directions, the robot may extend along the third axis direction and rotate about a rotational axis passing through the planar center (C) of the vehicle body. In addition, the sensing unit (112) may be disposed on the front surface of the vehicle body, and the loading unit (113) may be disposed on the upper surface thereof. The loading unit (113) may be configured to move up and down along the third axis direction, and racks or trays may be fixed on the upper surface via guides (113-1).

[83] However, the form of the AMR shown in FIG. 4 is merely illustrative, and the AGV may have a form similar to that of the AMR or that the AMR may have a different form.

[84] Next, with reference to FIG. 5, the traveling process
5 of the logistics robot (110) will be described.

[85] FIG. 5 is a flowchart illustrating an example of the traveling process of the logistics robot (110) that may be applied to embodiments of the present disclosure. In FIG. 5, for convenience, it is assumed that the logistics robot
10 (110) is an AMR capable of positioning and local path setting.

[86] Referring to FIG. 5, the AMR may first travel within the operating area (100) and acquire a measured grid map through a LiDAR, etc. (S501).

[87] When the AMR transmits the acquired grid map to the
15 control device (140), a grid map editing and matching process may be performed by the map management unit (148) of the control device (140) (S502). Here, the editing process may include setting various zones in the aforementioned grid map and assigning costs to individual grid cells. Here, the
20 cost assignment may be performed such that cells closer to obstacles or no-entry areas are assigned higher costs, preventing the AMR from moving into areas near the obstacles or the no-entry areas. This is because, when setting a

local path, the AMR selects as a path a set of cells between waypoints that have the lowest total cost.

[88] In addition, the map matching process may refer to the process of aligning coordinates among a CAD map used in
5 designing the operating area (100), a measured grid map (LiDAR map), and a topology map obtained through the editing process.

[89] Next, the control device (140) may share the topology map with all AMRs in a factory through the communication
10 unit (146) (S503).

[90] The subsequent steps may be processes applied to individual AMRs.

[91] The AMR may determine its current position on a map (localization) by using sensor data from the sensing unit
15 (112) and the acquired map (S504). For example, the AMR may determine its current position by comparing a surrounding terrain acquired via LiDAR with the map on the basis of feature points.

[92] The control device (140) may select a specific AMR and
20 assign a mission thereto, wherein the mission may generally include one or more waypoints determined through global path planning. The waypoints may be defined as coordinates on the map and may include information regarding a direction (i.e., heading) that the AMR should take at the
25 corresponding coordinates. On the basis of such mission

assignment, a destination may be set for the AMR (Yes in S505), and the AMR may perform local path planning between the waypoints on the basis of the costs of the topology map (S506).

5 **[93]** When the path is determined, the AMR may start traveling (S507), and when an obstacle is detected through the sensing unit (112) during travel (Yes in S508), the AMR may perform local path searching to bypass the detected obstacle and execute an avoidance maneuver (S509). In some
10 cases, depending on the avoidance maneuver or the failure thereof, the control device (140) may update the mission of the corresponding AMR.

[94] In addition, the AMR may correct its positional error during travel by using the aforementioned odometry
15 techniques until it reaches the destination (S510).

[95] After that, when the AMR reaches the destination (S511), the AMR may perform mission-based maneuvers (S512). For example, the AMR may determine whether conditions for entering a specific process area are met, retrieve an empty
20 pallet at the destination, or drop products loaded on the loading unit (113).

[96]

[97] In an embodiment of the present disclosure, the objective is to efficiently execute a process by receiving
25 information on the basis of a set logistics flow and

providing a logistics flow corresponding to the received information.

[98] Hereinafter, a system for controlling a logistics robot according to an embodiment will be described with
5 reference to FIG. 6.

[99] FIG. 6 is a block diagram illustrating the configuration of a system for controlling a logistics robot according to an embodiment of the present disclosure.

[100] Referring to FIG. 6, the system for controlling a
10 logistics robot according to an embodiment of the present disclosure may include logistics robots (110-1, 110-2), a plurality of control devices (140-1, 140-2) configured to control the respective logistics robots (110-1, 110-2), a path management device (150) configured to provide
15 information on path pairs connecting departure points and destinations for each of the plurality of control devices (140-1, 140-2), and a product production management system (160).

[101] Hereinafter, each of the components will be described,
20 but the path management device (150) will be described first.

[102] The path management device (150) may set one or more path pairs connecting at least one departure point and at least one destination, and may determine at least one
25 candidate path pair related to the mission of the logistics

robot (110) among the one or more path pairs set on the basis of information related to product production. To this end, the path management device (150) may include an information collection unit (151), a pair setting unit
5 (152), and a pair determining unit (153). However, this is merely illustrative, and in implementing the functions of the path management device (150), the path management device (150) may include fewer or more components than those described.

10 **[103]** The information collection unit (151) may collect information necessary to set and determine path pairs. For example, the information collection unit (151) may collect at least one of production sequence information and process setting information. The information collection unit (151)
15 may collect the production sequence information from the product production management system (160) provided to manage the production of products within the operating area (100). However, this is merely illustrative and is not necessarily limited thereto.

20 **[104]** In addition, the information collection unit (151) may collect the process setting information from the production device (120) or the monitoring device (130). In this case, the process setting information may refer to initial setting information of the production device (120) or the monitoring
25 device (130) set initially for performing the process.

[105] The pair setting unit (152) may set any one of at least one supply port, at least one retrieval port, and at least one work cell provided for each process as a departure point, and another thereof as a destination so as to set one
5 or more path pairs connecting the departure point and the destination. Specifically, the pair setting unit (152) may set at least one departure point and at least one destination on the basis of the information collected by the information collection unit (151), and may set one or more
10 path pairs connecting the at least one departure point and the at least one destination.

[106] For example, the operating area (100) may include a plurality of processes, and each process may be provided with at least one supply port, at least one retrieval port,
15 or at least one work cell. The pair setting unit (152) may set one or more path pairs connecting a departure point and a destination by setting a work cell of one among the plurality of processes as the departure point and a work cell of another process among the plurality of processes as
20 the destination so that inter-process work missions are performed. However, this is merely illustrative and is not necessarily limited thereto. For example, the pair setting unit (152) may set one or more path pairs connecting a departure point and a destination by designating a supply
25 port of one process among the plurality of processes as the

departure point, and designating a supply port or a work cell of a process, which requires parts, among the plurality of processes as the destination in order to supply parts required for a process. In addition, the pair setting unit
5 (152) may set one or more path pairs by designating a work cell of one of the plurality of processes as a departure point and a retrieval port of one of the plurality of processes as a destination for supplying parts required for the process.

10 **[107]** In addition, the pair setting unit (152) may set one or more path pairs connecting a single departure point with one or more destinations. However, this is merely illustrative and is not necessarily limited thereto. For example, the pair setting unit (152) may set one or more
15 path pairs connecting one or more departure points with one or more destinations, which correspond to the one or more departure points, or may set one or more path pairs connecting one or more departure points with a single destination.

20 **[108]** Furthermore, when setting one or more path pairs connecting a departure point with a destination the pair setting unit (152) may set the one or more path pairs such that at least one waypoint present between the departure point and the destination is included. For example, when at
25 least one waypoint is present between the departure point

and the destination, the pair setting unit (152) may set one or more path pairs connecting the departure point, the at least one waypoint, and the destination.

[109] Hereinafter, a path pair set by the pair setting unit (152) according to an embodiment of the present disclosure will be described with reference to FIG. 7.

[110]

[111] FIG. 7 is a diagram illustrating a path pair according to an embodiment of the present disclosure.

10 **[112]** Referring to FIG. 7, a plurality of processes (process A to process H) may be provided within the operating area (100). The pair setting unit (152) of the path management device (150) may set path pairs connecting each of the plurality of processes on the basis of collected
15 information. For example, the pair setting unit (152) may set path pairs by designating process A as a departure point, Processes B to D as waypoints, and Processes E to H as destinations, thereby connecting the departure point, the waypoints, and the destinations. However, this is merely
20 illustrative and is not necessarily limited thereto. For example, the pair setting unit (152) may set path pairs connecting a departure point and destinations by designating process A as the departure point and process B to process D as the destinations. The pair setting unit (152) may set
25 may also set path pairs connecting departure points and

destinations by designating process B to process D as the departure points and process E to process H as the destinations. That is, the pair setting unit (152) may set relatively long path pairs that include waypoints between a
5 departure point and destination points, or may set relatively short path pairs that consist only of a departure point and destination points without any waypoints.

[113]

[114] Referring again to FIG. 6, when one or more path pairs
10 are set as described above,, the pair setting unit (152) may store the set one or more path pairs in a separately provided memory (not shown). However, this is merely an illustrative and is not necessarily limited thereto. For instance, the memory may be provided together with the path
15 management device (150) or the pair setting unit (152), or the memory may be provided separately from the path management device (150).

[115] After the pair pairs are set in the pair setting unit (152), the information collection unit (151) may collect
20 information related to product production, and the pair determining unit (153) may receive the information collected by the information collection unit (151). The information related to product production may include process state information of the production device (120) or the monitoring
25 device (130) over time. The process state information may

include information regarding at least one of whether a light curtain provided in each process is ON or OFF, whether a safety sensor is ON or OFF, and whether entry or exit is allowed.

5 **[116]** In addition, the pair determining unit (153) may determine at least one candidate path pair related to the mission of the logistics robot (110) among one or more path pairs set by the pair setting unit (152) on the basis of the information related to product production. For example, the
10 pair determining unit (153) may determine the mission of the logistics robot (110) on the basis of the information related to product production. In this case, the information related to product production may refer to the process state information collected by the information
15 collection unit (151), but this is merely illustrative and is not necessarily limited thereto.

[117] In addition, the pair determining unit (153) may determine the mission of the logistics robot (110) by considering component supply information in addition to the
20 information related to product production. To this end, the information collection unit (151) may additionally collect the component supply information and provide the collected component supply information to the pair determining unit (153). The component supply information may include at
25 least one piece of information among information on parts

used in each process, information on the supply port and retrieval port for the parts, and information on the process that requires the parts, and may be information provided from the aforementioned product production management system
5 (160). However, this is merely illustrative and is not necessarily limited thereto.

[118] When the mission is determined, the pair determining unit (153) may determine at least one candidate path pair connecting a departure point and destination corresponding
10 to the determined mission among one or more path pairs set by the pair setting unit (152).

[119] In addition, the pair determining unit (153) may provide information on the at least one determined candidate path pair to each of the plurality of control devices (140-
15 1, 140-2). That is, the path management device (150) may provide the at least one determined candidate path pair to each of different heterogeneous devices. In this case, in order to provide information to the plurality of control devices (140-1, 140-2), the path management device (150) may
20 further include the communication unit (not shown) capable of transmitting information. However, this is merely illustrative and is not necessarily limited thereto.

[120] The plurality of control devices (140-1, 140-2) may perform transportation control of the logistics robots (110-
25 1, 110-2) on the basis of at least one candidate route pair

determined by the path management device (150) and provided to each of the control devices. To this end, the plurality of control devices (140-1, 140-2) may respectively include communication units (146-1, 146-2) and path control units
5 (149-1, 149-2). The plurality of control devices (140-1, 140-2) respectively control smart logistics vehicles (110-1, 110-2) performing different missions, but perform the same functions, and accordingly, hereinafter, for convenience of description, the functions of the communication unit (146-1)
10 and the path control unit (149-1) provided in a first control device (140-1) will be described. The same may be applied to a second control device (140-2).

[121] The communication unit (146-1) may transmit information on at least one candidate path pair provided by
15 the path management device (150) to the path control unit (149-1). In addition, the communication unit (146-1) may receive process state information related to the at least one candidate path pair provided by the path management device (150) and transmit the process state information to
20 the path control unit (149-1). In addition, the communication unit (146-1) may perform communication with the logistics robot (110-1) controlled by the first control device (140-1) and may transmit control information generated by the path control unit (149-1) thereto.

[122] The path control unit (149-1) may determine a final path pair from among the at least one candidate path pair on the basis of the process state information related to the at least one candidate path pair received from the communication unit (146-1), and may perform the transportation control of the logistics robot (110-1) on the basis of the determined final path pair. In this case, when a plurality of final path pairs are determined by the path control unit (149-1), the path control unit (149-1) may determine a distance of each of the plurality of final path pairs and determine one final path pair having the shortest distance. In addition, the path control unit (149-1) may perform the transportation control of the logistics robot (110-1) on the basis of the determined one final path pair with the shortest distance. However, this is merely illustrative but is not necessarily limited thereto.

[123] Meanwhile, the path control unit (149-1) may generate a global path including a plurality of waypoints corresponding to the determined final path pair. In addition, the path control unit (149-1) may perform the transportation control of the logistics robot (110-1) on the basis of the generated global path, thereby allowing the logistics robot (110-1) to travel along the plurality of waypoints. However, this is merely illustrative and is not necessarily limited thereto.

[124]

[125] After the transportation control of the logistics robot (110-1) is performed on the basis of the final path pair, the path control unit (149-1) may collect process
5 state information related to the final path pair. For example, the process state information related to the final path pair may be information regarding whether deviation from the current process is possible while moving along the final path pair, or whether entry into the next process is
10 possible. That is, the path control unit (149-1) may receive process state information while the logistics robot (110-1) is moving between processes along the path pair or attempting to move to the next process, and may determine whether the logistics robot (110-1) is capable of departing
15 from a departure point or is capable of entering a destination along the final path pair on the basis of the process state information.

[126] When it is determined that the logistics robot (110-1) cannot exit from the departure point or cannot enter the
20 destination, the path control unit (149-1) may change the predetermined final path pair to another path pair among at least one candidate path pair previously provided from the path management device (150). In this case, the path control unit (149-1) may change the path pair to the another
25 path pair corresponding to the same mission as the final

path pair among the at least one candidate path pair. In addition, the path control unit (149-1) may re-perform the transportation control of the logistics robot (110-1) on the basis of the changed path pair. This will be described with
5 reference to FIGS. 8 to 9.

[127]

[128] FIGS. 8 and 9 are diagrams illustrating changes in a path pair according to an embodiment of the present disclosure.

10 **[129]** First, with reference to FIG. 8, it is assumed that the path management device (150) determines at least one candidate path pair and the candidate path pair provided to the path control unit (149-1) of the first control device (140-1) includes a first path pair connecting Process A,
15 Process B, and Process F, and a second path pair connecting Process A, Process D, and Process F. It is further assumed that the first path pair is a final path pair having the shortest distance among the first path pair and the second path pair.

20 **[130]** The path control unit (149-1) may determine, on the basis of the collected process state information related to the final path pair, whether the transportation control of the logistics robot (110-1) can be performed. In a situation where the logistics robot (110-1) must depart from
25 Process A and arrive at Process F, when it is determined, on

the basis of the process state information, that entry into an intermediate process B is not possible and thus transportation control of the logistics robot (110-1) along the first path pair cannot be performed, the path control unit (149-1) may re-perform the transportation control of the logistics robot (110-1) on the basis of the second path pair forming a path to process F via another intermediate process. In this case, the path control unit (149-1) may determine whether entry into another intermediate process D is possible on the basis of the process state information, and when the entry into process D is possible, it may perform the transportation control of the logistics robot (110-1) on the basis of the second path pair.

[131] As another example, with reference to FIG. 9, it is assumed that at least one path pair determined by the path management device (150) includes a first path pair connecting process A, process B, and process E, a second path pair connecting process A, process B, and process F, and a third path pair connecting process A, process B, and process G. It is further assumed that the second path pair is a final path pair having the shortest distance among them.

[132] The path control unit (149-1) may determine whether the transportation control of the logistics robot (110-1) can be performed along the second path pair on the basis of

the collected process state information related to the final path pair. For example, when transportation control to process F along the second path pair is not possible, the path control unit (149-1) may change the path pair to
5 another candidate path pair among a plurality of candidate path pairs provided by the path management device (150).

[133] However, this is merely illustrative and is not necessarily limited thereto. For example, on the basis of the process state information collected by the path control
10 unit (149-1), it may be determined whether the transportation control of the logistics robot (110-1) along the final path pair can be performed, and when it is determined that transportation control cannot be performed, a path pair reallocation command may be transmitted to the
15 path management device (150) to receive a new path pair on which transportation control can be performed. In this case, the path management device (150) may collect information again, re-determine a path pair on the basis of the collected information, and provide the re-determined
20 path pair to the first control device (140-1). That is, the change of the path pair may be performed autonomously within the first control device (140-1), or when it is determined by the first control device (140-1) that the change of the path pair is required, the path management device (150) may

change the path pair and retransmit it to the first control device (140-1).

[134]

[135] Below, FIG. 10 illustrates a method for controlling a logistics robot by using the system for controlling a logistics robot described in FIG. 6. However, although FIG. 6 shows that the plurality of control devices (140-1, 140-2) receive information from a single path management device (150), FIG. 10 assumes, for the sake of convenience, that a single control device (140) receives information from the path management device (150). However, this is merely illustrative and should be understood as being equally applicable to each of the plurality of control devices (140-1, 140-2).

[136] In addition, with reference to FIG. 6, the control device (140) is composed of the communication unit (146) and the path control unit (149), and functions are performed by the respective components. However, in FIG. 10, for the convenience of description, it is assumed that all functions performed by individual components are performed by the control device (140).

[137] FIG. 10 is a diagram illustrating the method for controlling a logistics robot according to an embodiment of the present disclosure.

[138] With reference to FIG. 10, the information collection unit (151) of the path management device (150) collects the production sequence information provided from the product production management system (160) (S101-1) and may collect
5 the process setting information provided from the production device (120) or the monitoring device (130) (S101-2, S101-3). In addition, the information collection unit (151) may transmit provide the collected information to the pair setting unit (152) (S102-1, S102-2, S102-3).

10 **[139]** The pair setting unit (152) of the path management device (150) may select at least one departure point and at least one destination on the basis of the information provided by the information collection unit (151) and may set one or more path pairs connecting the at least one
15 departure point and the at least one destination (S103). A detailed description of the step of setting the path pairs (S103) has been provided above with reference to FIG. 6 and is thus omitted.

[140] Subsequently, the information collection unit (151)
20 may collect information related to product production from the production device (120) or the monitoring device (130) (S104-1, S104-2), and may also collect component supply information from the product production management system (160) (S104-3). In addition, the information collection
25 unit (151) may transmit the product production-related

information and component supply information, which have been collected, to the pair determining unit (153) (S105).

[141] The pair determining unit (153) of the path management device (150) may determine the mission of the logistics robot (110) on the basis of at least one of the product production-related information and the component supply information, and may determine at least one candidate path pair connecting the departure point and destination corresponding to the determined mission among the one or more path pairs set by the pair setting unit (152) (S106). A detailed description of the step of determining the at least one candidate path pair (S106) has been provided above with reference to FIG. 6 and is thus omitted.

[142]

[143] The pair determining unit (153) may transmit information regarding the at least one determined candidate path pair to the control device (140) (S107). According to an embodiment of the present disclosure, the pair determining unit (153) is described as transmitting the information regarding the at least one determined candidate path pair to the control device (140), but this is merely illustrative. Alternatively, the pair determining unit (153) may transmit the information regarding the at least one determined candidate path pair to the communication unit (not shown) separately provided in the path management

device (150), and the communication unit may transmit the information regarding the at least one candidate path pair to an external device (e.g., the control device (140)).

[144] In addition, the control device (140) may collect
5 process state information related to the at least one candidate path pair provided by the path management device (150) from the production device (120) or the monitoring device (130) (S108-1, S108-2).

[145] The control device (140) may determine a final path
10 pair among at least one candidate path pair provided from the path management device (150) on the basis of the collected process state information related to the at least one candidate path pair (S109). In addition, the control device (140) may transmit transportation control commands to
15 the logistics robot (110) on the basis of the determined final path pair (S110). As a result, the logistics robot (110) may perform transportation operations along the final path pair on the basis of the transportation control commands. A detailed description of steps S109 to S110 has
20 been provided above with reference to FIGS. 6 to 9 and is thus omitted.

[146] Subsequently, while performing transportation control of the logistics robot (110), the control device (140) may collect process state information related to the final path
25 pair, and on the basis of the collected process state

information, may determine whether the logistics robot (110) is capable of departing from a departure point or is capable of entering a destination. When the logistics robot (110) cannot exit from the departure point or cannot enter the destination, the control device (140) may change a predetermined final path pair to another path pair among at least one candidate path pair provided from the path management device (150) and may re-perform the transportation control of the logistics robot (110).

10 **[147]**

[148] Accordingly, according to the control method and control system of the operating area according to an embodiment of the present disclosure, when a problem occurs in a specific process in a logistics flow, the logistics flow may be modified so that the process is performed normally along the modified logistics flow, thereby enabling efficient management of the overall process. In addition, when performing the process along the logistics flow, it is possible to respond flexibly to various situations, thereby increasing a production output according to the cycle time of the overall process.

[149]

[150] Although the present disclosure has been illustrated and described with respect to specific embodiments, it will be apparent to those skilled in the art that the present

disclosure may be variously modified and altered without departing from the technical spirit of the present disclosure as provided by the following claims.

[151] The present disclosure described above can be
5 implemented as computer-readable code on a program-recorded medium. Computer-readable media include all types of recording devices that store data that can be read by a computer system. Examples of computer-readable media include a hard disk drive (HDD), a solid state disk (SSD), a
10 silicon disk drive (SDD), ROM, RAM, a CD-ROM, a magnetic tape, a floppy disk, and an optical data storage device, etc. Accordingly, the above detailed description should not be construed as restrictive in all respects and should be considered illustrative. The scope of the present
15 disclosure must be determined by reasonable interpretation of the attached claims, and all changes within the equivalent scope of the present disclosure are included in the scope of the present disclosure.

[152]

20 [153] <Description of the Reference Numerals in the Drawings>

[154] 100: Operating area

[155] 110: Logistics robot

[156] 120: Production device

[157] 130: Monitoring device

25 [158] 140: Control device

[159] 150: Path management device

[160] 160: Product production management system

CLAIMS

[Claim 1] A method for controlling a logistics robot,
the method comprising:

5 setting one or more path pairs connecting at least one
departure point and at least one destination;

 determining at least one candidate path pair related to
a mission of a logistics robot among the set one or more path
pairs based on information related to product production; and

10 performing transportation control of the logistics robot
based on the at least one determined candidate path pair.

[Claim 2] The method of claim 1, wherein the setting
comprises setting any one of at least one supply port, at
15 least one retrieval port, and at least one work cell provided
for each process as a departure point and setting another
thereof as a destination so as to set one or more path pairs
connecting the departure point and the destination.

20 [Claim 3] The method of claim 1, wherein when at least
one intermediate point is included between the departure
point and the destination, the setting comprises setting one
or more path pairs connecting the departure point, the at
least one intermediate point, and the destination.

25

[Claim 4] The method of claim 1, wherein the setting comprises:

collecting at least one of production sequence information and process setting information; and

5 setting one or more path pairs connecting at least one departure point and at least one destination based on the at least one collected information.

[Claim 5] The method of claim 1, wherein the determining
10 comprises:

determining the mission of the logistics robot based on the information related to product production; and

determining at least one candidate path pair connecting a departure point and a destination, which correspond to the
15 determined mission, among the set path pairs.

[Claim 6] The method of claim 5, wherein the determining of the mission comprises:

collecting component supply information; and

20 determining the mission of the logistics robot by considering the collected component supply information in addition to the information related to product production.

[Claim 7] The method of claim 6, wherein the performing
25 comprises performing the transportation control of the

logistics robot so that a component corresponding to the component supply information is transported based on the determined path pair.

5 [Claim 8] The method of claim 1, wherein the performing comprises:

collecting process state information related to the at least one determined candidate path pair;

determining a final path pair among the at least one
10 candidate path pair based on the collected process state information; and

performing the transportation control of the logistics robot based on the determined final path pair.

15 [Claim 9] The method of claim 8, wherein the performing comprises:

generating a global path including a plurality of waypoints corresponding to the determined final path pair;
and

20 performing the transportation control of the logistics robot based on the generated global path.

[Claim 10] The method of claim 8, further comprising:

collecting process state information related to the
25 final path pair;

determining whether the logistics robot is capable of departing from the departure point or is capable of entering the destination based on the collected process state information; and

5 re-performing the transportation control of the logistics robot by changing the final path pair to another path pair among the at least one candidate path pair when the departure of the logistics robot from the departure point is impossible or the entry of the logistics robot into the
10 destination is impossible, after the performing.

[Claim 11] A system for controlling a logistics robot, the system comprising:

a path management device configured to set one or more
15 path pairs connecting at least one departure point and at least one destination and to determine at least one candidate path pair related to a mission of a logistics robot among the set one or more path pairs based on information related to product production; and

20 at least one control device configured to perform transportation control of the logistics robot based on the at least one candidate path pair determined by the path management device.

25 [Claim 12] The system of claim 11, wherein the path

management device is configured to set any one of at least one supply port, at least one retrieval port, and at least one work cell provided for each process as a departure point and set another thereof as a destination so as to set one or
5 more path pairs connecting the departure point and the destination.

[Claim 13] The system of claim 11, wherein when at least one intermediate point is included between the departure
10 point and the destination, the path management device is configured to set one or more path pairs connecting the departure point, the at least one intermediate point, and the destination.

15 [Claim 14] The system of claim 11, wherein the path management device is configured to collect at least one of production sequence information and process setting information and set one or more path pairs connecting at least one departure point and at least one destination based
20 on the at least one collected information.

[Claim 15] The system of claim 11, wherein the path management device is configured to determine the mission of the logistics robot based on the information related to
25 product production and determine at least one candidate path

pair connecting a departure point and a destination, which correspond to the determined mission, among the set path pairs.

5 [Claim 16] The system of claim 15, wherein the path management device is configured to collect component supply information and determine the mission of the logistics robot by considering the collected component supply information in addition to the information related to product production.

10

 [Claim 17] The system of claim 16, wherein the at least one control device is configured to perform the transportation control of the logistics robot so that a component corresponding to the component supply information
15 is transported based on the path pair determined by the path management device.

 [Claim 18] The system of claim 11, wherein the at least one control device is configured to collect process state
20 information related to the at least one candidate path pair determined by the path management device, determine a final path pair among the at least one candidate path pair based on the collected process state information, and perform the transportation control of the logistics robot based on the
25 determined final path pair.

[Claim 19] The system of claim 18, wherein the at least one control device is configured to generate a global path including a plurality of waypoints corresponding to the determined final path pair and perform the transportation control of the logistics robot based on the generated global path.

[Claim 20] The system of claim 18, wherein the at least one control device is configured to collect process state information related to the determined final path pair; determine whether the logistics robot is capable of departing from the departure point or is capable of entering the destination based on the collected process state information; and re-perform the transportation control of the logistics robot by changing the final path pair to another path pair among the at least one candidate path pair when the departure of the logistics robot from the departure point is impossible or the entry of the logistics robot into the destination is impossible, after performing the transportation control of the logistics robot.